Managing the impact of growing low-acuity demand on ambulance services

Kathryn Jean Eastwood

MEmerg Health(MICA), GradDipEmerHlth(MICA), GradCertHigherEd, BSc, BNurs, BParamedicStudies, DipAmbParamedStudies, RN

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Department of Epidemiology and Preventive Medicine
School of Public Health and Preventive Medicine
Faculty of Medicine, Nursing and Health Sciences

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Abstract

The demand for emergency ambulances increases annually, placing a substantial burden on ambulance services and emergency departments (EDs). Many cases presenting to ambulance services are low-acuity, having no urgent clinical need and no need for the specific skills that paramedics possessIn an effort to manage increasing demand, some ambulance services have implemented nurse- or paramedic-led secondary telephone triage services for patients identified as low-acuity during the primary triage that occurred in response to a person calling the emergency telephone number. These secondary telephone triage services vary in their structure and operation. The Ambulance Victoria Referral Service (RS), a secondary telephone triage service that has operated in Melbourne, Australia, since 2003, functions by triaging potentially low-acuity cases using a computer-based questioning algorithm. Using a combination of the outcomes of the software-led questioning and paramedic or nurse questioning and clinical judgement, a disposition is assigned allocating a patient to a particular care pathway. This will result in the patient being referred to one of the following:

- emergency ambulance dispatch;
- non-emergency ambulance dispatch;
- referral to an alternative service provider (ASP)[1], including nursing, home visiting doctor (locum) services, mental health clinicians (crisis assessment and treatment teams (CATT)), and hospital outreach programs; or
- provision of advice allowing the patient to self-manage the condition and/or seek further medical attention independently (including self-presenting at the ED, or arranging an appointment with a doctor).

This thesis presents the first large-scale evaluation of an operational ambulance-based secondary telephone triage service. A large RS dataset spanning 34 months was linked to emergency ambulance paramedic records and ED and hospital admission records to allow for the call-taker triage decisions and patient journey through their care pathway to be examined.

The RS was found to have a substantial impact upon Ambulance Victoria's operations, with 72.4% of RS-managed cases directed away from emergency ambulance dispatch. The RS also referred 32.2% of its cases to care pathways that did not immediately result in an ED presentation.

[1] A list of abbreviations and glossary of terms can be found on pages XX and XXII.

The appropriateness of the referral of patients for emergency ambulance dispatch and ED presentation was examined and, overall, these triage decisions were found to be appropriate, however, a large proportion of overtriage remained following secondary telephone triage. Further exploration of the patient and case characteristics identified relationships between these characteristics and emergency ambulance and ED appropriateness highlighting potential avenues for the optimisation of the triage questioning and expansion of alternative care pathways to better service particular case types.

This research shows the RS to be a valuable tool for managing the demand for emergency ambulances in Melbourne through the referral of low-acuity cases away from emergency ambulance dispatch and the identification of cases appropriate for the emergency care pathways. Whilst demand management strategies vary based on the operational structure of the ambulance service within which they are embedded, the analysis described in this thesis represents a powerful and flexible approach for the investigation of the impact and effectiveness of similar services. The knowledge generated in this program of research can be used to inform policymakers and ambulance service managers about the successful operation of secondary telephone triage and be used to guide future research and evaluation of these services.

Declaration

In accordance with Monash University Doctorate Regulation 17.2 Doctor of Philosophy and Master of Philosophy (MPhil) regulations the following declarations are made:

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis contains five original papers submitted to, or published in peer-reviewed journals. The core theme of the thesis was to explore the appropriateness and impact of an ambulance-based secondary telephone triage service, and investigate its potential for refinement to improve its safety and provide better service delivery outcomes for patients who use this service. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Department of Epidemiology and Preventive Medicine under the supervision of Professor Johannes Stoelwinder, Professor Karen Smith and Dr Amee Morgans.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input to team-based research.

In Chapters 2, 4, 5, and 6, my contribution to the work involved the following:

Thesis Chapter	Publication Title	Publication Status	Nature and % of student contribution	Co-author name(s) Nature and % of Co-author's contribution*	Co-authors Monash student
2	Secondary triage in prehospital emergency ambulance services: a systematic review	Published	Principal author, responsible for the collection and review of the potentially relevant literature, interpretation of results, and drafting and writing of the manuscript, and accepts overall responsibility for the publication; 80%.	1) Morgans A, contributed to literature searching and editing of the manuscript, 10% 2) Smith K, contributed to study design and editing the manuscript, 5% 3) Stoelwinder J, contributed to editing the manuscript, 5%	No
4	A novel approach for managing the growing demand for ambulance services by low-acuity patients	Published	Principal author, responsible for the overall study concept, literature review, coding and recoding of variables and all preparation of datasets for analysis, data analysis, interpretation of results, drafting and writing of the manuscript, and accepts overall responsibility for the publication; 75%.	1) Morgans A, contributed to study design and editing of the manuscript, 5% 2) Smith K, contributed to study design and editing the manuscript, 5% 3) Hodgkinson A, contributed to editing the manuscript, 5% 4) Becker G, contributed to editing the manuscript, 5% 5) Stoelwinder J, contributed to study design and editing the manuscript, 5%	No
5	The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: a retrospective study.	Accepted	Principal author, responsible for the overall study concept, literature review, coding and recoding of variables and all preparation of datasets for analysis, linkage of Ambulance Victoria datasets, preparation of datasets for Victorian Data Linkage unit linkage, development of SPSS analysis syntax, data analysis, interpretation of results, drafting and writing of the manuscript, and accepts overall responsibility for the publication; 85%.	1) Smith K, contributed to study design, interpreting results and editing the manuscript, 5% 2) Morgans A, contributed to editing of the manuscript, 5%	No

				3) Stoelwinder J, contributed to study design and editing the manuscript, 10%	
	The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage	Submitted	Principal author, responsible for the overall study concept, literature review, coding and recoding of variables and all preparation of datasets for analysis, linkage of Ambulance Victoria data sets, preparation of datasets for Victorian Data Linkage unit linkage, development of SPSS analysis syntax, data analysis, interpretation of results, drafting and writing of the manuscript, and accepts overall responsibility for the publication; 80%.	1) Morgans A, contributed to editing of the manuscript, 5% 2) Stoelwinder J, contributed to editing the manuscript, 5% 3) Smith K, contributed to study design and editing the manuscript, 5%	No
6	Patient and case characteristics associated with ‘no paramedic treatment’ for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage	Accepted	Principal author, responsible for the overall study concept, literature review, coding and recoding of variables and all preparation of datasets for analysis, development of SPSS analysis syntax, data analysis, interpretation of results, drafting and writing of the manuscript, and accepts overall responsibility for the publication; 85%.	1) Morgans A, contributed to editing of the manuscript, 5% 2) Smith K, contributed to study design and editing the manuscript, 10%	No

I have renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Student signature: Date: 02/10/2017

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor signature: **Date:** 02/10/2017

Publications During Enrolment

This section presents the development of a research track record which occurred during candidature. Items directly relevant to this thesis are asterisked (*).

Awards

School of Primary Health Care Travel Grant*	2013
Australian Prehospital Emergency Health Research Forum (APEHRF) David Komesaroff Award for Best Paper prize*	2015
Australian Postgraduate Award*	2015
Paramedics Australasia Scholarship*	2015

Peer Reviewed Journal Articles

1. **Eastwood K,** Smith K, Morgans, A, Stoelwinder J. The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage. *Emergency Medicine Journal.* 2017; Submitted.*
2. **Eastwood K,** Morgans A, Smith K. Patient and case characteristics associated with 'no paramedic treatment' for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage. *Scandinavian Journal of trauma, resuscitation and emergency medicine.* 2017; Accepted.*
3. **Eastwood K,** Smith K, Morgans, A, Stoelwinder J. The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: A retrospective cohort study. *BMJ Open.* 2017; Accepted 2017 September 12.*
4. Johnson M, Peat A, Boyd L, Warren T, **Eastwood K**, Smith G. The impact of quantitative feedback on the performance of chest compression by Basic Life Support trained clinical staff. *Nurse Education Today.* 2016;45:163-166.
5. **Eastwood K,** Morgans, A, Smith K, Hodgkinson, A, Becker, G, Stoelwinder J. A novel approach for managing the growing demand for ambulance services by low-acuity patients. *Australian Health Review.* 2015;40(4):378-384.*
6. **Eastwood K,** Boyle M, Kim V, Stam, N, Williams B. Mathematical ability of first year undergraduate paramedic students – a before and after study. *Nurse Education Today.* 2015;35(11):1125-1129.
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1. Johnson M, Boyd L, Grantham H, **Eastwood K.** (Eds.). *Paramedic Principles and Practice ANZ.* Chatswood, Australia: Elsevier; 2016.

Book Chapters

1. **Eastwood K.** Perfusion: Paramedic Principles and Practice Australia and New Zealand. In: Johnson M, Boyd L, Grantham H, **Eastwood K.** *Paramedic Principles and Practice ANZ.* Chatswood, Australia: Elsevier; 2016. p.981-987.

Conference Presentations

1. **Eastwood K,** Morgans A, Smith K, Stoelwinder J. Was emergency ambulance dispatch appropriate following secondary telephone triage of low-acuity cases. Paramedics Australasia International Conference. Auckland, New Zealand. 17-19 November 2016.*

2. **Eastwood K,** Morgans A, Smith K, Stoelwinder J. The Referral Service: Managing growing demand for ambulance services from low-acuity patients with secondary telephone triage. Paramedics Australasia International Conference. Adelaide, Australia. 2-3 October 2015.*

3. **Eastwood K,** Morgans A, Smith K, Stoelwinder J. The Referral Service: Managing growing demand for ambulance services from low-acuity patients with secondary telephone triage. Council of Ambulance Authorities. Melbourne, Australia. 13-15 October 2015.*

4. **Eastwood K,** Morgans A, Smith K, Stoelwinder J. A novel solution for managing the growing demand for ambulance services by low-acuity patients. European Health Management Association Conference. Milan, Italy. 26-28 June 2013.*

5. Strong G. Acker J, Thompson S, **Eastwood K,** Ross, L, Williams B. Paramedic professionalism: An international comparison. Paramedics Australasia International Conference. Canberra, Australia. 17-19 October 2013.

6. Boyle M, Stam N, **Eastwood, K.** Mathematical ability of first year undergraduate paramedic students - A before and after study. Paramedics Australasia International Conference. Sydney, Australia. 7-8 October 2011.

7. Boyd, L., Sheen, J., Johnson, M., & **Eastwood, K.** Multidisciplinary responses to mental health crises in the pre-hospital setting. Australian College of Ambulance Professionals (ACAP) Conference. Perth, Australia. 14-16 October 2010.

8. Murcott P, Sheen J, **Eastwood K,** Boyd L, Johnson M, De Costa K. Mental health crises in the prehospital sector. Australian College of Ambulance Professionals (ACAP) Conference. Perth, Australia. 14-16 October 2010.

9. Boyd L, Sheen J, Johnson M, **Eastwood K.** Developing a Multidisciplinary Education Program: Challenges and Incentives. International Conference of Education, Research and Innovation (ICERI2010), Madrid, Spain, 15–17 November 2010.

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1. Archer F, Boyd L, Lord B, Huggins C, Allen J, Johnson M, Johnson A, Stam N, **Eastwood K,** Jurkovsky P, Williams B. 2011. Simulation to replace two weeks of emergency ambulance clinical placement. Health Workforce Australia ($295,700).

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Kathryn Eastwood

Abbreviations

The following terms are used throughout this thesis:

ABS	Australian Bureau of Statistics
ACEP	American College of Emergency Physicians
AIHW	Australian Institute of Health and Welfare
ALS	Advanced life support
ASP	Alternative service provider
AV	Ambulance Victoria
BLS	Basic life support
BP	Blood pressure
CATT	Crisis assessment and treatment team
CECC	Care enhanced call centre
CI	Confidence interval
DOB	Date of birth
ECG	Electrocardiogram
ED	Emergency department
EMS	Emergency medical system/service
ePCR	Electronic patient care record
GCS	Glasgow Coma Score
GP	General practitioner
ICD-10-AM	International Classification of Diseases, 10th Edition
IRSD (IRSED)	Index of relative socio-economic disadvantage
IV	Intravenous

LGA	Local Government Area
MET	Medical emergency team
MICA	Mobile intensive care
MPDS	Medical Priority Dispatch System
OR	Odds Ratio
PHIDU	Public Health Information Development Unit
PPV	Positive predictive value
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RS	Referral Service
SD	Standard deviation
SEIFA	Socio-Economic Indexes for Area database
SpO_2	Saturation of Peripheral Oxygen
SPSS	Statistical Package for the Social Sciences
TIA	Transient Ischaemic Attack
UK	United Kingdom
US/USA	United States of America
VACIS	Victorian Ambulance Clinical Information System
VAED	Victorian Admitted Episodes Dataset
VDL	Victorian Data Linkage unit
VEMD	Victorian Emergency Minimum Dataset
WHO	World Health Organization

Glossary

Admission The entry of a patient into the hospital beyond the ED (i.e., onto the wards) for the purposes of providing ongoing care.

Alternative Care Pathways Care pathways resulting from RS secondary telephone triage, whereby a patient's ultimate destination remains outside of the emergency care system (the emergency department). These pathways include referring a patient to an alternative service provider, referring them to their own healthcare practitioners, and giving the patient advice to manage themselves at home.

Alternative Service Provider Healthcare providers contracted to Ambulance Victoria to provide health services to patients who are referred by the RS. Examples include locum doctors (home visiting doctors), nursing services, CATT for psychiatric cases, and hospital outreach programs (providing physiotherapists and occupational therapists that can attend patients).

Ambulance Victoria Grid Specifies the priority and urgency of ambulance response required for particular case types. The grid also specifies the type (advanced life support or mobile intensive care ambulance paramedics), and number of ambulance resources to respond to a case.

Demand The total actual and perceived need for ambulance and emergency department services.

Dispatch To send an ambulance or non-emergency ambulance.

Emergency Ambulance A vehicle staffed with one or two trained paramedics who, in the setting studied in this thesis, operates under the *Ambulance Services Act 1986* to provide specialised emergency skills and transport for emergency patients.[1]

Emergency care pathway Care pathways resulting from the RS secondary telephone triage, whereby a patient's ultimate destination is likely to be the ED. These pathways include emergency ambulance dispatch, non-emergency ambulance dispatch and advice to self-present at an ED.

ED suitable A modification of the 'potentially avoidable general practitioner (GP-type presentation' measure used by the Australian Government for ED presentations.[2] These are ED presentations that are considered avoidable had an appropriate community-based service been accessed.[2] In this program of research, a patient was deemed ED-suitable if, on arrival at the emergency department, they:

- were triaged as category 1, 2 or 3 according to the Australian Triage Scale;
- were admitted to the hospital or referred to another hospital; or
- died.

Low-acuity Where the patient's physiological condition and main presenting problem do not require urgent medical intervention.

Non-emergency ambulance Ambulances staffed by attendants with basic life support skills to manage low-acuity problems and to provide low-urgency transportation for patients (often those who are immobile or have no means of transportation, e.g., the frail elderly).

Presentation A visit to a service. An ED presentation involves a patient visiting the ED for medical assessment.

Primary telephone triage The process of triage provided by triple zero operators (triple zero being the Australian emergency telephone number). Laypersons (i.e., non-medically trained personnel) conduct this telephone triage using the Medical Priority Dispatch System. In conjunction with a tailored Ambulance Victoria Grid, this process ascertains the patient's urgency and what resources should be dispatched.

Resourcing The ability to provide appropriate resources to meet the demand.

Referral service call-taker Registered nurses or qualified paramedics trained in secondary telephone triage. The minimum qualifications for call-takers are:

- Paramedicine
    - Minimum four years post-qualification experience.[3]
- Nursing
    - Division 1 registered nurse with a minimum of four years post-qualification experience including one of the areas listed below:
        - cardiac, cardiothoracic or intensive care nursing;

- triage nursing and/or ED nursing;
- community nursing.[3]

Triage The assignment of an urgency level for attention and/or treatment based on medical need.

Secondary telephone triage Conducted by Referral Service call-takers, this is a process of further triaging low-acuity patients. The call-takers use their clinical expertise and judgement, along with a computer-based triage tool, to ascertain firstly whether a patient can be diverted away from emergency ambulance dispatch, and secondly whether they can be referred away from the emergency pathway.

Self-care/home care An alternative care pathway outcome whereby a patient (or the carer) is given advice about how to manage themselves (or the patient), at home without any further intervention from a health professional.

Self-presentation at ED An emergency care pathway whereby a patient is identified as requiring assessment in an ED, but can present without medical transport. That is, a family member, friend or taxi driver can take the patient to hospital.

CHAPTER ONE: INTRODUCTION

The persistent rise in emergency ambulance demand is of major concern to many ambulance services nationally and internationally.[4-11] In particular, the increasing demand from low-acuity cases that do not require the skills or resources provided by paramedics[12,13] is forcing many services to investigate novel ways to manage these cases whilst maintaining high standards of clinical patient care and without overtaxing their existing resourcing capacity.[14-17]

With growing demand, providing the 'right care' in the 'right place' at the 'right time' is increasingly important. For ambulance services, achieving this alignment is particularly challenging when patient presentations are unplanned; usually acute, and information is initially limited to what is verbally communicated during the time-sensitive rigid questioning of the primary telephone triage. However, this short encounter, often lasting only minutes, is the only period of time in which the presence of a patient does not exert any demand for an emergency ambulance resource. This encounter is geared towards the rapid identification of patients with urgent health problems, and is quickly followed by the timely dispatch of appropriate ambulance resources.[18] Therefore, the point at which to intervene in the setting of low-acuity cases is ideally after the primary triage has established that the patient is not urgent, but before an emergency ambulance is dispatched.

The time-sensitive primary telephone triage offers limited scope for case-specific information to be gathered to better align patient healthcare needs with appropriate service provision for low-acuity cases. Therefore some ambulance services around the world have investigated a secondary telephone triage process that can take more time to establish the low-acuity patients' immediate needs and direct them to a more appropriate form of healthcare.[19-26] The impact of these systems and the appropriateness of the triage conducted have not been extensively investigated.[19-26] However, research into primary telephone triage systems has raised concerns over the safety of this form of patient management.[22,27,28]

The research described in this thesis investigated the use of a secondary telephone triage function by Ambulance Victoria (AV) to collect case-specific information from patients identified as low-acuity and suitable for secondary telephone triage at the primary triage. The goal of this strategy is to alleviate the demand for emergency ambulances by achieving better alignment between appropriate service delivery and the patient's current healthcare needs.

This chapter describes the setting for the research conducted in this thesis by firstly providing an explanation of the operation of both AV and the secondary telephone triage service, called the

Referral Service (RS), in the state of Victoria, Australia. Then, background information about ambulance service demand and low-acuity cases is presented. This chapter concludes with a description of the thesis structure and definitions for key terms used throughout the thesis.

1.1 Ambulance Victoria

Multiple independent ambulance services were first established in Victoria in the 1880s in various forms. Gradually these independent services merged to form a single government-controlled statewide ambulance service for Victoria called Ambulance Victoria.[1]

Ambulance Victoria operates as a two-tiered medical response system, and employs over 1000 Advanced Life Support (ALS) paramedics and over 400 MICA (Mobile Intensive Care Ambulance) paramedics working in metropolitan Melbourne, the capital of Victoria. According to federal legislation (the *Ambulance Services Act 1986*), the objectives of all Australian ambulance services are:

- to respond rapidly to requests for help in a medical emergency;
- to provide specialised medical skills to maintain life and to reduce injuries in emergency situations and while moving people requiring those skills;
- to provide specialised transport facilities to move people requiring emergency medical treatment;
- to provide services for which specialised medical or transport skills are necessary; and
- to foster public education in first aid.[1]

Ambulance Victoria fulfils the role laid out in the Act by providing the following services to the Victorian community:

- emergency medical response and out-of-hospital care;
- emergency medical transport by road or air;
- non-emergency patient transport (including road and air stretcher transport and clinic care transport for walking and wheelchair patients);
- major incident management and response;
- medical retrieval of critically ill adult patients (including advice and bed coordination);

- assistance for patients to access appropriate care when paramedic care or transport is not required;
- support for other health services in community where the full range of services is not easily accessible;
- community education in pre-ambulance arrival emergency care; and
- the AV Membership Scheme (ambulance insurance).[29]

Ambulance Victoria's ability to meet its obligations under the Act is currently compromised by increasing demand. Ambulance Victoria's service pathways and the demand for them are described in the following sections.

1.2 Service access

Ambulance Victoria's primary service is emergency medical response to calls for community-based emergencies and the provision of out-of-hospital emergency medical care. Calling triple zero (000) (the Australian emergency telephone number) in Victoria will result in one of two pathways. The first is the dispatch of an emergency ambulance and the second pathway results in the transfer of the call for secondary telephone triage.

Upon calling triple zero and being transferred to the Triple Zero ambulance call-centre, callers are taken through a time-sensitive primary telephone triage by a layperson qualified in the use of the commercial triage software (Medical Priority Dispatch System (MPDS)).[18] Triage is a process for determining the problem, its urgency and the best response for the patient in the shortest time frame possible.[30-32] It is a crucial tool that enables care providers to prioritise incoming cases for emergency ambulance response.[33] The MPDS software utilises rigid questioning protocols that, in conjunction with AV dispatch protocols, culminates in two key decisions: the level of paramedic expertise that is required to respond (Figure 1), and the urgency (expressed as a code) with which to dispatch an emergency ambulance resource (Table 1).

Table 1: Dispatch urgency levels and corresponding target response times[10]

Dispatch urgency level	Examples of case types	Target response timeframe
Code 1 **(High-acuity)**	Cardiac arrest, chest pain, shortness of breath	Ambulance resource on scene within 15 minutes
Code 2 **(Medium-acuity)**	Fractures, seizures that have ceased, minor haemorrhage	Ambulance resource on scene within 30 minutes
Code 3 **(Low-acuity)**	Generally unwell, non-traumatic back pain	Ambulance resource on scene within one hour

Ambulance Victoria offers a range of paramedic expertise levels to respond to calls for emergency medical assistance in the community (Figure 1). The level of expertise dispatched is dependent upon the type and location of the case. In cases deemed to be high-acuity, such as cardiac arrests, chest pain or shortness of breath, primary telephone triage may result in a response from an ALS paramedic crew with or without a MICA paramedic crew. In medium- and low-acuity cases, ALS paramedics will be dispatched alone.

Given the close proximity of hospital emergency departments (ED) in metropolitan Melbourne, MICA flight paramedics (Figure 1), who operate on helicopters and fixed wing aircraft, are not generally dispatched to cases in this region. Exceptions are when the patient is trapped or there is an indication that the patient will not be able to be delivered to an ED within a reasonable timeframe, and the clinical information on scene indicates that the patient would benefit from the MICA flight paramedic skill set. Figure 1 outlines the skill sets of the various clinical expertise levels AV offers.

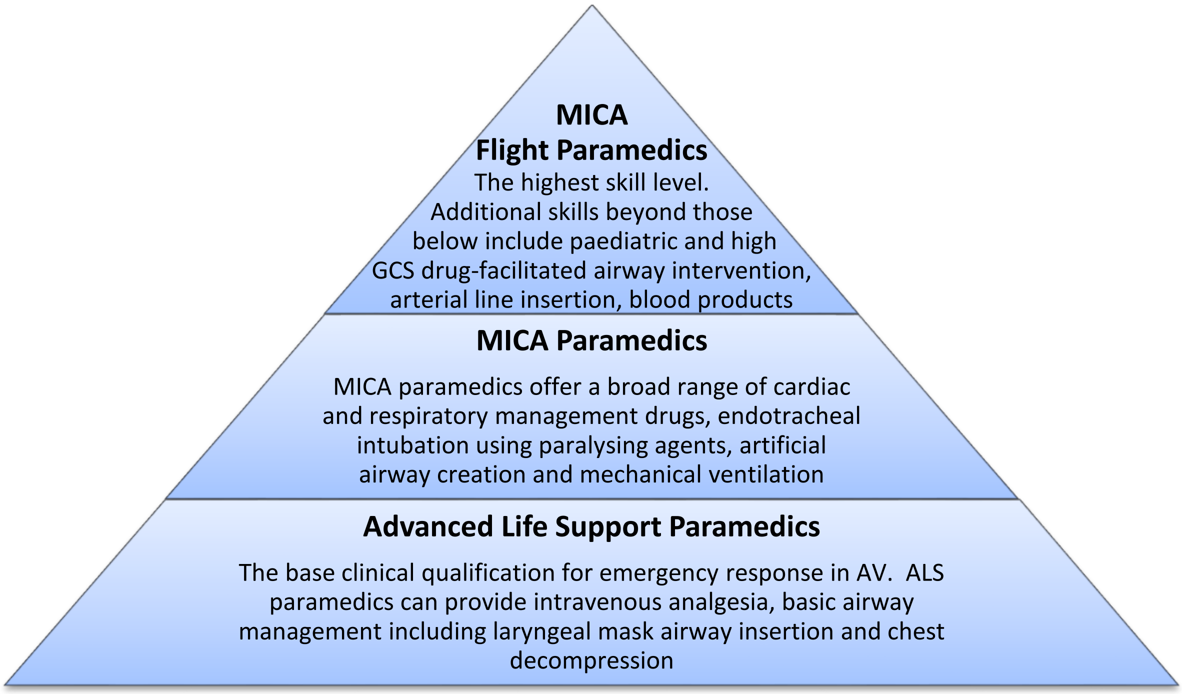

Figure 1: Clinical skill set levels of AV paramedics

The skill sets outlined in Figure 1 continue to expand to allow for the improvement of prehospital patient care.[9,34] Such skills include interventions that were previously reserved for the ED, but have been evidenced as being best for patient morbidity and mortality if they occur as early as possible.[35,36] Whilst patients have benefited from this increase in skill level, the episodes of care for some patients have lengthened as prehospital treatment regimes become more complex. Therefore, resource availability is not only reduced by increasing demand from low-acuity cases, but also from high-acuity cases that require more resources for longer periods of time.

1.3 The demand for ambulance assistance

Each year, many countries have seen the demand for ambulance services increase.[4-11] When this demand exceeds resource availability,[37] delays in response times potentially compromise patient safety.[12,37-44] Associated with this increase in demand is the flow-on effect of ED overcrowding,[8,45] potentially endangering the lives of those who need these services quickly and placing additional strain on the health care system overall.[12,38,46-48]

This increasing demand is also exerting financial pressure upon ambulance services, with the gap between government funding and resources required to meet demand widening each year.[9,14,37,38,49-51] When seeking to improve the quality of care, simply increasing the number of resources, improving paramedic knowledge and expanding paramedic skills is not always sufficient.[52] The World Health Organization (WHO) has recommended a focus on the importance of 'whole health system' reform, including changes in care delivery models;[52] innovative demand management solutions are indicated.

1.3.1 The demand for ambulances in Victoria

The program of research outlined in this thesis was focused on the state of Victoria, Australia, where there has been a steady increase in ambulance demand of approximately 5% per year over the past six years.[10] Changing demographics, population growth, rising prevalence of chronic illness, increased outpatient services, decreased availability of out-of-hospital services (i.e., no general practitioner (GP) appointments available in a patient's preferred timeframe or geographic region) and high community expectations have been identified as some of the factors contributing to this growth in demand.[8,10,29,53,54] In addition to increasing overall demand for ambulance services, the proportion of low-acuity cases has been increasing.[10,12,13]

In the absence of additional resources, the increase in demand for emergency ambulance services, compounded by the expanding low-acuity caseload, is delaying ambulance responses and thus potentially endangering the lives of those in need of urgent medical attention.[10,38] AV has been able to respond to a decreasing proportion of code 1 cases (allocated to a lights and sirens emergency ambulance dispatch) within the agreed acceptable timeframe of 15 minutes as the utilisation of ambulances increases (**Error! Reference source not found.**).[17,44,55]

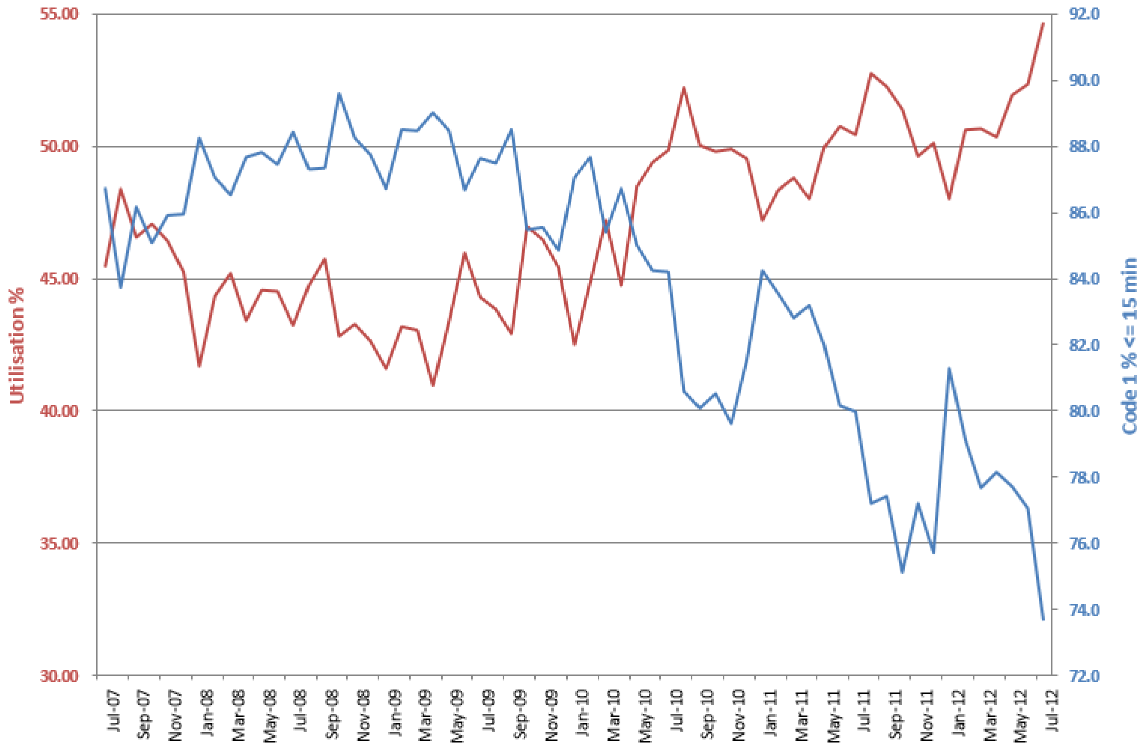

Figure 2: Increasing utilisation of ambulances and concurrent decreasing percentage of code 1 cases responded to within the required timeframe in Victoria, 2007-12[44]

Diverting suitable low-acuity cases to more appropriate care pathways before ambulance dispatch would allow for better ambulance availability,[38] quicker response times to patients requiring urgent attendance, more appropriate care for low-acuity patients, and allow for safer working conditions for paramedics by reducing unnecessary exposure to the risks of 'lights and sirens' responses.[12,37]

1.4 Low-acuity cases

It has been reported in the literature that much of the ambulance workload falls outside of what would generally be defined as an 'emergency'. This workload has been described as 'inappropriate' or 'medically unnecessary'.[51,56-60] However, drawing a clear line between those who should and shouldn't be attended and /or transported by emergency ambulance is extremely difficult. Studies to date of inappropriate use of ambulances by patients with little or no clinical need used a range of methods to identify cases as inappropriate.[37,40,41,51,56,60-64] Some used clinicians of varying backgrounds to judge appropriateness based on their expert opinion,[51,56,58-61,64] other studies used patient ED records before diagnosis to make the decision,[37,40,51,60,61] while others used the ED diagnosis or discharge outcome.[62,63] Some studies supplemented these methods with patient opinion about whether it was an emergency.[51,58]

Studies using clinicians, including emergency physicians and paramedics, to find concordance in defining what constitutes an emergency have had little success.[64-68] Some research has found emergency physicians tend to overtriage the cases, suggesting more cases are emergencies,[69,70] while other studies have suggested that paramedics tend to undertriage cases,[71] resulting in fewer determinations of medical necessity. Snooks et al.'s review of the literature found that the judgment of doctors was unreliable with respect to appropriateness of care.[12]

Some research has attempted to use the MPDS to classify cases as low-acuity and suitable for alternate management strategies.[68] However, this method has not been successful in gaining consensus from the clinicians involved in making these decisions, with one study gaining consensus on only 5% of the total number of codes after two rounds of consideration.[68]

A joint position paper by the American College of Emergency Physicians and the National Association of EMS Physicians identified that emergency medical service (EMS) systems were frequently encountering patients who did not require ALS-level care or ED evaluation.[72] The lack of medical intervention has been used when reviewing medical need for ambulance as a reference point for deciding whether the emergency service was necessary.[41,73] This method is preferable, because studies that use ED data alone or ambulance data pertaining to patient complaints without considering paramedic intervention do not account for the level of skill paramedics now possess and the impact of utilising finite paramedic resources. Also, various studies have acknowledged that whilst some patients do require ED treatment, they may not require an ambulance to deliver them to it.[70,74,75] Therefore, simply using data about patient complaint in isolation does not sufficiently identify whether the ambulance resources was best utilised, and in turn, whether a patient was low-acuity or not.

Often patients call the emergency services, not in response to an emergency medical situation, but simply as a point of entry into the healthcare system for some non-urgent medical problems due to a lack of alternative entry points.[47,76] It has also been found that these low-acuity patients generally have access to their own means of transportation, yet choose not to use it.[77]

1.5 Secondary telephone triage

Alternative processes are being investigated to determine whether better care options can be provided to low-acuity cases, thus reserving traditional emergency ambulance resources for cases more likely to require them.[4,12,13,19,20,23-26,47,77] Government and privately funded agencies in various countries have used telephone triage to manage unscheduled health care demand in settings such as general and specialist medical practices and EDs.[78-81] Secondary telephone triage has been trialled or implemented in ambulances services internationally,[19,20,22-26] and aims to reduce the number of emergency ambulances being dispatched by diverting low-acuity cases to alternate healthcare providers or providing healthcare advice.[82] It is conducted by qualified healthcare clinicians specifically trained in this type of patient evaluation, and occurs directly after the primary triage.[32] Using clinicians allows for a more in-depth analysis of the patient's problem and urgency, with a view to providing the most appropriate medical response available.[32]

Whilst some ambulance services have been using this strategy for over a decade, it is still an emerging approach and its effectiveness and safety are yet to be fully evaluated.[19,22,28,83-85] In order to manage the demand for ambulances in the setting of limited funding for additional paramedic resources, this strategy is increasingly being suggested as a means of meeting patient demand whilst maintaining safe and effective patient care.[77]

1.5.1 Ambulance Victoria's Referral Service

The AV RS has operated 24 hours a day, seven days a week since 2003 within metropolitan Melbourne, servicing a population of 4.35 million in 2012.[86] In 2013–14, the RS was expanded to manage cases statewide.[87] The objectives of the RS are to:

- manage the demand for ambulance resources (and to a lesser degree hospital EDs) by identifying those patients that do not require an emergency ambulance response, and may also not need a face-to-face hospital emergency department consult;
- better match the clinical service provided with patient needs;
- effectively and efficiently utilise resources to ensure AV provides the best overall service to the community with the resources available;
- assist in the mitigation of the continuing growth in demand for ambulance services and the pressure on hospital emergency departments;

- assist in improving ambulance service response performance; and
- maintain patient continuum of care through redirection to the current treating health professional or complying with medically authorised plans.[88]

The MPDS has demonstrated its ability to identify high-acuity patients,[77,89,90] and many ambulance services around the world accept the acuity assigned by this software within their safety parameters. AV also overlays a grid that has been formulated through a process of case review, which identifies individual case types that have historically received very low frequencies of paramedic treatment or transport and do not re-present to ambulance within 24 hours; these are identified as low-acuity and suitable for RS triage. These cases are either passed directly onto RS clinicians from the Triple Zero call-taker, or called back within a short timeframe. Nurses or paramedics trained in telephone triage further assess these patients using a computer-based questioning algorithm (CECC – Care Enhanced Call Centre).[91] Based on the recommended outcome, or disposition, RS clinicians will arrange:

- emergency ambulance dispatch;
- non-emergency ambulance dispatch;
- referral to an alternative service provider (ASP), including nursing, home visiting doctor (locum) services, mental health clinicians (crisis assessment and treatment teams (CATT)), and hospital outreach programs; or
- provision of advice for the patient to self-manage the condition by either seeking further medical attention independently (including self-presenting at the ED, or arranging an appointment with their doctor) or with no further intervention required (Figure 3).

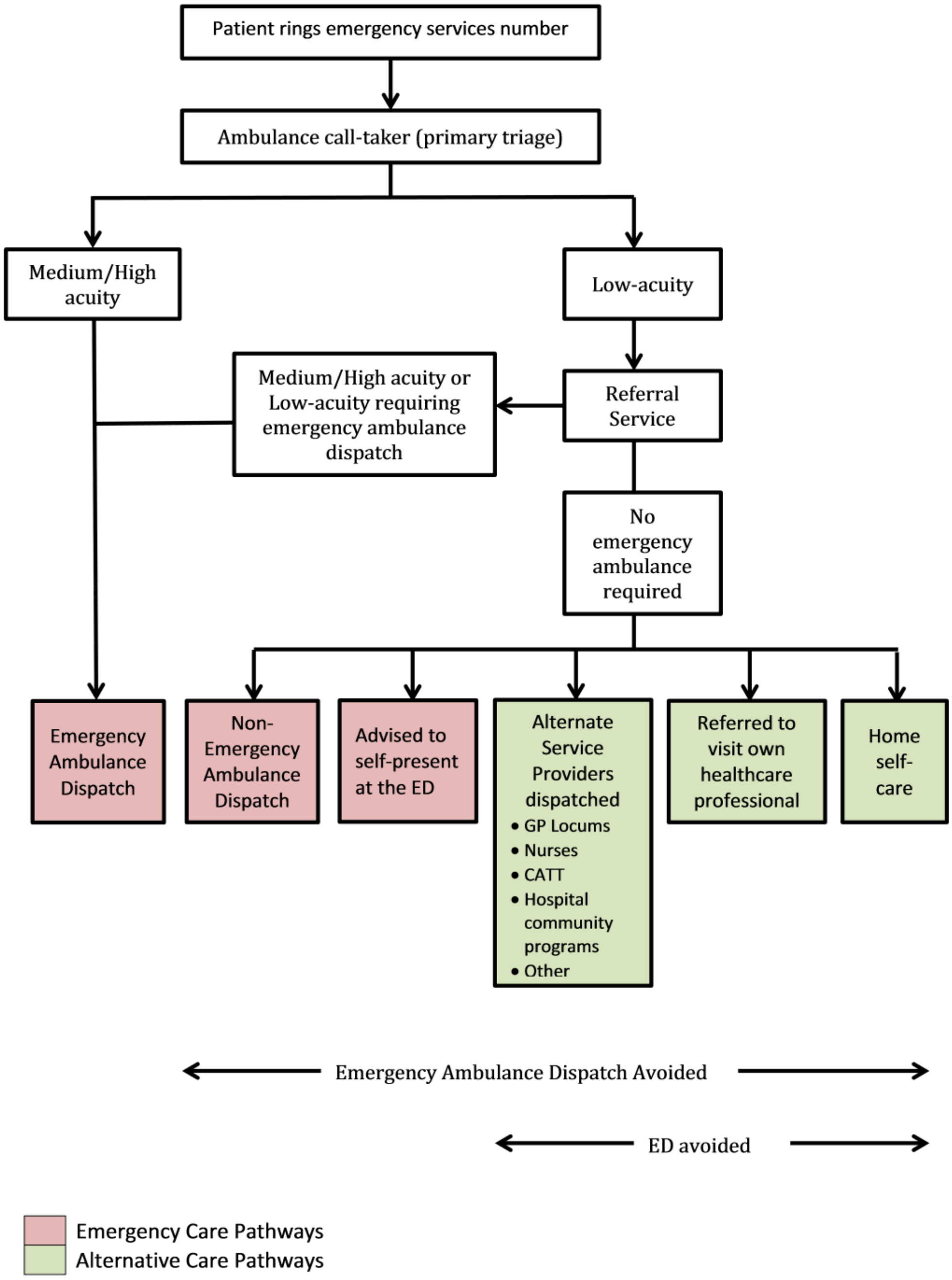

Figure 3: Ambulance Victoria service provision pathways

In 2012, the RS handled 49 different low-acuity event types with further event types constantly being evaluated for their appropriateness for inclusion. In addition to its everyday function, during times of increased demand (such as natural disasters) the RS has the capacity to expand its operating boundaries to respond to and provide secondary triage for cases that may be deemed medium acuity. One such case was during the 2009 Victorian bushfires, when the RS ran at full capacity and extended its geographical reach statewide. This escalation has proven to be crucial to maintaining high levels of patient care in times of unusual demand.

1.5.1.1 Alternative service providers

One of the features that separates the AV RS from those trialled overseas is the network of ASPs whose services AV has contracted to provide more appropriate care to low-acuity patients in their homes. Over the past decade the list of ASPs has increased, further strengthening the effectiveness of the RS. The ASPs working with AV during the study period are shown in Table 2.

Table 2: The roles of the alternative service providers contracted to the AV Referral Service

ASP	Services provided
Nursing Service	Division 1 and 2 Registered Nurses (0900–1700 hours)
Locum Services	Locum doctors attend the patients in their home, or nursing homes, hostels and special accommodation units Monday–Friday: 1800–0600 hours; Saturday: 1200–0000 hours; Sunday: 0000–Monday 0600 hours and public holidays.
Crisis Assessment & Treatment Teams (CATT)	AV has arrangements with the metropolitan mental health services (operating 24 hours)
Hospital outreach programs	Outreach programs provide extended business hours services, including nursing and allied health services such as physiotherapists and occupational therapists, that can attend patients in their homes or nursing homes, hostels and special accommodation units
Other Health Services	AV has arrangements with multiple health services (operating hours vary). The key groups are: - aged care assessment services; - out-of-hospital medical care coordination teams; - psychiatric and mental health services; - the Poisons Information telephone line; - sexual assault medical teams; - the Dental Hospital; - drug and alcohol services; - community health and wellbeing services; - rehabilitation services; - veterans affairs services.

Partnerships are continually being created with other groups to assist in managing patients identified as appropriate for care in the primary care setting.

The AV RS has developed and grown substantially over time, yet there has been no detailed evaluation of its efficacy and efficiency in managing ambulance demand from low acuity cases. Plans for its expansion to manage 30% of AV caseload announced in the 2016 strategic plan provided an opportunity to focus on this aspect of AV's service delivery, and examine measurable impacts on patient outcomes and service use at a metropolitan level.[29] This also presented an important opportunity to add to the small body of research about the impact and safety of secondary telephone triage in ambulance services, in an age when addressing increasing demand is becoming crucial to ensuring the primary goal of effective management of patients requiring emergency medical treatment is met.[1]

1.6 Thesis aim and objectives

The overarching aim of this research was to investigate the operation, impact and appropriateness of the AV RS.

<u>Objectives</u>

I. To describe the use, structure and impact of secondary telephone triage systems embedded into ambulance service operational structures through a systematic review of the literature.
II. To produce a detailed description of the Ambulance Victoria Referral Service and conduct a population-based epidemiological study of cases from the Referral Service to:
    a. describe the impact of this strategy on the demand for emergency ambulances;
    b. describe the patient population;
    c. identify the most common patients problems, and;
    d. identify the utilisation rates of the final disposition pathways available to the Referral Service call-takers.
III. To conduct large-scale data linkage between secondary telephone triage patient records, paramedic care records, emergency department and hospital admission records.
IV. To utilise the linked data to investigate the appropriateness of the referral of cases to the following emergency care pathways:

a. the emergency department (via emergency ambulance, non-emergency ambulance or via self-presentation);
b. Emergency ambulance;

V. To identify variables associated with paramedic treatment and ED suitability that may be useful in further optimising the Referral Service triage process.

1.7 Thesis outline

The research is presented over seven chapters, as outlined in Figure 4: Thesis outline and described in more detail below.

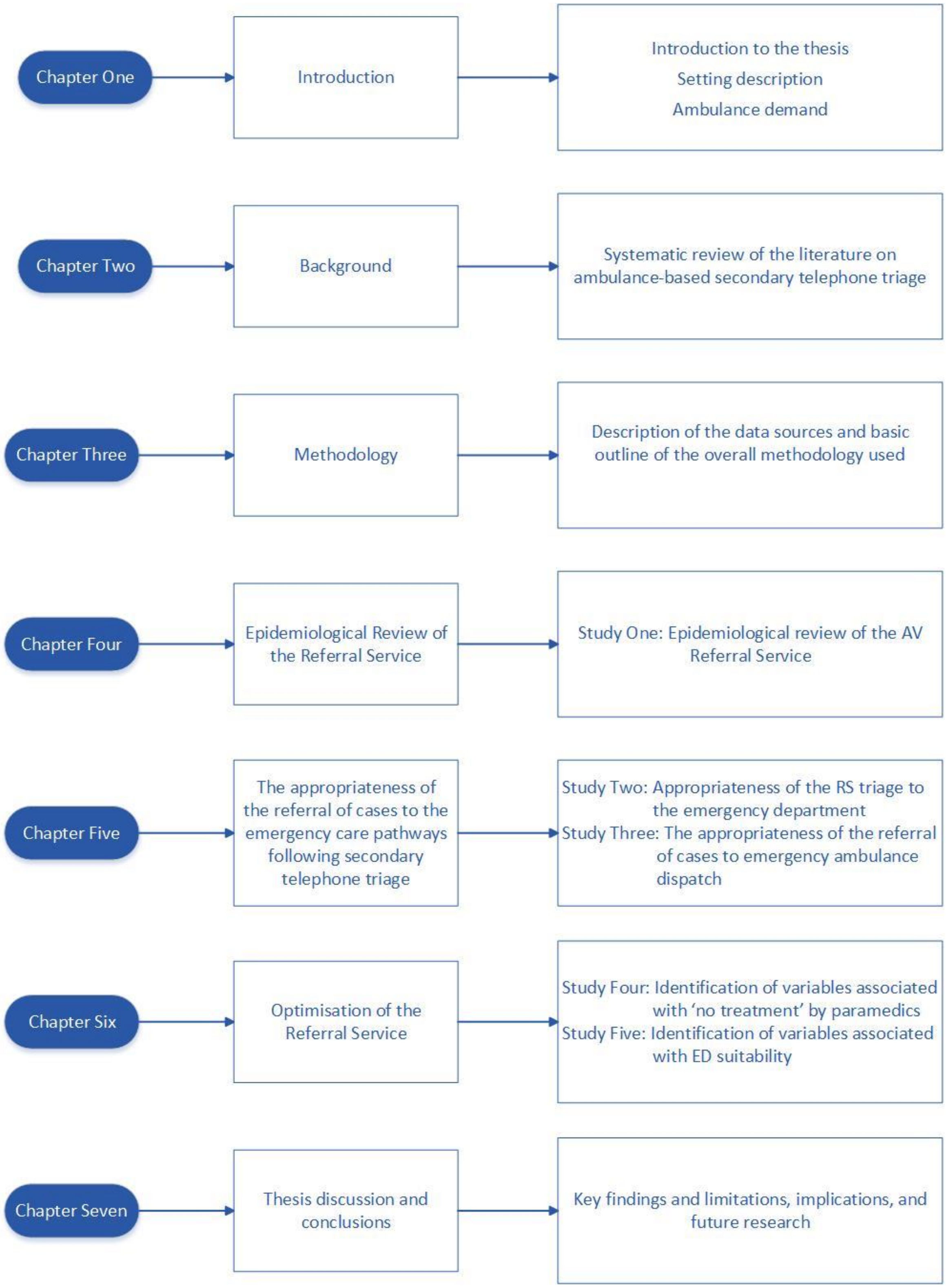

Figure 4: Thesis outline

The body of the thesis contains two published, one in press and two submitted manuscripts, and a traditional presentation of results for the final study in Chapter Six. Chapter summaries and a rationale for each study are presented below.

Chapter One provides background and context to the research.

Chapter Two contains a systematic review of international research on models of low-acuity patient management within ambulance services using telephone triage.

> Publication One: **Eastwood K,** Morgans, A, Smith K, Stoelwinder J. Secondary triage in prehospital emergency ambulance services: a systematic review. *Emergency Medicine Journal.* 2015;32(6):486-492.

Chapter Three describes the datasets analysed and provides information pertaining to their preparation and management. The methodologies for the individual studies are provided in the relevant results chapters.

Chapter Four is the first of the results chapters, and presents an epidemiological study of the AV RS. This study provides the first detailed description of an operational secondary telephone triage service. It makes a substantial contribution to the field, being easily the largest study of its type. It also provides an overview of the AV RS, upon which subsequent studies in this program of research were based.

> Publication Two: **Eastwood K,** Morgans, A, Smith K, Hodgkinson, A, Becker, G, Stoelwinder J. A novel approach for managing the growing demand for ambulance services by low-acuity patients. *Australian Health Review.* 2015;40(4):378-384.

Chapter Five contains two studies using linked ambulance and hospital datasets. The chapter provides an overview of the patient journey from the AV RS to the hospital (where appropriate). This chapter describes the first large-scale studies of the appropriateness of ambulance-based secondary telephone triage systems referring patients back into emergency care pathways. The research generated a transparent methodological approach that can be replicated in other services, and addressed a knowledge gap about the safety of ambulance-based secondary telephone triage.

> Publication Three: **Eastwood K,** Smith K, Morgans, A, Stoelwinder J. The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: A retrospective cohort study. *BMJ Open.* 2017; Accepted 2017 September 12.

Submitted manuscript One: **Eastwood K,** Smith K, Morgans, A, Stoelwinder J. The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage. *Prehospital Emergency Care.* 2017; Submitted.

Chapter Six is the final results chapter. The research presented in this chapter consists of exploratory investigations of the relationships between explanatory variables available in the patient care records and paramedic treatment and ED suitability. This work forms another important contribution to the body of research around secondary telephone triage as a demand management strategy for ambulances, by highlighting the potential to optimise the RS through the retrospective investigation of its cases. It also contributes to the knowledge around ambulance triage system overtriage for emergency ambulances and EDs.

Accepted manuscript Two: **Eastwood K,** Morgans A, Smith K. Patient and case characteristics associated with 'no paramedic treatment' for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine.* 2017; Accepted.

Chapter Seven is the final chapter of this thesis. This chapter identifies the key findings and reflects upon all of the studies and the research aim and objectives. This chapter also outlines the limitations of the work, as well as its implications for real-world application. Recommendations for future research are made.

1.8 Summary

This chapter provides background information about AV, ambulance demand and secondary telephone triage. A description of low-acuity cases and the processes through which they are identified is given. The research rationale, aim and objectives are outlined, and the chapters' contents are summarised.

CHAPTER TWO: SYSTEMATIC REVIEW

The need for ambulance services to deal with increasing demand from low-acuity cases was outlined in Chapter One. Secondary telephone triage by ambulance services has emerged as a potential low-acuity demand management strategy. The literature describing and evaluating this strategy has not previously been reviewed systematically. A formal systematic review was conducted during 2013 to provide a foundation for this thesis, and this chapter presents it in the form of a publication entitled *Secondary triage in prehospital emergency ambulance services: a systematic review* (http://emj.bmj.com/content/32/6/486). An additional review of the literature was conducted in 2016 to identify any subsequent studies of ambulance-based secondary telephone triage, and is also presented here.

This chapter addresses Objective I of this thesis:

I. To describe the use, structure and impact of secondary telephone triage systems embedded into ambulance service operational structures through a systematic review of the literature.

Publication 1: Secondary triage in prehospital emergency ambulance services: a systematic review

CO-AUTHOR DECLARATION FOR PUBLICATION INCLUDED IN THESIS

Monash University

Eastwood KJ, Morgans A, Smith K, Stoelwinder JU. Secondary triage in prehospital emergency ambulance services: A systematic review.

Declaration by candidate

In the case of the publication listed above, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Principle author, responsible for literature search, development and writing the manuscript. Responsible author who accepts overall responsibility for the publication.	80

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Amee Morgans	Contributed to literature searching and editing of the manuscript	N/A
Karen Smith	Contributed to editing of the manuscript	N/A
Johannes Stoelwinder	Contributed to editing of the manuscript	N/A

Candidate's Signature Monday 14th April, 2013

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.

(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

(4) there are no other authors of the publication according to these criteria;

(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) **Department of Epidemiology and Preventive Medicine, Monash University**

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department, centre or institute, with specific campus identification where relevant.]

Signature 1 **Date** 20/5/13

Signature 2 20/5/2013

Signature 3 17/04/2013

Secondary triage in prehospital emergency ambulance services: a systematic review

Kathryn Eastwood,[1,2,3] Amee Morgans,[3] Karen Smith,[1,2] Johannes Stoelwinder[1,2]

[1]Department of Epidemiology and Preventative Medicine, The Alfred Centre, Monash University, Melbourne, Victoria, Australia
[2]Ambulance Victoria, Melbourne, Victoria, Australia
[3]Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria, Australia

Correspondence to
Kathryn Eastwood, Department of Epidemiology and Preventative Medicine, The Alfred Centre, Monash University, 99 Commercial Road, Melbourne, VIC 3004, Australia; Kathryn.Eastwood@monash.edu

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ABSTRACT

Objective Secondary telephone triage to divert low-acuity patients to alternative non-ambulance services before ambulance arrival has been trialled in the UK and USA as a management strategy to cope with the increase in ambulance demand. The objective of this systematic review was to examine the literature on the structure, safety and success of secondary triage systems.

Methods For inclusion in the study, the telephone triage system had to be a secondary process, receiving referred patients who had already been categorised as low priority by a primary triage process. Two independent reviewers conducted the search to identify relevant studies. Six articles and one report were identified.

Results The major theme of the papers was the safety and accuracy of secondary telephone triage in identifying low-acuity patients. Two studies also discussed patient satisfaction. There was a low incidence of adverse events, as expected as these patients had already been subjected to primary telephone triage. In the studies identifying ambulance dispatch as a potential final disposition, at least half of the patients were diverted away from ambulance dispatch. In the studies that identified self/home care as a final disposition, a maximum of 31% of patients were categorised to this outcome. Otherwise all patients were recommended for assessment by a healthcare professional other than ambulance clinicians. Patients appeared to be satisfied with secondary telephone triage on follow-up.

Conclusions These results suggest that, while secondary triage of these patients is safe, further research is required to determine its most appropriate structure and its effect on ambulance demand.

INTRODUCTION

This systematic review was conducted to identify the reported ambulance-based secondary telephone triage systems for triaging low-priority patients in terms of the structure, safety and efficacy of such systems.

The demand for ambulance services has been increasing in many countries[1–7] and is predicted to continue to increase, driven mainly by a disproportionate growth in demand from those with chronic illness, particularly the elderly.[1 8] A portion of this workload is made up of patients categorised as low priority by primary telephone triage who have no, or minimal, physiological derangement, yet still access ambulance resources.[2 3 9–13] The concern expressed in the literature is that the use of ambulance resources by this low-priority caseload is potentially delaying responses, thus endangering the lives of those in need of more urgent medical attention[13] and contributing to both emergency department overcrowding and the mounting cost of ambulance services.[9–14] Strategies such as secondary telephone triage to divert ambulance requests from patients categorised as low priority to alternative non-ambulance transport services could be an important part of coping with these challenges.

Many ambulance services use computer-based priority dispatch systems to undertake primary triage and allocate a priority level of service on receiving the initial call for assistance.[14–19] Ambulance clinicians of varying skill level are dispatched, depending on this computer-based prioritisation and categorisation, to provide assessment and treatment, where necessary, followed by the option to transport to an appropriate hospital-based emergency department. This is an expensive and time-consuming response to situations that may not always require it.

In attempting to address this issue, some ambulance services have implemented secondary telephone triage services using various healthcare professionals to further assess the low-priority cases. These services attempt to provide these patients with more appropriate alternative care options to meet their immediate healthcare needs, rather than the resource-intensive ambulance response.[12 15 19–22] This strategy of low-priority patient management has the potential to significantly affect the way ambulance services manage their growing demand and could contribute to ameliorating emergency department overcrowding. Concerns have been raised, however, about the safety of such systems.[15 22]

MATERIALS AND METHODS

Search strategy

This systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria.[23] The databases searched included the seven EBM Reviews databases, Books@Ovid, Journals@Ovid Full Text, PsycARTICLES Full Text, The Joanna Briggs Institute EBP Database, AMED (Allied and Complementary Medicine), Ovid MEDLINE(R), Maternity and Infant Care, Mental Measurements Yearbook, PsycBOOKS, PsycCRITIQUES, PsycINFO, Transport Database, CINAHL and Embase from their beginning until the end of November 2012.

The prehospital search strategy used was a simplified version of the search strategy developed by the Cochrane Collaboration's Prehospital and Emergency Health Field.[24]

The medical subject headings (MeSHs) and keywords used in the prehospital search were: emergency medical service, emergency medical technician, ambulance, air ambulance, military

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medicine, prehospital, pre-hospital, out-of-hospital, out of hospital, paramedic, emergency health service, paramedical personnel, emergency services, emergency technician, emergency practitioner, emergency dispatch, emergency despatch, first responder, ems and emt.

Then a second search containing the following MeSHs and keywords was conducted: telenursing, NHS 24 referral, telephone telemetry, telephone triage, telephone assessment, secondary telephone assessment, secondary telephone triage, telephone medicine. These two searches were then combined and duplicates were removed.

Study selection

Two reviewers independently screened the articles for their eligibility for inclusion. To be included, the telephone triage system had to be a secondary process, where the patient had already been categorised as low priority. The secondary telephone triage system had to be part of, or feed into, an ambulance service directly, where cases could be transferred for an ambulance response. Articles about primary telephone triage, out-of-hospital triage of patients seeking general practitioner (GP) appointments or with emergency departments were excluded. Editorials and letters were also excluded. All screening conflicts were resolved by consensus. The reference lists were reviewed to identify additional articles. A flow diagram of the phases of the systematic review was produced according to the PRISMA statement (figure 1).[23]

Assessment of study quality

Methodological quality of the studies was assessed using a previously described five-level modified instrument that has been applied to clinical trials, descriptive studies and surveys.[25] Quality levels 1 and 2 consisted of prospective studies with random or consecutive sampling and clearly defined outcome measures. The sample sizes in studies meeting quality level 1 are larger, allowing narrower CIs and increased generalisability. Quality level 3 studies met the criteria for level 1 and 2 studies, except that they were retrospective. Quality level 4 studies used convenience sampling or other techniques that could potentially allow the introduction of bias, and quality level 5 did not have clearly defined or validated outcome measures.[25]

RESULTS

The prehospital search resulted in 41 470 English references in Ovid MEDLINE, 97 596 in Embase, and 73 464 in CINAHL. The second search specifically relating to telephone triage returned 510 references in Ovid Medline, 1005 in Embase, and 5641 in CINAHL. Once the prehospital and telephone triage searches were combined, grey literature and reference list searches were included and the duplicates were removed, 1607 references were returned for title and abstract review. After title and abstract review by KE and AM, 1544 articles were found to be irrelevant, as they were not related to secondary triage, ambulance dispatch and low-acuity patients, leaving 63 articles for manuscript review.

After manuscript review, six articles and one report were identified specifically relating to secondary triage processes and alternative responses for callers to emergency ambulance health services. Two of these articles related to the same study of telephone triage in the UK (figure 1).

After methodological quality review, three studies were found to meet quality level 2, one study each met quality level 3, 4 and 5, and one paper was more of a commentary on a study that had occurred than a report of the results. The seven papers referred to six secondary triage systems and varied in what they reported. One paper outlined a pilot study; however, only minimal quantitative analysis was provided. Four papers reported some demographical data, three papers included follow-up surveys on the patients' condition, and six papers made some statement about the safety of secondary triage systems. Four studies reported on the patient disposition at the end of the secondary triage, and three papers investigated whether there was a financial benefit in having secondary triage systems in place. A summary of these papers is presented in table 1.

The major theme the papers discussed was the ability and safety of the secondary triage process to identify low-acuity patients. Patient satisfaction was also discussed in two of the studies.

It was expected that the secondary triage systems used in each of the studies would have some level of variation. Five studies had preformulated questioning algorithms for patients, three of which were identified as computer-based.[12 14 15 20 26] Two studies included either paramedics or emergency medical technicians (intermediate) conducting secondary triage,[12 15 22] and five used nurses.[15 19 20 22 26] The secondary telephone triage systems used in the various studies safely differentiated the low-acuity patients.[14 19 20 22]

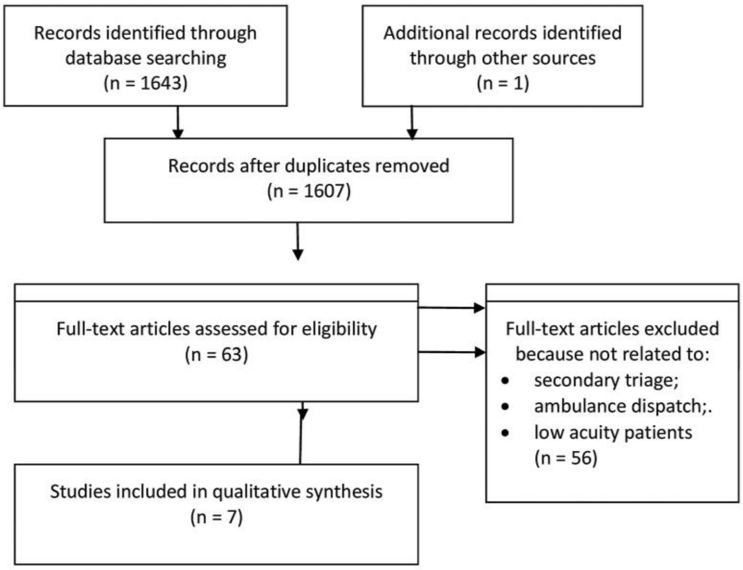
The 2004 study by Dale *et al*[22] was conducted because the authors identified that the use of hospital admission as an outcome measure in their 2003 study was not an accurate means of determining the safety or the success of the secondary triage process and the decision to send an ambulance or not. After reanalysing their results, they found there were only two cases (0.3%) where a panel of experts believed a patient should have received emergency ambulance transport to avoid potential harm. One other potentially adverse event (0.2%) was reported in another paper, where a patient allocated to a non-ambulance transport disposition was subsequently admitted to an intensive care unit.[19] No details about this patient were given in the paper with regard to their condition at the time of secondary triage, ambulance attendance or emergency department assessment. Another study involving 133 patients had no adverse events occur as a result of secondary telephone triage.[20] Conversely, one study reported four cases (0.2%) that were identified as requiring immediate ambulance dispatch (three for potential cardiac complaints and one for intubation), which would otherwise have remained coded as low priority.[14]

As stated above, using hospital admission as an outcome measure does not provide an accurate picture of the safety of secondary telephone triage, as many patients who require admission may be best transported by private vehicle (eg, elective surgery), just as many patients appropriate for ambulance transport (eg, simple dislocations or fractures) may be discharged from the emergency department. Analysis of the success of such systems should be limited to differentiating between patients who require ambulance intervention and/or transport and patients who do not. The need for emergency department intervention should not carry the weight some studies have attributed to it in assessing the triage system. While the 2004 study by Dale *et al*[22] identified the flaw in using hospital admission, this paper, along with the remaining papers included in this study, did not clearly identify the importance of limiting the analysis of the secondary triage system to the need for ambulance intervention and/or transport.[12 14 15 19 20 22 26]

Five of the six studies reported the final disposition following secondary telephone triage. Three studies specified which cases were recommended for ambulance dispatch following secondary

Eastwood K, *et al*. *Emerg Med J* 2014;**0**:1–7. doi:10.1136/emermed-2013-203120

Figure 1 Flow diagram of study selection for this review.



triage, which ranged from 17% to 48% of the calls. The remainder of the calls within each study were categorised into dispositions recommending other levels of care. Three studies reported the number of patients categorised to the home care or self-care disposition.[14 15 20] This was the only category, to the authors' knowledge, that did not result in an assessment from a healthcare professional. The number of cases categorised to this disposition ranged from 2% to 31%.[14 15 20] This low proportion of cases going without any face-to-face assessment may suggest a conservative approach to patient triage by those conducting the secondary triage and/or the triage algorithms themselves. It also demonstrates that a large amount of the ambulance and emergency department workload is being directed to more appropriate healthcare services—bypassing both ambulance clinician attendance and transport to hospital—and emergency department assessment and referral.

Two studies included follow-up surveys, with the patients involved being asked about their experiences.[14 20] In one study, 96% of the respondents were satisfied with the outcome.[20] This study reported that many of the patients did not want an ambulance response or assessment in an emergency department. Instead, they were seeking information and direction to appropriate services.[20] Another study found that 75% of patients were satisfied with the service, and 20% would have liked advice about alternatives to ambulance attendance.[14] This study did, however, find that this satisfaction level was lower in the group who underwent secondary triage than in a control group where no secondary telephone triage intervention was used (85%).[14]

DISCUSSION

While there is a large amount of literature on telephone triage, only six studies were identified that specifically addressed secondary telephone triage of calls to emergency services. These articles are of varying quality and date back to 1981, indicating that the need for alternative healthcare options to manage low-acuity ambulance demand was identified long ago.[12] There was considerable variation among the systems and studies, making comparison difficult. Four studies were prospective, two were retrospective, and one paper was a narrative describing a study. Sample sizes were relatively small, ultimately affecting our ability to rate the studies as quality level 1 using the quality instrument used.[25] Despite this, three of the six studies were able to be classified as quality level 2.

Studies have found primary telephone triage software for ambulance dispatch to be safe[8 16]; however, the safety of nurse- or paramedic-led telephone triage has been questioned, because of the higher level of subjectivity involved in the decision-making and algorithm usage.[15 27 28] The present systematic review has found that generally the advice given and disposition assigned was safe, appropriate and reflective of the likelihood of hospital admission.[12 14 15 19–22 27 29 30] We have found that the weight of concerns raised in the literature about the risks associated with the loss of a face-to-face assessment[31 32] is reduced, as those conducting the triage referred many of the patients to further medical assessment rather than home/self-care. These patients were then being managed by more appropriate healthcare professionals for their current needs, rather than simply having ambulance clinicians sent. This delegation of care will result in a reduction in patients presenting to the emergency department by ambulance, contributing to a reduction in emergency department workload and time for the patient to reach suitable definitive management.

As expected, the number of adverse events was small, as all cases had already been put through a primary triage process and categorised as low priority. The occurrence of potentially adverse events was further mitigated by the fact that these patients were then subjected to a secondary telephone triage by a healthcare professional, providing a second opportunity for indicators of higher acuity to be identified. In fact, more cases with potentially high-priority indicators were found that were missed by primary triage than those that resulted in potentially adverse outcomes as a result of secondary triage. Overall, five of the six studies concluded that secondary telephone triage was safe.[14 19 20 22 26]

Ambulance services have moved beyond simply responding to a call for help and transporting patients to medical attention. Ambulance clinicians now provide highly skilled medical care, and, based on this, ambulance services now to need to consider delegating the right care to the right patient to appropriately

Table 1 Secondary telephone triage of low-priority ambulance patients

First Author (Year)	Study Design	Study Quality Level	Bias Reported	Country	Triagist	Peak Times Indicated	Reported Financial Benefit	Alternate Service Providers	Final Patient Recommendation /disposition
Study									
Crowther (2009)	N/A	N/A	Not Reported	Wales	Nurse	No	Not Reported	Unknown	▶ ambulance dispatch ▶ referred to ED ▶ routine primary care service required ▶ urgent primary care service required ▶ self-care ▶ other healthcare professional ie. midwife, dentist ▶ other services required (no figures given)
Smith (2001)	Two-phase prospective study	2	Yes. Selection Bias	USA	Nurse	43% 1500–2300 hrs; 69% 1500–0700 hrs	Unspecified saving reported	None	▶ referred to 911 (17%) ▶ referred to ED (11%) ▶ referred to urgent care clinic (5%) ▶ referred to patients primary care provider (24%) ▶ referred to community resource (11%) ▶ home self care (31%)
Fox (1981)	Prospective	5	Not Reported	USA	EMT-I (intermediate)	No	Unspecified saving reported	Private conveyance service	None
Dale (2003)	Pragmatic controlled trial	2	Not Reported	UK	Nurse/ Paramedic	No	Not Reported	None	▶ immediate care (25%) ▶ urgent care (23%) ▶ moderately urgent (24%) ▶ routine care (14%) ▶ home care (14%)
Dale (2004)	Case Series	3	Yes Professional bias of data reviewers	UK	Nurse/ Paramedic	No	Not Reported	N/A	None
Studnek (2012)	Two-phase retrospective study	4	Not Reported	USA	Nurse	No	Not Reported	None	▶ immediate care (71%) ▶ delayed care (29%)
Turner (2006)	RCT & Observational study	2	Not Reported	UK	Nurse	No	£8-102 saving per patient	None	▶ 999 ambulance (27%) ▶ ED immediately (11%) ▶ ED within 4hrs (6%) ▶ GP immediately (16%) ▶ GP other (6%) ▶ Pharmacist (0.2%) ▶ other professional care (1%) ▶ self care (2%) ▶ missing (31%)

Gender	Patient Age	Follow up Survey	Underwent Secondary Triage	Decision-making Support Tools	Hours of Operation	Deemed Safe?
None	None	None	Unknown 3041 calls handled post pilot	Computer-base algorithm	0800–2000	Yes
Male 46% Female 54%	Range 0–10 29.3% 11–20 12% 21–30 17.3% 31–40 14.3% 41–50 9.8% 51–60 4.5% 61–70 0.8% >70 12%	▶ 85 (64%) participated in follow-up ▶ Condition better than at the time of 911 call 88% ▶ Condition the same as at the time of 911 call 6% ▶ missing 6% ▶ 81 (96%) satisfied with the outcome	133	Triage algorithm (unknown if computer-based)	24/7	Yes
None	None	None	Unknown	List of questions. (unknown if computer-based)	1300–2100	Not Stated
Male 40% Female 60%	Mean age 44.5 years	▶ 15.4% of those triaged as requiring an ambulance were admitted to hospital ▶ 9.1% of those triaged as not requiring an ambulance were admitted to hospital	635	Computer-based algorithm	0700–1100 hrs or 1100–1500 hrs or 1500–1900 hrs or 1900–2300 hrs	Uncertain
None	None	None	635	None	N/A	Yes
None	Mean age 49.9 years	None	530	Not Specified	Not Specified	Yes
Male (43%) Female (57%) Missing (0.6%)	Range 0–15 7.7% 16–45 26.7% 46–75 28.7% >75 35.6% Missing 1.3%	▶ 601 (34%) participated to varying degrees in follow-up ▶ Problem completely better (15%) ▶ Improved (48.7%) ▶ The same (25.6%) ▶ Worse (10.7%) ▶ 241 (of 284; 85%) were satisfied with the service	1766	Computer-based algorithm	Region 1: 0800–1800 hrs 7 days Region 2: 1100–2300 hrs, then 24/7 Region 3: 0900–1900 hrs Mon-Fri; then 0700 hrs – 2345 hrs 7 days	Yes

ED, emergency department; EMT-I, emergency medical technician–intermediate; GP, general practitioner.

manage their resources. Ambulance services need to review their service delivery models and decide whether simply sending an ambulance is fulfilling their responsibility to answer the call for help. When doing this, they need to consider the increasing demand on emergency medical services, including emergency departments, and consider whether they need to respond with a broader range of medical response options.

The potential benefits of secondary telephone triage identified in this systematic review include appropriate, more timely medical attention for patients seeking medical intervention, increased patient satisfaction, a reduction in demand on ambulance and emergency departments, cost savings to ambulance services, improved resourcing for cases requiring urgent medical attention, decreased response times, and potentially improved outcomes for emergency patients who will receive the care they require sooner.[12 14 15 19–21] However, the effectiveness of secondary triage is limited by the range of options available for those conducting the triage. We are aware of at least one ambulance service that offers home nursing and GP visits, hospital response team visits, direct transfer to other health-management telephone lines such as poisons' advice, community psychiatric services response teams and non-emergency ambulance response as an alternative service.[33] This is in contrast with the studies reported here, where advice and a recommendation to self-access further medical advice or attention were the only alternative outcome options. Providing such alternative options may reduce the reported high level of referral back to ambulance transport.

Limitations

Most ambulance services have evolved around the population they service and the resources available. As a result, they can be very different in their general operation, including the receiving and processing of initial calls for assistance. The secondary triage software or algorithms used in each of the studies was not identified. There is likely to be variation among call centres in the primary telephone triage software they use, which can result in different primary triage outcomes. As a result, there is likely to be a difference in the cohorts of patients identified as suitable for secondary triage within each of the studies.

Only one of the systems had an alternative service provider identified. This was a private conveyance service. The lack of any linked alternative service providers may have resulted in higher referral to ambulance dispatch to ensure patients received a face-to-face assessment and lower patient satisfaction in terms of service provision. Health professionals conducting the secondary triage could only refer patients to self-access other healthcare resources, resulting in a potential for non-compliance from the patients. This could have also potentially influenced the decision-making of those conducting the triage.

The sample sizes in most of the studies were relatively small, and the hours of operation were limited in some studies to times when there was generally no access to other community-based medical services . The final patient recommendation or disposition was not uniform between the studies, so a clear picture of the volume of patients potentially suitable for each category could not be ascertained. Finally, response rates for the follow-up surveys were low, so there may be some selection bias in the results from this part of the studies.

Recommendations

Further research is required to more accurately measure the appropriateness of each disposition outcome recommended by the secondary triage process. To do this, appropriate outcome measures must first be identified. Follow-up surveys of patients to determine whether they adhered to the advice given, whether they received any intervention at the disposition level to which they were assigned, and whether any escalation of medical services was required within a given timeframe would also help to more accurately measure the safety and accuracy of such systems.

Further research should be carried out into those conducting the secondary triage to determine what level of skills and education are required and what decision-support strategies are best used to ensure consistent, appropriate and safe patient care.

Finally, the primary triage process will need to be reviewed with respect to the new service delivery model to determine whether more discrimination needs to occur at the point of first contact.

CONCLUSION

The literature does indicate a potential positive effect in terms of financial viability for ambulance services, resource supply and demand management, and—most importantly—patient outcomes. Owing to the limited number of studies, small sample sizes and variation among secondary triage systems, the findings from this systematic review would be difficult to generalise. Further comprehensive studies need to be conducted into these systems before the safety can be truly established.

Contributors KE: study conception, devised and implemented the search strategy, analysed data and wrote the paper. AM: discussed core ideas to study, was involved in search strategy and study selection, and edited the paper. KS: discussed core ideas to study and edited the paper. JS: discussed core ideas to study and edited the paper; JS is KE's primary PhD supervisor.

Competing interests KE is an intensive care paramedic who intermittently works for the Ambulance Victoria Referral Service (secondary telephone triage service). JS is the Chair of the Board of Ambulance Victoria.

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2.1 Additional literature review

In October 2016 the search strategy outlined in the publication above was re-run using the same databases. Reference lists and grey literature sources were also searched to identify additional articles. The grey literature search used a modification of the search strategy described in the systematic review publication above. The terms were searched in the Google internet search engine and the first five pages retrieved were screened for relevant material. The PRISMA criteria were applied.[92]

The database search identified 49 new articles, and one more was found by inspecting reference lists and searching the grey literature. These articles were assessed for their eligibility on the basis of their titles, abstracts and ultimately full-text reviews. This process added two studies of ambulance-based secondary telephone triage services (Table 3) to the original review.[21,93] The service examined by Infinger et al.[21] appeared to be the same as that studied by Studnek et al.[20] but the latter study was conducted two years after the former.

Like the studies evaluated in the published systematic review, these retrospective studies were of low methodological quality (level 3) because they were retrospective, and Infinger et al.'s research involved a small study population (Table 3).[30,94] Infinger et al. examined the impact of a referral service upon the overall EMS system and patient satisfaction.[21] Fivaz et al. investigated the distribution of cases to the various outcome dispositions and the impact of age and gender on these outcomes.[93]

Table 3 below lists the specific factors that were assessed during the systematic review process. Both studies utilised two communication centres. Infinger et al. studied telephone triage occurring at two external call centres,[21] whereas Fivaz et al. studied two '911' call centres operated by an EMS.[93] Both sets of authors acknowledged the limitations associated with using two separate call centres that may have developed different internal approaches and protocols to managing these calls,[21,93] and one study cites some lack of compliance with call-taking protocols that contributed to variance in case management, however they do not elaboarate on what the compliance issues were.[93]

Infinger et al. found that the impact of a secondary telephone triage service upon ambulance demand was minimal using the established patient selection criteria for secondary triage, with less than two patients eligible for triage per day (633 patients over 12 months). No secondary telephone triage occurred for 304 patients who either refused triage or lacked personal transportation (and therefore demonstrated an inability to follow potential recommendations to self-manage further care).[21] However, of the 119 patients who responded to a follow-up telephone call, 87.4% (n=104) felt the service had met their health needs.[21]

The patients in Fivaz et al.'s study were predominantly female over 50 years of age who had called an ambulance for medical complaints rather than trauma-related complaints.[93] Nearly a third of these patients were referred away from the emergency ambulance and ED pathways in the secondary triage process.

The results reported in these studies (Table 3) support those identified in the original systematic review. Fivaz et al. demonstrated that a secondary telephone triage service can reduce ambulance service and ED workloads, with 37.2% (N=2,502) being diverted away from the ED as a result of secondary telephone triage.[93] Patient satisfaction was high in Infinger et al., with most patients reporting their needs were met following secondary telephone triage.[21] Neither study reported on the safety or accuracy of the secondary telephone triage process.

Both studies have limited generalisability because the EMS systems in each setting varied from those used by other ambulance services.[21,93] The data were collected retrospectively, limiting scope for analysis.[21] The two call centres used by Fivaz et al. not only appeared to vary in their compliance with call-taking protocols, but had different workloads and one commenced earlier than the other,[93] which resulted in one call centre returning a larger proportion of the sample, which the researchers acknowledge skewed their data.[93] Finally, the call centres studied by Fivaz et al. did not operate 24 hours a day, seven days a week, and the authors state that this may have affected the type of main presenting problems constituting their workload.[93]

Table 3: Updated literature review content

First Author (Year)	Study Design	Study Quality Level	Country	Call-taker	Peak times indicated	Reported Financial benefit	Alternate Services Providers	Final Patient Recommendation /disposition
Infinger (2013)	Retrospective cohort study	3	US	Nurse	No	No	No	None
Fivaz (2015)	Retrospective Cohort study	3	US	Nurse	No	No	No	Emergency response (911) (4.1%) Emergency care as soon as possible (62.8%) Seek medical care within 1-4 hours (12.0%) Consult doctor to review symptoms (2.2%) Consult regional poison control (0.06%) See doctor in the next 12 hours (6.3%) See doctor in the next 1-3 days (3.7%) Routine appointment with doctor (3.4%) Routine appointment with dentist (0.19%) Self-care/Home-care (5.0%) Others (0.31%)

First Author (Year)	Gender	Patient Age	Follow-up survey	Underwent secondary triage	Decision-making support tools	Hours of operation	Deemed Safe?
Infinger (2013)	Not specified	None	Yes	329	Not Specified	24/7	Not stated
Fivaz (2015)	Female (60.3%)	< 3 months (0.31%) 3-12 months (1.1%) 1-4 years (2.5%) 5-16 years (2.9%) 16-64 years (55.1%) 65+ years (38.0%)	No	6,727	Computer-based algorithm	Communication centre 1: 0800-2000 hours Mon-Friday, and 0800-1600 hours on Saturdays Communication centre 2: 0900-1700 hours Mon-Friday	Not stated

2.2 Summary

This review of previous research confirms that secondary telephone triage is being implemented within ambulance services in some countries in response to increasing demand. It highlights that the few studies that have been conducted were of low rigour, mostly with small sample sizes, and of varying methodological quality. The secondary telephone triage processes used in the studies varied in their operational implementation, as did their patient care pathways. However, the review did identify that secondary telephone triage has some impact upon demand for ambulance services and more appropriate service provision may be possible for patients. The research objective listed in the introduction of this chapter was achieved through this process of systematic review.

In order to build a more rigorous foundation for formally evaluating secondary telephone triage, a detailed review of an operating system is required. The impact of this service upon emergency ambulance dispatch, the appropriateness of its processes and identification of the factors associated with the successful operation of secondary telephone triage services is required to inform policymakers about how best to introduce such a system into other ambulance services or whether to implement such a system at all.

The following chapter presents the methodology, data sources and dataset preparation used in examining the AV RS.

CHAPTER THREE: METHODOLOGY

This chapter outlines the data and research methods used in this program of research. An overview of the ethics approval, study setting, study design and dataset will be given for each of the studies presented in this thesis. Further details of the methods employed in each of the studies are provided in the subsequent results chapters.

3.1 Study design and setting

Six empirical studies were conducted in this program of research to explore and analyse the functioning of a large ambulance-based secondary telephone triage service, the AV RS. These studies are represented in the research framework outlined in Figure 5 below.

3.1.1 Study design

The study design involved a pragmatic retrospective analysis of patient-based ambulance and hospital data in conjunction with population data from the Australian Bureau of Statistics (ABS), the Victorian Government Department of Health and the University of Adelaide Public Health Information Development Unit (PHIDU). Secondary telephone triage call data collected over a 34-month period between September 2009 and June 2012 was available for analysis. All other data collected was aligned (where possible) to this timeframe.

3.1.2 Study setting

The geographical study setting was metropolitan Melbourne in the state of Victoria, Australia. The city of Melbourne covers an area of approximately 10,000km^2 and had a 2012 population of 4.35 million.[86,95]

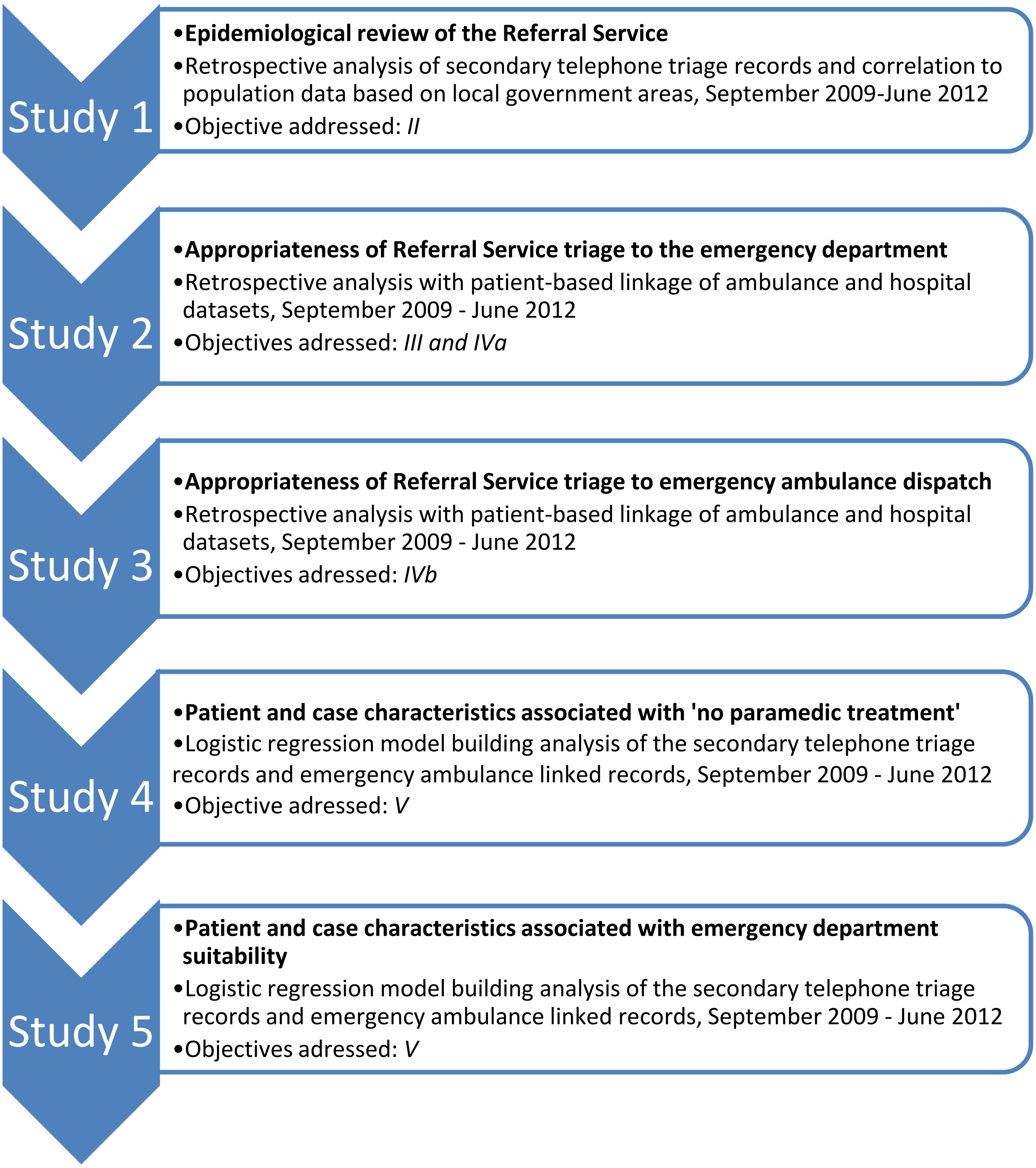

Figure 5: Studies included in the program of research

The primary health care system in Australia consists of GPs, dentists, nurses, Indigenous health workers, allied health professionals and pharmacists.[96] In metropolitan Melbourne in 2012, there were 1.19 GPs per thousand population,[97] which was below the national ratio of 2.02.[98] Access to these GPs appears adequate, with 60% of patients able to obtain appointments within four hours, a further 15% able to make same-day appointments and only 12% of patients needing to wait more than two days for a GP appointment for urgent medical care.[99]

The secondary health care system comprises medical specialists and facilities that require a referral from primary care practitioners, such as cardiologists and services like aged care, disability, drug and alcohol and mental health services.[96,100] To some extent the hospital system is also part of the secondary health care system, however patients can directly access it through the ED.[100]

The hospital system includes private and public hospitals. Private hospitals are privately owned and operated, and patients entering these facilities incur fees for which private health insurance may fully or partially reimburse them. Public hospitals are operated by Australian states and territories and provide free medical care for all Australian residents. In 2010 in the state of Victoria, there were 18 public hospitals and five private hospitals with an ED;[101,102] private hospitals provided 6% of the total emergency department services between 2009 and 2012.[103-105]

Australian residents are covered for medical costs under the federal health program, Medicare.[106] This coverage is not comprehensive – some services and procedures are not covered or only partially covered. For example, GPs may bulk bill all patients or particular sections of the community (e.g., children or those on welfare), resulting in no out-of-pocket expenses for these patients. Alternatively, GPs may charge a fee and Medicare gives a partial refund to patients, as determined in the Medicare Benefits Schedule. Medicare's financial coverage does not extend to emergency ambulance attendance and transport, and each state and territory has its own payment arrangements. In Victoria, if a patient is on welfare benefits, pays an annual ambulance subscription, or has private health insurance that includes ambulance coverage, they will not incur the ambulance fees (or will subsequently be fully reimbursed).

3.2 Data sources and data quality

Several data sources were used in this program of research, including the data collected through the systematic review process, two patient-based ambulance datasets, two patient-based hospital datasets, and population data from the ABS and PHIDU. Details of these data sources are outlined below.

3.2.1 Evaluation and synthesis of previous research

The systematic review adhered to Hemingway and Brereton's[107] criteria for a high-quality systematic review by seeking to:

- identify all relevant literature relating to the use of secondary telephone triage systems in prehospital EMS systems by identifying published and unpublished studies, reports, conference proceedings and commentaries related to this topic;
- use pre-determined selection criteria for inclusion and exclusion;
- assess the quality of the relevant literature identified;
- synthesise the findings from the literature in an unbiased way; and
- interpret the findings of the relevant literature in a balanced and impartial summary whilst considering the flaws in the evidence.

The search strategy, inclusion/exclusion criteria, data quality assessment and limitations of the review are outlined in the publication in Chapter Two.

3.2.2 Datasets

The datasets used in studies one to six are described briefly in Table 4.

Table 4: Datasets used in this program of research

	Dataset	Description of datasets specific to each study
3.2.2.1	Call Enhanced Call Centre (CECC)	**Ambulance Victoria** Contains the electronic secondary telephone triage records produced by the AV RS. • September 2009 – June 2012
3.2.2.2	Victorian Ambulance Clinical Information System (VACIS)	**Ambulance Victoria** The electronic patient care records (ePCR/paramedic record) for patients attended by AV paramedics. • September 2009 – June 2012
3.2.2.3	Victorian Emergency Minimum Dataset (VEMD)	**Victorian Government Department of Health** Collects demographic, administrative and clinical data on all ED presentations at Victorian public hospitals[108] • September 2009 – June 2012
	Victorian Admitted Episodes Dataset (VAED)	**Victorian Government Department of Health** Data pertaining to admission to hospital and the related episode of care[109] • September 2009 – June 2012
3.2.2.4	Local Government Area (LGA) website data & Socio-Economic Indexes for Areas database (SEIFA)	**Australian Bureau of Statistics** Publicly available Australian municipality-based demographic information • January 2009 – December 2012
3.2.2.5	Social health atlas of Victorian local government areas, 2011	**University of Adelaide - Public Health Information Development Unit** Data relating to GP numbers and utilisation • January – December 2011
3.2.2.6	Australian hospital statistics – emergency department care	**Australian Institute of Health and Welfare** Avoidable hospitalisation data • July 2011 – June 2012

3.2.2.1 Care Enhanced Call Centre

Data Source

This database contains the patient care records created during the secondary telephone triage process. The CECC software consists of a range of questioning algorithms that RS call-takers utilise when conducting their secondary telephone triage. The CECC software collects demographic, clinical and operational information specifically relating to the encounter including patient problem, disposition (the care pathway recommended by the software), and final outcome (what the call-taker ultimately arranged for the patient).[110] A list of the variables collected and an explanation of each can be found in the data dictionary in Appendix Three.

Data Quality

Information provided to the RS call-taker throughout the telephone triage is entered into the CECC computer software during the triage process. The data collected is subject to the usual human errors associated with entering this information whilst also talking to a patient on the telephone.

3.2.2.2 Victorian Ambulance Clinical Information System

Data Source

The VACIS is an electronic patient care record (paramedic record) generated from data collected in the field by paramedics via a tablet computer. The VACIS database includes data on patient demographics, clinical signs and symptoms, paramedic assessment and treatment and operational variables such as times and transport decisions.[111]

Paramedic records corresponding to RS cases referred for emergency ambulance dispatch were collected for the study period. The VACIS variables extracted for this program of research, along with the sub-category coding created for analysis, are listed in Appendices Two and Three.

Data Quality

Given the data in this dataset is based on records created by paramedics, it is subject to human error. In particular the data is subject to recall bias, as paramedics often complete the paramedic record at the end of a case, either when they have left the patient or handed him or her over to the hospital.

3.2.2.3 Victorian Emergency Minimum Dataset & Victorian Admitted Episodes Dataset

Data Sources

The Department of Health is a department of the Victorian State Government. In addition to the provision of freely available public health information and notices, collections of de-identified data are available pertaining to relevant health service usage. The VEMD and VAED are collected and managed by the Department in fulfilment of its obligation under the National Health Information Agreement 2013.[112]

Clerical and clinical staff collect VEMD data within public hospital EDs during the patients' episodes of care.[108] Only the minimum data pertaining to each episode of care, allowing for monitoring and analysis, are collected.[108] Standard protocols and definitions guide data collection to allow for comparability across hospitals and over time.[113] Most private hospitals do not provide this information to the Department of Health, and no private hospital ED patient records were available for the duration of this program of research. However, as noted earlier, private hospital ED presentations make up only about 6% of all ED presentations in Victoria.[103-105]

The Department of Health collects VAED data for patients admitted to both public and private hospitals. The dataset is used to monitor population morbidity, hospital utilisation and performance, and for funding decision-making.[109] The variables from the VEMD and VAED used in this research are listed in Table Three in Appendix Two.

Data Quality

Because this data is used in policymaking, funding decisions and service and infrastructure planning and monitoring, it must be reliable and accurate.[114] For this reason a reference group comprising hospital clinicians, management and clerical staff in association with Department of Health staff oversee data quality.[114] The Department of Health also adheres to the ABS Data Quality

Framework.[115,116] Despite this, previous researchers have found up to 95.8% of case were missing at least one piece of data,[117] and up to 87% had at least one error in the VEMD and VAED datasets.[118] The factors contributing to this are believed to be the many different ED-based personnel that enter the information, and lack of knowledge of the VEMD system and training in data entry.[118] The software used for data entry was also cited as a factor impeding accurate data entry, along with time constraints.[118] The VEMD and VAED datasets are therefore subject to human error just as the other datasets included in this program of research are.

3.2.2.4 Local Government Area website data & Socio-Economic Indexes for Areas database

Data Sources

The LGA and SEIFA data was sourced from the ABS website. The ABS collects statistical data on all areas of Australian life.[119] Whilst the ABS is an Australian Government agency, it acts independently and objectively in carrying out its duties whilst taking into account the Government's broad policy frameworks.[120] ABS information is used by governmental and official bodies as well as business and community groups in Australia and overseas to inform decision-making, policy discussion and research activities.[121,122]

The data collected for this program of research was:

- *Index of Relative Socio-economic Disadvantage (IRSD or IRSED)* information. This information, extracted from the ABS website, was collected for LGAs and summarises a range of information about social and economic conditions within particular geographical areas. The information included in the index is shown in Table 5 below, along with the weighting allocated to each variable when calculating the IRSED.

Table 5: Variables included in the IRSED calculation

FINAL VARIABLE LIST

Variable	Description	Loading
ENGLISHPOOR	% of people who do not speak English well	-0.34
NOEDU	% of people aged 15 years and over who have no educational attainment	-0.44
OCC_SERVICE_L	% of employed people classified as low skill Community and Personal Service workers	-0.50
OCC_DRIVERS	% of employed people classified as Machinery Operators and Drivers	-0.52
OVERCROWD	% of occupied private dwellings requiring one or more extra bedrooms	-0.52
SEP_DIVORCED	% of people aged 15 years and over who are separated or divorced	-0.54
NOCAR	% of occupied private dwellings with no cars	-0.56
DISABILITYU70	% of people under the age of 70 who have a long-term health condition or disability and need assistance with core activities	-0.66
ONEPARENT	% of one parent families with dependent offspring only	-0.71
LOWRENT	% of occupied private dwellings paying rent less than $166 per week (excluding $0 per week)	-0.73
UNEMPLOYED	% of people (in the labour force) who are unemployed	-0.74
NOYEAR12ORHIGHER	% of people aged 15 years and over whose highest level of education is Year 11 or lower	-0.75
OCC_LABOUR	% of employed people classified as Labourers	-0.75
NONET	% of occupied private dwellings with no internet connection	-0.81
CHILDJOBLESS	% of families with children under 15 years of age who live with jobless parents	-0.85
INC_LOW	% of people with stated household equivalised income between $1 and $20,799 per year	-0.90

(Source: Australian Bureau of Statistics Website, IRSED,
http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2033.0.55.001main+features100052011)

- *Local Government Area* data, which provides a snapshot of designated regions and their economic, social, population, labour, environmental, health and health services status. This information is collated by the ABS.
    - The data extracted for the studies was:
        - population size;
        - median household income; and
        - median age.

<u>Data Quality</u>

The ABS adheres to the ABS Data Quality Framework, which outlines the standards utilised for assessing and reporting on the quality of the data.[116] Seven dimensions of quality are considered:

- institutional environment;
- relevance;
- accessibility;
- timeliness;

- accuracy;
- interpretability; and
- coherence.[116]

All data published on the ABS website includes a Data Quality Declaration to inform researchers about issues that may affect the data quality of that dataset and provide information to allow them to judge its 'fitness for purpose'.[116]

3.2.2.5 Social Health Atlas of Victorian Local Government Areas, 2011

Data Source

The PHIDU was established at The University of Adelaide in 1999. This unit has compiled national, jurisdictional, regional, and local-level data that describes demographic, socioeconomic, health and disability characteristics.[123] PHIDU used Victorian Department of Health information relating to the number of GP services according to the Medicare Benefits Schedule and the Department of Veteran Affairs and Estimated Residential Population data from the ABS to calculate GP numbers and utilisation at the LGA level. This data was used in this program of research. A list of LGAs used in this study can be found in the data dictionary in Appendix Three.

Data Quality

The quality of the original ABS and Department of Health data has already been discussed in other sections of this chapter. PHIDU staff are experienced in health data systems and collection, integration of data collections, development of new information systems, as well as heath research, monitoring and evaluation, health demography and statistics.[124] Upon receipt of data from the various national or jurisdictional bodies (remembering this data has undergone quality assurance measures at this level first), the PHIDU returns to the published databases provided by these bodies and compares the data to those sources.[125]

3.2.2.6 Australian hospital statistics – emergency department care

Data Source

The Australian Institute of Health and Welfare (AIHW) collects statistical data from hospital EDs, including over 6.5 million ED presentations between 2011–2012.[2] Data is gathered from state and territory health authorities and public hospitals. It includes information regarding ED activity, waiting times and time spent in the EDs.[2] Information about the suitability of ED presentations and the number of presentations were taken from this data source.

Data Quality

The AIHW validates the data by consulting with state and territory health authorities and public hospitals.[2] They provide data quality statements in the appendices of the government reports they produce.[126]

3.2.3 Datasets used in each study

The data sources used to generate the results displayed in Chapters Four, Five, and Six are summarised in Table 6.

3.2.4 Data management

All of the data analysed for this program of research was supplied in a de-identified format. In order to comply with privacy legislation requirements, the data was stored in a password-protected computer database accessible only to the researcher and her supervisors. This database was held on a secure file server that is backed up daily to a nearby facility. All data will be retained for a period of seven years from completion date as per the ethics committee approvals.

Table 6: Data sources by study

Study population	Data sources
Study One: Epidemiological review of the Referral Service	
Chapter Four: Cases triaged by the Referral Service between September 2009 and June 2012	**Ambulance Victoria** Care Enhanced Call Centre (CECC) database September 2009-June 2012 **Australian Bureau of Statistics** Local Government Area dataset 2010–2012 **Public Health Information Development Unit** Social Health Atlas Victorian Local Government Areas, 2011 **Department of Health** VAED July 2010 – June 2012
Study Two: The appropriateness of cases presenting in the emergency department following secondary telephone triage: a retrospective cohort study.	
Chapter Five: Cases triaged by the Referral Service between September 2009 and June 2012 which were able to be linked to a VACIS record	**Ambulance Victoria** Care Enhanced Call Centre (CECC) database September 2009 – June 2012 VACIS database September 2009 – December 2012 **Department of Health** VEMD September 2009 – December 2012 VAED September 2009 – December 2012
Study Three: The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage: a retrospective cohort study.	
Chapter Five: Cases triaged by the Referral Service between September 2009 and June 2012 and had a linked VACIS	**Ambulance Victoria** Care Enhanced Call Centre (CECC) database September 2009-June 2012 VACIS database September 2009 – December 2012
Study Four: Case characteristics associated with no paramedic treatment for cases referred to emergency ambulance following secondary telephone triage: a retrospective cohort study.	
Chapter Six: Cases triaged by the Referral Service between September 2009 and June 2012 with a linked VACIS record	**Ambulance Victoria** Care Enhanced Call Centre (CECC) database September 2009 –June 2012 VACIS database September 2009 – December 2012

3.3 Data preparation

3.3.1 Data coding

The data for all of the studies needed to be categorised and coded to allow for particular outcome measures to be analysed and made comparable to other settings and research. Some of the variables listed in Appendix Three had sub-categories created to allow for scaled measurement.

<u>Standard versus researcher defined classification</u>

The table in Appendix Three identifies whether the sub-categories created for the variables were established conventions (standard) or researcher-defined categories. The 'standard' term means that commonly used sub-categories or scales were utilised in these studies without alteration, for example male and female for gender, or triage guideline title. 'Researcher defined' indicates that the researcher devised the sub-categories to best analyse, translate and apply the data. For example, the physiological vital signs variables needed to be applicable to both the ED and AV settings when discussing the appropriateness of particular case presentations. In the ED the medical emergency team (MET) activation criteria have physiological parameters that trigger a medical response, and these criteria vary slightly between hospitals,[127-129] so the most conservative values were used. AV also has physiological parameters that trigger a medical intervention or a flag in the clinical governance process. The physiological parameters used in this study were therefore categorised according to both of these sets of criteria so the results may be applicable to both settings. This means that some of the ranges appear small, such as the SpO_2 (capillary oxygen saturation) range of 90–93%, but this allows for the treatment thresholds for AV (<94%) and for the EDs (MET call at <90%) to be distinguishable.

3.3.2 Data Linkage

The ambulance (Referral Service and VACIS) and hospital (VEMD and VAED) datasets were linked for the studies in Chapters 5 and 6. This allowed for the entire patient journal from ambulance, into the ED and finally hospital admission to be examined (where applicable). A specific patient identifier was not available to conduct the linkage, therefore deterministic data linkage techniques were used for the linkage of the ambulance datasets, and again later for the linkage of the hospital datasets to the linked ambulance datasets. The data linkage process has been outlined in Section 5.3.2. Whilst the linkage processes were successful, the process was more labour intensive with manual quality control conducted to ensure the accuracy of the linkages. This process is further outlined in Section 5.3.2.

3.3.3 Data analysis

Various data analysis techniques were utilised in the studies presented in this thesis:

- systematic review;
- descriptive statistics;
- regression modelling; and
- probabalistic data linkage.

These techniques are further discussed within the respective study chapters and associated publications or manuscripts.

3.4 Ethics approvals

Each study described in this thesis was approved on the 15th March 2012 by the Research Governance Committee of Ambulance Victoria (R11-021) and on the 17th April 2012 by the Monash University Human Research Ethics Committee (CF12/0547 – 2012000215). The Victorian Data Linkage Unit of the Victorian Department of Health accepted these approvals and granted access to their datasets. All datasets used for this program of research were de-identified prior to release to the researchers.

3.5 Summary

This chapter outlines the studies, study setting, and research design used in the studies presented in this thesis. A detailed description of the data sources and quality and the data preparation for the datasets is provided. Further information about the methods employed to examine data within each of the individual studies is provided in the relevant chapters and the associated publications or manuscripts. The following chapters present the analysed data in published or manuscript format or as results sections.

CHAPTER FOUR: EPIDEMIOLOGY OF THE REFERRAL SERVICE

This study describes in detail the operation of the AV RS and the epidemiological characteristics of the cases triaged by the RS during the study timeframe. The systematic review in Chapter Two identified that few studies have been conducted into secondary telephone triage within ambulance services, and no detailed descriptions employing rigorous methodological approaches using large datasets have been published.[30]

This study addresses Objective II of this research:

VI. To produce a detailed description of the Ambulance Victoria Referral Service and conduct a population-based epidemiological study of cases from the Referral Service to:

a. describe the impact of this strategy on the demand for emergency ambulances;

b. describe the patient population;

c. identify the most common patients problems, and;

d. identify the utilisation rates of the final disposition pathways available to the Referral Service call-takers.

This epidemiological review was published as:

Eastwood K, Morgans, A, Smith K, Hodgkinson, A, Becker, G, Stoelwinder J. A novel approach for managing the growing demand for ambulance services by low-acuity patients. *Australian Health Review.* 2015;40(4):378-384.

http://www.publish.csiro.au/AH/AH15134.

4.1 Study 1: Epidemiological review of the Referral Service

Publication 2: A novel approach for managing the growing demand for ambulance services by low-acuity patients

CO-AUTHOR DECLARATION FOR PUBLICATION INCLUDED IN THESIS

Monash University

Eastwood KJ, Morgans A, Smith K, Hodgkinson A, Becker G, Stoelwinder JU. A novel approach for managing the growing demand for ambulance services by low-acuity patients.

Declaration by candidate

In the case of the publication listed above, the nature and extent of my contribution to the work was the following:

Nature of contribution	**Extent of contribution (%)**
Principle author, responsible for literature search, development and writing the manuscript. Responsible author who accepts overall responsibility for the publication.	75

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	**Nature of contribution**	**Extent of contribution (%) for student co-authors only**
Amee Morgans	Contributed to literature searching and editing of the manuscript	N/A
Karen Smith	Contributed to editing of the manuscript	N/A
Angela Hodgkinson	Contributed to editing of the manuscript	N/A
Gareth Becker	Contributed to editing pf the manuscript	N/A
Johannes Stoelwinder	Contributed to editing of the manuscript	N/A

Candidate's Signature		Thursday 20th August 2015

Declaration by co-authors

The undersigned hereby certify that:
(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	**Department of Epidemiology and Preventative Medicine, Monash University**

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department, centre or institute, with specific campus identification where relevant.]

Amee Morgans		**Date** 20/08/2015
Karen Smith		20/08/2015
Angela Hodgkinson		20/08/2015
Gareth Becker		20/08/2015
Johannes Stoelwinder		20/8/2015

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A novel approach for managing the growing demand for ambulance services by low-acuity patients

Kathryn Eastwood[1,2,3] MEmergHealth(MICA), MICA Paramedic and PhD Candidate

Amee Morgans[1] BSc(Hons), PhD, Senior Research Fellow RDNS Institute

Karen Smith[1,2] BSc(Hons), PhD, Associate Professor and Manager Research and Evaluation

Angela Hodgkinson[2] Referral Service Manager

Gareth Becker[2] ALS Paramedic and Referral Service Team Leader (G-PB)

Johannes Stoelwinder[1] MBBS, MD, FRACP, FRACMA, FACHSE, FAFPHM, Professor and Chair of Health Services Management

[1]Department of Epidemiology and Preventative Medicine, The Alfred Centre, Monash University, 99 Commercial Road, Melbourne, Vic. 3004, Australia. Email: amee.morgans@monash.edu; just.stoelwinder@monash.edu

[2]Ambulance Victoria, 31 Joseph Street, Blackburn, Vic. 3130, Australia.
Email: karen.smith@ambulance.vic.gov.au; gareth.becker@ambulance.vic.gov.au; angela.hodgkinson@ambulance.vic.gov.au

[3]Corresponding author. Email: Kathryn.Eastwood@monash.edu

Abstract

Objective. The aim of the present study was to describe the Ambulance Victoria (AV) secondary telephone triage service, called the Referral Service (RS), for low-priority patients calling triple zero. This service provides alternatives to ambulance dispatch, such as doctor or nurse home visits.

Methods. A descriptive epidemiological review of all the cases managed between 2009 and 2012 was conducted, using data from AV case records, the Victorian Admitted Episodes Dataset and the Australian Bureau of Statistics. Cases were reviewed for patient demographics, condition, final disposition and RS outcome.

Results. In all, 107 148 cases were included in the study, accounting for 10.3% of the total calls for ambulance attendance. Median patient age was 54 years and 55% were female. Geographically based socioeconomic status was associated with the rate of calls to the RS ($r = -0.72$; 95% confidence interval CI –0.104, –0.049; $P < 0.001$). Abdominal pain and back symptoms were the most common patient problems. Although 68% of patients were referred to the emergency department, only 27.6% of the total cases were by emergency ambulance; the remainder were diverted to non-emergency ambulance or the patient's own private transport. The remaining 32% of cases were referred to alternative service providers or given home care advice.

Conclusions. This paper describes the use of an ongoing secondary triage service, providing an effective strategy for managing emergency ambulance demand.

What is known about the topic? Some calls to emergency services telephone numbers for ambulance assistance consist of cases deemed to be low-acuity that could potentially be better managed in the primary care setting. The demand on ambulance resources is increasing each year. Secondary telephone triage systems have been trialled in ambulance services in the US and UK with minimal success in terms of overall impact on ambulance resourcing.

What does this paper add? This study describes a model of secondary telephone triage in the ambulance setting that has provided an effective way to divert patients to more suitable forms of health care to meet their needs.

What are the implications for practitioners? The implications for practitioners are vast. Some of the issues that currently face paramedics include: fatigue because of high workloads; skills decay because of a lack of exposure to patients requiring intervention with skills the paramedics have, as well as a lack of time for paramedics to practice these skills during their downtime; and decreasing job satisfaction linked to both these factors. Implications for patients include quicker response times because more ambulances will be available to respond and increased patient safety because of decreased fatigue and higher skill levels in paramedics.

Additional keywords: emergency medical service communication systems, emergency medical services, telephone, triage.

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Introduction

The steady increase in demand ambulance services face includes a substantial proportion of low-acuity clinical conditions.[1–5] Although computer-based ambulance triage systems safely triage patients into high-, medium- and low-acuity categories, the response is typically the same: an ambulance is dispatched.[6,7] With increasing sophistication of prehospital care, this 'one size fits all' response is becoming unsustainable and misallocates skilled resources to low-acuity patients, impacting on the availability and response times for more urgent cases.[6,8–14] Furthermore, transporting low-acuity patients to hospital emergency departments (ED) may delay more appropriate care, such as primary medical or nursing care, from being implemented.

Various secondary telephone triage services have been reported by ambulance services in the UK and US.[14–21] After initial triage categorisation as low-acuity, these services typically provide nurse-led telephone advice and may suggest the patient self-initiate accessing further care. A consensus conference in 2003 on the development of triage criteria and outcome measures to be used to investigate medical necessity in emergency medical services (EMS) made several recommendations relating to triage systems and refusal of care, including that no triage system should refuse care but should offer alternatives to EMS, and this should not be limited to simply offering self-care advice.[22] To date, no literature reporting these alternative services has been identified.

This paper describes the use of a secondary telephone triage service, called the Referral Service (RS), by Ambulance Victoria (AV) to manage low-acuity patients that contact triple zero (000), the national emergency telephone number in Australia.

Through the RS, AV offers a range of complete alternative pathways of clinical assistance in addition to the traditional emergency ambulance. Established low-acuity calls are transferred to a nurse or paramedic for further assessment and, where appropriate, referral to one of a variety of healthcare providers for further medical assessment and intervention. As a result, these patients will be in receipt of more appropriate healthcare services within hours of their initial call for assistance.

Herein we provide a description of the RS over a 34-month period, with data sourced from the RS database and Victorian Department of Health hospital database, covering the following: (1) the caseload compared with the AV workload, and a description of repeat usage management; (2) patient profile, including a demographic profile and description of the most common primary complaints; and (3) the final disposition and RS outcome.

Methods

A descriptive epidemiological review of all the cases sent to the RS from 2009 to 2012 was conducted.

Population and setting

Over the period 2011–12, AV responded to just over 350 000 cases in the metropolitan region.[23] This number increases by approximately 4% per annum.[24,25]

Calls to 000 undergo primary triage by a layperson using a widely used prioritising system that categorises cases into an urgency-based triage category. This system, combined with an AV formulated service allocation matrix, identifies the speed of a response and which paramedic skill level should respond. The first skills tier involves two advanced life support paramedics authorised to undertake tasks such as laryngeal mask airway insertion and intravenous drug delivery. The second tier is an intensive care paramedic (ICP) response with either one or two ICPs authorised to implement additional management strategies, including drug-facilitated endotracheal intubation and a broader range of drugs. Cases are categorised into Code 1 (representing high-acuity cases requiring the quickest response), Code 2 (medium-acuity) and Code 3 (with low-acuity symptoms and the longest acceptable time frame to respond).[26]

Referral service

Established in 2003, the RS operated within metropolitan Melbourne and, in late 2012, commenced its state-wide expansion. The RS operates 24 h a day, 7 days a week with the objective of managing patients who do not require a traditional ambulance response and to better match a clinical service with patient needs.

Suitable low-acuity (Code 3) calls identified during primary triage are either passed directly onto RS call-takers from the 000 call-taker or are called back within a short time frame. At the time of the study, the RS handled 49 different low-acuity event types that historically had low paramedic intervention and conveyance rates to hospital. Nurses or paramedics trained in telephone triage specifically for the RS assess these patients with condition-specific computer-based questioning algorithms contained within the Care Enhanced Call Centre (CECC).[27] As shown in Fig. 1, according to the resulting disposition, the RS call-takers will arrange either emergency ambulance dispatch, non-emergency ambulance dispatch (generally reserved for appointment-based or pre-arranged medical transfers of physiologically stable patients), referral to an alternative service provider (ASP) or self-management advice, including home care or to seek further medical attention independently.

During times of increased ambulance demand, such as natural disasters, the scope of practice of the RS has been expanded to include certain types of medium-acuity cases.

Alternative service providers

One of the features that separates the RS from similar systems trialled overseas is the network of ASPs contracted by AV to provide more appropriate care to low-acuity patients in their homes. The current ASPs include nursing services (including mental health nurses), general practitioner (GP) locum services for home visits to patients outside normal GP surgery hours, crisis assessment and treatment teams that provide 24-h community mental health services, hospital out-reach programs that provide extended business hours services, including nursing and allied health services (e.g. physiotherapists and occupational therapists) that do home visits and other health services, including aged care assessment services, out-of-hospital medical care coordination teams, poisons information, sexual assault medical teams, dental

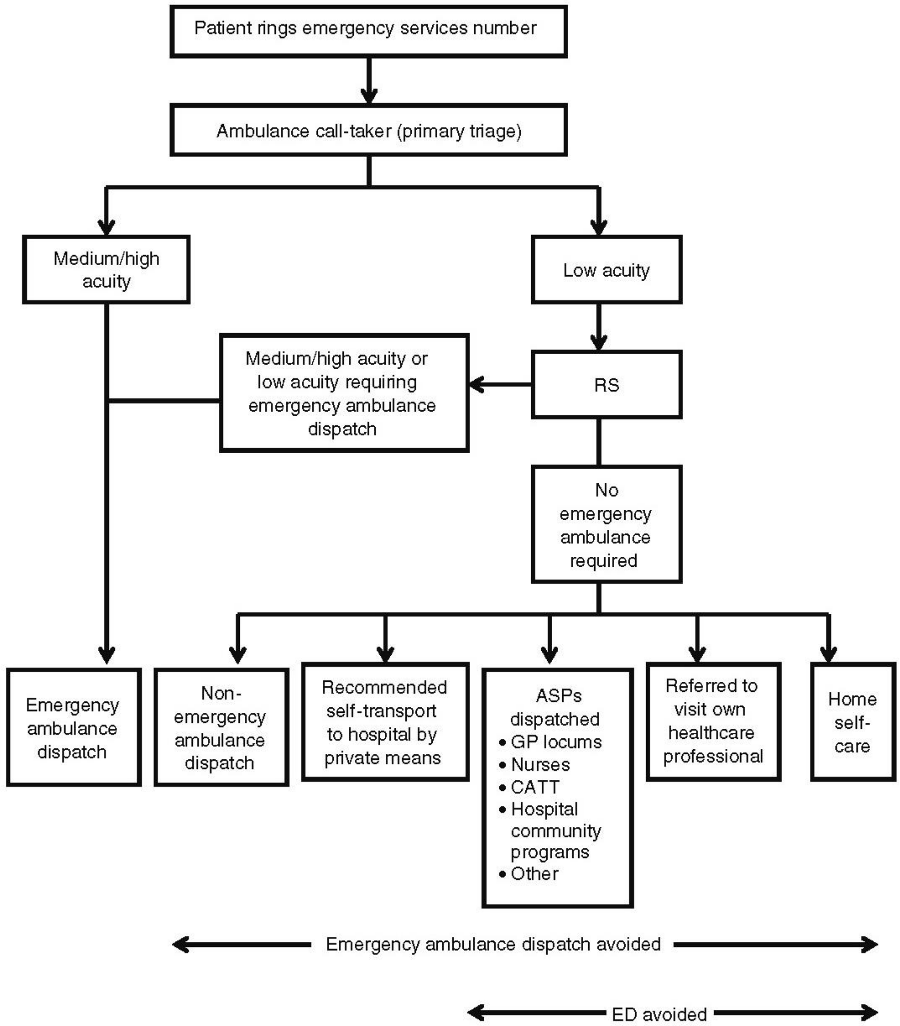

Fig. 1. Case flow from the call to the emergency services to referral service (RS) outcome. ASPs, alternative service providers; GP, general practitioner; CATT, crisis assessment and treatment teams; ED, emergency department.

hospital, drug and alcohol services, community health and well being services, rehabilitation and veteran affairs services.

The cost of some of these services, such as the nursing and locum services, are paid for by AV. Some ASPs bill the publicly funded Australian healthcare scheme, whereas others are free services available to the wider community, and the RS simply makes the connection on the patient's behalf.

RS care plans

As with many services, there can be a cohort of patients with a high frequency of use. Some of this usage is justified, as with patients with significant medical problems requiring specialist medical management. However, there is also a group of patients, many with psychiatric histories, that call for problems that are either inappropriate for the emergency services or that are behavioural problems rather than physical medical issues.

RS care plans are created to manage frequent callers who have a confirmed history of calling for the same condition for which medical management is not required. These plans are created in conjunction with hospitals, the ambulance service and the patient's healthcare providers, including their GP, psychiatrists or psychologists and social workers. The care plans aim to manage the patient within their usual support network of family and healthcare professionals, rather than the emergency healthcare system. When these patients present with conditions that are not among their usual pattern, they are managed according to their presentation.

Data collection and analysis

Data were collected from the CECC database for all cases that underwent a secondary telephone triage by the RS from September 2009 to June 2012. Specific data collected included demographic information, call duration and date, patient medical condition, questioning guideline used, final disposition and RS outcome.

Other datasets used for analysis included the Victorian Admitted Episodes Dataset (VAED),[28] which collects morbidity data on all statewide hospital admissions, and the Australian Bureau of Statistics (ABS) Local Government Area (LGA) dataset (providing municipality-based demographic information). These datasets were accessed for the period 2010–11.[29–31]

From the VAED, data on ambulatory care sensitive conditions (ACSCs) were collected. ACSCs are conditions for which hospitalisation is thought to be avoidable with the application of community interventions and early disease management. The LGA data facilitated comparison of the RS data with several key municipality-based variables, including, median age, socioeconomic status (SES; by using the Index of Relative Socioeconomic Disadvantage (IRSED)[32]), median household income, GP availability and GP visit rates per thousand people.

Data were analysed using descriptive statistics and stepwise regression analyses to identify any relationships between the demographic data and the RS data. Pearson's and Spearman's correlation coefficients and 95% confidence intervals (CIs) are used to describe associations between the variables in the study. All tests were considered to be significant at two-sided $P < 0.05$. All data analysis was performed using SPSS version 20 (IBM Corporation, Armonk, NY, USA) and Microsoft (Redmond, WA, USA) Excel version 14.3.6.

Results

Caseload

There were 1 036 114 calls to 000 in metropolitan Melbourne during the study period. The RS handled 123 458 of these cases (11.9%), of which 107 148 (86.8%) were available for review. The cases that were not available for review ('missing cases') included cases where the ambulance call-taker aborted the process of sending a case for RS triage after they gathered further information, duplicate cases were created when patients rang back to cancel the ASP arranged by the RS and cases in which technical issues were experienced (computer/software issues). No further information was available for these missing cases. These three issues accounted for 13 924 of missing cases (85.4%). The remainder of missing cases were received from rural regions that were not eligible for RS triage ($n = 87$; 0.5%) or were managed during periods when the RS accepted cases outside of the 49 accepted case types sent for RS triage (during incidents such as natural disasters; $n = 2299$; 14.2%).

The mean ($\pm$ s.d.) time for the case to be completely managed by the RS, through to the arrangement of an ASP where indicated, was 7.72 ± 5.00 min (95% CI 7.69–7.75 min).

Frequency of repeat usage

The service was used by 88 247 patients and just over 9000 patients (9.7%) called more than once during the study period. One patient called more than 1000 times, seven called more than 100 times and 36 called more than once a month. At the time of the study there were 256 active care plans.

RS patient profile

Females comprised 55.2% of cases. Patient age ranged from 2 days to 110 years, with a median (interquartile range) age of 54 years (33–76 years).

When divided into LGA municipalities, the number of RS cases ranged from 9.6 to 33.9 cases per 1000 people. LGA and VAED data for age, GP visits per 1000 people, GP numbers per 1000 people, ACSC rate per 1000 people, median household income and IRSED were compared with the number of RS cases per 1000 people in each municipality to determine whether there was a different frequency of usage among the varying measures of social disadvantage. No significant associations were found between each of these variables and RS call rates except for the IRSED category, which exhibited a strong association between decreasing SES and the number of calls to the RS ($r = -0.72$; $P < 0.001$; 95% CI –0.104, –0.049). IRSED accounted for 52.3% of the variability in call rates; when the remaining variables were included in the model, 62% of the variation in call rates to the RS could be accounted for.

Patient condition

There were 343 different CECC-based triage guidelines used to triage the 107 148 cases. Thirteen of these guidelines were used for more than half the cases. The most frequently used guidelines are listed in Table 1, along with the most common RS outcomes of care for patients in these triage guidelines.

Just over 55% of patients within these top 13 conditions or guidelines were referred to the ED (either by emergency or non-emergency ambulance or self-presentation); however, only 13% of these went by emergency ambulance.

RS final disposition

Following secondary triage, 27.6% of cases were returned to emergency dispatch, 18.7% were sent to non-emergency ambulance dispatch, 21.5% were advised to self-present at a local ED, 11% were diverted to ASPs for further management, 2.7% were frequent callers and were managed according to care plans and 17.7% were given self-care advice.

Of the 11% diverted to ASPs, 75.3% were sent a locum GP, followed by 11% who went to nursing services and 6.2% who went to psychiatric services. The remaining cases were distributed among other ASPs.

Discussion

The present study is the first comprehensive report of any secondary triage service within Australia. The RS in metropolitan Melbourne has successfully operated since 2003. In total, it managed 10.3% of the total emergency metropolitan caseload for AV over the period of the study. During this time, the RS diverted 72.4% of the cases it managed away from emergency ambulance dispatch and 32.2% of the cases away from the ED, indicating a potential to impact upon the demand for these services. This impact was seen in an unrelated study, which also noted a reduction in the rate of ambulance

Table 1. Referral service (RS) outcome for the 13 most common triage guidelines
ED, emergency department; ASP, alternative service provider

Triage guideline	% of RS workload	Distribution of cases to RS outcome (%) Emergency ambulance dispatch	Non-emergency ambulance dispatch	ED	ASP	Care plan	Home care	Other	Total
Abdominal pain or discomfort	12.0	37.2	10.7	38.0	3.9	0.1	9.4	0.7	100
Back symptoms (upper or lower)	11.8	22.3	38.8	12.5	13.5	0.1	12.3	0.5	100
Nausea or vomiting	5.5	24.8	14.7	19.0	17.0	0.1	23.8	0.6	100
Dizziness or vertigo	5.0	34.4	9.7	11.3	20.8	0.1	23.4	0.3	100
Frequent caller	3.7	1.3	0.7	1.8	5.8	68.3	20.7	1.4	100
Weakness or paralysis	2.7	35.7	32.9	9.5	12.3	0.1	9.2	0.3	100
Fever	2.6	39.7	15.7	22.6	8.0	0.1	13.5	0.4	100
Flank pain	2.4	32.8	11.3	40.9	6.3	0.0	8.1	0.6	100
Urinary symptoms or prostate problems	2.4	13.4	37.8	22.5	18.4	0.0	7.6	0.3	100
Lower leg, non-injury	2.3	15.4	40.8	16.9	11.3	0.0	14.6	1.0	100
Headache	2.1	43.6	7.4	23.9	11.2	0.0	13.1	0.7	100
Diarrhoea or change in bowel habits	2.0	16.6	24.0	18.4	17.3	0.1	23.1	0.5	100
No suitable guideline or reference (adult)	2.0	26.9	25.0	12.6	11.7	0.5	19.8	3.5	100
Total	56.5								

transports to the ED attributed to the implementation of the RS in Melbourne.[24]

The mean RS management time of 7.72 min was important for cases identified by the RS call-takers as requiring emergency ambulance dispatch, because there would still be sufficient time to dispatch an emergency ambulance within the 30 min time frame required under the current system from the time of the patients original call to triple zero to the dispatch of an ambulance. Therefore, these cases were not subject to a delay that would have been perceived as a risk to patient welfare under the current system and they have had the additional benefit of being subject to an initial assessment by a healthcare professional.

The link between low SES and poor health has been well established,[33,34] as has the link between low SES and increased medical services use, including ambulance, ED and other primary healthcare services.[33,35–37] The results of the present study support these links, demonstrating that areas of lower SES were associated with higher RS workload. Combined, all the LGA characteristics investigated explained 62% of the variability in RS demand; however, 52.3% of this variability was explained by socioeconomic status (IRSED) alone. This was the only characteristic to have a significant effect on demand ($r = -0.72$; $P < 0.001$; 95% CI –0.104, –0.049). When planning similar referral services, local healthcare services should be involved to ensure there are accessible and sufficient alternative care services, particularly in areas of low SES.

Other studies of ambulance-based secondary telephone triage services have found that abdominal pain and back pain were among the most frequent patient conditions.[16,17,38] This was reflected in the present study with abdominal pain and back pain accounting for over 23% of cases. The complexity in providing a telephone assessment of abdominal pain cases is represented in the rate of ED presentation recommendations for these cases. The logistical management issues of back pain cases where mobilising the patient is often the problem for those calling triple zero also results in high return rates for analgesia, lifting assistance and stretcher transport. In association with a further 11 conditions, 56% of the RS workload was accounted for. The frequent caller guideline was among the top 13 guidelines used, giving an indication of the volume of work these callers present to AV on a daily basis.

The level of success of this secondary triage service has not been reflected in trials conducted elsewhere in various ambulance services.[14,16,17,19,38,39] However, those systems have not been equipped with the variety of ASPs used by the RS. In the present study, 78.8% of patients still received a clinical assessment, but only 27.6% received such a clinical assessment from an emergency ambulance paramedic. The RS used clinical resources contracted to AV to ensure that patients were in receipt of the most appropriate care for their current condition. This potentially had a positive effect on the call-takers' confidence in diverting cases away from an ambulance.

In the US and UK, it was found that many patients who used a similar referral service rang for advice and direction on where to access help, rather than for an emergency ambulance response.[17,39] The authors also speculated that patients use the emergency telephone line as a first point of contact, rather than attempting to access this information through their GP.[17] However, this must be taken in the context of the system in place in the US, because the patients surveyed in that study[17] also commented on the cost of an ED visit, whereas both the RS and a public ED do not charge for these services in Australia. Nonetheless, systems such as the RS do have the potential to build a 'customer base' rather than simply dealing with low-acuity emergency services calls, and this effect of potentially recruiting a new customer base needs to be weighed against its effect in managing the current demand.

The increasing scope of the RS during times of increased demand indicates that there is potential for the RS to further impact on AV workload and ED presentations.

The generalisability of such a service would be dependent on the type of healthcare system a region has in place. The RS described herein is successful in its setting because of the publicly funded healthcare scheme and a single ambulance provider. User-pays systems may have different outcomes based on the cost of EDs and ASPs.

The present study assumed that when an emergency ambulance was dispatched to a case following RS triage, the patient was transported to hospital. This was not necessarily the case and some of these patients may have remained at home following paramedic assessment.

Conclusion

This paper provides a detailed description of a sustainable secondary triage service operating in Melbourne, Australia. The service has been found to have a meaningful effect on the way calls for emergency ambulances are managed and the findings of the study indicate that the provision of alternative services to patients is a key area in ensuring the success of such a system compared with similar systems internationally.

Further research is required into the potential for systems such as the RS described herein to build a 'customer base', rather than simply managing selected cases following a call for an emergency ambulance. The overall accuracy of the secondary triage requires validation and, finally, a financial evaluation should be performed to determine the economic impact on the ambulance service and EDs.

Competing interests

KJE has previously worked for the RS and is currently an intensive care paramedic with AV. JS was the Chair of the AV Board, AH is the manager of the RS and GB is currently employed by the AV RS.

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Please refer to Appendix Four for a supplemental flowchart outlining cohort populations for RS care pathways.

4.2 Summary

The article presented above is the first detailed description of an ambulance-based secondary telephone triage system operating successfully in Australia. It is the first known study to use a large population to epidemiologically describe the patients involved in secondary telephone triage, their health problems and disposition outcomes, and the impact of secondary telephone triage upon emergency ambulance demand. It is also the first study to identify how an ambulance service can employ secondary telephone triage to manage patients with a high frequency of inappropriate ambulance usage. This study addressed the second objective of this program of research – to describe the RS and the characteristics of the cases it manages.

Like the secondary telephone triage services identified in the systematic review[30] (Chapter Two), the RS refers a proportion of its workload back to emergency ambulance or the ED. Referral Service cases that return to the emergency care pathways needed to be further investigated to determine whether the secondary triage system was correctly identifying cases appropriate for this pathway. Furthermore, the system needed to be studied to determine whether it is an appropriate safety net for the primary triage process by identifying medium- or high-acuity patients accurately, as well as low-acuity patients who need paramedic or hospital care. Hence, the studies described in Chapter Five used data linkage to investigate the cases that were referred to the emergency care pathways, or that presented at the ED, to reflect upon the appropriateness of AV RS triaging.

CHAPTER FIVE: APPROPRIATENESS OF THE REFERRAL OF CASES TO EMERGENCY CARE PATHWAYS FOLLOWING SECONDARY TELEPHONE TRIAGE

This chapter explores the appropriateness of cases presenting in the ED and referred for emergency ambulance dispatch following the AV RS secondary telephone triage.

The value of ambulance-based secondary telephone triage systems lies in identifying suitable care pathways. Diverting cases requiring emergency care away from emergency care pathways (undertriaging) risks their safety. Similarly, referring cases to emergency care pathways that could have been effectively managed by other pathways (overtriaging) compromises effectiveness of secondary triage, strains resources and potentially prolongs response times to patients requiring urgent care. Overtriage is of little benefit to low-acuity patients, and can contribute to a delay in definitive care (e.g. referral to a GP for antibiotics for a chest infection versus emergency ambulance attendance where no such treatment would be given).[130,131] Therefore, identifying whether the RS appropriately allocates cases to care pathways provides valuable information about the safety and effectiveness of this process, and can guide the improvement and development of the secondary triage tool and call-taker decision-making.

This chapter addresses Objectives III and IV of this thesis:

III. *To conduct large-scale data linkage between secondary telephone triage patient records, paramedic care records, emergency department and hospital admission records.*

IV. *To utilise the linked data to investigate the appropriateness of the referral of cases to the following emergency care pathways:*

  a. The emergency department (via emergency ambulance, non-emergency ambulance or via self-presentation);

  b. Emergency ambulance.

This chapter begins with a brief history and description of measures of appropriateness in the healthcare setting and a review of the current literature. This is followed by an article and manuscript describing studies that make a useful contribution to knowledge and address some of the limitations identified in the previous research.

5.1 Appropriateness in healthcare

The concept of the appropriateness of healthcare arose in the 1980s, when variations in the delivery of care interventions were identified based on geographical location.[132,133] This raised the question of whether inappropriate care was being delivered in some areas.[133] In order to answer this question researchers developed methods of appropriateness evaluation, focused primarily on procedural appropriateness.[132,134] The broader definition of appropriateness, however, has failed to develop to the same extent as many of the evaluation methods[132] and to date there is no standard operational definition.[135] Appropriateness of health care is generally defined as care that has a positive effect upon a patient's health,[132,135] but this does not take into account societal and economic factors. Another, broader definition is 'the outcomes of a process of decision-making that maximises net individual health, within society's available resources'.[136] Furthermore, some have suggested that the patient perspective on 'the desirability of care' should be included;[137] and doing so would tailor 'appropriate' care to a patient's individual views and beliefs, and consider' the patients quality of life.[137,138] Finally, when formulating a definition the term 'appropriateness' has been linked with terms in the literature such as 'medical necessity' and 'critical services'.[135] Here, the definition of appropriateness focuses on service provision: 'medically necessary services are those that a patient needs to avoid a negative health consequence.'[135,139,140]

All of these definitions essentially present a threshold beyond which a patient's care episode would be considered appropriate. The Canadian Medical Association definition provides a range within which a patient's care would be considered appropriate. This definition states that care should be 'provided by the right providers, to the right patient, in the right place, at the right time, resulting in optimal quality of care.'[141] Unlike the other definitions, this allows for the overuse of resources to be eliminated from what is considered appropriate, by recommending the care provider or resources are neither under- or over-qualified or equipped to provide the care.

Emergency departments contain the resources and skills to provide care to almost all patients who present, but many of these cases could also be managed effectively in the primary care setting.[142] Emergency ambulance paramedics, on the other hand, have a narrower skill set primarily focused upon the emergency management of life-threatening medical or trauma events, including urgent medical transport.[34] Whilst they are able to manage many non-life threatening situations, many of these cases could also be better managed in the primary care setting.

One of the major issues facing appropriateness studies is the lack of a standard set of criteria for appropriateness. What is considered appropriate varies for each healthcare service, including ambulance services and EDs; it also differs between ambulance services and between EDs depending on their skill sets and resources. Therefore, studies into the appropriateness of health services often produce results that are applicable only to the local setting. To address this deficiency, research methods should be replicable and applicable to different settings.

As noted earlier, to date methodological development in the evaluation of appropriateness has predominantly been limited to procedural appropriateness.[132,134] Methodologies assessing appropriateness are generally devised on an ad hoc basis. Expert opinion is popular, but this approach often involves experts who are not familiar with the field (e.g., ED physicians commenting on prehospital emergency ambulance settings) and is based on retrospective patient records review where all the patient information and outcomes are provided. Moreover, this approach is often laborious, consensus is often lacking, and the findings can contradict evidence from other methods and systematic reviews.[68] In this chapter, an alternative methodological approach is proposed which is less labour intensive, less prone to the opinion-based bias of experts, and can be reproduced in different systems, allowing for local generalisability and comparisons across systems.

5.1.1 Emergency ambulance appropriateness

Cases considered inappropriate for emergency ambulance dispatch have generally been defined as cases that do not require the specific skills or resources provided by emergency ambulance services.[13,40,41,58,143] Defining these specific skills and resources has proven more complex. A conference convened in 2003 specifically to identify criteria for medical necessity in EMS was unable to reach consensus when attempting to define criteria for EMS dispatch treatment and transport;[144] however, a range of measures were identified that could be useful in the retrospective assessment of medical necessity for emergency ambulances. These were:

- patient vital signs;
- patient pain score;
- protective interventions (e.g., spinal immobilisation);
- use of critical care skills or medications;
- federal (United States) definition of medical necessity; and
- ongoing assessment and monitoring during transportation.

Not all of these measures are suitable for all settings; for example, in Australia there is no single definition for medical necessity. Furthermore, the healthcare system in which an EMS system is embedded will dictate, to some extent, the breadth of service required from emergency ambulances to service the community. As outlined in the epidemiological review in Chapter Four, AV is supported by a fleet of non-emergency ambulances, in addition to other primary healthcare setting resources. Therefore, in Victoria, Australia, some of the measures identified during the conference, such as ongoing assessment and monitoring and the use of protective interventions, can be used by non-emergency ambulance services.

Critical care skills, or ALS interventions, have been used in some studies to identify cases in which an emergency ambulance staffed with ALS-qualified paramedics was unnecessary.[9,38,89,90,145-150] Another study used 'non-transportation by ambulance' outcomes to retrospectively identify primary triage protocols where an emergency ambulance was not necessary,[151] and Dale et al. reported on paramedic transport in their assessment of ambulance-based secondary telephone triage.[19] Other studies have used paramedic, doctor or nurse opinion to determine ambulance appropriateness based on patient history and presentation,[51,56,58-60,68,74] and ED triage or ED diagnosis have also been used to identify cases considered inappropriate for emergency ambulance attendance.[57,61,152] These studies have been primarily focused upon the primary triage of cases and have had some success in validating primary triage protocols for the identification of high and low-acuity cases.[9,90,148-150,152] Measures of ED appropriateness have not been reliable in determining emergency ambulance appropriateness,[19,74] and do not specifically relate to the function of the emergency ambulance in the community.

This chapter describes paramedic treatment, paramedic transport and patient presentation for assessing the appropriateness of referral for an emergency ambulance dispatch. No studies to date have combined all of these measures to assess the appropriateness of ambulance-based secondary telephone triage services.

5.1.2 Emergency department appropriateness (ED suitability)

Previous researchers used various methods of assessing ED suitability, ranging from simple single-item measures such as hospital admission[153] through to combinations of variables including patient signs and symptoms, ED triage category, ED treatments, final ED diagnosis, death, referral by a GP, need for immediate ED treatment, wait time to treatment, length of stay, and potential for treatment in the primary care setting.[154,155] Some of these variables have set criteria assigned whilst other are based on ED staff or researcher opinion.[154] The range of variables used and multiplicity of criteria for assessing appropriateness using these variables has resulted in some contention about the volume and impact of inappropriate cases, with studies reporting 5–82% of cases being inappropriate for the ED.[156-158]

Whilst the studies in this chapter's literature review (Section 5.2) reported hospital admission rates were higher in the cases triaged as requiring an emergency ambulance, the authors were not using this measure to evaluate the ED suitability of these cases. Instead, this outcome measure was reported to support the secondary telephone triage decision to refer cases to the 'ambulance required', or 'no ambulance required' care pathways.[19,20] Therefore no studies have specifically investigated the ED suitability of cases referred to the ED following secondary telephone triage.

The ED suitability measure used in this program of research was a modification of the 'potentially avoidable GP-type presentation' measure used by the Australian Government for ED presentations that are considered avoidable had an appropriate community-based service been accessed.[2] A 'potentially avoidable GP-type presentation' is an ED presentation in which the patient:

- was triaged as a category 4 or 5 according to the Australasian Triage Scale (ATS);[159]
- did not arrive by ambulance;
- was not admitted to the hospital, referred to another hospital, and
- did not die.[2]

The ATS is used in Australian EDs to categories patients into one of five categories as follows:

- category 1 –immediately life-threatening, to be seen immediately;
- category 2 –imminently life-threatening, to be seen within 10 minutes;
- category 3 –potentially life-threatening, important time-critical treatment or severe pain, to be seen within 30 minutes;
- category 4 –potentially life-serious, situational urgency or significant complexity, to be seen within 60 minutes; and
- category 5 –less urgent, to be seen within 120 minutes.

For the research conducted in this program of research, the ambulance arrival criterion was removed from the 'potentially avoidable GP-type presentation' and the modified measure was then referred to as 'ED suitability'. This measure was chosen as it uses data collected by all public hospital EDs in Australia, and many EDs internationally use similar triage scales, allowing this measure to be applied in local analysis elsewhere. In addition, the data for this measure is collected during the patient's episode of care, rather than for a study, removing any potential bias introduced by specific study objectives. Finally, the fact that it is multifaceted, and depends upon established criteria rather than physician preference, makes it a measure that can be more reliably used in studies of ED suitability.

5.2 Review of the literature

To date, only two studies have investigated the appropriateness of ambulance-based secondary telephone triage to allocate cases to care pathways. Dale et al. measured the appropriateness of referring patients to the 'ambulance required' or 'no ambulance required' pathways, using paramedic conveyance rate and hospital admission or referral to an outpatient clinic.[19] Studnek et al. used hospital admission to compare the appropriateness of the triage to the 'immediate care required' group or the 'delayed care required' group.[20] Both of these studies initially avoided the use of expert opinion, however one used it in an extension of their original study to assess the appropriateness of the triage to the 'no ambulance required' group.[22]

The secondary telephone triage systems investigated were being trialled in both settings and were therefore accompanied by a concurrent emergency ambulance dispatch to avoid any detrimental delays to patient care. In both studies the patients had an opportunity to decline the emergency ambulance response following the secondary telephone triage, and 9.8% (n=62) were reported to have done so in one of the studies prior to the arrival of the ambulance.[19]

Dale et al. found that patients classified as requiring an ambulance were more likely to be transported to the ED (Table 7).[19] Of the cases that were transported to the ED, those identified as not requiring an ambulance were less likely to be admitted[19,20] or receive a referral to an outpatient clinic and were more likely to be discharged from the ED (Table 7).[19] Dale et al. acknowledged that while their results achieved statistical significance, the groups displayed little clinical difference.[19] Both studies concluded that secondary telephone triage allowed identification of patients who were less likely to require ED care or hospital admission.[19,20]

Table 7: Results of the analysis of linked data following secondary telephone triage

	Triaged to ambulance/ immediate care	No transportation			Admitted			Referral to an outpatient clinic		
		Triaged as requiring an ambulance	Triaged as not requiring an ambulance[2]		Triaged as requiring an ambulance	Triaged as not requiring an ambulance		Triaged as requiring an ambulance	Triaged as not requiring an ambulance[1]	
Dale et al. 2003	48% (n=305)	18.1% (n=55)	36.6% (n=119)	OR 2.62; 95% CI 1.78-3.85	15.5% (n=47)	9.2% (n=30)	p<0.05	9.9% (n=30)	4.0% (n=13)	p<0.05
Studnek et al. 2012	71.3% (n=378)	No transportation used as an exclusion criteria			29.1% (n=110)	15.8% (n=24)	p<0.01			

[2] All cases in both studies were dispatched an ambulance irrespective of the secondary telephone triage outcomes during the trials. Patients had the opportunity to cancel their request for an ambulance at the end of the triage; therefore, cases were only theoretically grouped as 'not requiring an ambulance' following secondary triage.

5.2.1 Critique of the literature

The instrument used to assess the methodological quality of these studies is described in the systematic review in Chapter Two. Briefly, a five-level instrument was used. Quality levels one and two characterise prospective studies that use random or consecutive sampling and well-defined outcome measures.[143] Quality level one studies have larger sample sizes producing narrower confidence intervals and better generalisability. Quality three level studies only differ in that they have a retrospective study design. Quality level four studies use sampling measures that have potential to introduce bias, and quality level five studies lack clearly defined or validated outcome measures.[143]

Dale et al.'s pragmatic controlled trial was rated at level two for methodological quality because it was prospective and had clearly defined outcome measures.[19,94] Studnek et al.'s study was rated level four because it was retrospective and used convenience sampling.[20,94] Both studies had small populations – 635 and 530 patients respectively.[19,20] Dale et al.'s extended analysis of 231 cases was rated level three, because it was retrospective and had a small sample size.[22]

These studies predominantly used hospital outcomes to assess the appropriateness of referral to the emergency ambulance dispatch pathway. This 'appropriateness construct' has been criticised for not being able to demonstrate the 'need' for these services,[160] and Dale et al. did acknowledge that hospital admission does not necessarily mean the triage decision to refer the patient to the emergency ambulance was correct, or that the patient required an emergency ambulance in the interim.[19]

The authors acknowledged several major limitations. Dale et al. noted that the call-takers conducted the secondary triage in the knowledge that an emergency ambulance was concurrently being dispatched, potentially influencing the triage process through the removal of any risk;[19] this was also the case for the study by Studnek et al.[20] The emergency ambulance often arrived whilst the secondary telephone triage was still being conducted, potentially influencing the final dispositions.[19,20] Neither study sought outcome data for patients not transported by emergency ambulance following secondary telephone triage,[19,20] so it was not known if these cases were appropriately allocated to this pathway. Both studies stated that not all of the eligible cases had a secondary telephone triage,[19,20] which may have introduced sampling bias to the study. Moreover, Dale et al identified that in some instances, the primary call-taker opted not to transfer some cases to the secondary triage call-taker, and other times the latter was busy with other calls.[19] Studnek et al. cited technical difficulties and patient refusal as reasons for some eligible cases not being transferred.

The timing of the data collection affected both studies. Dale et al. abandoned an attempt to randomly allocate four-hour time periods to nurse assessment, paramedic assessment or a control period because of staff availability,[19] instead attempting to match the timing of the intervention and control sessions across the data collection period.[19] They later noted that the different qualifications and telephone triage experience may have influenced the triage decision making outcomes.[19] Studnek et al. conducted their data collection in two phases lasting 12 months and 10 months, with the secondary telephone triage intervention occurring during phase two. During the seven-month gap between phases a newer version of the MPDS was introduced, which the authors state 'directly affected the classification of low-acuity' calls and was therefore likely to have accounted for the decreased hospital admissions in phase two. They also expanded the eligibility criteria for phase two by including cases transported to seven hospitals in the catchment area rather than four in phase one.

The gap in the evidence regarding the appropriateness of ambulance-based secondary telephone triage is clear. No large-scale studies, using rigorous, locally reproducible methodologies have been conducted. No previous researchers have investigated the appropriateness of secondary telephone triage cases for emergency ambulance dispatch, or for the ED using ED measures beyond forward referral, admission or discharge. The epidemiological review in Chapter Four found that the RS referred 27.6% (n=29,579) of the cases it managed between September 2009 and June 2012 back to emergency ambulances, and 67.8% (n=72,646) to the ED. It also showed that some of the cases referred to emergency ambulance were referred as medium and high-acuity cases requiring more expedient ambulance dispatch. The appropriateness of these triage decisions has never been investigated.

The studies presented in this chapter used the measures of appropriateness discussed in Section 5.3.4 and in the publication in Section 5.4.2 in a large-scale investigation of the appropriateness of the presentation of cases in the ED following secondary telephone triage (Study Two), and then in an investigation of cases specifically referred to the emergency ambulance dispatch pathway (Study Three) (Figure 6). Both studies address evidence gaps identified in the literature around the effectiveness and appropriateness of prehospital triage systems, and more specifically secondary telephone triage systems in EMS.[19,20,33]

Figure 6: Referral Service case flow and service provision outcome pathways

5.3 Methodological approach

The study design, setting, data sources and data preparation were the same for both of the studies detailed in this chapter and are specified in Sections 3.1, 3.2 and 3.3 respectively in Chapter Three. Briefly, the researcher conducted retrospective analyses of patient-based ambulance and hospital data. Paramedic records (VACIS/ ePCR records), ED (VEMD) and admission (VAED) records were linked to RS case records (CECC) that occurred in metropolitan Melbourne between September 2009 and June 2012. Australian hospital statistics data and AV treatment and transport statistics were also used in these studies.

The initial general dataset preparation for both studies is outlined below. Further details about the methodological approaches in the individual studies is given within the relevant sections in this chapter.

5.3.1 General dataset preparation

The epidemiological dataset described in Chapter Four was utilised for this analysis, however the data underwent further cleaning to eliminate cases in which a patient used the RS on more than one occasion in a single day. An example is when a triaged patient calls again to cancel a response, such as when a home visit from a doctor has been arranged; this patient may be re-triaged to ensure no new symptoms requiring attention have arisen before their disposition is changed. Therefore, where a patient had multiple CECC records on a single day for the same problem, only the records with outcomes that were implemented were retained. This resulted in 3,380 cases being removed from the dataset, leaving 103,768 cases available for data linkage and analysis.

5.3.2 Data linkage

The data linkage process involved linkage to four datasets to allow for the full patient encounter to be examined, from the RS call to the hospital admission (if applicable). As depicted in Figure 7, some cases involved records from each dataset, while others appeared in fewer datasets. No assessment of individual patients occurred.

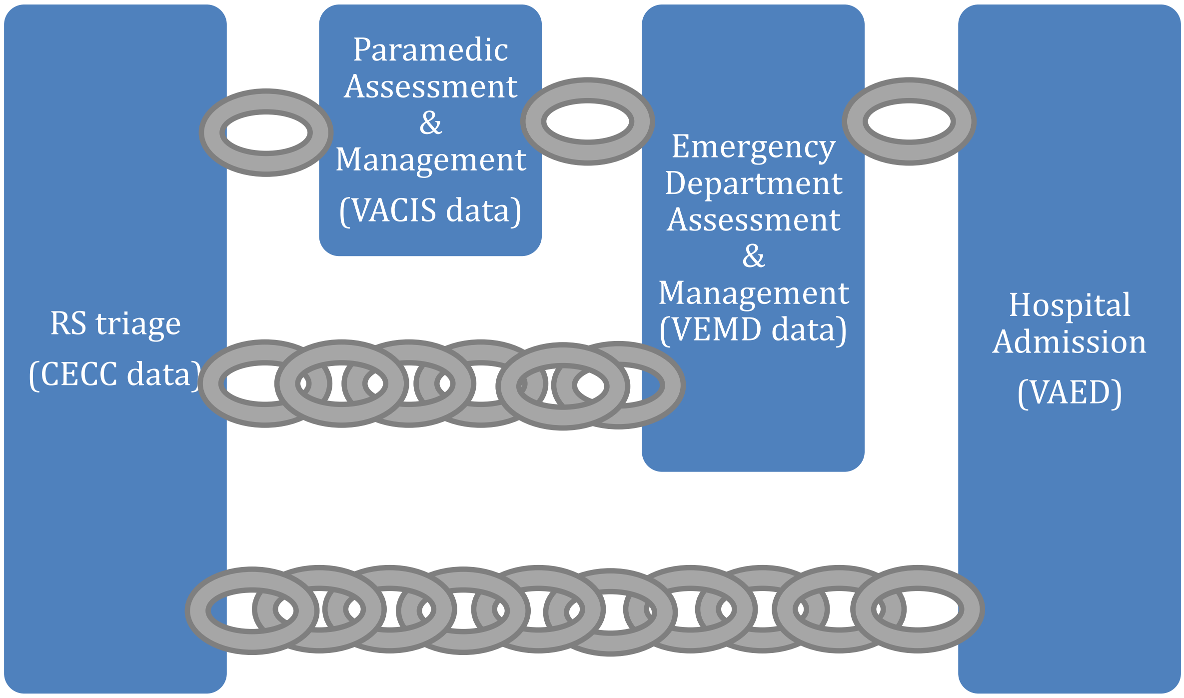

Figure 7: Data linkage

An iterative deterministic data linkage was used to link the AV datasets.[161] Deterministic data linkage involves an exact match between two records using one or more identifiers.[161] Iterative deterministic data linkage is a process of stepwise data linkage whereby the records are matched using identifier combinations that are progressively less restrictive.[161]

5.3.2.1 CECC-VACIS Linkage

The researcher linked the ambulance datasets (the CECC and VACIS datasets). No common patient-specific identifier existed in the datasets that allowed for direct linkage of the de-identified CECC and VACIS cases. Instead, case numbers and case dates were used to conduct the linkage in the primary linkage stages. When calling triple zero, each case is allocated a case number which is unique to that case on that day; at midnight the case numbering resets. This combination of case number and case date was the only case-specific identifier available to aid in the linkage process. When cases are referred for emergency ambulance dispatch following secondary telephone triage, the case number is manually entered into the CECC record, therefore allowing for transcription and omission errors to occur.

SPSS was used to conduct the iterative deterministic data linkage. All of the variables in each step needed to exactly match in order for a linkage to occur. Each subsequent linkage step used a different combination of variables to identify potential linkages. These steps are:

1. case date, case number, date of birth (DOB), gender = 18,889 linkages
2. case date case number, DOB = 413 linkages
3. case date, case number, suburb, age = 951 linkages
4. case date, case number, suburb, gender = 758 linkages
5. case date, case number, age, gender = 732 linkages
6. case date, case number = 790 linkages
7. case date, DOB, suburb, gender, age = 754 linkages
8. case date, DOB, suburb, gender = 29 linkages
9. case date, DOB, gender = 600 linkages
10. case date, suburb, age, gender = 41 linkages
11. case number, date of birth, gender = 283 linkages (this allowed for cases crossing over midnight, i.e., cases that had concurrent dates recorded)
12. manual search on case date, age, time of call, presenting problem = 65 linkages

There were 25,670 VACIS case records that should have had associated CECC records. This process linked 24,305 cases, or 94.7% of all eligible ambulance case records. This included all cases that had a VACIS record within 48 hours of the CECC case date, irrespective of whether they were referred for emergency ambulance dispatch following secondary telephone triage.

The accuracy of each linkage was checked in all of these deterministic matching exercises. The quality of the first seven linkage exercises was high, as the case numbers are unique to a single case within each 24-hour period. Even so, these variables were not used in isolation until the sixth round of deterministic matching. Case date was removed in one linkage step (step 11) as some cases that were triaged by the RS before midnight went on to have a paramedic record generated after midnight. This linkage step allowed for these cases to be identified by their case number, date of birth and gender. As case numbers are allocated throughout the day, the number rises. A high case number immediately after midnight was a flag that the case may have been from the previous date. These cases were subject to the verification process described below to ensure correct linkage.

The process of ensuring accuracy was further supported by calculating the time difference between the CECC record and the VACIS records. Any linked records time-stamped more than 90 minutes apart were manually checked. This process involved using the urgency code assigned by the RS call-taker, the main presenting problem and the free-text to confirm the match. One error was found in the seventh round of linking, involving a patient who was seen by paramedics, transported to hospital and then after returning home from hospital later that day, called triple zero and received a RS triage. This linkage was removed, as the VACIS record occurred before the secondary triage. Two other cases appeared to involve the same patient, but this could not be confirmed using the extra variables listed above, so the linkages were removed. The 8th and 10th round of linking had no linkage errors. The 9th and 11th linkage check identified four cases that could not be confirmed as correct due to insufficient data, so the linkages were removed. The 12th and final round was a manual matching round and all cases were therefore individually assessed. This process resulted in seven linkages within the entire linkage process that could not be verified as a true match (0.0003% error rate); these were removed.

5.3.2.2 CECC-VACIS dataset linkage to VEMD and VAED data

To preserve the highest standards of patient confidentiality and anonymity this deterministic data linkage was conducted by the Victorian Data Linkage unit (VDL)[162] at the Department of Health. The linked ambulance datasets were provided to the VDL with the variables listed in Appendix Two (Table One) as potentially suitable to be used in a deterministic data linkage process.

The results of the linkage are shown in **Error! Reference source not found.**. A 100% linkage rate was not the expected outcome, as researchers calculated that 16.2% of cases were not transported to hospital following paramedic assessment, and 9.8% of cases were transported to private hospital EDs, thereby not generating an ED record (or if transported to a private hospital, not generating an ED record that is collected for the VEMD). Accounting for these cases, 97.6% of the CECC-VACIS linked cases were explained.

It was expected that up to 42,562 cases (56.8% of the CECC records provided to the VDL) would have a corresponding ED record. However attendance at private hospitals (which do not provide ED data for the VEMD dataset), potential non-compliance with triage recommendations and administrative errors meant that only 32.6% were linked to an ED and 18.9% to a hospital admission record.

Table 8: Data linkage results from the VDL

Patient Group	Destination hospital type	Overall case no.	VEMD linkage (n)	VEMD linkage (%)	VAED linkage (n)	VAED linkage (%)
Transported by emergency ambulance (CECC–VACIS data)	Public hospitals	25,431	18,578	79.3	11,520	45.3
All other care pathways (CECC only)	All	74,946	24,405	32.6	14,184	18.9

5.3.3 Definitions

Three emergency care pathways ultimately resulted in an emergency ambulance response or ED presentation. These were the 'emergency ambulance dispatch', 'non-emergency ambulance dispatch' and 'self-presentation at the ED' pathways. The alternative care pathways consisted of cases triaged to ASP or 'self-care advice' pathways (see Figure 3).

5.3.4 Additional outcome measures

Two further variables were included in the studies presented in this chapter: ED treatment and the patient's main presenting problem. ED treatment was not reported on in the manuscript because ED treatment strategies can vary depending on the hospital and medical staff even within the local setting. Nonetheless, this variable was included in a supplementary analysis to provide baseline data on the ED treatment rates of RS cases entering the ED. The main presenting problem was included in the primary and supplementary analyses to provide further information about the appropriateness of ED presentation and emergency ambulance dispatch.

5.3.4.1 ED treatment

The VEMD includes data on all procedures and treatment provided in each episode of care in the ED (see the Data Dictionary in Appendix Two for the full VEMD list). For the purposes of this study, any case with a procedure assigned in the VEMD dataset was considered to have received ED treatment. This variable is not reported upon in the Australian Hospital Statistics,[2] so comparison to all Victorian ED presentations was possible.

5.3.4.2 Main presenting problem

The RS call-taker must identify the main presenting problem for the patient when commencing triage process. During the study timeframe the RS had 343 triage guidelines, each specifically relating to a particular main presenting problem. Once the main presenting problem is identified, the call-taker selects the most appropriate triage guideline to guide the triage. Triage guideline titles were used to allocate cases to a main presenting problem.

The ED diagnoses are classified in the VEMD according to the International Classification of Diseases Version 10 Australian Modification (ICD-10-AM) at the completion of patient care. Up to three diagnoses can be entered, but for this study only the primary entry was analysed as it was assumed that this was the primary reason for the patient presentation. In total, 740 different ICD-10-AM codes were used for the study. Almost twice as many ED diagnoses were available as RS presenting problems, and the ED diagnoses were more specific, meaning that chest pain or discomfort for the RS could have been diagnosed as several different ICD-10-AM codes depending on the ED investigation outcomes.

The linkage of the data allowed for the main presenting problem allocated during the RS triage to be compared to the ED diagnosis. Only aggregate data pertaining to the main presenting problems and ED diagnoses were used. Further information relating to the specific data preparation, definitions, outcome measures and methodological approaches is provided in each of the relevant sections and associated publications or manuscripts in this chapter.

Study Two: Appropriateness of Referral Service triage to the emergency department

This study addressed Objective IV-a by investigating the appropriateness of cases presenting to the ED following secondary telephone triage. It used the ED suitability outcome measure and hospital admission as an isolated outcome measure to allow for comparison to previous studies of ambulance-based secondary telephone triage.

The ED suitability and hospital admission rates of cases in the emergency care pathways (planned ED presentations) were compared to cases from the alternative care pathways that presented at the ED within 48 hours of their secondary telephone triage (unplanned ED presentations) (Figure 6). Then the ED suitability, ED treatment and hospital admission for each pathway within the planned ED presentations (emergency care pathways) were compared. Finally, the most common main presenting problems and ED diagnoses were identified for each pathway.

5.3.5 Method

The methodological approach used in this study is outlined in the publication in Section 5.4.2 of this chapter. This approach was applied to the comparison of the three emergency care pathways presented in the supplementary results. These supplementary results also include an analysis using the additional outcome measures of ED treatment and main presenting problems.

5.3.6 Results

The results of Study Two were published as:

Eastwood K, Smith K, Morgans, A, Stoelwinder J. The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: A retrospective cohort study. *BMJ Open.* 2017; Accepted 2017 September 12.

Publication 3: The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: A retrospective cohort study.

CO-AUTHOR DECLARATION FOR PUBLICATION INCLUDED IN THESIS

Monash University

Eastwood KJ, Smith K, Morgans A, Stoelwinder JU. The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage.

Declaration by candidate

In the case of the publication in chapter Chapter 5, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Principle author, responsible for study design, data analysis, development and writing the manuscript. Responsible author who accepts overall responsibility for the publication.	85

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Amee Morgans	Contributed to study protocol and editing of the manuscript	N/A
Karen Smith	Contributed to study protocol and editing of the manuscript	N/A
Johannes Stoelwinder	Contributed to study protocol and editing of the manuscript	N/A

Candidate's Signature		Thursday 1st December, 2016

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.

(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

(4) there are no other authors of the publication according to these criteria;

(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	**Department of Epidemiology and Preventative Medicine, Monash University**

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department, centre or institute, with specific campus identification where relevant.]

Karen Smith		**Date** 1/12/16
Amee Morgans		1/12/16
Johannes Stoelwinder		1/12/16

The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: A retrospective cohort study.

K Eastwood, K Smith, A Morgans, J Stoelwinder

Department of Epidemiology and Preventive Medicine, Monash University, Ambulance Victoria, Melbourne Australia, 3004, Kathryn Eastwood PhD Candidate, Ambulance Victoria, Department of Epidemiology and Preventive Medicine, Monash University, 3004, Karen Smith Professor, Emergency Services Telecommunications Authority, Melbourne Australia, 3151, Dr Amee Morgans Chief Operating Officer (Acting), Emergency Services Telecommunications Authority, Department of Epidemiology and Preventive Medicine, Monash University, Melbourne Australia, 3004, Johannes Stoelwinder Professor.

Correspondence to: K Eastwood kathryn.eastwood@monash.edu

Word count: 4241

Key words: Health Services Misuse; Health Services Needs and Demand; Triage; Telephone; Referral and Consultation

Objective

To investigate the appropriateness of cases presenting to the emergency department (ED) following ambulance-based secondary telephone triage.

Design

A pragmatic retrospective cohort analysis of all the planned and unplanned ED presentations within 48 hours of a secondary telephone triage.

Setting

The secondary telephone triage service, called the Referral Service, and the hospitals were located in metropolitan Melbourne, Australia and operated 24 hours a day, servicing 4.25 million people. The Referral Service provides an in-depth secondary triage of cases classified as low-acuity when calling the Australian emergency telephone number.

Population

Cases triaged by the Referral Service between September 2009 and June 2012 were linked to ED and hospital admission records (N=44,523). Planned ED presentations were cases referred to the ED following the secondary triage, unplanned ED presentations were cases that presented despite being referred to alternative care pathways.

Main outcome measures

Appropriateness was measured using an ED suitability definition and hospital admission rates. These were compared to mean population data which consisted of *all* of the ED presentations for the state (termed the 'average Victorian ED presentation').

Results

Planned ED presentations were more likely to be ED suitable than unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; P<0.001) and the average Victorian ED presentation (OR1.85; 95% CI 1.01 to 3.4; P=0.046). They were also more likely to be admitted to the hospital than the unplanned ED presentation (OR 1.5, 95% CI 1.4 to 1.6; P<0.001) and the average Victorian ED presentation (OR 2.3, 95% CI 2.24 to 2.33; P<0.001). Just under 15% of cases diverted away from the emergency care pathways presented in the ED (unplanned ED attendances), and 9.5% of all the alternative care pathway cases were classified as ED suitable and 6.5% were admitted to hospital.

Conclusions

Secondary telephone triage was able to appropriately identify many ED suitable cases, and whilst most cases referred to alternative care pathways did not present in the ED, further research is required to establish that these were not inappropriately triaged away from the emergency care pathways.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first Australian study to link secondary telephone triage records to emergency department (ED) and hospital records to track a patient's process through the prehospital to hospital healthcare system.
- This is the first large-scale study to investigate the appropriateness of cases presenting in the ED following secondary telephone triage.
- This study did not rely upon retrospective expert opinion to measure appropriateness but used a range of independently derived ED outcomes to assess appropriateness.
- Due to the heterogeneity of ambulance services and secondary telephone triage services the generalisability of the results may be limited, however the methodology can be replicated to generate locally reproducible results.

AUTHOR CONTRIBUTORS

Author contributions were as follows:

Ms Kathryn Eastwood: Study conception, conducted the data-linkage for the Ambulance Victoria data sets, analysed data and wrote the paper.

Professor Karen Smith: Discussed core ideas, oversaw the data extraction, consulted on the data analysis and edited the paper.

Dr Amee Morgans: Discussed core ideas, consulted on the data analysis and edited the paper.

Professor Johannes Stoelwinder: Discussed core ideas, edited the paper. Professor Stoelwinder was Ms Eastwood's Primary PhD supervisor.

ACKNOWLEDGEMENTS

The staff from the Victorian Data Linkages unit at the Victorian Department of health who conducted the hospital data extraction and linkage to the pre-linked Ambulance Victoria data sets.

TRANSPARENCY DECLARATION

Kathryn Eastwood affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

ETHICAL APPROVALS

Ethics approval was granted by the Monash University Human Research Ethics Committee (CF12/0547-2012000215) and the Ambulance Victoria Research Committee (R11-021).

FUNDING STATEMENT

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

COMPETING INTERESTS

Kathryn Eastwood is an intensive care paramedic has previously worked as a call-taker with the Ambulance Victoria Referral Service (secondary telephone triage service). Also Professor Johannes Stoelwinder was the Chair of the Board of Ambulance Victoria. Professor Karen Smith is the Manager of Research and Evaluation for Ambulance Victoria.

INTRODUCTION

An increasing proportion of ambulance service workload involves patients with low-acuity health events that do not require the specific resources provided by ambulance services or emergency departments (ED).[1-19] Responding to these cases with a traditional emergency ambulance attendance and transport to a hospital ED negatively impacts on ambulance services' efficiency and efficacy by reducing the availability of these resources for emergency cases and thus potentially compromising patient outcomes.[8,14,20,21] The notion of whether these unnecessary ED users place a similar stress upon the ED is one of contention, with some research suggesting that the number and the impact of these patients is much lower than the high levels reported in other literature.[22-24] Depending on the study, these figures range from as little as 5% up to 82% of all ED presentations.[22,24,25] Despite this, there appears to be some level of consensus that these patients often present with conditions that can be suitability managed in community-based healthcare services rather than the ED.[15,21] The ability of ambulance services and EDs to expand resources to meet their increasing demand is limited, and as a result, alternative strategies are being implemented to manage low-acuity cases.[26-37]

Secondary telephone triage has been used by some ambulance services as a demand management strategy for the identification and referral of low-acuity cases to alternative health care services and away from the emergency care pathways involving ambulances and the ED.[1,38] As its name implies, secondary telephone triage occurs after a primary triage has taken place when a patient contacts the emergency dispatch centre. Cases classified as low-acuity during primary triage are then triaged by qualified nurses or paramedics to further elucidate the patients presenting problem. Where appropriate these cases are diverted to other means of transportation to hospital, alternative service providers for management outside of the emergency care pathways, or they are given self-care advice for management in the home. Ambulance Victoria in Victoria, Australia, operates the Referral Service, a secondary telephone triage service that managed nearly 12% of the total emergency ambulance workload in the capital city of Melbourne between 2009-2012.

The Referral Service diverted 72.4% of the triaged low-acuity cases away from emergency ambulances and 32.2% away from the ED.[1] This strategy has had a measurable impact in metropolitan Melbourne and across Victoria with a 10% decrease in growth of demand for emergency ambulance transports upon its implementation.[39]

Despite the policy intention of reducing low-acuity cases from the emergency ambulance and from ED workloads, some cases remain or re-emerge in the emergency care pathways following secondary triage.[1,40] These can be categorised into two groups of cases -- those that are planned ED attendances and those that are unplanned ED attendances. *Planned ED attendances* are cases identified at secondary telephone triage as suitable to remain in the emergency care pathways. These cases may be sent an emergency ambulance, non-emergency ambulance or referred to self-present at the ED.[1] If these cases are later identified as inappropriate for the ED, then the question is raised about whether they were incorrectly triaged by the Referral Service to these care pathways. *Unplanned ED attendances* are cases that present in the ED despite being referred to alternative care pathways. These pathways include advice to allow the patient to manage their presenting problem at home (self-care advice), referral to the patient's own general practitioner (GP) or allied healthcare worker, or referral to one of a range of alternate service providers contracted by Ambulance Victoria, who will attend the patient's home.[1] If these cases subsequently and appropriately attend the ED they may represent a cohort of cases that were incorrectly triaged by the Referral Service as suitable for alternative care pathways.

The effectiveness of an ambulance-based secondary telephone triage service is reflected in its ability to provide patients with the most appropriate care for their needs. The appropriateness of the ED presentation of cases following secondary telephone triage has only been investigated in two small trials which found that patients were more likely to be admitted to the hospital if they were identified as being suitable to remain in the emergency care pathways (ie. they were a planned ED attendance).[30-32] No large scale evaluations have been conducted using an established secondary telephone triage service operating within an ambulance service.

The aim of this study was to investigate the appropriateness of the ED presentation of cases following secondary telephone triage by the Referral Service.

METHODS

Design

A pragmatic retrospective cohort analysis was conducted of all the planned and unplanned ED presentations within the emergency care and alternative care pathways within 48 hours of a Referral Service triage.

Setting

Ambulance Victoria is a statewide publicly funded ambulance service operating in the state of Victoria, Australia. In June 2012, 4.25 million people lived in metropolitan Melbourne which covers an area of approximately 10,000km^2.[41] During the study timeframe the Referral Service operated within metropolitan Melbourne 24 hours a day, seven days a week.

The Referral Service has been described extensively elsewhere.[1] Briefly, cases identified as low-acuity during the call to the emergency services telephone number (in Australia, this is triple zero), using the Advanced Medical Priority Dispatch System (AMPDS), are transferred for secondary triage. Case-types designated as low-acuity have been specifically identified by Ambulance Victoria as having low paramedic treatment and transportation rates and are unlikely to represent to the ambulance service within a 24- hour timeframe. Referral Service call-takers use a condition-specific computer-based questioning algorithm (CECC –Care Enhanced Call Centre)[42] during secondary telephone triage to arrive at a disposition with a recommended resource allocation outcome as listed below:

<u>Emergency care pathways</u>

1. Return for emergency ambulance dispatch;
2. Non-emergency ambulance dispatch;
3. Advise the patient to self-present at the ED;

<u>Alternative care pathways</u>

4. Referral to an Alternative Service Provider; or
5. Self-care advice including home care or to seek further non-urgent medical attention independently (please refer to Figure One).

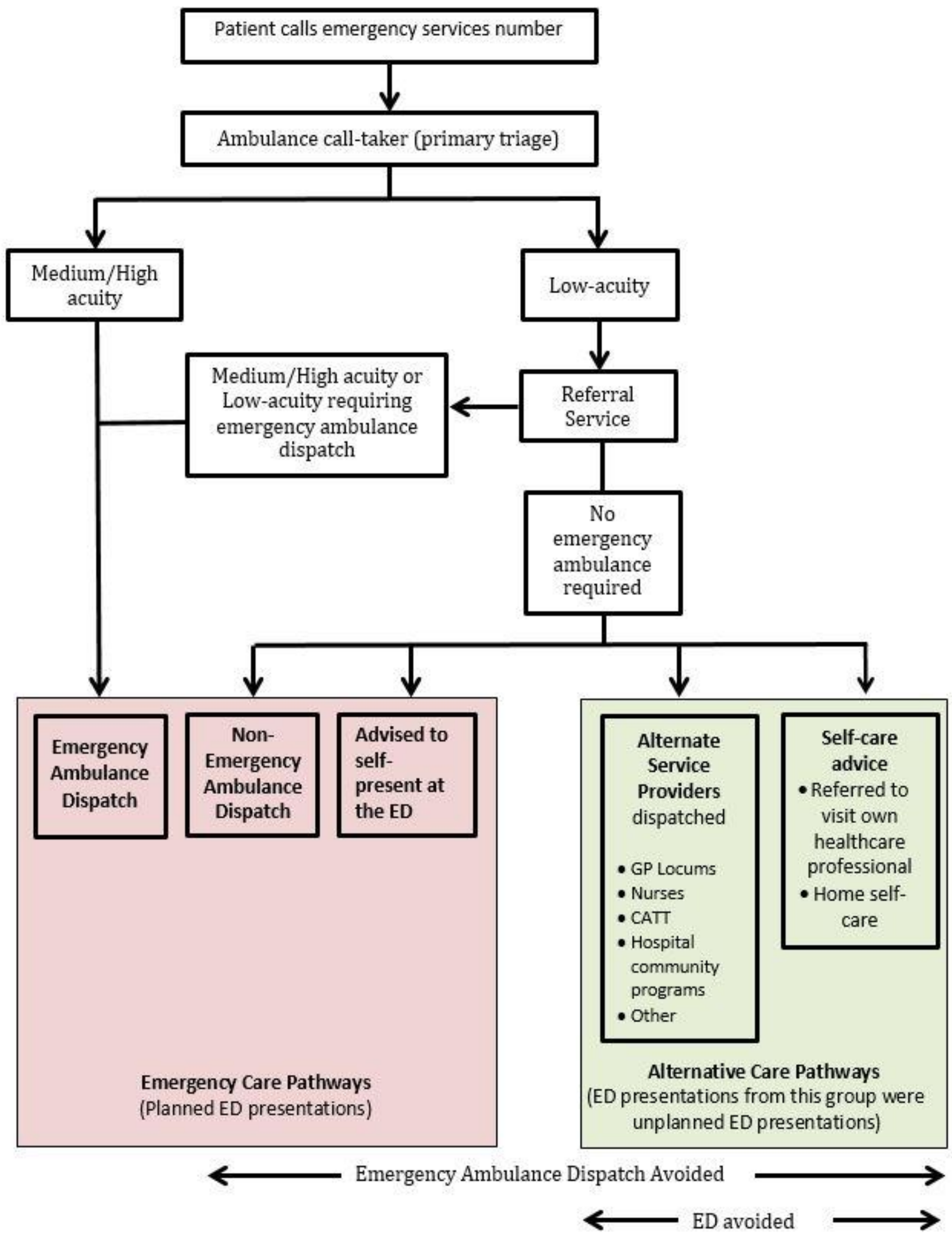

Figure One: Case flow and service provision pathways of the Referral Service

The alternative service providers that the Referral Service utilises include out-of-hours home-visiting doctor services, home-visiting nurses, hospital outreach programs (that send allied health staff into the community), crisis assessment and treatment teams (CATT) for psychiatric cases, poisons telephone advice line, and other services that can assist with non-medical issues such as lifting patients.

Data Sources

Data were collected between September 2009 and June 2012 for the datasets below unless otherwise stated.

Referral Service

Referral Service records were extracted from the Referral Service database. Data items included case date and time, case number, de-identified patient-specific code, date-of-birth, age, gender, suburb, presenting problem, free text entry with details of the patient triage, and triage disposition.

Paramedic Records

Cases referred for an emergency ambulance dispatch had an electronic patient care record (paramedic record) generated documenting assessment, treatment, demographic and operational information. Paramedic records included case date and time, case number, Medicare suffix (first 3 characters of the patients given name), date-of-birth, age, gender, suburb, dispatch urgency, treatment, transport outcome, destination hospital (where appropriate), and transport urgency (where appropriate).

Hospital datasets (ED and admission records)

Hospital data was sourced from the Victorian Emergency Minimum Dataset (ED records) and the Victorian Admitted Episode Dataset (admission records). The ED records contains de-identified administrative, demographic, treatment and clinical information detailing ED presentations at designated Victorian public hospitals and others as directed by the Victorian Government Department of Health.[43] Similarly the admission records contains de-identified administrative data for Victorian hospital admissions.[44] The Department of Health does not routinely collect ED data from private hospitals (privately owned hospitals running on a user-pays system), which on average received about 8.1% of all Victorian ED presentations.[25,45] Private hospitals do provide their admission records to the Department of Health and this was the only indicator of whether a patient attended a private hospital ED. If, however a patient was not admitted following their ED presentation at a private hospital, then no record of their ED presentation could be obtained. Variables extracted included case date and time, de-identified patient-specific code (this is a different code to that used in the Referral Service dataset), ICD-10-AM code (International Classification of Diseases, 10th Edition, Australian Modification), arrival mode, ED triage category, outgoing referral, admission and death.

Data Linkage

Deterministic data-linkage was used to link the Referral Service and paramedic records for cases referred to the emergency ambulance pathway (the ambulance datasets).[46] The variables used for linkage included case date, case number, date-of-birth, age, gender and suburb. Nearly all of the paramedic records (94.7%) were linked to Referral Service records, and these linkages were verified using case-time, presenting problem, urgency level set by Referral Service call-takers and free-text analysis where required. This process resulted in seven linkages that could not be verified as a true match (0.0003% error rate).

These ambulance datasets were then linked to the hospital datasets (the ED and admission records) also using deterministic data linkage methods.[46] For this linkage ambulance case number, Medicare suffix, date-of-birth, address (postal code or locality), and record date within 48 hours of arrival at the ED were used. The algorithm utilised allowed for a single day discrepancy in date-of-birth, date of ambulance records and date of hospital records. Validation of the deterministic linkage between the linked ambulance datasets and the hospital datasets was completed using gender. A mismatch was identified for 2% of linkages and these were discarded (n=856). Linkages where the hospital record occurred before Referral Service triage were also discarded (n=2,300).

<u>Data linkage outcomes for planned ED presentations</u>

During the study timeframe, 27.5% of all metropolitan Ambulance Victoria cases that had an ambulance attendance were not transported to hospital. This, combined with the fact that the private hospitals do not supply their ED records, meant a linkage rate of 100% between ambulance and hospital records was not expected.

Figure Two depicts the proportion of Referral Service cases for each of the three emergency care pathways for which an ED record was linked. Cases in the emergency ambulance pathway had the highest rate of linkage to ED records (62.8%). Some cases in this pathway were found to have been transported to private hospital (6.7%), meaning no ED record was available, or left at home after paramedic assessment (14.0%). The remaining 15.7% of cases for which an ED record was expected were unable to be accounted for.

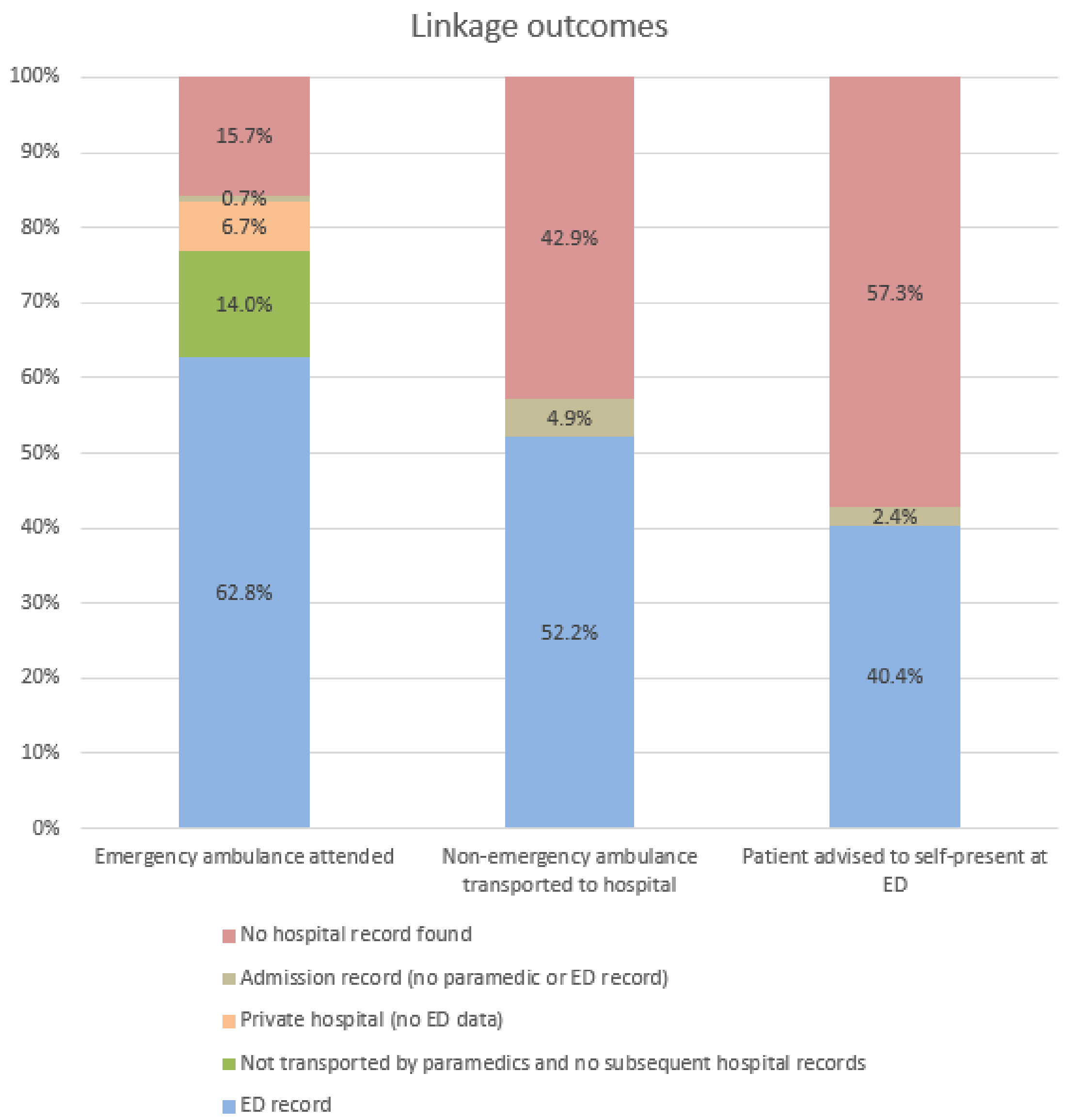

Figure Two: Linkage outcomes for each of the emergency care pathways

Over half of the 'non-emergency ambulance' pathway cases (57.3%) and 42.8% of the 'self-present at ED' pathway cases were linked to an ED record or an admission record (Figure Two). Some of these cases may have been transported to a private hospital. The proportion of private hospital ED presentations is 8.1% of all Victorian ED presentations, and assuming a similar proportion of this population attended a private hospital ED, a large number of cases would remain unaccounted for.

The lack of an ED record for 37.0% of the planned ED attendances does not necessarily mean these patients did not attend the ED. The linkage process may have failed to identify a corresponding ED record, or they may have attended a private hospital ED. When comparing the number of cases

Ambulance Victoria reported as being transported to hospital, to the number of ambulance presentations reported in the Australian government reports,[25,47,48] there is only a 2.2% discrepancy in the numbers. This suggests that there may be a number of missed linkages rather than simply no presentation at the ED, however a level of non-compliance was expected.[49]

A systematic bias evaluation was conducted, comparing age, gender and main presenting problems between the cases with a linked ED record and those with no linked ED record. Significance testing was pragmatically unsuitable because the large size of the dataset would result in a high level of statistical sensitivity to small distribution differences. This is demonstrated in Table One, where despite some areas of statistical significance, the actual differences for age and gender between the 'ED record' and 'no ED record' groups were unlikely to be clinically significant. When comparing the presenting problems of the cases within each group in Table One there was also little variation in the three most common case types between those with and without an ED record. Therefore age, gender and presenting problem were considered as not imposing any clinically significant bias on the results, and the results presented in this paper were considered to be representative of the cases referred to the emergency care pathways by the Referral Service.

Emergency care pathway cases (Planned ED attendances)		Linked ED record	No ED record found	Statistical comparison
Emergency ambulance	**Missing cases (%)**		37.2	
	age	56.0	56.0	t(21820.5) = -1.82, p=0.068
	Gender (% female)	54.3	56.1	Chi-square = 9.14, df=1, p<0.002
	Main presenting problem with RS (%)	Abdominal pain (17.0) Back pain (9.8) Dizziness & vertigo (5.7)	Abdominal pain (14.9) Back pain (9.2) Dizziness & vertigo (7.1)	
Non-emergency ambulance	**Missing cases (%)**		47.8	
	age	65.0	47.8	t(19432.2) =4.26, p<0.001
	Gender (% female)	53.2	53.9	Chi-square = 1.04, df=1, p=0.31
	Main presenting problem with RS (%)	Abdominal pain (24.6) Back pain (7.2) Urinary symptoms (6.9)	Abdominal pain (24.6) Back pain (6.4) Urinary symptoms (6.0)	
Self-present at ED	**Missing cases (%)**		59.6	
	age	44.0	41.0	t(22754) = -7.34, p<0.001
	Gender (% female)	55.5	56.4	Chi-square = 1.72, df=1, p=0.2
	Main presenting problem with RS (%)	Abdominal pain (21.0) Back pain (7.1) Flank pain (5.8)	Abdominal pain (21.4) Back pain (6.7) Nausea and vomiting (4.9)	

Table One: Comparison of emergency care pathways cases that were matched to an ED record (RS –Referral Service)

Patient Involvement

This was a retrospective study of established data sources, as such no patients were involved in this study.

Patient Outcomes

General demographic, triage outcome and main presenting problem information was collected during this study.

Indicators of appropriateness

ED suitability and admission to hospital were used as indicators of appropriateness for cases that presented at the ED. Planned and unplanned ED presentation were analysed using these measures and then compared to the average Victorian ED presentation.

ED suitability

ED suitability was based on a modified version of the 'potentially avoidable GP-type presentation' measure used by the Australian Government for ED presentations that are considered avoidable had an appropriate community-based service been accessed.[50] A 'potentially avoidable GP-type presentation' is defined as cases that present to an ED where the patient:

- Was triaged as a category 4 or 5 according to the Australian Triage Scale;[51]
- Did not arrive by ambulance;
- Was not admitted to the hospital, referred to another hospital, and
- Did not die.[50]

This 'potentially avoidable GP-type presentation' outcome was modified in this study to exclude the criterion involving arrival by ambulance and was referred to as 'ED suitability'.

Hospital admission

Despite hospital admission being used as part of the ED suitability indicator, this indicator has also been used in isolation in other studies[30,32] and was therefore retained to allow for comparison. Also, hospital admission was provided by both public and private hospitals, therefore allowing for cases transported to private hospitals to be included in the analysis.

Average Victorian ED Presentation for Victoria

Each year the Australian government report the overall rates of hospital admission and 'potentially avoidable GP-type presentations' for all public hospital ED presentations in each state of Australia.[50] The overall rates are inclusive of all ED attendances, including Referral Service cases that present at the ED. The rates of ED suitability and hospital admission were compared to the overall rates for Victoria, which were referred to as 'the average Victorian ED presentation' in this paper. The rates from the 2011/2012 report were utilised in this study.[50]

Data Analysis

Data were analysed using descriptive statistics, chi-squared tests of association, independent samples t-tests and logistic regressions to identify relationships with 95% CIs. All tests were considered to be significant at 0.05 level. All data analysis was performed using SPSS Version 20.[52]

RESULTS

<u>Outcomes</u>

During the study timeframe Ambulance Victoria received just over one million calls for assistance, of which 11.9% were triaged by the Referral Service. At the end of this triage, 69.5% of cases were referred to care pathways other than the emergency ambulance dispatch pathway, and 30.5% were referred away from an ED presentation (the emergency care pathways). Figure Three outlines the selection of cases eligible for inclusion in this study, resulting in 44,523 cases undergoing further analysis.

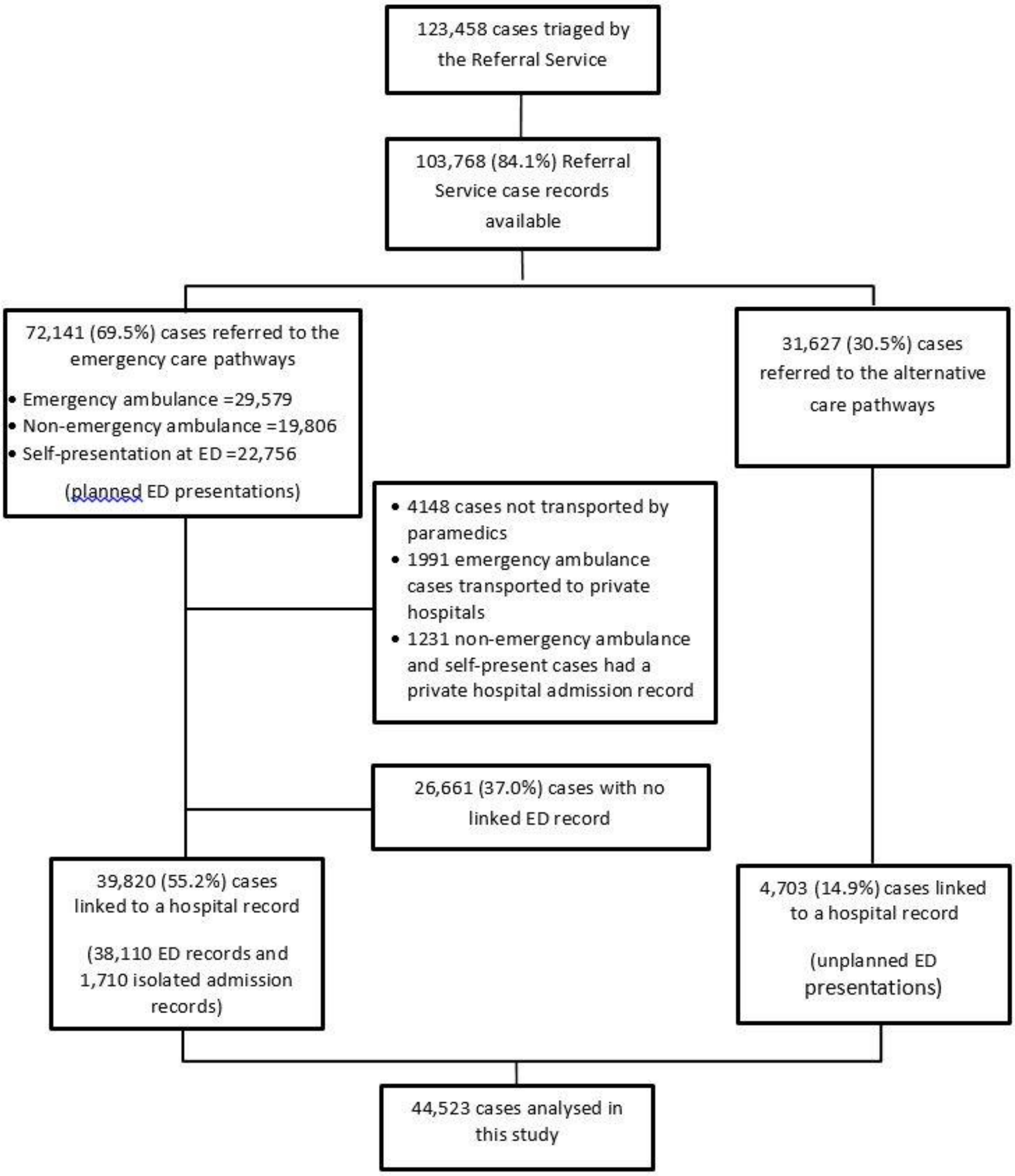

Figure Three: Case inclusion flow-chart

Patient demographics

The gender distribution for cases presenting to the ED was similar for all care pathway groups (Table Two). Triage outcomes that required the patients to self-source further care, including the 'self-present at the ED' cases and 'self-care advice' cases, were younger than those sent further care (Table Two).

Five main presenting problems made up 80% of the most common problems for each of the care pathways (Table Two). These were abdominal pain, back pain, nausea and vomiting, urinary symptoms and dizziness and vertigo. Abdominal pain and back pain featured in the top five main presenting problems for every care pathway.

	Planned ED presentations (Emergency care pathways)			Unplanned ED presentations (from the Alternative care pathways)	
	Emergency ambulance	**Non-emergency ambulance**	**Referred to self-present at ED**	**Cases referred to an Alternative service provider**	**Cases given self-care advice**
ED record (% of total cases referred to that pathway)	18,578 (62.8)	10,348 (52.2)	9,184 (40.4)	2,207 (19.3)	2,496 (12.5)
Female (%)	54.3	53.2	55.5	53.2	52.6
Median age (years)	60	70	41	59	47
Most common main presenting problems (of ED presentation cases)	1. Abdominal pain (17.0%) 2. Back pain (9.8%) 3. Dizziness/ vertigo (5.7%) 4. Nausea/ vomiting (5.0%) 5. Fever (4.1%)	1. Back pain (24.6%) 2. Abdominal pain (7.2%) 3. Urinary symptoms (5.2%) 4. Weakness/ paralysis (4.8%) 5. Lower leg non-injury (4.8%)	1. Abdominal pain (21.0%) 2. Back pain (7.1%) 3. Flank pain (5.8%) 4. Nausea/ vomiting (4.8%) 5. Urinary symptoms (3.0%)	1. Back pain (16.1%) 2. Nausea/ vomiting (8.4%) 3. Dizziness/ vertigo (7.5%) 4. Urinary symptoms (5.3%) 5. Abdominal pain (4.4%)	1. Back pain (10.6%) 2. Abdominal pain (8.1%) 3. Nausea/ vomiting (7.0%) 4. Dizziness/ vertigo (5.9%) 5. Constipation/rectal symptoms (3.6%)
ED suitability of RS cases that attended ED (Absolute Risk (%))	77.8	71.3	70.6	68.8	60.3
Overall ED suitability for RS cases with an ED record (Absolute Risk (%))	74.3			64.1	
Hospital admission for RS cases with an ED record (Absolute Risk (%))	55.0	58.3	46.4	51.3	39.4
Overall hospital admission for RS cases with an ED record (Absolute Risk (%))	53.8			43.5	

Table Two: Hospital management of cases that presented at ED following Referral Service (RS) triage.

ED suitability

The planned ED presentations were more likely to be classified as ED suitable than the unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; p<0.001). The ED suitability for planned ED presentations ranged from 70.6% to 77.8% for each of the emergency care pathways, which was significantly higher than the ED suitability for the average Victorian ED presentations of 61.0% (OR 1.85; 95% CI 1.01 to 3.4; p=0.046) (Table Two).

Of the alternative care pathway cases, the unplanned ED presentations that were originally referred to alternative service providers had an ED suitability rate higher than the average Victorian ED presentation (68.8%), and the cases originally given self-care advice had an ED suitability rate almost the same as the average Victorian ED presentation (60.3%) (Table Two). These unplanned ED presentations were therefore at least as 'ED suitable' as the average Victorian ED presentation. It should be noted however, that only 19.3% of all the cases referred to the alternative service providers and 12.5% of all the cases given self-care advice presented in the ED. Overall, only 9.5% of the total alternative care pathway cases were identified as ED suitable (14.7% of all the alternative service provider cases and 8.2% of all the self-care advice cases).

Hospital Admission

Planned ED presentations were significantly more likely to be admitted to hospital than unplanned ED presentations (53.8% versus 43.5%; OR 1.5, 95% CI 1.4 to 1.6; p<0.001). Both the planned ED presentations (OR 2.3, 95% CI 2.24 to 2.33; p<0.001), and the unplanned ED presentations (OR 1.6, 95% CI 1.5 to 1.73; p<0.001) were more likely to be admitted than the average Victorian ED presentation (36.0%) (Table Two). Overall only 6.5% of all the alternative care pathway cases were admitted to hospital (11.3% of all the alternative service provider pathway cases and 5.1% of all the self-care advice pathway cases).

DISCUSSION

This was the first large-scale study to link ambulance service data and hospital data to investigate the outcomes of both planned and unplanned ED presentations following an ambulance-based secondary telephone triage. Overall the cases referred to the emergency care pathways, (the planned ED presentations), appeared to be appropriate with ED suitability and hospital admission rates being higher than both the unplanned ED presentation group and the average Victorian ED presentation.

The decision to send cases to the alternative care pathways appears sound with over 85% not emerging in the emergency care system within 48 hours. The overall rates of ED suitability and admission for the cases sent to the alternative care pathways were well below that of the average Victorian ED presentation predominantly because so few went on to present at the ED. When only the unplanned ED presentations were considered, the ED suitability and admission rates were the same, if not higher, that those for the average Victorian ED presentation. These results suggest that whilst the overall numbers of unplanned ED presentations were relatively small, they may have been appropriate for the ED and further investigation of these cases needs to be done to ensure they are not being incorrectly triaged to the alternative care pathways.

The results of this study are consistent with previous research whereby cases classified as requiring an emergency ambulance were more likely to be admitted to the hospital than those classified as not requiring an emergency ambulance.[30,32] The admission rate of cases in the alternative care pathways (unplanned ED presentations) of 6.5% was below that found in these other studies, which had rates of 9.2% and 15.8%.[30,32] This lower rate of admission may indicate that the secondary telephone triage process used by Ambulance Victoria, is more effective in identifying which cases are suitable for the alternative care pathways. While the previous research have accepted these admission rates and suggested the secondary telephone triage process is a safe and feasible means of managing ambulance demand,[30,32] further investigation of the unplanned ED attendances is warranted.

This evaluation of ED suitability casts a broader net than simply basing the appropriateness of an ED presentation on whether a patient was admitted or not. The 'ED suitability' outcome measure increased the sensitivity, whereas the 'admissions only' outcome measure was felt to be more specific and prone to excluding appropriate cases. The ED suitability measure used a range of variables to eliminate the potential bias imposed by the decisions made by individual healthcare professionals during the patient care phase. Also, given that these variables are likely to be recorded in most emergency departments and are collected independent of any assessment of appropriateness, the ED suitability measure used in this study offers future researchers the opportunity to generate locally generalizable results that are also reproducible. ED treatment itself was not included in this outcome measure as it was the researcher's view that the ED healthcare workers will naturally instigate at a minimum, investigative procedures that could have been conducted in the primary care setting, which would have been viewed as a positive result for ED treatment. In this study, the ED suitability and admission outcome measures, also allowed for a comparison with the greater population of cases that present at the ED in Victoria.

Whilst the results from this study suggest that the Referral Service was appropriate in filtering the cases ultimately destined for the ED, more can potentially be done to increase the sensitivity and specificity of the triage process. The unplanned ED presentation cases need to be further investigated to determine whether their condition evolved within the potential 48 hour window between Referral Service triage and ED presentation, whether they should have been triaged to the emergency care pathway, or whether other services, not within the suite of alternative service providers used by the Referral Service, would have been able to manage these cases in the primary care setting. Similarly cases from the planned ED presentation pathway that were not ED suitable, or not admitted, need to be further investigated to determine if a primary care alternative is available to manage these cases out of the hospital setting.

Optimizing the suite of pathways available to the Referral Service call-takers may lead to increased specificity of cases for emergency ambulance and the emergency department, therefore increasing the effectiveness of the Referral Service. In doing this, care should be taken to ensure that more than just physiological or clinical indicators are considered when decisions are made, particularly when these decisions result in the omission of a face-to-face assessment within a particular timeframe. Nonclinical situations have been identified where it would be considered appropriate for a low-acuity patient to be assessed and transported by paramedics, or present in the ED.[53] An example of this is where there may be a perceived risk of physical harm to the patient, either through the threat of violence, an unattended minor or a patient who may appear physically or psychologically incompetent.[53] Any secondary telephone triage process should ensure that the patients overall wellbeing is taken into consideration.

This study was limited by the inability to link some of the cases between the datasets. There are several possible reasons for a failure of an appropriate linkage, or for records to not have been available for linkage. These include private hospital attendance (therefore no ED records were available), transcription errors in case numbers and dates-of-birth during data acquisition and handovers, usage of a written paramedic record rather than an electronic paramedic record, ambulance cancellation prior to arrival and patient non-compliance.[49] This highlights a need for consistent patient identifiers and a means of transcribing data at the various transitions of care that reduces errors, such as electronic transfer.

Whilst no clinically significant systematic bias was detected, the potential for this bias remained given the volume of unlinked cases in each of the emergency care pathways.

The mean population data for the average Victorian ED presentation included all of the patient presentations for the respective time period, including those from the Referral Service who were sent to the emergency care pathways and presented in the ED. The presence of these cases in the 'average ED presentation' group will increase the overall ED suitability rate for this group. The impact would be negligible however with all Referral Service cases referred to the emergency care pathways only constituting 1.6% of the total ED workload if they had all presented at the ED during the study timeframe. Finally, the ED suitability measure was directly compared to the 'potentially avoidable GP-type presentations' despite their slight difference.

Whilst the variation in secondary telephone triage system structure and functionality could not be addressed in this study, the research variables used were specifically selected to allow for similar methodological approaches, less vulnerable to personal opinion, to be utilised in future work. Using these methodological approaches, the findings may be somewhat limited in their broader generalisability, however they should be locally reproducible.

CONCLUSION

This study utilised linked ambulance and hospital data to analyse the appropriateness of the referral of cases for ED presentation following secondary telephone triage and provided a methodological approach that can be applied in future research. Overall secondary telephone triage was able to appropriately identify many cases that were suitable for the ED and that would be admitted, at a rate higher than that of the average Victorian ED presentation. A small cohort of cases identified as suitable for alternative care pathways presented in the ED and were ED suitable. Further investigation is required beyond this study beyond this study to ensure cases were not incorrectly triaged to the alternative care pathways and to optimise the suite of alternate pathways to ensure the right patient is being triaged to the right service.

DATA SHARING STATEMENT

Data sharing: no additional data available.

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5.3.7 Additional analysis

In addition to analyses included in the manuscript, the three emergency care pathway streams were compared with respect to ED suitability, hospital admission and paramedic treatment rates. Establishing the differences between the pathways is important for determining the ability of the RS-call taker to delineate the need for each.

5.3.7.1 A between-groups analysis of the emergency care pathways for ED suitability, ED treatment and hospital admission

The age and gender distributions of patients in the three emergency care pathways are provided in Table Two in the manuscript in this chapter. There was no difference in gender distribution between the three emergency care pathways, but there was a statistically significant difference in age ($p<0.001$), with the oldest patients being referred to non-emergency ambulances and the youngest being referred to self-present at the ED.

ED suitability and treatment was highest amongst patients transported by emergency ambulance, with similar rates between those transported by non-emergency ambulance and those who self-presented (Table 9). The differences in ED treatment rates between the three groups were clinically insignificant. Hospital admission was highest amongst the patients transported by non-emergency ambulances, and these patients were also older than the other cohorts.

Table 9: A comparison of hospital outcomes for cases referred to the three care pathways

	ED suitable		ED treatment		Admission	
	Absolute risk (%)	**Statistics**	**Absolute risk (%)**	**Statistics**	**Absolute risk (%)**	**Statistics**
Emergency ambulance (compared to self-present cases)	77.8	OR 1.46 95% CI 1.38-1.55; p<0.001	57.5	OR 1.09 95% CI 1.04-1.15; p<0.001	55.0	OR 1.41 95% CI 1.35-1.49; p<0.001
Non-emergency ambulance (compared to self-present cases)	71.3	OR 1.04 95% CI 0.97-1.1; p=0.28	55.7	OR 1.02 95% CI 0.96-10.8; p=0.58	58.3	OR 1.61 95% CI 1.53-1.71; p<0.001
Self-present	70.6		55.3		46.4	

5.3.7.2 Main presenting problem

The most common RS main presenting problems and ED diagnoses were similar for each of the planned and unplanned ED presentations according to their care pathways (Table 10). The most common main presenting problem and diagnosis for each of the planned ED presentations were similar for the three emergency care pathways. Most of the main presenting problems and diagnoses related to pain, with abdominal pain and back pain being present in nearly all categories.

Table 10: Ten most common RS main presenting problems in descending order and ED diagnoses for each of the RS emergency care pathways

		RS presenting problem	ED diagnosis
Planned ED presentations (Emergency care pathways)	**Emergency ambulance**	1. Abdominal pain 2. Back pain 3. Dizziness/vertigo 4. Nausea and vomiting 5. Fever 6. Headache 7. Weakness/paralysis 8. Flank pain 9. Confusion/disorientation 10. Chest pain/discomfort	1. Abdominal pain 2. Unspecified renal colic 3. Urinary tract infection 4. Dorsalgia – unspecified site 5. Lower back pain 6. Dizziness and giddiness 7. Other gastroenteritis and colitis infections 8. Nausea and vomiting 9. Syncope or collapse 10. Migraine
	% of total cases	55.5%	33.0%
	Non-emergency ambulance	1. Back pain 2. Abdominal pain 3. Urinary symptoms 4. Weakness/paralysis 5. Lower leg non-injury 6. Nausea & vomiting 7. Knee non-injury 8. Hip non-injury 9. Diarrhoea 10. Dizziness and vertigo	1. Lower back pain 2. Dorsalgia – unspecified site 3. Abdominal pain 4. Sciatica 5. Urinary tract infection 6. Cellulitis 7. Other gastroenteritis and colitis infections 8. Joint pain 9. Malaise and fatigue 10. Constipation
	% of total cases	60.9%	35.9%
	Referred to self-present at ED	1. Abdominal pain 2. Back pain 3. Flank pain 4. Nausea and vomiting 5. Urinary symptoms 6. Fever 7. Headache 8. Abdominal swelling 9. Abdominal pain – male paediatric 10. Dizziness and vertigo	1. Abdominal pain 2. Unspecified renal colic 3. Other gastroenteritis and colitis infections 4. Urinary tract infection 5. Constipation 6. Non-infective gastroenteritis 7. Dorsalgia – unspecified site 8. Lower back pain 9. Viral infection – unspecified 10. Nausea and vomiting
	% of total cases	53.2%	40.8%
Unplanned ED Presentations (Alternative care pathways)	**Cases referred to an ASP**	1. Back pain 2. Nausea and vomiting 3. Dizziness and vertigo 4. Urinary symptoms 5. Abdominal pain 6. Weakness/paralysis 7. Constipation 8. Diarrhoea 9. Lower leg non-injury 10. Fever	1. Lower back pain 2. Dorsalgia – unspecified site 3. Abdominal pain 4. Urinary tract infection 5. Other gastroenteritis and colitis infections 6. Constipation 7. Dizziness and giddiness 8. Sciatica 9. Mechanical problem with urinary catheter 10. Non-infective gastroenteritis

	% of total cases	59.9%	36.3%
Unplanned ED Presentations (Alternative care pathways)	**Cases given self-care advice**	1. Back pain 2. Abdominal pain 3. Nausea and vomiting 4. Dizziness and vertigo 5. Constipation 6. Frequent caller 7. Flank pain 8. Lower leg non-injury 9. Fever (paediatric) 10. Anxiety –mild	1. Abdominal pain 2. Other gastroenteritis and colitis infections 3. Constipation 4. Lower back pain 5. Dorsalgia –unspecified site 6. Unspecified renal colic 7. Non-infective gastroenteritis 8. Urinary tract infection 9. Viral infection –unspecified 10. Dizziness and giddiness
	% of total cases	48.9%	34.3%

5.3.8 Study Two conclusions

This was the first study to use ED outcomes to determine the appropriateness of cases presenting in the ED following secondary triage. This study found that planned ED attendances were more appropriate for the ED than unplanned ED attendances, and cases referred for emergency ambulance dispatch were also more appropriate for the ED than those in the other emergency care pathways. According to the ED suitability and hospital admission outcome measures, planned ED attendances were more appropriate for the ED than unplanned ED presentations, and both of these groups were more appropriate for the ED than the average Victorian ED presentation. The same was seen for the three emergency care pathways within the planned ED presentations, with all three pathways being more appropriate for the ED than the average Victorian ED presentation. High admission rates have been noted in other studies of the elderly, and this could explain the higher rates of admission in the cases referred to the non-emergency dispatch pathway.[8]

The presenting problem analysis showed that the top 10 case types in each of the emergency care pathways were similar. They also displayed similarities to the ED diagnoses, indicating that the main presenting problem is generally being appropriately elucidated at the point of secondary triage. These similarities were also evident in all of the alternate care pathways in the unplanned ED presentations, with the exception of the 'care plan' pathway.

This study addressed the gap in the literature pertaining to a large cohort analysis of ED appropriateness. The article above presents a methodological approach that involves a combination of factors accessible in most ED datasets to assess ED appropriateness, increasing reproducibility and external validity.

The ED suitability outcome measure used in this analysis uses multiple factors relating to the ED episode of care therefore reducing its susceptibility to clinican opinion or preference (that may be present if only one of these factors were used), and therefore more generalizable and specific for ED appropriateness. This measure allows for the expert opinion approach, commonly used in appropriateness studies, to be avoided, therefore removing some of the bias introduced into other studies. However, this measure is not a perfect reflection of ED suitability. ED treatments can vary depending upon the clinician, the hospital and the region; however, inclusion of key treatments, unlikely to be available in the primary care setting, could increase the specificity of the ED suitability criteria and should be considered in future analyses. In addition, the ability to identify areas of difference between the care pathways was dependent upon the variables available for analysis. Finally, non-clinical factors that might influence the triage process, such as the patients living arrangements or frailty, were not available for analysis.

While the cases transported by emergency ambulance were found to be more appropriate for the ED than cases arriving by other means following RS triage, the appropriateness of these cases for emergency ambulance dispatch was not investigated. Study Three investigates this RS triage outcome to determine if there is any overtriage to this pathway.

5.4 Study Three: Appropriateness of the Referral Service triage to emergency ambulance dispatch

This study addressed objective IV-b by investigating the appropriateness of cases referred for emergency ambulance dispatch following secondary telephone triage. Study Two highlights that all three emergency care pathways demonstrated high levels of appropriateness for the ED, indicating that secondary telephone triage is able to identify cases suitable for these pathways. However, the question of the appropriateness of cases referred for emergency ambulance dispatch was not sufficiently addressed, but is important because the primary objective of the RS is to reduce emergency ambulance demand. The ambulance and hospital outcomes for cases referred for emergency ambulance dispatch were examined in this study according to the three dispatch acuity level categories to determine whether the triage decision to allocate these cases to the emergency ambulance dispatch pathway was appropriate.

5.5.1 Method

The methodological approached used in this study is outlined in the manuscript below. The supplementary results continue the analysis of the three emergency ambulance dispatch acuity level categories using ED treatment, ED suitability, hospital admission rates and main presenting problems.

5.5.2 Results

The results of Study Three were submitted to Paramedic Emergency Care as:

Eastwood K, Smith K, Morgans, A, Stoelwinder J. The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage. *Prehospital Emergency Care.* 2017; Submitted.

Manuscript 1 (submitted): The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage

CO-AUTHOR DECLARATION FOR PUBLICATION INCLUDED IN THESIS

Monash University

Eastwood KJ, Morgans A, Stoelwinder JU, Smith K. The appropriateness of cases referred for emergency ambulance dispatch following ambulance service secondary telephone triage.

Declaration by candidate

In the case of the publication in chapter Chapter 5, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Principle author, responsible for study design, data analysis, development and writing the manuscript. Responsible author who accepts overall responsibility for the publication.	90

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Amee Morgans	Contributed to study protocol and editing of the manuscript	N/A
Karen Smith	Contributed to study protocol and editing of the manuscript	N/A

Candidate's Signature		Monday 4th September, 2017

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.

(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

(4) there are no other authors of the publication according to these criteria;

(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	**Department of Epidemiology and Preventative Medicine, Monash University**

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department, centre or institute, with specific campus identification where relevant.]

Amee Morgans		**Date** 04/09/17
Just Stoelwinder		04/09/17
Karen Smith		04/09/17

The appropriateness of cases referred for emergency ambulance dispatch following an ambulance service secondary telephone triage

ABSTRACT

Objective: Ambulance-based secondary telephone triage systems have been established in ambulance services to divert low-acuity cases away from emergency ambulance dispatch. However, some cases still receive an emergency ambulance dispatch following secondary triage. To date no evidence exists identifying whether these cases were overtriaged and could have been suitable for an alternative response. Examination of patients receiving an emergency ambulance dispatch following secondary triage could assist in refining triage protocols and hence strengthen the alignment of clinical response and patient acuity. The aim of this study was to investigate whether cases referred for emergency ambulance dispatch following secondary telephone triage were appropriate for an emergency ambulance response.

Methods: A retrospective cohort analysis was conducted of cases referred for emergency ambulance dispatch in Melbourne, Australia following secondary telephone triage between September 2009 and June 2012. Appropriateness was measured by assessing the frequency of advanced life support (ALS) treatment by paramedics, and paramedic transport to hospital.

Results: There were 23,696 cases eligible for inclusion in this study of which 1,882 (7.9%) were referred for high-acuity emergency ambulance dispatch, 7,728 (32.6%) for medium-acuity dispatch and 14,086 (59.4%) for low-acuity dispatch. The overall rate of paramedic treatment was 54.0% and paramedic transport was 82.2%. High-acuity cases were more likely to be treated (58.7%) and transported (85.4%) by attending paramedics than low-acuity cases (treatment: 53.8%, transport 82.0%); there was no difference between the medium (treatment: 53.2%, transport 82.0%) and low-acuity cases. High-acuity cases demonstrated paramedic treatment rates above those of all emergency ambulance cases (55.5%), and medium and low-acuity cases had rates similar to all emergency ambulance cases. All secondary telephone triage cases referred for emergency ambulance dispatch had transportation rates higher than all emergency ambulance cases (71.1%).

Conclusions: Paramedic treatment and transportation rates at least the same as all emergency ambulance cases indicate that cases referred for emergency ambulance dispatch following ambulance-based secondary telephone triage were appropriate for this care pathway. Nevertheless, the paramedic treatment rates in particular indicate a considerable rate of overtriage that should be further investigated to optimise the efficacy of secondary telephone triage.

INTRODUCTION

Many ambulance services are investigating alternative service provision options to meet increasing demand,[1] and to manage the increasing costs of responding with finite emergency ambulance resources.[2] In doing so, they have reviewed their current dispatch practices and paramedic utilisation rates, revealing a large proportion of the emergency ambulance workload comes from low-acuity cases that are not treated by attending paramedics.[1,3-8] Studies of primary triage tools such as the Medical Priority Dispatch System (MPDS) have identified that these systems can have overtriage rates (triaging cases as more urgent than they actually are) of up to 78%.[9,10] The lack of advanced life support (ALS) treatment has been used to define low-acuity cases and to highlight that the skill sets of attending paramedics are not being utilised.[3-8] In two studies approximately 95% of the cases paramedics attended received only basic life support (BLS) treatment,[3,4] and the other studies identified high numbers of MPDS codes receiving BLS treatment only, but did not quantify the rates.[5-8] This has raised the question of whether emergency ambulance dispatch is the most appropriate management pathway for some cases entering the emergency ambulance system.

Demand management strategies such as secondary telephone triage have been examined to determine the feasibility of these systems in managing low-acuity demand.[11] Secondary telephone triage aims to divert cases identified as low-acuity at primary triage away from emergency ambulance dispatch to alternative management pathways by aligning the patient's needs with the most appropriate management pathway. These studies have identified that secondary telephone triage can reduce demand by diverting cases to more appropriate care pathways, however a proportion of the cases triaged are not diverted and are referred for emergency ambulance dispatch. Whilst this outcome is considered a valid management pathway for cases undergoing secondary telephone triage, it is contrary to the policy intention of these services, which is to reduce demand upon emergency ambulances. Two studies have investigated the appropriateness of cases referred for emergency ambulance dispatch for the emergency department (ED), and found that secondary telephone triage was feasible for identifying cases that were less likely to receive ED care or hospital admission.[12,13] To date, no research has been conducted to determine whether these cases required an emergency ambulance prior to their ED presentation.

Examination of patients receiving an emergency ambulance dispatch following secondary triage could assist in refining triage protocols and hence strengthen the alignment of clinical response and patient acuity. The aim of this study was to investigate whether cases referred for emergency ambulance dispatch following secondary telephone triage were appropriate for an emergency ambulance response.

METHODS

Study design

A retrospective cohort analysis was conducted of secondary telephone triage cases referred for emergency ambulance dispatch between September 2009 and June 2012. Cases with a secondary telephone triage record and a corresponding paramedic patient care record were included in the study.

Study setting

Ambulance Victoria is the sole provider of emergency medical services (EMS) to the state of Victoria, Australia. Melbourne is the capital and largest city in Victoria, with a population of 4.25 million in 2012.[14] Between 2009 and 2012, Ambulance Victoria responded to just over a million cases in Melbourne using a two-tiered medical response system. The lower tier consists of ALS paramedics, and mobile intensive care ambulance (MICA) paramedics form the upper tier. ALS paramedics are authorised to gain intravenous (IV) access, provide intravenous drug and fluid therapy, use a range of pharmacological agents, insert laryngeal mask airways, provide continuous positive airway pressure (CPAP) therapy, and perform chest decompression.[15] MICA paramedics are authorised to perform additional procedures including rapid sequence endotracheal intubation (RSI), cricothyroidotomy, elective cardioversion, mechanical ventilation, 12-lead electrocardiogram interpretation and administer a broader range of pharmacological agents. The decision to respond ALS paramedics, MICA paramedics or both is made using the Advanced Medical Priority Dispatch System (AMPDS) primary triage tool and an Ambulance Victoria formulated service allocation matrix.[16]

The Referral Service has operated since 2003 and is a subsidiary of Ambulance Victoria. It provides secondary telephone triage 24 hours a day, seven days a week to cases identified as low-acuity following primary triage. These cases are identified during the AMPDS-led primary triage, and pre-defined event types are transferred to the Referral Service for further triage. Qualified and experienced paramedics or nurses conduct the secondary telephone triage using a computer-based triage algorithm to ascertain the most appropriate disposition outcome for the case (Figure One). The broad dispositions are:

- advice regarding the provision of self-care advice or to self-present at a community-based medical or health service;
- the dispatch of an alternative service provider including home-visiting doctors, nurses and hospital outreach programs;
- referral to self-present at the ED;
- the dispatch of a non-emergency ambulance, or
- the dispatch of an emergency ambulance.

Only the cases in the 'emergency ambulance dispatch' group were investigated in this study. The Referral Service has been described in more detail elsewhere.[16]

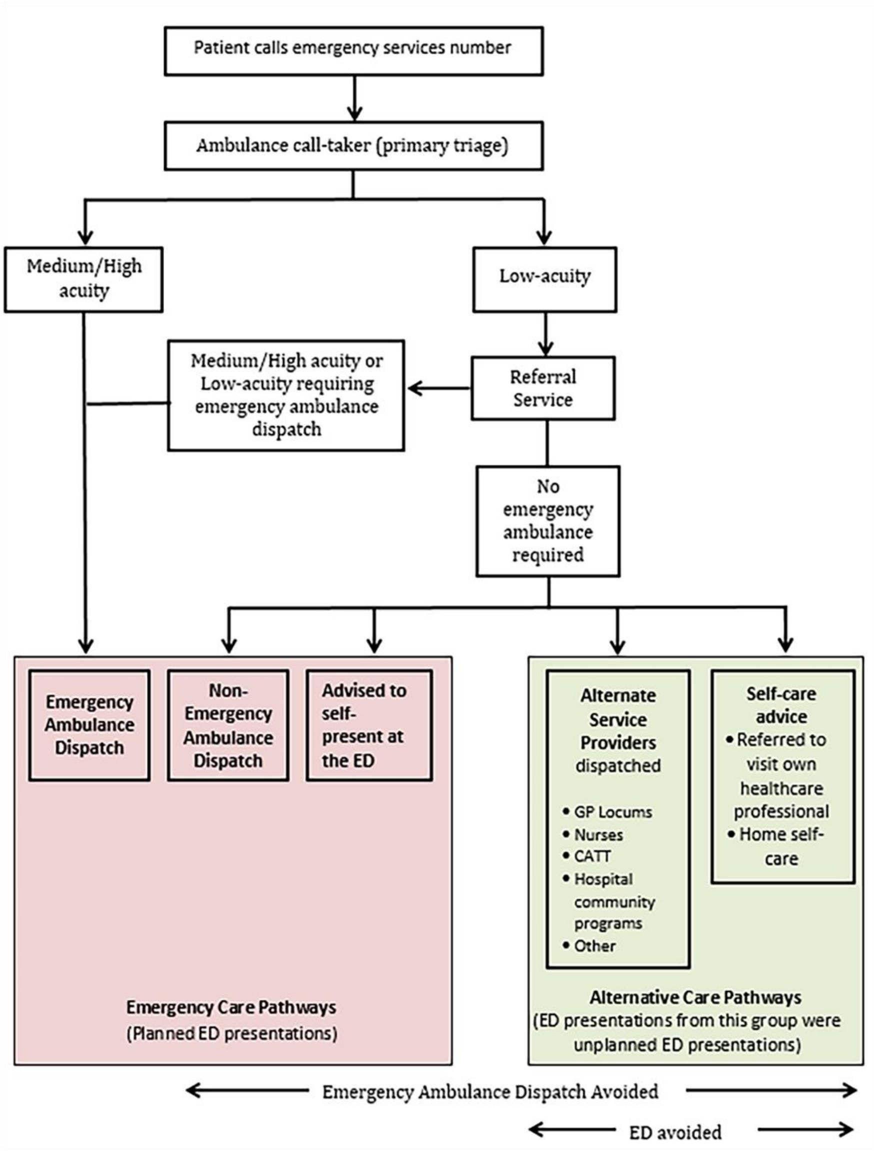

Figure One: Referral Service care pathways

Data sources

Referral Service records were extracted from the Referral Service database and corresponding paramedic records for the cases referred for emergency ambulance dispatch were extracted and linked. These records documented patient demographic, assessment and treatment information, and operational information.

Indicators of appropriateness

The appropriateness of triaging cases for emergency ambulance dispatch was analysed using data about paramedic treatment and paramedic transport.

Paramedic treatment

Treatment by emergency ambulance paramedics was defined as the utilisation of ALS-level treatment strategies with the intent of modifying the patient's current physiological condition or medical presentation. Paramedic treatment therefore consisted of drug or fluid administration, airway/oxygen therapy, perfusion or cardiovascular support management, and mental health management including chemical or physical restraint. Intravenous line insertion was excluded from 'paramedic treatment' if it was not subsequently used for drug or fluid resuscitation.[6] BLS treatments such as first aid, or other tasks such as ongoing monitoring or extrication, can be performed by non-emergency ambulance officers in Victoria and were therefore not included in the paramedic treatment definition for this study. Furthermore, some of the treatments within the categories listed above can be administered by BLS ambulance officers, however a simple approach was adopted to defining treatment in this study to allow for comparison to other ambulance systems internationally.

Paramedic treatment has been used in this study, and others,[1,3-8] to suggest that cases that are not treated (i.e. do not receive ALS treatment) are more appropriate for transport or care pathways other than an emergency ambulance.

Paramedic transport

Not all Ambulance Victoria cases are transported to hospital after paramedic attendance. Reasons for non-transportation include provision of definitive treatment, paramedic referral to other healthcare providers, and transportation to the ED by other means, such as a private vehicle. This variable was used to identify cases that paramedics viewed as suitable for transport via emergency ambulance to hospital.

Other variables for investigation

The paramedic treatment and transportation rates were further analysed using the following variables.

Dispatch acuity categories

Cases referred to emergency ambulance dispatch after secondary triage are allocated to a dispatch level based on the call-taker's clinical judgement of acuity. These levels correspond to the urgency with which the emergency ambulance should respond. These acuity levels are:

- high-acuity– lights and sirens response within 15 minutes (e.g. suspected cardiac arrests, severe respiratory distress, unconscious patients, acute chest pain, respiratory distress);
- medium-acuity– expedient response, obeying traffic road rules, within 30 minutes (e.g. abdominal pain, many musculoskeletal injuries); and
- low-acuity– expedient response, obeying traffic road rules, within 60 minutes (e.g. generally unwell, vomiting with no other significant symptoms, chronic musculoskeletal problems).

Physiological parameters

Ambulance Victoria has physiological parameters that trigger a medical intervention by paramedics or a flag in the clinical governance process. The 'acceptable limits' derived from this process are shown in Table Three.

Procedures

The analysis was conducted in three stages. First all the Referral Service cases referred for emergency ambulance dispatch were compared to the statewide rates for paramedic treatment, and the metropolitan rates of paramedic transportation to hospital. (A metropolitan rate of paramedic treatment was not available.) Then, to provide more granularity to the analysis, the Referral Service cases were analysed according to their dispatch acuity level and the physiological parameters. Finally the treated and non-transported cases underwent further descriptive analysis.

Statistical analysis

Data were analysed using descriptive statistics, chi-squared tests of association, independent samples t-tests and logistic regressions to identify relationships with 95% CIs. All tests were considered to be significant at p=0.05. All statistical analysis was conducted using SPSS Version 23.[17]

Ethical Approval

Ethical approval was granted by the Monash University Human Research Ethics Committee (MUHREC) (CF12/0547 – 2012000215), and organisational approval by the Ambulance Victoria Research Governance Committee (R11-021).

RESULTS

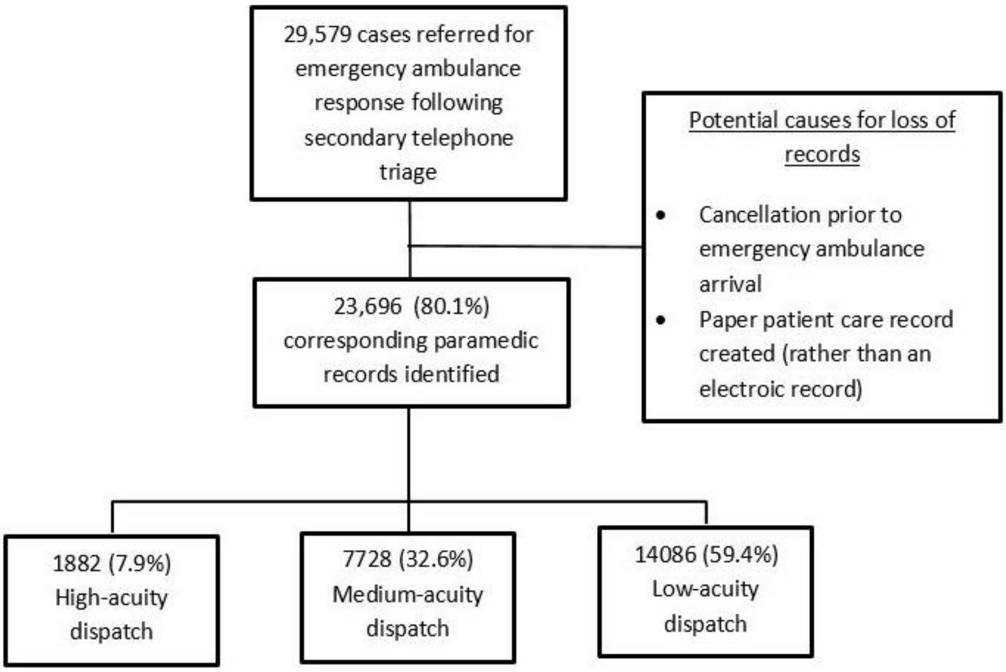

Figure Two: Case selection flow-chart

During the study period 29,579 (28.5%) of the cases triaged by the Referral Service were referred for emergency ambulance dispatch and 23,696 (80.1%) of these cases were included in this study (Figure Two). There were 7.9% (n=1882) of cases referred as high-acuity, 32.6% (n=7728) referred as medium-acuity and 59.4% (n=14,086) referred as low-acuity.

Analysis of all Referral Service cases referred for emergency ambulance dispatch to all the statewide emergency ambulance cases found that the overall rate of paramedic treatment for cases referred for emergency ambulance dispatch following secondary telephone triage was similar to the statewide rate for paramedic treatment (54.0% versus 55.5%). When compared to the rate of transportation of all cases in Melbourne (71.1%), the cases referred for emergency ambulance dispatch following secondary telephone triage had a higher transportation rate of 82.2% (Table

One).

When comparing the dispatch acuity levels of Referral Service cases, the high-acuity dispatch cases had higher rates of paramedic treatment and transport (Table One), and they were 9.5 times more likely to be transported using warning beacons and sirens than those triaged as low-acuity (95% CI 7.2-12.5; p<0.001). There was no statistically significant difference in provision of treatment or transport between those triaged to medium and low-acuity dispatch (Table One).

Overall, 79.8% of cases had some physiological measure outside of the normal parameters. High-acuity dispatch cases had the highest rates of physiological derangement (84.4%; n=1,589), followed by medium acuity (80.1%; n=6,191) and low-acuity dispatch cases (79.0; n=11,134). The high and medium-acuity dispatch cases were more likely than the low-acuity cases to have physiological derangement in all the physiological parameters except for oxygen saturations (Table Two). In all significant physiological variables it can be seen that the frequency of cases outside of the acceptable parameters decreased as acuity level decreased. Interestingly, the proportion of patients with pain scores greater than two out of 10 increased as acuity level decreased.

Cases that were positive for physiological derangement were more likely to be treated (62.9%) than those with no physiological derangement (18.3%; OR 7.6, 95% CI 7.0–8.2; p<0.001). However, of those not treated by attending paramedics, 65.5% (n=7017) still had some physiological derangement.

	Patient demographics		Paramedic treatment			Paramedic transport		
	Age (mean years)	**Gender** (% female)	**%**	**Compared to cases referred as low-acuity**	**Compared to all ambulance cases**	**%**	**Compared to cases referred as low-acuity**	**Compared to all ambulance cases**
High acuity (compared to low acuity)	57.9	51.7	58.7	OR 1.25 (95% CI 1.13-1.38; p<0.001)	OR 1.22 (95% CI 1.11-1.34; p<0.001)	85.4	OR 1.3 (95% CI 1.13-1.48; p<0.001)	OR 2.23 (95% CI 1.96-2.5; p<0.001)
Medium acuity (compared to low acuity)	56.0	53.6	53.2	OR 0.988 (95% CI 0.935-1.05; p=0.675)	OR 0.97 (95% CI 0.92-1.01; p=0.132)	82.0	OR 1.0 (95% CI 0.93-1.08; p=0.991)	OR 1.7 (95% CI 1.63-1.83; p<0.001)
Low acuity	58.5	56.0	53.8		OR 0.98 (95% CI 0.95-1.01; p=0.185)	82.0		OR 1.7 (95% CI 1.65-1.8; p<0.001)
All emergency ambulance cases following RS triage	57.6	54.9	54.0		OR 0.99 (95% CI 0.97-1.02; p=0.49)	82.2		OR 1.76 (95% CI 1.7-1.8; p<0.001)
General ambulance population			55.5 (statewide)			71.1 (metropolitan)		

Table One: Ambulance outcomes for cases referred to emergency ambulance dispatch by the Referral Service compared to (1) the low-acuity emergency ambulance dispatch pathway, and (2) the ambulance outcomes for all emergency ambulance cases.

	Physiological parameters within acceptable limits													
Dispatch Urgency	**Glasgow Coma Score (GCS>13)**		**Temperature (35.0-39.5°C)**		**Respirations (8-20 breaths/minute)**		**Pulse (55-99 beats/minute)**		**Blood Pressure (systolic: 100-139)**		**Peripheral capillary oxygen saturation (SpO_2>93%)**		**Pain score <2 (out of 10)**	
	%	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**
High-acuity (compared to low-acuity)	94.6	OR 0.42 95% CI 0.34 to 0.53 p<0.001	93.6	OR 0.42 95% CI 0.33 to 0.54 p<0.001	77.9	OR 0.50 95% CI 0.44-0.56 p<0.001	66.9	OR 0.53 95% CI 0.47-0.56 p<0.001	37.3	OR 0.65 95% CI 0.58 to 0.72 p<0.001	86.5	OR 1.17 95% CI 0.87 to 1.56 p=0.295	68.1	OR 2.13 95% CI 1.91 to 2.38 p<0.001
Medium-acuity (compared to low-acuity)	96.8	OR 0.73 95% CI 0.62 to 0.86 P<0.001	95.5	OR 0.61 95% CI 0.51 to 0.73 p<0.001	83.3	OR 0.70 95% CI 0.65 to 0.76 p<0.001	73.8	OR 0.73 95% CI 0.69-0.78 P<0.001	45.0	OR 0.89 95% CI 0.84 to 0.94 P<0.001	87.4	OR 1.27 95% CI 1.02 to 1.59 P=0.037	60.9	OR 1.55 95% CI 1.46 to 1.65 p<0.001
Low-acuity	97.6		97.2		87.7		79.3		47.9		84.6		50.1	
Total	97.1		96.3		85.5		76.5		46.1		85.9		55.1	

Table Two: Likelihood of patients having physiological observations within acceptable or non-life-threatening limits.

The frequency of individual paramedic treatments for each of the acuity-levels is shown in Table Three. It can be seen that analgesia was the most common paramedic treatment, followed by intravenous access and airway/oxygen therapy. The high-acuity cases had the highest proportion of cases treated in most treatment categories. Analgesia was a major exception to this, whereby high-acuity cases had the lowest proportion of cases treated. This aligns with the pain score findings from the physiological parameters assessment.

	Proportion of acuity-level treated % (n)		
	High-acuity dispatch	**Medium-acuity dispatch**	**Low-acuity dispatch**
Airway/oxygen therapy	33.0 (622)	18.0 (1,393)	10.7 (1,509)
Perfusion /cardiovascular management	1.6 (30)	1.7 (135)	0.9 (122)
Mental health	0.2 (3)	0.1 (11)	0.2 (22)
Intravenous access	30.9 (582)	22.5 (1,738)	19.8 (2,793)
Analgesia	23.9 (449)	33.7 (2,603)	42.4 (5,972)
Antiemetics	9.6 (180)	7.4 (571)	6.1 (856)
Intubation drugs	0.2 (4)	0.03 (2)	0.007 (1)
Sedation drugs (not for intubation)	0.2 (4)	0.2 (14)	0.2 (23)
Cardiovascular drugs	11.5 (217)	2.1 (166)	0.6 (84)
Respiratory drugs	1.8 (33)	0.5 (35)	0.3 (45)
Fluid administration	9.6 (180)	7.3 (567)	6.2 (867)
Other drugs	2.0 (38)	0.8 (60)	0.4 (52)

Table Three: Frequency of paramedic treatment for acuity levels

The most common triage guidelines used to triage the treated cases were abdominal pain (21.3%), back pain (14.1%) and dizziness/vertigo (5.1%). Table Four shows the treatment categories for the cases that were treated within these triage guidelines. The rate of paramedic treatment for each of these guidelines indicates that the abdominal pain cases had a high rate of treatment, and the back pain and dizziness/vertigo have low rates of treatment (Table Four). The treatment predominantly consisted of analgesia for the two pain triage guidelines and oxygen therapy for the dizziness/vertigo triage guideline. There was a significant difference in the rates of paramedic treatment for the abdominal pain and dizziness/vertigo triage guideline depending on whether they were dispatched

Triage guideline	Sample size	Paramedic treatment (%)	Dispatch acuity level						Paramedic treatment type (for cases that were treated)											
			High-acuity dispatch (%)		Medium-acuity dispatch (%)		Low-acuity dispatch (%)		Perfusion/ cardiovascular management	Airway/ oxygen therapy	Mental health	Intravenous access (IV)	Analgesia	Anti-emetics	Intubation drugs	Sedation (not for intubation)	Cardiovascular drugs	Respiratory drugs	Fluid administration	Other drugs
			Treated	Not treated	Treated	Not treated	Treated	Not treated												
Abdominal pain/discomfort	3627	74.9	80.3	19.7	80.9	19.1	72.2	27.8	1.5	11.0	0.0	43.8	95.0	11.5	0.0	0.0	0.7	0.1	13.2	0.2
Back pain	12415	14.5	82.7	17.3	77.9	22.1	77.8	22.2	0.6	7.6	0.0	38.0	97.8	7.1	0.0	0.1	1.1	0.3	9.0	0.2
Dizziness/ vertigo	5235	12.5	16.4	10.6	44.9	41.0	38.7	48.4	4.9	61.8	0.0	31.9	11.5	34.8	0.0	0.2	11.2	0.9	12.4	2.3

Table Four: Rates of treatment for the most common triage guidelines as high-, medium-, or low-acuity ($p<0.001$). The back pain triage guideline category, however, did not demonstrate a significant difference ($p=0.701$).

Overall, 17.7% (n=4209) of cases were not transported by ambulance to hospital following paramedic assessment and of these only 2.8% received paramedic treatment. Patients not transported had a mean age of 54.3 years and 56.9% were female. Nearly two-thirds (60.3%) had been referred for low-acuity ambulance dispatch, 33.1% were dispatched as medium-acuity and 6.5% as high-acuity.

The most common triage guidelines for this cohort of patients were abdominal pain (10.0%; n=420), dizziness/vertigo (9.0%; n=380) and back pain (7.6%; n=319) (Table Five). Of the treated patients in this cohort, the most common triage guidelines were abdominal pain (9.4%; n=11), diabetes: out of control (9.4%; n=11) and back pain (6.0%; n=7). None of the high-acuity dispatch abdominal pain (n=7) or back pain (n=5) cases were treated by paramedics.

Triage guideline	Mean age		Dispatch acuity level for patients not transported following paramedic attendance					
	Transported	Not transported	High-acuity dispatch (%) (n=39)		Medium-acuity dispatch (%) (n=304)		Low-acuity dispatch (%) (n=772)	
			Treated	Not treated	Treated	Not treated	Treated	Not treated
Abdominal pain/discomfort	53.9	51.5	0	100	3.1	96.9	2.5	97.5
Difference			$p<0.001$		$p<0.001$		$p<0.001$	
Dizziness/ vertigo	69.1	64.1	12.9	87.1	0.6	99.4	1.0	99.0
Difference			$p<0.001$		$p<0.001$		$p<0.001$	
Back pain	56.1	56.2	0	100	98.0	2.0	2.3	97.7
Difference			$p<0.001$		$p<0.001$		$p<0.001$	

Table Five: Most common triage guidelines for cases not transported following paramedic assessment

DISCUSSION

This was the first large-scale study of cases referred for emergency ambulance dispatch following low-acuity secondary telephone triage. Overall the cases referred for emergency ambulance dispatch had almost the same paramedic treatment rate as all Victorian emergency ambulance cases, however they were more likely to be transported to hospital. Nonetheless, the paramedic treatment rates – and to a lesser extent the transportation rates – are consistent with primary triage research,[1,3-10] suggesting that there is considerable overtriage occurring, even in the setting of a healthcare professional-led secondary triage. The high-acuity cases were more likely than the medium and low-acuity cases to be treated and transported by attending paramedics. There was no difference for these outcomes between medium and low-acuity cases. When compared to the statewide rates of paramedic treatment, only the high-acuity cases demonstrated higher rates of treatment, whereas the medium and low-acuity cases showed no difference. The physiological parameters showed a delineation between each of the three pathways, with high-acuity and medium-acuity cases having higher rates of physiological derangement than low-acuity cases. The frequency of physiological derangement decreased as the acuity level decreased. When using the paramedic treatment rate for all emergency ambulance cases as a benchmark for appropriateness, the results from this study suggest that the RS is appropriately identifying cases similar to all Victorian ambulance cases in terms of their paramedic treatment rates, unless they are identified as high-acuity, in which case they appear to be more appropriate for an emergency ambulance dispatch. However, the large rate of 'no paramedic treatment' suggests more can be done to reduce the overtriage.

Interestingly, the secondary telephone triage process appears to identify cases that are 76% more likely to be transported to the ED by attending paramedics than the average ambulance case occurring in the city of Melbourne. This suggests that the Referral Service is able to more appropriately identify cases suitable for the emergency ambulance dispatch pathway than primary triage. Despite this, more work can be done to determine whether alternative means of transportation would be appropriate for some cases.

The identification of varying rates of paramedic treatment for variables such as the triage guideline suggests that there are cohorts within the patients triaged by the Referral Service that are better suited to other management pathways. When using paramedic treatment to measure appropriateness, the structure of the healthcare system within which a secondary telephone triage service sits plays a crucial role. For example, in this study, analgesia was found to be the most common treatment measure, and whilst this intervention resulted in the classification of ‘appropriate’, many other services in Victoria had the potential to manage patients with pain. The Referral Service is supported by home-visiting doctors and non-emergency ambulances, both of which can provide varying types of analgesia. Some of these cases may have been suitable to be managed in the primary care setting, which is better suited to improving outcomes through continuity of care, particularly those suffering with chronic pain.[18,19] For this reason, more granular research is recommended at the local level to produce a local definition of appropriateness, and to tailor the secondary telephone triage process to identify cases appropriate for alternative management pathways.

The lack of variation in the dispatch acuity level cohorts for some variables warrants further investigation to determine if the secondary telephone triage call-takers were adequately delineating between the medium and low-acuity cases or whether the triage algorithm could be improved to assist in this process. The inclusion of other variables in future analyses may reveal a distinction between these cohorts. Such variables may reveal that non-clinical reasons, such as patient safety, are being applied to decision-making about acuity level, and an investigation of such factors in the decision-making of the call-takers may reveal more about the patient cohorts in each acuity level.

Limitations

The inability to link all of the data records between the Referral Service and paramedic datasets may have biased the results. Healthcare systems vary in their operational structures and functions, so the triage outcomes of secondary telephone triage services working within these systems will differ. This is also true for the role of ambulance services and paramedics. Different societal and operational expectations and requirements will result in different approaches to management. The definition of ALS treatment also varies depending upon time, geography and jurisdictional resources, therefore studies using an ALS treatment measure will produce different findings depending on the study setting. Finally, using paramedic treatment and transport to determine appropriateness does not consider the non-clinical skills paramedics utilise or the alternative reasons for defining cases as appropriate for emergency ambulance dispatch.[20] Finally, the identification of cases that are ‘inappropriate’ for emergency ambulances does not suggest that they are not suitable for ED presentation.

CONCLUSION

Paramedic treatment and transportation rates at least the same as all emergency ambulance cases indicate that cases referred for emergency ambulance dispatch following ambulance-based secondary telephone triage were appropriate for this care pathway. Despite this, the paramedic treatment rates in particular indicate considerable overtriage that should be further investigated to optimise the efficacy of secondary telephone triage.

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5.5.3 Additional analyses

The following analyses were conducted to supplement the results in the manuscript presented above. Reviewing the hospital outcomes and main presenting problems of the cases presented in Study Three (Section 5.5.2) provides an insight into whether there is a difference in the ED suitability of cases depending upon whether they were referred for high-, medium-, or low-acuity emergency ambulance dispatch. This may indicate some concordance or discordance between emergency ambulance appropriateness and ED appropriateness, which may be useful in identifying cases suitable for the emergency care pathways or that may be better managed by alternative care pathways.

5.5.3.1 Hospital outcomes of cases transported to hospital following referred for emergency ambulance dispatch

Emergency department records were linked to 95.3% (n=18,578) of the cases transported by emergency ambulance to hospital. The reasons for the potential loss of records are outlined in the Study Two publication.

Cases with a high-acuity dispatch were 58% more likely than patients with a low-acuity dispatch to be ED suitable, and medium-acuity dispatch cases also demonstrated a statistically significant difference in their ED suitability, compared to the low-acuity dispatch cases (Table 11). There was no significant difference in ED suitability between the patients with high and medium-acuity dispatches ($p=0.11$). Overall, 57.5% of the cases referred for emergency ambulance dispatch (that had an ED record) were treated in the ED. There was negligible difference between the rates of ED treatment for all three dispatch categories. Finally, both the high and medium-acuity dispatch cases demonstrated significantly higher rates of admission than low-acuity dispatches (Table 11), and there was no difference between the high and medium-acuity dispatches ($p=0.183$).

Table 11: Hospital outcomes for cases referred to the emergency ambulance pathway

	ED suitable		ED treatment		Admission	
	Absolute Risk (%)	**Statistics**	**Absolute Risk (%)**	**Statistics**	**Absolute Risk (%)**	**Statistics**
High-acuity (compared to low-acuity)	83.1	OR 1.58 95% CI 1.37-1.82 p<0.001	58.3	OR 1.05 95% CI 0.94-1.17 p=0.415	56.1	OR 1.16 95% CI 1.06-1.26 p<0.002
Medium-acuity (compared to low-acuity)	81.2	OR 1.4 95% CI 1.29-1.51 p<0.001	57.9	OR 1.03 95% CI 0.97-1.1 p=0.346	56.6	OR 1.08 95% CI 1.03-1.14 p<0.002
Low-acuity	75.2		57.2		54.0	

Of all of the ED presentations that occurred in metropolitan Melbourne between 2011 and 2012, 61.0% were considered ED suitable. The RS cases referred for emergency ambulance dispatch that had a corresponding ED record demonstrated a significantly higher ED suitability rate of 77.8% (Table 12). Over half of all the cases referred for emergency ambulance dispatch were admitted to hospital, which is higher than the admission rate for all Victorian ED presentations of 36% (Table 12).

Table 12: Comparison of hospital outcomes for cases referred to emergency ambulance by the RS compared to the hospital outcomes for all cases presenting at the ED in a year.

	ED suitable		ED treatment	Admission	
	Absolute Risk (%)	**Statistics**	**Absolute Risk (%)**	**Absolute Risk (%)**	**Statistics**
High-acuity	83.1	OR 2.8 95% CI 2.4-3.2; p<0.001	58.3	56.1	OR 2.51 95% CI 2.26-2.78; p<0.001
Medium-acuity	81.2	OR 2.4 95% CI 2.27-2.59; p<0.001	57.9	56.6	OR 2.56 95% CI 2.4-2.7; p<0.001
Low-acuity	75.2	OR 1.7 95% CI 1.63-1.78; p<0.001	57.2	54.0	OR 2.3 95% CI 2.22-2.39; p<0.001
All emergency ambulance cases following RS triage	77.8	OR 1.96 95% CI 1.9-2.03; p<0.001		55.0	OR 2.4 95% CI 2.3-2.47; p<0.001
All ED presentations	61.0			36.0	

5.5.3.2 Main presenting problem

The most common main presenting problems for patients triaged by RS are shown in Table 13. In all three dispatch categories the most common main presenting problems are similar for both the RS and the ED. For the RS cases, the top 10 problems accounted for 57.0% of the cases. The top 10 ED diagnoses accounted for 33.0% of all the diagnoses. Once again, there is a high representation of pain amongst the presenting problems and diagnoses.

Table 13: Top 10 RS main presenting problems and ED diagnoses for each acuity level

Emergency ambulance dispatch category (transported)		RS presenting problem	ED diagnosis
	High-acuity	1. Chest pain or discomfort 2. Dizziness/vertigo 3. Abdominal pain 4. Neurological symptoms/Transient ischaemic attack (TIA) 5. Nausea and vomiting 6. Weakness/paralysis 7. Breathing problems 8. Headache 9. Confusion/disorientation 10. Back pain	1. Unspecified chest pain 2. Abdominal pain 3. Syncope/collapse 4. Dizziness and giddiness 5. Urinary tract infection 6. Unspecified TIA 7. Migraine 8. Stroke 9. Nausea and vomiting 10. Essential hypertension
	% of total cases	65.4%	34.0%
	Medium-acuity	1. Abdominal pain 2. Dizziness/vertigo 3. Fever 4. Back pain 5. Nausea and vomiting 6. Headache 7. Confusion/disorientation 8. Weakness/paralysis 9. Flank pain 10. Neurological symptoms (TIA)	1. Abdominal pain 2. Unspecified renal colic 3. Dizziness and giddiness 4. Urinary tract infection 5. Syncope/collapse 6. Other gastroenteritis and colitis infections 7. Migraine 8. Lower back pain 9. Fever 10. Dorsalgia –unspecified site
	% of total cases	54.6%	31.6%
	Low-acuity	1. Abdominal pain 2. Back pain 3. Nausea/vomiting 4. Dizziness and vertigo 5. Flank pain 6. Fever 7. Weakness/paralysis 8. Headache 9. Confusion/disorientation 10. Hip non-injury	1. Abdominal pain 2. Dorsalgia –unspecified site 3. Lower back pain 4. Unspecified renal colic 5. Urinary tract infection 6. Other gastroenteritis and colitis infections 7. Dizziness and giddiness 8. Nausea and vomiting 9. Constipation 10. Unspecified intestinal obstruction
	% of total cases	61.1%	35.9%
	All cases	1. Abdominal pain 2. Back pain 3. Dizziness/vertigo 4. Nausea and vomiting 5. Fever 6. Headache 7. Weakness/paralysis 8. Flank pain 9. Confusion/disorientation 10. Chest pain/discomfort	1. Abdominal pain 2. Unspecified renal colic 3. Urinary tract infection 4. Dorsalgia –unspecified site 5. Lower back pain 6. Dizziness and giddiness 7. Other gastroenteritis and colitis infections 8. Nausea and vomiting 9. Syncope/collapse 10. Migraine
	% of total cases	57.0%	33.0%

5.5.4 Study three conclusions

The policy objective of the RS is to reduce demand upon emergency ambulances, however the appropriateness of cases returning for emergency ambulance dispatch following secondary telephone triage has never been investigated using ambulance-based outcomes. Whilst the paramedic treatment outcome measure cannot be used to categorically decide whether cases were appropriate for an emergency ambulance attendance, it does given an indication of whether the skills that paramedics possess were required, and has been used in other studies to measure the appropriateness of emergency ambulance usage.[9,20,145-149,163] This study found that 54.0% of cases referred for emergency ambulance dispatch received paramedic treatment. Whilst this rate shows a large amount of overtriage, (given that 46% are not treated), it is comparable to the paramedic treatment rate for all Victorian emergency ambulance cases (55.5%; OR 0.99, 95% CI 0.97–1.02; p=0.49). Therefore using the paramedic treatment rate for all Victorian emergency ambulance cases as a benchmark, the RS triage appears to be appropriately identifying cases for the emergency ambulance dispatch pathway. Furthermore, these cases demonstrated a significantly higher rate of paramedic transport to hospital (82.2%) than all emergency ambulance cases in metropolitan Melbourne (OR 1.76; 95% CI 1.7–1.8; p<0.001). This finding suggests that in terms of the paramedics' decisions about suitability for ambulance transportation to hospital, the cases referred to the emergency dispatch pathway are appropriate.

The analysis of cases according to their dispatch acuity level identified that the high-acuity cases were more likely to be treated than low-acuity cases (58.7%; OR 1.25, 95% CI 1.13–1.38; p<0.001) and all Victorian ambulance cases (58.7%; OR 1.22, 95% CI 1.12–1.34; p<0.001). The medium-and low-acuity cases showed no difference in paramedic treatment. The medium-acuity cases had the same rate of paramedic transportation to hospital, however both of these groups were significantly more likely to be transported to hospital than all metropolitan emergency ambulance cases (medium-acuity dispatch: 82.0%; OR 1.7 95% CI 1.63–1.83; p<0.001; low-acuity: 82.0%; OR 1.7 95% CI 1.65–1.88; p<0.001).

Cases with high (83.1%; OR 2.8; 95% CI 2.4–3.2; p<0.001) and medium-acuity (81.2%; OR 2.4; 95% CI 2.27–2.59; p<0.001) dispatches were more likely to be considered ED suitable than low-acuity cases (75.2%), however despite the statistical significance of these differences there was no clinically significant difference in the acuity levels for admission. Finally, the ED treatment rates for the three dispatch levels ranged between 57.2% and 58.3%, indicating that there was no difference in ED treatment based on dispatch acuity level. The increased paramedic treatment rates and ED suitability for high-acuity cases indicates that there is some concordance between the emergency ambulance and ED appropriateness for this group of cases, however the results for the medium and low-acuity cases for these outcome measures did not demonstrate a similar concordance.

The comparison of the top 10 RS presenting problems and ED diagnoses confirms that the secondary triage is appropriately elucidating the problem that later forms the primary diagnosis in the ED. The analysis of the top three triage guidelines that received paramedic treatment in the manuscript in Section 5.5.2 demonstrated that there were varying rates of paramedic treatment depending upon the triage guideline used (12.5%–74.9%). This indicates that there are cohorts that can be further investigated to determine whether there are other management pathways that are better suited to their needs, and whether these cases can be identified prior to emergency ambulance dispatch.

This study addressed the major gap in knowledge around the appropriateness of emergency ambulance dispatch following secondary telephone triage by being the first to use ambulance outcome measures to assess appropriateness. The paramedic treatment outcome measure has been used in studies investigating primary triage dispatch codes,[9,145-149,163] but it has never been applied to secondary telephone triage systems. Whilst this outcome measure was useful in identifying cases receiving ALS treatment from paramedics, future work needs to consider whether the treatment provided by paramedics can be provided elsewhere. As stated in the manuscript in Section 5.5.2, non-emergency ambulance officers are trained to provide BLS care, including a range of pharmacological agents. Similarly, home-visiting doctor services can provide patients with care that can sustain them until they can see their own GP. Encouraging patients to visit their own GPs is also important to improve patient outcomes.[131] Free care in the ED, that can usually be accessed within a matter of hours, and that can provide almost all of the diagnostic tests required has been shown to be a motivating factor for inappropriate ED presentation.[130] However, this pathway deprives patients of the continuity of care that can be provided by an ongoing relationship with a GP,[131] and potentially delays the implementation of ongoing management strategies.

The identification of case types demonstrating low paramedic treatment rates also suggests that there are cohorts within the population that are being significantly overtriaged and could be better managed using other care pathways. Overtriage is an accepted part of computer-based triage systems in ambulance services in order to maintain patient safety,[147] however the goal of secondary telephone triage systems is to reduce the margin of overtriage. The ability to identify cases unlikely to receive paramedic treatment prior to emergency ambulance dispatch should be investigated to reduce the margin of overtriage. Finally, these low-paramedic treatment case types should be investigated to determine whether any alternative care pathways are missing or can be expanded to improve the effectiveness of the RS.

5.6 Summary

The studies presented in this chapter address the gaps in knowledge identified in the introduction, namely to produce research based on large datasets collected over time, using outcome measures that specifically reflect the appropriateness of cases for the ED or emergency ambulance dispatch. The objectives identified at the beginning of this chapter were achieved through the linkage of four large datasets, allowing for appropriateness studies to be conducted using outcomes.

These studies demonstrate that the cases that the AV RS returns to the emergency care pathways are both appropriate for emergency ambulances (when referred to this pathway) and for the ED when compared to data from the broader ED and ambulance populations. In both of these studies of the emergency care pathways and dispatch levels, the rates indicating appropriateness were the same or better than in all the emergency ambulance cases and ED presentations.

Whilst the rates of paramedic treatment and transport, ED suitability and hospital admission demonstrate that the RS is identifying cases appropriate for these pathways (when compared to the rates seen in the general populations that use these services), there is still room for further identification of cases that could benefit from alternative care pathways. Even though the paramedic treatment rates were similar to that of all emergency ambulance cases, the treatment rate demonstrates that there was still overtriage, whereby cases were being referred to emergency ambulances that may have been better served by other care pathways. Whilst the rates of ED suitability were higher, around 25% of cases were potentially overtriaged and not considered ED suitable, therefore these cases would also benefit from further investigation. The episode of care for these cases may be unnecessarily extended by being moved through the emergency care pathway, when a community-based resource may have been able to manage their immediate problem and link them to services that can assist them on an ongoing basis if necessary. Identifying case-types suitable for alternative care pathways has not been conducted for cases triaged by secondary telephone triage services. The RS has reduced the emergency ambulance convenyance to ED rates, and shifted some of the cases requiring ED presentation to other transportation methods. It has also shifted some of this work into the primary care setting.

In the next chapter, the associations between ED suitability and a range of explanatory variables for paramedic treatment will be explored. This may allow for the identification of variables that warrant further investigation to increase the specificity of the secondary triage. The findings may also identify gaps in the alternative care pathways that should be addressed when expanding RS suite of service provision options.

CHAPTER SIX: OPTIMISATION OF THE REFERRAL SERVICE

This program of research has demonstrated that the RS has had a measurable impact upon AV operations.[143] It has also shown that the cases the RS identified as requiring ED assessment, and particularly those referred for emergency ambulance dispatch, were more appropriate for the ED than the average Victorian ED presentation.[164] However, the RS cases had similar rates of appropriateness for emergency ambulance to all Victorian ambulance cases (54.0% versus 55.5%). The investigation of both ED suitability and paramedic treatment rates in Chapter Five revealed that there was nearly 25% overtriage for ED suitability, and 46% for emergency ambulance dispatch. Reducing this margin of overtriage will contribute to the optimisation of the RS and the allocation of patients to more appropriate care pathways.

Dale et al.'s[19] study of a secondary telephone triage system revealed differences in case type, age and gender for cases presenting at the ED depending upon whether they were triaged to the emergency ambulance dispatch pathway. Whilst they did not test for any association between these variables and the decision to refer these cases to the emergency ambulance dispatch pathway, these results indicate relationships. In this chapter, the relationships between a range of patient and case characteristics (explanatory variables) and the paramedic treatment and ED suitability outcome measures are investigated.

This addresses Objective V of this thesis:

> *V. To identify variables associated with paramedic treatment and ED suitability that may be useful in further optimising the Referral Service triage process.*

This chapter begins with a brief description of overtriage and a review of the current literature, then presents two studies of the relationships between a range of patient and case characteristic explanatory variables and the paramedic treatment and ED suitability outcome variables.

6.1 Overtriage and undertriage

As mentioned briefly in Chapter Five, overtriage is the allocation of cases to a care pathway that has the skills or resources to provide care beyond what the patient requires (resource overutilisation) and undertriage is the failure to allocate patients to a sufficiently high level of care to meet their immediate needs.[165] Overtriage is said to unnecessarily occupy limited resources, increase service costs, endanger paramedics and the general public through unnecessary lights-and-sirens responses, cause resource shortages, and risk the lives of more seriously ill patients.[165,166] Undertriage, on the other hand, has the potential to risk the health of the patient being triaged should their care be delayed.[166]

Most research into over- and undertriage has focused on trauma systems, which have been implemented to optimise the use of hospital resources and improve patient outcomes.[167-171] The American College of Surgeons Committee on Trauma assigned acceptable rates of over- and undertriage as quality indicators of the triage systems being used.[172] Undertriage should not exceed 5% and overtriage should not exceed 35%.[172] However, due to the heterogeneity of cases and primary dispatch systems used by ambulance call centres, no consensus on acceptable rates of over- and undertriage by primary medical dispatch systems has been achieved.[166,173] Five studies have measured over- and undertriage rates of primary medical dispatch systems, with overtriage rates varying from 29% to 78% and undertriage from 3.5% to 32%.[152,166,174-176]

The use of primary triage systems to gather information quickly means that their data collection is relatively crude, and more focus has naturally been placed upon their sensitivity for life-threatening events to avoid undertriage. As a result, ambulance services expect and accept a degree of overtriage.[152,163,177] However, as demand on resources increases, reduced availability due to overtriage is being recognised as imposing risk on patients.[178] This is partially acknowledged by the demand management work being done by ambulance services to better align patients with resources.[30,143]

As stated in the introduction, Chapter Five reports an emergency ambulance overtriage rate of 46.0% and an ED presentation overtriage rate of 22.2% for cases triaged by the AV RS. This chapter describes an investigation of the relationship between case cohorts and these outcomes to determine whether these cohorts can be used to optimise the RS triage process and reduce the margin of overtriage.

6.1.1 Review of the current literature

No researchers have investigated the relationship between any explanatory variables and ambulance-based secondary telephone triage outcomes. However, primary triage systems such as the MPDS have been studied to determine if they are predictive of, or associated with outcomes such as patient problem, patient acuity, paramedic treatment and ED outcomes.[9,146-148,153,179-181] These studies have produced mixed results. Several studies found that a low-acuity classification at primary triage was predictive of 'no paramedic treatment',[9,146,149] and a study of 28 dispatch codes found that 94.8% of cases did not require ALS care and were therefore classed as low-acuity.[148] An attempt to validate these results failed to isolate any dispatch codes predictive of 'no paramedic treatment', however these authors did identify overtriage in their cohort of cases, with only 56% of cases receiving ALS care.[150] Another study was only able to establish a 'modest' ability of a dispatch system to identify cases that would receive ALS treatment.[145] A Norwegian study identified a strong association between emergency dispatch acuity groups and paramedic treatment ($p<0.001$),[9] and this was the only study to include other explanatory variables such as age, which was associated with paramedic treatment, and gender, which was not.[9] Finally, the only study investigating MPDS with ED outcomes found similar results for these patient characteristics, and they found some dispatch codes had positive predictive values (PPV) of greater than 90% for ED discharge, and others had PPVs over 60% for admission/death.[153]

6.1.2 Critique of the literature

Despite the fact that the studies cited above did not investigate secondary telephone triage, their methodological approach to establishing the relationships between the explanatory and outcome variables was relevant to the development of the studies in this chapter. Most claimed to be identifying the ability of the explanatory variables to predict the outcome. However, the methodological approaches used in these studies did not allow for the associations between the variables and outcomes to be ascertained accurately. Likelihood ratios and predictive values were used in some studies,[146,147,149] and others simply used the frequencies of 'no paramedic treatment' or BLS/ALS intervention.[145,148,163,182] None of these statistical analyses specifically tested for a relationship between the explanatory variables and the outcome variable, or where predictive values were used, took into account the effect of other explanatory variables on this relationship. Only one study utilised regression techniques to evaluate the explanatory capacity of a range of adjusted variables with prehospital treatment.[9] However, statisticians have criticised the variable selection process used to produce the final model in this study as producing biased and potentially misleading results that overfit the data and do not take into consideration other models and variables that may perform equally as well in explaining the outcome.[183,184] As a result of the limited use of appropriate methodological approaches to establishing relationships between variables, there is no reliable existing research investigating the associations of patient characteristics and triage outcomes with paramedic treatment.

6.2 General Method

The study design, setting, data sources and data preparation were the same for both of the studies presented in this chapter, and are outlined in Sections 3.1, 3.2 and 3.3 respectively in Chapter Three. Briefly, a retrospective cohort analysis was conducted for cases referred for emergency ambulance dispatch, or who presented in the ED by emergency ambulance, in metropolitan Melbourne following secondary telephone triage between September 2009 and June 2012. The linked dataset described in Chapter Five, containing RS, paramedic, ED and admission records, was used for the analysis outlined in this chapter.

The general dataset preparations for both studies are outlined below. Further details about the methodological approaches used in each of the studies can be found in the methods sections for the studies this chapter.

6.2.1 Paramedic treatment and ED suitability

These outcome measures are discussed in Section 5.3.4 and in the publication in Section 5.4.2. Briefly, paramedic treatment is defined as the utilisation of ALS treatment measures with the intent of modifying a patient's current physiological condition or medical presentation. It consists of drug or fluid administration, airway/oxygen therapy, perfusion or cardiovascular support management, and mental health management including chemical or physical restraint. The insertion of IV lines were excluded if they were not used for treatment.

This definition of paramedic treatment is suitable in the setting in which AV operates because there is a non-emergency ambulance service, staffed with BLS-trained ambulance officers, also operating in this region. This non-emergency ambulance service receives bookings for its services both independently and through AV to respond to cases. These ambulances are able to provide basic cardiac monitoring and drug administration as well as transportation to the ED.

The ED suitability measure is a modification of the 'potentially avoidable GP-type presentation' measure used by the Australian Government for ED presentations.[2] These presentations are considered avoidable had an appropriate community-based service been accessed.[2] The criteria for the ED suitability measure are that the patient:

- was triaged as a category 1, 2 or 3 according to the Australian Triage Scale;[159]
- was admitted to the hospital, or referred to another hospital for admission; or
- died in the ED.

6.2.1.1 Descriptive and comparative analyses

Categories of the explanatory variables that were significantly associated with the outcome were compared to the population mean rates for paramedic treatment, ED suitability and admission established in Chapter Five. The population mean data related to the average RS case referred for emergency ambulance dispatch, the average Victorian ambulance case, and the average Victorian ED presentation (Table 14).

Table 14: Average rates of paramedic treatment, ED suitability and admission for all RS cases that are referred for an emergency ambulance dispatch, all Victorian ambulance cases and all ED presentations in Victoria

	Paramedic treatment rate	ED suitability rate	Admission rate
All RS cases referred for emergency ambulance dispatch	54.0%	77.8%	55.0%
All Victorian ambulance cases	55.5%		
All Victorian ED presentations		61.0%	36.0%

6.2.2 General dataset preparation

The dataset described in Chapter Five underwent further preparation for use in these studies. Binary logistic regression model-building techniques were used to develop models for 'no paramedic treatment' and ED suitability. In order to utilise these modelling techniques and produce the most meaningful output, some of the variables needed to be modified. The explanatory variables used in the multivariable logistic regression modelling are listed in Table 15 below, along with a description of their manipulation.

Table 15: Explanatory variables used in Study Four and Five

Variable Name	Manipulation
Age	Grouped into five-year age blocks starting at zero, except for 85+ which included all patients over this age.
Gender	No changes were made
Income status	Converted to a binary variable, identifying patients residing in LGAs with a median wage below or above the metropolitan median (AU$54,100 in 2011–12). The 'above' category was used as the reference category for the logistic regressions.
Qualification	This variable related to the RS call-taker and identified nurses, ALS paramedics, and intensive care paramedics
Comorbidities	The number of comorbidities recorded on the paramedic record for a patient was used as a continuous variable in logistic regression.
Pain level	Pain scores of 1–10 were divided into one of three groups. In AV, any patient in the moderate or severe pain group is expected to be treated with analgesia unless the patient declines treatment. In this study, the mild pain category was used as the reference category. Mild pain <3; Moderate pain 3–6; Severe pain 7–10
Time of day	Converted to a binary variable corresponding to the day shift (0700–1700 hours) and night shift (1700–0700 hours) roster that most emergency ambulance crews worked at the time of the study. The day shift category was used as the reference category for logistic regression.
Triage guidelines	There were 343 triage guidelines used to triage the RS cases. Many of these guidelines related to similar problems, but varied slightly in their questioning based on issues such as the severity of the presenting problem. For example, there were three allergy guidelines: the Anaphylaxis (paediatric) guideline, the Allergic Reaction Severe guideline and the Allergies/Hay Fever Symptoms guideline. In this study, guidelines that related to the same core problem or groups of problems were grouped together into triage guideline groups. Also, triage guidelines with populations of fewer than 100 cases were identified and consolidated into larger triage guideline groups. The ICD-10-AM was used to guide the consolidation process.[185] This grouping resulted in the creation of 44 triage guideline groups (see Appendix Five). This reduction in the number of guidelines improved model parameter approximations and maintained the logistic regression model's predictive power.[186,187] Only the most frequently used guideline groups were analysed in the studies in this chapter. These guidelines were selected until 80% of the total eligible population were included in the relevant study. Using these guideline groups ensured sufficient group populations for reliable results.

6.2.3 Statistical analysis

Binary logistic regression analysis was used to build the models in Studies Four and Five. Other statistical analyses are outlined in the manuscript in Section 6.3 and in the statistical analysis section of Study Five (Section 6.4.1.5). Binomial tests of equality were used to compare the explanatory variable categories to the population mean data. All data analysis was performed using SPSS Version 20.[188]

6.2.3.1 Binary logistic regression model assumptions

A series of multivariable binary logistic regressions was used in Studies Four and Five to produce the final models. There were a range of model assumptions that were taken into consideration when conducting these analyses. Binary logistic regressions require a large sample size, and some texts recommend more than 30 cases for each explanatory variable,[189,190] which was the case in both studies.

The dependent variable must be binary and the factor level 1 (of the two binary factor levels 0 and 1) of the dependent variable should be the desired outcome,[189] which in Study Four was 'no paramedic treatment' and in Study Five was 'ED suitable'. Each case and each variable needs to be independent (i.e., there should be minimal or no multiple collinearity).[189] This assessment was conducted for all variables in both studies.

A logistic regression does not require a linear relationship between the explanatory and outcome variables.[189,191] The residuals and the outcome variables do not need to be normally distributed.[189-191] The variability between the categories of an outcome variable do not need to be equal, and the explanatory variables can be ordinal and nominal values.[189,190] For the logistic regressions conducted in Studies Four and Five, all of these assumptions were met.

The binary logistic regression model building process used in both studies is outlined in the manuscript in Section 6.3. These models were built to identify explanatory variables associated with the outcome variables, and not for prediction. For this reason, no validation of the models was required.

6.3 Study Four: Patient and case characteristics associated with 'no paramedic treatment'

This study addressed Objective V of this thesis by investigating relationships between a range of explanatory variables and ALS paramedic treatment. Study Three in Chapter Five found that the cases referred for emergency ambulance dispatch were treated at around the same rate as all Victorian emergency ambulance cases (54.0% versus 55.5%). This suggests that the cases referred for emergency ambulance dispatch are similar to all Victorian emergency ambulance case in terms of their requirement for ALS paramedic treatment, however it also shows that there is still considerable overtriage, even after a secondary triage by a healthcare clinician. This overtriage indicates that more can be done to optimise the RS triage, particularly given the availability of non-emergency ambulance dispatch and self-presentation care pathways for cases requiring an ED presentation. In this study explanatory variables associated with 'no paramedic treatment' were identified and analysed in an attempt to elucidate case characteristics that may be useful for future refinement of the RS triage process to better match patients to appropriate care pathways.

The results of Study Four were submitted to Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine as:

Eastwood K, Morgans A, Smith K. Patient and case characteristics associated with 'no paramedic treatment' for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine.* 2017; Submitted.

Manuscript 2 (accepted): Patient and case characteristics associated with 'no paramedic treatment' for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage.

CO-AUTHOR DECLARATION FOR PUBLICATION INCLUDED IN THESIS

Monash University

Eastwood KJ, Smith K, Morgans A, Stoelwinder JU. Patient and case characteristics associated with 'No paramedic treatment' for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage

Declaration by candidate

In the case of the publication in chapter Chapter 6, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Principle author, responsible for study design, data analysis, development and writing the manuscript. Responsible author who accepts overall responsibility for the publication.	90

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Amee Morgans	Contributed to study protocol and editing of the manuscript	N/A
Karen Smith	Contributed to study protocol and editing of the manuscript	N/A

Candidate's Signature		Friday 9th June, 2017

Declaration by co-authors

The undersigned hereby certify that:
(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	**Department of Epidemiology and Preventative Medicine, Monash University**

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department, centre or institute, with specific campus identification where relevant.]

Karen Smith		**Date** 09/06/17
Amee Morgans		09/06/17

Patient and case characteristics associated with 'no paramedic treatment' for low-acuity cases referred for emergency ambulance dispatch following a secondary telephone triage

ABSTRACT

Objective: Predicting case types that are unlikely to be treated by paramedics can aid in managing demand for emergency ambulances by identifying cases suitable for alternative management pathways. The aim of this study was to identify the patient characteristics and triage outcomes associated with 'no paramedic treatment' for cases referred for emergency ambulance dispatch following secondary telephone triage.

Methods: A retrospective cohort analysis was conducted of cases referred for emergency ambulance dispatch following secondary telephone triage between September 2009 and June 2012. Multivariable logistic regression modelling was used to identify explanatory variables associated with 'no paramedic treatment'.

Results: There were 19,041 cases eligible for inclusion in this study over almost three years, of which 8510 (44.7%) were not treated after being sent an emergency ambulance following secondary triage. Age, time of day, pain, triage guideline group, and comorbidities were associated with 'no paramedic treatment'. In particular, cases 0–4 years of age or those with psychiatric conditions were significantly less likely to be treated by paramedics, and increasing pain resulted in higher rates of paramedic treatment.

Conclusions: This study highlights that case characteristics can be used to identify particular case types that may benefit from care pathways other than emergency ambulance dispatch. This process is also useful to identify gaps in the alternative care pathways currently available. These findings offer the opportunity to optimise secondary telephone triage services to support their strategic purpose of minimising unnecessary emergency ambulance demand and to match the right case with the right care pathway.

INTRODUCTION

The increasing demand for emergency ambulances, particularly from patients not requiring specific paramedic interventions, has been reported in numerous studies.[1-9] This demand places significant strain upon costly and finite emergency ambulance resources,[2,8,10,11] and risks the lives and health of patients who need these skills by contributing to resource scarcity.[2,12-14] In order to manage increasing demand some ambulance services have implemented secondary telephone triage services, whereby specific low-acuity cases undergo a nurse, doctor or paramedic-led telephone triage prior to or concurrent with an emergency ambulance dispatch.[13,15-22] The goal of this triage is to reduce the demand for emergency ambulances by diverting suitable cases to alternative transportation or management pathways.[15,23] The impact upon ambulance demand has varied, with some services referring up to 71% of the cases triaged for emergency ambulance dispatch.[17] The Referral Service, a secondary telephone triage service operated by Ambulance Victoria in Victoria, Australia, referred 27.6% of its cases for emergency ambulance dispatch between 2009-2012.[15,24] Whilst these decisions may have been appropriate, 44.7% of these cases were not treated by paramedics, suggesting there is opportunity for optimisation of triage processes. Using emergency ambulance resources for cases not requiring specific paramedic treatment when other options exist is an inappropriate and costly use of resources and does not provide the most suitable care for these patients.

Primary triage tools such as the Medical Priority Dispatch System (MPDS) have been investigated to identify cases not likely to be treated by advanced life support (ALS) paramedics, however most have used simple measures such as frequencies,[4,5,7,9] likelihood ratios and predictive values,[3,6,8] which do not allow for associations or relationships to be ascertained accurately. Furthermore, investigating primary triage tools for case types associated with 'no paramedic treatment' is impractical because these triage tools are designed to rapidly dispatch ambulances and therefore lack granularity in their assessment of cases. Unsurprisingly, the few studies examining triage of low-acuity patients have achieved only moderate success in identifying cases unlikely to be treated by ALS paramedics.[2-8] In summary, there is little reliable research investigating the associations between paramedic treatment, low-acuity patient characteristics and triage outcomes.

Ambulance-based secondary triage systems that utilise less time-sensitive, more granular triage tools which are applied by healthcare clinicians presents a better opportunity to investigate low-acuity cases and their association with ALS paramedic treatment. Identifying cases unlikely to be treated by paramedics that appear suitable for diversion to alternative forms of transportation or care can potentially reduce the demand for emergency ambulances and better align appropriate care pathways with patient need. The aim of this study was to identify the patient characteristics and triage outcomes associated with 'no paramedic treatment' for cases referred for emergency ambulance dispatch following secondary telephone triage.

METHODS

Study Design

A retrospective cohort analysis was conducted of cases referred for emergency ambulance dispatch following secondary telephone triage between September 2009 and June 2012.

Study Setting

Ambulance Victoria is the sole emergency medical service (EMS) provider in the state of Victoria, Australia. Melbourne is the capital and largest city in Victoria, and during the study timeframe Ambulance Victoria responded to 1,036,114 cases in Melbourne, which had a population of 4.25 million in 2012.[25,26] Ambulance Victoria uses a two-tiered medical response system to respond to calls for emergency medical assistance. ALS paramedics form the base qualification level, and mobile intensive care ambulance (MICA) paramedics comprise the upper tier. ALS paramedics are authorised to insert laryngeal mask airways, provide continuous positive airway pressure (CPAP) therapy, gain intravenous (IV) access, provide intravenous drug and fluid therapy, use a range of pharmacological agents and perform chest decompression.[27] In addition to these procedures, MICA paramedics are authorised to perform procedures such as rapid sequence endotracheal intubation, cricothyroidotomy, elective cardioversion, administration of a broad range of pharmacological agents, and perform 12-lead electrocardiogram interpretation. The decision to respond ALS paramedics, MICA paramedics or both is made using the Advanced Medical Priority Dispatch System (AMPDS) primary triage tool and an Ambulance Victoria formulated service allocation matrix.[15]

The Referral Service, a subsidiary of Ambulance Victoria, has operated 24 hours a day, seven days a week since 2003, providing secondary telephone triage to cases identified as low-acuity following primary triage. These low-acuity cases are specific case types that Ambulance Victoria has identified previously as having low paramedic treatment and transportation rates and that rarely re-present with the ambulance service within 24 hours. Cases that are identified as low-acuity following the AMPDS-led primary triage are transferred to the Referral Service instead of an immediate emergency ambulance dispatch. Cases undergo secondary telephone triage by qualified paramedics or nurses using a computer-based triage algorithm to determine the most appropriate disposition for the case. This may involve the provision of self-care advice, advice to self-present at a community-based medical or health service or hospital, the dispatch of an alternative service provider including home-visiting doctors, nurses and hospital outreach programs, or the dispatch of a non-emergency ambulance or emergency ambulance. During the study period the Referral Service triaged 103,768 low-acuity cases in metropolitan Melbourne. The Referral Service has been described in more detail elsewhere.[15]

Definitions

Local protocols have been utilised in other studies to define ALS and basic life support (BLS) levels of paramedic treatment, and the latter has also been used to define low-acuity cases.[4,6-8] In Victoria, non-emergency ambulance officers are able to provide BLS care, including cardiac monitoring, extrication and manual handling assistance, basic first aid and utilise a small range of drugs to manage patients. Therefore in Victoria, low-acuity cases that still require transportation to an emergency department should be suitable for referral to a non-emergency ambulance following secondary telephone triage.

In this study, ‘no paramedic treatment’ was defined as being when no prehospital treatment or only BLS treatment occurred (i.e. no ALS paramedic level of treatment was required). Intravenous line insertion, when it was not subsequently used for drug or fluid resuscitation, was excluded from the ALS level of treatment, which aligns with previous studies.[4] Paramedic treatment therefore consisted of drug or fluid administration, airway management (including oxygen therapy through to airway adjuncts), perfusion or cardiovascular support management, and mental health management including chemical or physical restraint.

Data Sources

Referral Service records were extracted from the Referral Service database and corresponding paramedic records for the cases referred for emergency ambulance dispatch were extracted and linked. These records documented patient assessment, treatment, demographic and operational information.

Procedures

Only cases with a secondary telephone triage record and a corresponding paramedic care record were included in the study. The explanatory variables selected were patient age, gender, income status, comorbidities, pain score, triage guideline, time of call, and call-taker qualification. These were selected based on their availability in the datasets and likely association with the outcome. The categories investigated within each of these variables are listed in Table One. The 343 triage guidelines used to triage the cases directed to the Referral Service were consolidated into 44 triage guideline groups to improve model parameter approximations and maintain the predictive power of the logistic regression.[28,29] The 21 guideline groups with the highest frequency of usage were utilised for this study to aid identification of relationships with the greatest impact. These guideline groups contained 80.4% of the cases eligible for inclusion in this study. Using these guideline groups ensured sufficient group populations for reliable results.

The median wage in local government areas (LGAs) was converted to a binary variable, consisting of LGAs with a median wage above or below that of the median metropolitan Melbourne wage (AU$54,100) in 2011–12. Similarly, the time of day variable was dichotomised to correspond to the day shift (0700–1700 hours) and night shift (1700–0700 hours) roster that most emergency ambulance crews worked at the time of the study. The call-taker qualification variable distinguished qualified nurses, ALS paramedics and MICA paramedics. Finally pain scores recorded on a scale of 1–10 were divided into three groups: mild pain <3, moderate pain 3–6 and severe pain 7–10. According to the local protocols, any patient in the moderate or severe pain group was expected to have been treated with analgesia unless the patient declined treatment.

The reference categories for the seven categorical variables are listed and explained in Table One.

Variable Name	Reference category
Age	55–59 year olds (selected because it contained the mean age for the cases included in this study)
Gender	Males
Income status	The ‘above’ category
Qualification	ALS paramedics (because they triaged the largest volume of cases)
Pain level	Mild
Time of day	Day shift
Triage guideline groups	Given the outcome variable involved the presence or absence of ALS paramedic treatment, the category with the most similar paramedic treatment rate to all Victorian emergency ambulance cases (55.5%) was chosen to compare with the triage guideline groups – the urinary symptoms group (paramedic treatment rate of 55.2%)

Table One: Explanatory variables used in the prediction modelling

A systematic bias evaluation was conducted, involving comparison of age, gender and triage guideline groups for cases that had a corresponding paramedic record and those that did not (but where the triage outcome indicated an ambulance had been dispatched). The gender distribution did not differ between these groups (54.9% versus 55.1% respectively; chi-square = 0.093, df=1, p=0.760). However, these groups had different mean ages (57.6 years versus 49.8 years; t(8885.5) 21.85, p<0.001) and triage guideline groups (chi-square = 411.567, df=44, p<0.001). The most common triage guideline groups for the cases with a corresponding paramedic record were abdominal pain (18.2%), back pain (9.9%) and dizziness and vertigo (6.7%). For the cases referred to an emergency ambulance without a corresponding paramedic record, the most common triage guideline groups were abdominal pain (24.2%), back pain (9.1%) and psychiatric conditions (7.8%). It should be noted that a large sample size can result in high statistical sensitivity to small distribution differences, which may be apparent in the statistical difference in the triage guideline groups. Nonetheless, this systematic bias evaluation does suggest that the missing cases may have imposed some bias.

Statistical Analysis

This study utilised descriptive statistical analysis and multivariable binary logistic regression analyses to determine whether there were associations between the explanatory variables and the paramedic treatment outcome variable. All the explanatory variables were assessed for multiple collinearity and found to have no correlation likely to affect the multivariable analysis.[30] All statistical analysis was conducted using SPSS Version 23.[31]

Ethical Approval

Ethical approval was granted by the Monash University Human Research Ethics Committee (CF12/0547 – 2012000215), and organisational approval by the Ambulance Victoria Research Governance Committee (R11-021).

RESULTS

Ambulance Victoria received over one million calls to triple zero during the study timeframe and 103,768 cases had a complete Referral Service triage during this time. Of these cases, 29,579 (28.5%) were referred for an emergency ambulance dispatch. Figure One outlines the case selection process that resulted in 19,041 cases being eligible for inclusion.

There were 8510 cases (44.7%) were not treated by attending paramedics after having an emergency ambulance dispatched following secondary telephone triage. This 'no paramedic treatment' cohort of cases averaged 59.3 years of age (SD 25.3 years) and 54.4% were female.

The multivariable logistic regression model shown in Table Two identifies that patient age, pain, triage guideline group, time of day and comorbidities variables were associated with 'no paramedic treatment' ($p<0.001$). The reference categories for these variables were 55–59 year old patients (mean age), pain <3/10, urinary symptoms (which had a paramedic treatment rate most similar to all emergency ambulance cases), day shift and no comorbidities respectively. Compared to these reference categories, some of the other categories within these variables demonstrated a significant relationship with 'no paramedic treatment'. Call-taker qualification ($p=0.816$) and income status ($p=0.544$) demonstrated no association with 'no paramedic treatment'.

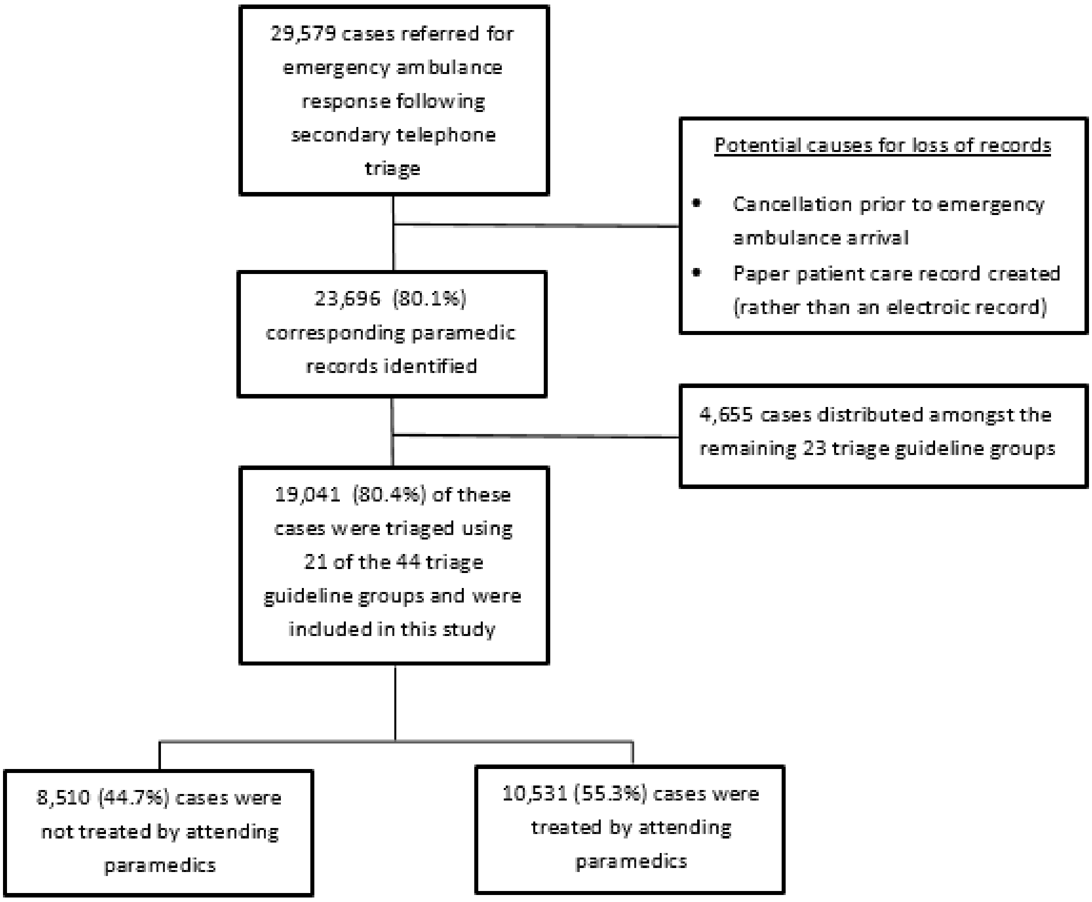

Figure One: Case-flow inclusion chart

				Multivariable logistic regression		
Explanatory variable	Categories	Frequency	% not treated by paramedics (95% CI)	OR (95% CI)	Category p-value	Variable p-value
Gender	Male	7,700	45.2 (44.2-46.3)	1	-	0.477
	Female	9,256	44.2 (43.3-45.2)	1.03 (0.95-1.11)	0.477	
Age	0-4yrs	300	92.7 (89.7-95.6)	6.14 (3.81-9.88)	<0.001	<0.001
	5-9yrs	182	69.2 (62.5-76.0)	2.46 (1.62-3.74)	<0.001	
	10-14yrs	202	52.0 (45.0-58.9)	1.51 (1.01-2.26)	0.047	
	15-19yrs	436	46.3 (41.6-51.0)	1.61 (1.18-2.20)	0.003	
	20-24yrs	656	45.6 (41.8-49.4)	1.40 (1.07-1.83)	0.015	
	25-29yrs	847	39.3 (36.0-42.6)	1.24 (0.96-1.60)	0.098	
	30-34yrs	1,006	38.8 (35.8-41.8)	1.27 (0.99-1.61)	0.057	
	35-39yrs	1,041	34.6 (31.7-37.5)	1.10 (0.87-1.40)	0.425	
	40-44yrs	1,195	35.5 (32.8-38.2)	1.19 (0.94-1.50)	0.150	
	45-49yrs	959	35.1 (32.1-38.2)	1.01 (0.79-1.29)	0.927	
	50-54yrs	932	38.3 (35.2-41.4)	0.94 (0.74-1.18)	0.580	
	55-59yrs	981	39.8 (36.7-42.8)	1	-	
	60-64yrs	1,183	40.2 (37.4-43.0)	0.97 (0.78-1.21)	0.793	
	65-69yrs	1,280	45.3 (42.6-48.0)	1.06 (0.86-1.31)	0.589	
	70-74yrs	1,519	43.8 (41.4-46.3)	0.97 (0.79-1.19)	0.758	
	75-79yrs	1,782	47.1 (44.8-49.4)	1.04 (0.85-1.26)	0.732	
	80-84yrs	2,056	50.5 (48.3-52.7)	1.18 (0.97-1.42)	0.101	
	85+yrs	2,484	52.8 (50.8-54.7)	1.16 (0.96-1.40)	0.124	
Time of day	0700-1859hrs	11,621	44.6 (43.7-45.5)	1	-	<0.001

	1900-0659hrs	7,420	44.8 (43.7-46.0)	1.17 (1.08-1.26)	<0.001	
Income status of patients LGA	Above median income of $54K	2,499	47.6 (45.7-49.6)	1	-	0.544
	Below median income of $54K	16,542	44.3 (43.5-45.0)	1.03 (0.93-1.15)	0.544	
Pain level	Mild (pain <3/10)	11,139	68.6 (67.7-69.4)	1	-	<0.001
	Moderate (pain 3-6/10)	2,696	24.0 (22.4-25.6)	0.16 (0.14-0.18)	<0.001	
	Severe (pain >6/10)	5,206	4.4 (3.8-4.9)	0.02 (0.02-0.03)	<0.001	
Triage guideline groups	Abdominal pain	4,276	27.2 (25.9-28.5)	0.83 (0.63-1.08)	0.158	<0.001
	Back pain	2,319	22.3 (20.5-23.9)	0.79 (0.60-1.04)	0.098	
	Dizziness	1,566	58.4 (56.2-61.1)	0.77 (0.58-1.01)	0.056	
	Nausea / vomiting	1,320	54.0 (51.4-56.7)	0.72 (0.55-0.95)	0.022	
	Psychiatric conditions	1,087	89.8 (87.9-91.5)	4.44 (3.19-6.18)	<0.001	
	Fever	1,068	62.9 (60.1-65.8)	0.86 (0.64-1.14)	0.287	
	Weakness	907	64.7 (61.6-67.8)	1.05 (0.79-1.40)	0.749	
	Headache	839	42.0 (38.6-45.3)	1.18 (0.87-1.61)	0.287	
	Confusion / Disorientation / Agitation	753	65.7 (62.3-69.0)	1.01 (0.75-1.35)	0.966	
	Flank Pain	663	14.9 (12.3-17.8)	0.68 (0.47-0.97)	0.035	
	Hip Non-Injury	526	22.2 (18.9-26.1)	0.65 (0.46-0.92)	0.016	
	Chest Pain / Discomfort	497	38.5 (34.3-42.8)	0.58 (0.42-0.81)	0.001	
	Neurological Symptoms/TIA	436	58.3 (53.7-62.9)	0.76 (0.55-1.05)	0.097	
	Trauma	415	47.0 (42.2-51.8)	1.21 (0.85-1.72)	0.301	
	Fainting	370	61.8 (56.9-66.7)	0.79 (0.56-1.12)	0.179	
	Hypertension	370	69.4 (64.7-74.1)	1.46 (1.03-2.07)	0.033	
	Hip Injury	324	27.8 (23.0-32.7)	0.60 (0.41-0.88)	0.009	
	Diabetes-related problems	319	52.6 (47.2-58.1)	0.78 (0.55-1.11)	0.169	

	Musculoskeletal other	311	50.8 (45.2-56.4)	1.34 (0.91-1.95)	0.136	
	Diarrhoea	310	64.9 (59.5-70.2)	1.20 (0.84-1.73)	0.316	
	Urinary symptoms	365	44.8 (39.7-49.9)	1	-	
Referral Service call-taker qualification	Nurse	2700	45.3 (43.4-47.1)	1.01 (0.91-1.12)	0.903	0.816
	ALS paramedic	15,813	44.7 (43.9-45.5)	1	-	
	Intensive care paramedic	528	41.1 (36.9-45.3)	0.93 (0.74-1.17)	0.538	
Continuous variables	**Mean number of comorbidities for those treated (SD)**		**Mean number of comorbidities for those not treated (SD)**			
Comorbidities	3.15 (SD 2.3)		2.96 (2.2)	0.92 (0.91-0.94)	<0.001	<0.001

Table Two: Univariable and multivariable analyses of the explanatory variables being assessed for their association with 'no paramedic treatment'

Patients under the age of 25 years were significantly more likely to receive 'no paramedic treatment' than 55–59 year olds (Table Two). The 'no paramedic treatment' rates in cases under 15 years of age ranged from 52.0–92.7% within 5-year age groups (Table Two). Cases occurring overnight were more likely to go untreated by paramedics (OR 1.17, 95% CI 1.08-1.26; p<0.001) than cases that occurred during the day. With each additional comorbidity, patients became less likely to be untreated (OR 0.92, 95% CI 0.91-0.94; p<0.001). Seven of the triage guideline groups demonstrated a significant association with 'no paramedic treatment' when compared to the reference group (Table Two). Finally, increasing pain was associated with decreasing rates of 'no paramedic treatment' (Table Two). Overall the multivariable analysis explained 47.3% of the variation in the outcome and the ability of the model to correctly predict the outcome was 78.6%. The sensitivity of the model was good at 87.3% and the specificity was 72.3%.

Of those categories demonstrating a statistically significant association with 'no paramedic treatment', the paediatric cases, psychiatric condition cases and pain cases showed the greatest association with this outcome and greatest potential for impact upon demand. The strongest association occurred for the 0–4 year old category, who were over six times more likely to be left untreated (OR 6.14, 95% CI 3.81-9.88; p<0.001) than the 55–59 year old category. The mean age for cases aged 0–4 years was 1.6 years; only 7.3% of cases were treated by paramedics, and they received oxygen therapy (48.3%; n=14), analgesia (24.1%; n=7) and other drug administration

(10.3%; n=3). The most common triage guideline groups used for the 0–4 year old category were fever (38.8%, n=118) and nausea and vomiting (24.7%, n=75). When the 0–4 year old cases with fever were compared to the remaining 0–4 year old cases, they demonstrated paramedic treatment rates almost the same as the remaining cases (8.5% versus 9.8%; χ^2 (1)=0.158; p=0.691). However the 0–4 year old cases with nausea and vomiting had significantly lower rates of paramedic treatment than the remaining 0–4 year old cases (1.3% versus 11.9%; χ^2 (1)= 7.519; p=0.006).

Psychiatric condition cases were over four times more likely to be untreated than the reference group (OR 4.44, 95% CI 3.19–6.18; p<0.001). The mean age for this category was 44.1 years. Further investigation of the age groups in this category demonstrated no association between age and ‘no paramedic treatment’ (p=0.854). The most common paramedic treatments for the 10.2% of cases treated in this category were oxygen therapy (49.5%, n=55), analgesia (29.7%, n=33) and mental health management (15.3%, n=17). Local protocols have changed since the study period, whereby oxygen therapy is only indicated in patients with an oxygen saturation of <94%. Had this protocol been active during the study, only two psychiatric condition cases would have been indicated for oxygen therapy.

The severe pain group were 98% more likely to be treated than patients with mild pain (OR 0.02, 95% CI 0.02–0.03; p<0.001), and the moderate pain group were 84% more likely to be treated than patients with mild pain (OR 0.16, 95% CI 0.14–0.18; p<0.001). Mean ages for these categories were mild pain: 64.2 years, moderate pain: 56.9 years and severe pain: 51.3 years. The most common paramedic treatments for moderate and severe pain cases were analgesia (89.1%, n=1864 and 98.2%, n=4962 respectively) and IV access (31.3%, n=654; and 47.6%, n=2406 respectively). The mild pain category was most commonly treated with oxygen therapy (58.4%; n=1781) and IV access (36.8%; n=1122). Again, had more recent oxygen administration protocols been in place, 47.1% of the cases that received oxygen in this variable would no longer be indicated for it.

The most common triage guideline groups for patients complaining of mild pain were dizziness (13.1%; n=1454), abdominal pain (11.3%; n=1261) and nausea and vomiting (9.6%; n=1070). The two most common triage guidelines for moderate and severe pain were abdominal pain (moderate: 33.0%; n=890; severe: 40.8%; n=2125) and back pain (moderate: 20.3%; n=546; severe: 23.7%; n=1236). Headache was the third most common triage guideline for moderate pain (5.7%; n=155) and flank pain (8.4%; n=435) was the third triage guideline for severe pain.

DISCUSSION

This is the first study to use secondary telephone triage records and paramedic records to identify factors associated with 'no paramedic treatment' in patients with an emergency ambulance dispatch. Five of the eight variables investigated were significantly associated with this outcome. Both the 0–4 years' age category and psychiatric conditions triage guideline category had high rates of 'no paramedic treatment', whilst the pain variable demonstrated low rates of 'no paramedic treatment'. Hence these categories appear to offer the most potential for increasing the specificity of triage decisions regarding the likely need for paramedic intervention.

Paediatric cases, particularly those under five years old, were over six times less likely to be treated than 55–59 year olds. This is supported by previous work showing paediatric cases had lower rates of paramedic treatment and higher rates of inappropriate usage.[32-34] The triage guideline group used to triage this age group also influenced the paramedic treatment rates, with the nausea and vomiting cases having extremely low paramedic treatment rates (1.3%), suggesting that emergency ambulance is not the most appropriate option for these cases. An investigation of whether these cases were appropriate for the ED and their temporal trends in ambulance service usage may reveal that access to alternative service providers specifically relating to childhood illness, such as specialist telephone advice lines, may allow for these cases to be managed with other care pathways.[34] Should these cases be found to be suitable for the ED, other forms of transportation to hospital such as non-emergency ambulances or transportation by the child's family (where appropriate) should be considered.

The high rates of 'no paramedic treatment' for psychiatric condition cases are consistent with previous research which found these cases make up a large proportion of low-acuity work for ambulance services,[12] and may be more suitable for other forms of transportation to hospital.[35] During the study period Ambulance Victoria was responsible for the transportation of psychiatric cases considered too unwell to be transported by mental health staff alone.[36] The protocol for the transportation of psychiatric cases was adjusted in 2014, after this study's timeframe, to reflect the increasing skill level of non-emergency patient transport attendants, emergency ambulance paramedics and the increasing workload. The revised protocol now states that an emergency ambulance is to be used when the patient's medical needs can only be met by an emergency ambulance service, and includes non-emergency ambulances as a potential option for these cases.[37] The paramedic treatment rate identified in this study supports this shift in responsibility.

Increasing pain was the most significant predictor of 'no paramedic treatment' (Table Two). A UK study of a secondary telephone triage services found a large proportion of pain cases were referred for emergency ambulance dispatch following triage.[20] Pain severity is not explored during the primary triage process and not considered when classifying cases as low-acuity, so the subsequent referral of severe pain cases back to emergency ambulance dispatch was not surprising. Furthermore, the strong relationship between pain and 'no paramedic treatment' was expected given the range of analgesic agents carried by ALS paramedics. This lack of consideration of pain severity has been a source of dissatisfaction with secondary telephone triage for patients, who feel that this process delayed access to analgesia.[20] The assessment of pain during the secondary telephone triage process could be refined to determine whether an expedient alternative response for managing pain could be introduced into the alternative care pathways. This could include a referral to a home-visiting doctor or the development of a pain pathway that allows patients with chronic pain to have a telephone consultation with a pain specialist. This may allow the provision of advice on how to use their current resources and medications to manage this acute episode whilst arranging an appointment with their regular pain management healthcare worker. For patients requiring ED assessment in Victoria, non-emergency ambulance officers have analgesia that could be used during transportation of these patients.

On initial inspection the categories and variables that had high rates of paramedic treatment suggest that these cases should have had an emergency ambulance dispatched without secondary telephone triage. However, in some instances these cases may only represent a small proportion of the total number of these case types that underwent a secondary telephone triage, and other cases within this case type may have successfully been referred away from emergency ambulance dispatch. They may constitute a sub-cohort that was successfully identified by the call-takers as requiring emergency ambulance dispatch. Therefore, further investigation is required before any recommendations can be made. Moreover, a study of the care delivered in the ED, and in the primary care setting should be conducted to direct the development of alternative care pathways and identification of cases suitable for these pathways.

Finally, the identification of 'no paramedic treatment' was used in this study, and in others,[2-8] to suggest that cases falling into this category are not suitable for emergency ambulance attendance. However, there may be some cases that have low rates of paramedic treatment that are suitable for an emergency ambulance. There are a range of non-clinical indicators for appropriateness when considering emergency ambulance transport,[38] which predominantly relate to patient welfare, safety and a responsibility of the ambulance services to ultimately 'do the right thing' as part of a bigger healthcare system.[38] When optimising secondary telephone triage systems, key questions should be incorporated to identify some of these situations (e.g. an unattended minor), and the ability to override the system disposition will ensure that call-takers are able to dispatch an emergency ambulance in situations where they feel it is appropriate.

LIMITATIONS

This was a retrospective analysis using predefined variables that were not primarily devised to ascertain relationships. A potential for systematic bias was exerted by the 19.1% of cases that could not be linked to a paramedic record. In developing the logistic regression model, reference categories had to be chosen for comparison between the categories (the rationale for the reference categories is given in the study methodology). This makes the outcomes relative to this category and can make generalisability difficult.

Secondary telephone triage systems embedded in ambulance services differ in their operational structures, alternative service providers and staff qualifications, therefore potentially altering triage outcomes and limiting the generalisability of the results. Finally, the researchers acknowledge that using paramedic treatment to identify cases suitable for alternative management streams does not take into consideration the non-clinical management skills and knowledge paramedics have, and alternative reasons why a patient might be considered suitable for an emergency ambulance dispatch.

CONCLUSION

This study has highlighted that case characteristics can be used to identify particular case types that may benefit from care pathways other than emergency ambulance dispatch. This process is also useful to identify gaps in the alternative care pathways that may allow some case types to avoid entering the emergency care pathways. These findings offer the opportunity to optimise secondary telephone triage services to achieve their strategic purpose of minimising unnecessary emergency ambulance demand and match the right case with the right care pathway.

DECLARATION OF INTEREST

Kathryn Eastwood is an intensive care paramedic who intermittently works for the Ambulance Victoria Referral Service (secondary telephone triage service). Professor Karen Smith is the Director of the Centre for Research and Evaluation at Ambulance Victoria.

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6.4 Study Five: Patient and case characteristics associated with Emergency Department suitability

This study addressed Objective V of this thesis by investigating the relationships of a range of explanatory variables with ED suitability. ED suitability was found to be high (77.8%) for cases referred for emergency ambulance dispatch (Chapter Five), however nearly a quarter of cases were not considered ED suitable. Other studies of inappropriate ED attendances have established that factors such as age, income, gender, comorbidities and access to GPs can impact upon a patient's decision to present at the ED.[154] Identifying cohorts of patients that are not suitable for the ED may allow more appropriate care pathways to be found for these cases, therefore improving patient care and reducing the demand upon emergency ambulances and receiving EDs. Identifying these cases for future study will allow the specific needs of particular patient cohorts to be elucidated, which may in turn highlight gaps in the suite of alternative care pathways the RS currently employs. This will contribute to the optimisation of the RS triage process, making it more effective in matching the correct care to the right patient.

This study identifies patient and case characteristics associated with ED suitability and a preliminary descriptive analysis of these characteristics to assess their potential for use in the refinement of the RS triage process.

6.4.1 Methods

This study involved a retrospective cohort analysis of cases transported to the ED by an emergency ambulance after being referred for emergency ambulance dispatch by the RS between September 2009 and June 2012. The methodology of this study is largely the same as that of Study Four, described in Section 6.3; please refer to the manuscript presented above for details of the study design, setting and data sources. Note that ED suitability was used as the outcome measure in this study instead of 'no paramedic treatment', and this is briefly explained in the General Methods section of this chapter.

6.4.1.1 Procedures

The analytical procedure implemented for this study was the same as for Study Four. The same explanatory variables were used: age, gender, income status, comorbidities, pain score, triage guideline group, time of call and call-taker qualification (Table 15). However, only 20 triage guideline groups were selected for this study, compared to the 21 in the ‘no paramedic treatment’ study. The top 20 triage guideline groups met the arbitrary minimum membership level of 80% of the total eligible population, therefore only these groups were retained. The procedure for the consolidation of the triage guidelines into these groups was the same as outlined for the ‘no paramedic treatment’ study in Table 15.

The reference categories used are shown in Table 16, and were the same as used in Study Four except for the age and triage guideline group variables. The mean age of the population included in the study was used to select the reference category for the age variable (55–59 years) and the triage guideline group with the ED suitability rate closest to that of all Victorian ED presentations (61.0%) was selected (back pain).

Variables found to have a significant association with the ED suitability outcome measure underwent further analysis. Sub-cohorts of case types based on age or triage guideline group and override status (defined below) were further examined for ED suitability and hospital admission rates. As with Study Two in Chapter Five (Section 5.3.2), hospital admission was reported upon separately to allow for comparison to other studies where possible.

6.4.1.2 Guideline or age sub-analysis

The variable categories significantly associated with the outcome variables were also analysed for the effect of the most common triage guideline group or age group. The sub-category and triage guideline combination, and sub-category and age combination, were compared to the sub-category alone to determine if the combinations demonstrated any difference to the sub-category groups alone that could be used to refine the RS triage process for the cases in these combination groups.

6.4.1.3 Overridden case sub-analysis

An override occurred when a RS call-taker had finished the computer-based triage process and had reached a software-allocated 'system disposition'. This system disposition may for example be a recommendation that the patient see his or her own doctor within four hours. If, based on their clinical expertise, RS call-takers felt this outcome was inadequate to meet the patient's immediate needs, they could override the system disposition to a higher level. The override information from the RS records was used in this study for comparative analyses between overridden and non-overridden cases.

6.4.1.4 Systematic bias evaluation

A systematic bias evaluation was conducted for the cases that were recorded as having been transported via emergency ambulance, comparing cases that had a corresponding ED record to those that did not. Age, gender and triage guideline group were compared across these groups. The gender distribution did not differ between the ED record and no ED record groups (54.2% and 55.1% respectively; chi-square = 0.773, df=1, p=0.379). However, these groups differed in mean age (57.6 years versus 64.62 years; t(4475.011) 15.525, p<0.001) and triage guideline groups (chi-square = 94.653, df=19, p<0.001). The most common triage guideline groups for the cases with a corresponding ED record were abdominal pain (17.0%), dizziness and vertigo (11.7%) and back pain (10.4%). For the cases transported by emergency ambulance without a corresponding ED record, the most common triage guideline groups were abdominal pain (21.5%), back pain (14.1%) and dizziness and vertigo (8.7%). The large sample sizes for these calculations could produce high statistical sensitivity to small distribution differences, which is apparent in the statistical difference in the triage guideline groups. Nonetheless, this systematic bias evaluation does suggest that the missing cases introduce some bias.

6.4.1.5 Statistical analysis

Descriptive statistics and multivariable binary logistic regression analysis were used to produce a model identifying the variables associated with ED suitability. All the explanatory variables underwent assessment for multiple collinearity and were found to have no correlation likely to affect the multivariable analysis.[192] Pearsons chi square test of independence was used to compare the ED suitability and admission rates between the overridden and not overridden cases. All data analysis was performed using SPSS Version 20.[188]

6.4.2 Results

Ambulance Victoria received just over one million calls for assistance in metropolitan Melbourne during the study timeframe, of which 11.9% (N=123,458) underwent the Referral Service's secondary telephone triage. Of these, case records for 84.1% (n=103,768) were available for review and 28.5% (n=29,579) were triaged for emergency ambulance dispatch. Corresponding paramedic records were identified for 80.1% (n=23,696) of the cases triaged for emergency ambulance dispatch. Figure 8 outlines the case selection process that resulted in 12,720 cases with ED records being eligible for inclusion. These cases had a mean age of 56.9 years (SD 23.7 years) and 54.3% were female.

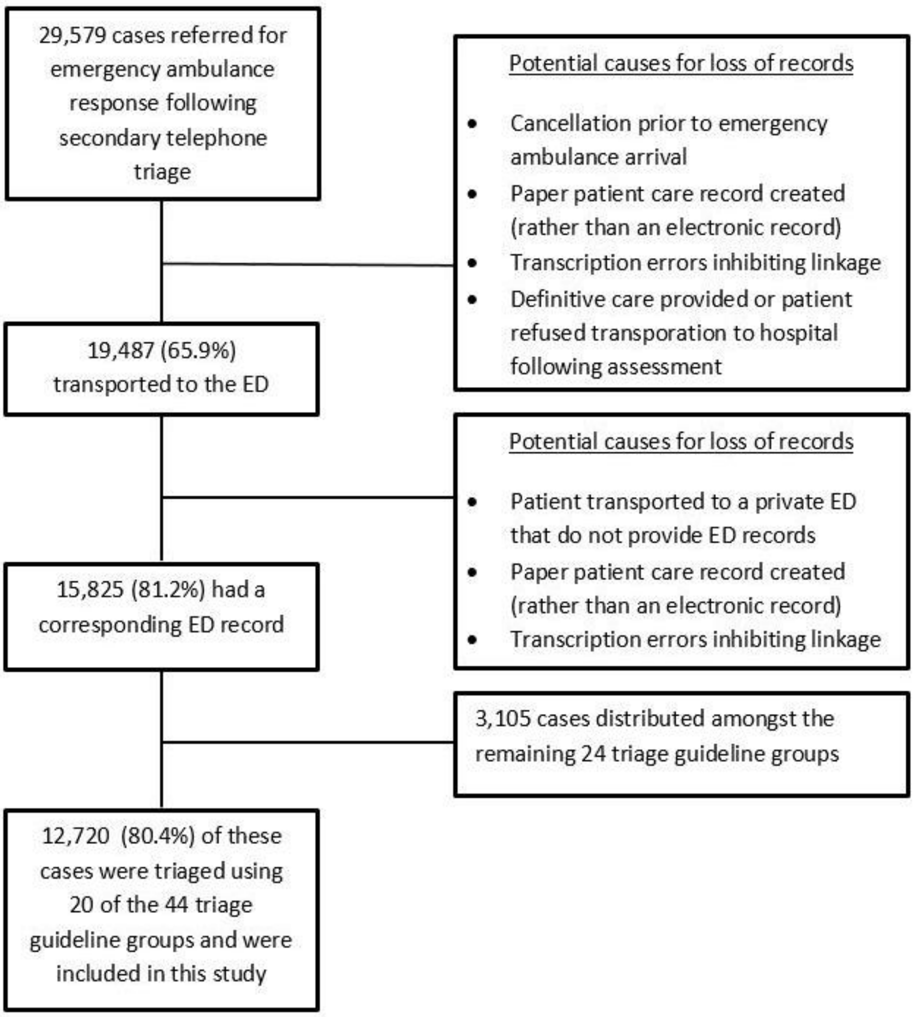

Figure 8: Case inclusion flow chart

Table 16: Multivariable analyses of the associations between explanatory variables and 'ED suitability'.

				Multivariate logistic regression results			
Explanatory variable	Categories	Sample size	% ED suitable	OR (95% CI)	Category p-value	Variable p-value	Admission %
Gender	Male	5829	79.9	1	-	0.108	56.1
	Female	6891	77.9	0.93 (0.85-1.02)	0.108		56.4
Age	0-4yrs	167	70.1	0.62 (0.41-0.92)	0.019	<0.001	26.3
	5-9yrs	115	58.3	0.47 (0.31-0.72)	0.001		35.7
	10-14yrs	143	70.6	0.83 (0.55-1.25)	0.362		35.7
	15-19yrs	291	70.4	0.77 (0.56-1.05)	0.099		37.8
	20-24yrs	444	67.6	0.69 (0.53-0.91)	0.009		40.3
	25-29yrs	611	70.2	0.79 (0.61-1.02)	0.065		38.5
	30-34yrs	712	73.9	0.97 (0.75-1.24)	0.787		40.0
	35-39yrs	753	75.7	1.06 (0.83-1.36)	0.644		48.6
	40-44yrs	871	73.8	0.96 (0.76-1.22)	0.753		46.7
	45-49yrs	688	78.3	1.20 (0.93-1.56)	0.160		56.5
	50-54yrs	633	76.5	1.09 (0.84-1.41)	0.516		56.6
	55-59yrs	679	75.1	1	-		55.4
	60-64yrs	801	79.9	1.29 (1.01-1.66)	0.045		59.7
	65-69yrs	886	84.8	1.75 (1.35-2.26)	<0.001		63.1
	70-74yrs	1024	85.0	1.84 (1.43-2.36)	<0.001		65.7
	75-79yrs	1453	83.3	1.61 (1.27-2.03)	<0.001		64.6
	80-84yrs	1023	85.3	1.98 (1.56-2.52)	<0.001		67.2
	85+yrs	1426	83.5	1.74 (1.38-2.20)	<0.001		68.2
Time of day	0700-1859hrs	7796	79.3	1	-	0.118	57.3
	1900-0659hrs	4924	78.0	0.93 (0.85-1.02)	0.118		54.7
Income status (case LGAs)	Above median income of $54K	1426	81.3	1	-	0.055	60.2
	Below median income of $54K	11294	78.5	0.87 (0.75-1.003)	0.055		55.8
Pain level	Mild	5258	79.9	1	-	<0.001	57.2
	Moderate	1902	75.1	1.18 (1.02-1.35)	0.023		55.7
	Severe	4221	79.3	1.76 (1.55-2.003)	<0.001		55.1
Triage guideline groups	Abdominal pain	3126	77.8	1.97 (1.71-2.26)	<0.001	<0.001	53.7
	Back pain	1589	66.8	1	-		51.2
	Dizziness/vertigo	937	81.3	2.47 (1.989-3.06)	<0.001		62.6
	Nausea/vomiting	873	82.8	3.09 (2.48-3.85)	<0.001		61.5
	Psychiatric conditions	745	73.8	2.36 (1.89-2.94)	<0.001		40.1
	Fever	728	90.4	6.32 (4.72-8.44)	<0.001		63.7
	Headache	565	80.4	2.50 (1.97-3.18)	<0.001		55.6
	Weakness	555	84.3	2.85 (2.18-3.73)	<0.001		67.4
	Flank pain	528	84.8	2.72 (2.09-3.54)	<0.001		58.7
	Confusion/disorientation/ agitation	493	88.4	4.30 (3.15-5.86)	<0.001		68.4
	Hip non-injury	346	72.8	1.10 (0.84-1.43)	0.496		63.3
	Chest Pain/discomfort	325	86.2	3.45 (2.46-4.85)	<0.001		58.5
	Trauma	294	71.8	1.45 (1.09-1.93)	0.011		50.7
	Neurological symptoms/TIA	286	87.4	3.98 (2.73-5.81)	<0.001		66.4
	Urinary problems	275	81.8	2.18 (1.56-3.04)	<0.001		46.2
	Hip Injury	229	82.1	1.90 (1.33-2.73)	<0.001		70.7
	Fainting	211	74.4	2.53 (1.79-3.58)	<0.001		43.6
	Diabetes-related problems	209	85.6	3.42 (2.27-5.17)	<0.001		58.9
	Musculoskeletal other	209	68.9	1.26 (0.91-1.74)	0.162		48.8
	Hypertension	197	74.1	1.49 (1.05-2.11)	0.025		45.7
RS call-taker qualification	Nurse	1754	79.3	1.07 (0.94-1.21)	0.314	0.237	58.4
	Ambulance paramedic	10,595	78.8	1	-		53.1
	Intensive care paramedic	371	76.0	0.86 (0.67-1.11)	0.242		56.0
Continuous variables	**Not ED suitable (mean)**		**ED suitable (mean)**				
Comorbidities	2.8	12,720	3.24	1.02 (0.99-1.04)	0.182	0.182	

The adjusted gender, time of day, income status, RS call-taker qualification and comorbidities variables demonstrated no association with ED suitability in multivariable logistic regression (Table 16). Only the age, pain and triage guideline groups variables had statistically significant relationships with ED suitability. This model only explained 7.6% of the variation in ED suitability, but it had good fit (χ^2 6.628, df 8, p=0.577), and the ability of the model to correctly predict the outcome was 78.7%. The model demonstrated good sensitivity for identifying cases that were ED suitable (99.6%), but poor specificity (1.2%).

Paediatric cases under the age of 10 years and 20–24 year olds were less likely to be ED suitable than 55–59 year olds (Table 16). Conversely, all cases over the age of 60 years were more likely to be ED suitable than the 55–59 year old cases (Table 16). The average ED suitability rate for all Victorian ED presentations was 61.0% for 2011–2012, and the back pain cases had an ED suitability rate closest to this (66.8%), hence this was chosen as the reference category. By comparison, the average ED suitability rate for all RS cases referred to the ED was 77.8%, so it was expected that many of the triage guideline group categories would demonstrate a strong positive relationship with ED suitability. The strongest relationship was seen for the fever category, which was six times more likely to be considered ED suitable than the reference category. Cases triaged with the confusion/disorientation/agitation triage guideline were next, being over four times more likely to be ED suitable than back pain cases (Table 16). The chest pain, neurological symptoms/TIA, nausea and vomiting and diabetes-related problems categories were also more likely to be ED suitable, with odds more than three times that of back pain cases. Finally, the dizziness/vertigo, psychiatric conditions, headache, weakness, flank pain, urinary symptoms and fainting categories were all at least twice as likely to be ED suitable as the back pain cases (Table 16). The only cases that were not more likely than back pain cases to be associated with ED suitability were those also involving musculoskeletal structures, including the hip non-injury and musculoskeletal other categories (Table 16). Finally, worsening pain severity was associated with increasing ED suitability.

Further investigation of the variables and categories with the strongest relationships with the ED suitability outcome variable was conducted to better understand these relationships. Patients younger than 10 and older than 60 years were further investigated, along with the pain variable, and the fever, chest pain, neurological symptoms/TIA, confusion/disorientation, diabetes-related problems and nausea and vomiting triage guideline group categories. Whilst cases over 65 years are referred to as 'the elderly' by the Organisation for Economic Cooperative and Development (OECD) when reporting upon ED presentations,[193] in this analysis cases aged between 60–64 years were grouped with the elderly cases as they returned a significant association for ED suitability, like all the cases over 65 years of age.

6.4.2.1 Age categories

<u>0–4 years</u>

Of the 167 cases with a corresponding ED record, 70.1% were ED suitable, which was below the average rate for cases transported to hospital after the RS referred them for emergency ambulance dispatch (p=0.001). However, this rate was higher than the ED suitability rate for all cases that presented at the ED in Victoria in 2011-12 (p=0.024).

Frequently used triage guidelines

The most common triage guideline groups for this age category are discussed in the manuscript in Section 6.3 of this chapter. The most common triage guideline groups for the cases that were ED suitable were the same as for the group as a whole (fever 44.0%, n=80 and nausea and vomiting 24.2%, n=44). There were 75 corresponding ED records for the fever group (93.8%) and 39 (88.6%) for the nausea and vomiting group. The rate of ED suitability in the fever triage guideline cases was 77.3% (n=58), and they were more likely to be ED suitable than members of the 0–4-year age group who weren't triaged using this guideline (62.2%; χ^2 (1)=4.338; p=0.037). There was no difference between the 0–4 year nausea and vomiting group and the remaining 0–4 year category with respect to ED suitability (66.7%; χ^2 (1)=0.417; p=0.518).

Frequently used triage guidelines override analysis

The RS triage guideline software originally allocated over half of the 0–4 year old fever triage guideline cases and a third of the 0–4 year old nausea and vomiting triage guideline cases to the emergency ambulance pathway (Table 17). There was no significant difference in ED suitability or admission rates between the overridden and non-overridden cases for either of these age–triage guideline group combinations (Table 17).

Table 17: Comparison of cases the triage system allocated to the emergency ambulance dispatch pathway and the cases the RS call-taker overrode to this pathway

	Cases 0–4 years old and:	
	Fever (%)	**Nausea and vomiting** (%)
System disposition referral to: Emergency ambulance dispatch (%) Self-present at ED (%)	 58.7 (n=44) 41.3 (n=31)	 33.3 (n=19) 56.4 (n=22)
Overridden to emergency ambulance dispatch (% of cases with a system disposition other than emergency ambulance dispatch)	32.0 (n=24)	51.3 (n=20)
Linked ED record (N)	24	25
ED suitability (% of overridden cases)	79.2	70.0
% non-overridden ED suitability rate; chi-square; p-value	75.0 χ^2 (1)=0.161; p=0.688	68.4 χ^2 (1)=0.835; p=0.361
Admission (% of overridden cases)	33.3	32.0
% non-overridden admission rate; chi-square; p-value	23.2 χ^2 (1)=0.889; p=0.346	33.3 χ^2 (1)=0.009; p=0.923

The most common reasons noted for the overrides were 'no access to appropriate transportation' (fever: 32.5% and nausea and vomiting: 38.6%), 'stress level merits' (fever: 30.0% and nausea and vomiting: 20.5%), 'caller demands ambulance' (fever: 10.0% and nausea and vomiting: 4.5%) and 'possible deterioration within four hours' (fever: 7.5% and nausea and vomiting: 18.2%).

<u>5–9 years</u>

ED suitability and admission rates were almost the same as for all Victorian ED presentations (ED suitability: p=0.372; admission: p=0.541), however they were lower than the rates for all RS cases that were referred back to the emergency ambulance pathway (ED suitability: p<0.001; admission: p<0.001) (Table 16).

Frequently used triage guidelines

The two most common guidelines used in the 5–9 year category were abdominal pain (48.6%, n=89) and fever (16.4%, n=30). Given the small sample size for the 5–9 year old fever guideline group, no further analysis was conducted.

Sixty-seven of the 5–9 year old abdominal pain cases had an ED record and 56.7% (n=38) were considered ED suitable, which was just below the rate for cases in this age category without abdominal pain (61.4%; $\chi^2(1)=0.279$; $p=0.597$). The admission rate was slightly higher than average for this age category, at 38.8% (31.6%; $\chi^2(1)=0.703$; $p=0.402$).

Frequently used triage guidelines override analysis

None of these cases were allocated to the emergency ambulance pathway by the triaging software. RS call-takers overrode 64.0% of the cases to the emergency ambulance pathway. There were 10 additional 5–9 year abdominal pain cases present in the ED that were not transported by emergency ambulance (96.6% of the 5–9 year abdominal pain cases triaged were originally advised to self-present at the emergency department, but many of these were overridden). There was no significant difference between the overridden and non-overridden case for ED suitability (61.4%, n=27) (50.0%, n=9; χ^2 (1)=0.677; $p=0.410$) and hospital admission (40.9%, n=18) (33.3%, n=6); χ^2 (1)=0.309; $p=0.578$).

The most common reasons for the RS call-taker override included 'no access to appropriate transportation' (31.6%), 'stress level merits' (28.1%) and 'possible deterioration within four hours' (19.3%).

<u>Cases 60 years and over</u>

The ED suitability (85.1%) and admission rates (68.6%) for the elderly cases were higher than for all RS cases presenting at the ED by emergency ambulance ($p<0.001$ and $p<0.001$ respectively), and Victoria ED presentation population rates ($p<0.001$ and $p<0.001$ respectively). The admission to hospital rates increased with age and were nearly double that of all Victorian ED presentations in some categories.

Frequently used triage guidelines

The most common triage guideline groups for these age categories were abdominal pain (16.2%; n=1681), dizziness and vertigo (11.2%; n=1162) and back pain (9.4%; n=978). ED suitability and admission rates for these triage guideline and age group categories are shown in Table 18. The chi-square tests demonstrate that cases over 60 years triaged under the back pain triage guideline had a significantly different rate of ED suitability to the remainder of cases over 60 years. There was no difference in the admission rate for these triage guideline and age group categories and the remainder of the cases over 60 years.

Table 18: ED suitability and admission rates for the top three triage guideline groups for cases over 60 years of age and comparisons of these groups to all the cases over 60 years.

	Cases over 60 and:					
	Abdominal pain	**All other guidelines**	**Dizziness and vertigo**	**All other guidelines**	**Back pain**	**All other guidelines**
	% (n)	%; χ^2-test; p-value	% (n)	%; χ^2-test; p-value	% (n)	%; χ^2-test; p-value
ED suitability	85.4 (1150)	85.1 χ^2 (1)=0.088; p=0.766	84.4 (688)	85.2 χ^2 (1)=0.348; p=0.555	78.1 (586)	85.9 χ^2 (1)=31.915; p<0.001
Admission	67.2 (903)	68.9 χ^2 (1)=1.400; p=0.237	68.7 (559)	68.6 χ^2 (1)=0.002; p=0.962	68.0 (510)	68.7 χ^2 (1)=1.139; p=0.709

Frequently used triage guidelines override analysis

Most of the cases over 60 years old with abdominal and back pain that had an emergency ambulance dispatched were not originally referred to this pathway (Table 19). In all three age and triage guideline combinations, over half were overridden back into the emergency ambulance dispatch pathway. The rates of ED suitability and admission were similar for the overridden cases and non-overridden cases.

Table 19: Comparison of cases the triage system allocated to the emergency ambulance dispatch pathway and the cases the RS call-taker overrode to this pathway

	Over 60 and:		
	Abdominal pain % (n)	**Dizziness and vertigo** %(n)	**Back pain** % (n)
System disposition referral to emergency ambulance dispatch	31.7 (533)	69.7 (810)	30.8 (301)
Overridden to emergency ambulance dispatch (% of remaining cases)	57.4 (659)	65.6 (231)	64.8 (439)
Linked ED record (N)	517	153	335
ED suitability (% of overridden cases)	84.1	80.4	75.2
% not-overridden ED suitability rate; chi-square; p-value	86.1; χ^2 (1)=1.026; p=0.311	85.3; χ^2 (1)=2.320; p=0.128	80.5; χ^2 (1)=3.000; p=0.083
Admission (% of overridden cases)	66.7	68.6	64.8
% not-overridden admission rate; chi-square; p-value	67.6; χ^2 (1)=0.124; p=0.725	68.7; χ^2 (1)=0.000; p=0.989	70.6; χ^2 (1)=2.892; p=0.089

The most common reasons given for the decision to override cases are given in Table 20. As with the other variables being further investigated, the reasons were often not based on a clinical need for an emergency ambulance but a logistical need.

Table 20: Three most common reasons for overrides in abdominal pain, dizziness and vertigo and back pain cases over 60 years of age

Over 60 and:	Most common override reasons	%
Abdominal pain	1.No access to appropriate transportation 2.Stress level merits 3.Possible deterioration within four hours	39.8 22.9 17.1
Dizziness and vertigo	1.Possible deterioration within four hours 2.No access to appropriate transportation 3.Stress level merits	32.5 21.6 19.9
Back pain	1. No access to appropriate transportation 2. Stress level merits 3. Possible deterioration within four hours	39.9 31.0 13.9

6.4.2.2 Triage guideline groups – Fever, chest pain, confusion disorientation diabetes-related problems, neurological symptoms/TIA and nausea and vomiting

ED suitability and hospital admission rates were significantly higher in all of these triage guideline groups than the population based rates (for the RS cases referred to emergency ambulance with an ED record and all Victorian ED presentations) (Table 16) (Table 21).

<u>Age analysis</u>

An age analysis was not conducted for any of these triage guideline groups as only a few of the age categories included more than 100 patients. It was decided that an analysis on such a narrow age range would not provide any results of value.

Table 21: Binomial test of equality for a range of triage guideline groups and the population mean data for ED suitability and admission rates

	ED suitability rate		Admission rate	
	All RS cases referred to emergency ambulance	All Victorian ED presentations	All RS cases referred to emergency ambulance	All Victorian ED presentations
Fever	p<0.001	p<0.001	p<0.001	p<0.001
Chest pain/discomfort	p<0.001	p<0.001	p=0.015	p<0.001
Confusion/ disorientation	p<0.001	p<0.001	p<0.001	p<0.001
Diabetes related problems	p<0.001	p<0.001	p=0.03	p<0.001
Neurological symptoms /TIA	p<0.001	p<0.001	p<0.001	p<0.001
Nausea & vomiting	p<0.001	p<0.001	p<0.001	p<0.001

RS call-taker override analysis

The RS triage guideline software allocated over half of the cases referred to emergency ambulance dispatch to this pathway (Table 22). The RS call-taker overrode over 60% of the remaining cases into the emergency ambulance dispatch pathway. There was little difference between the cases triaged to the emergency ambulance dispatch pathway and the cases overridden to this pathway (Table 22). Of two significant differences between these groups, one occurred in the fever triage guideline group, in which the overridden cases were more likely to be considered ED suitable than the non-overridden cases. The second significant difference occurred in the confusion triage guideline group, in which overridden cases were more often admitted than non-overridden cases (Table 22).

Table 22: Comparison of cases the triage system allocated to the emergency ambulance dispatch pathway and the cases the RS call-taker overrode to this pathway

	Fever	Chest pain/ discomfort	Confusion/ disorientation	Diabetes-related problems	Neurological symptoms /TIA	Nausea & vomiting
System disposition referral to emergency ambulance dispatch: % (n)	61.0 (660)	96.8 (490)	89.1 (671)	52.6 (171)	96.4 (423)	60.0 (792)
Overridden to emergency ambulance dispatch – % of remaining cases (n)	61.6 (260)	68.8 (11)	67.1 (55)	64.3 (99)	75.0 (12)	63.8 (337)
Linked ED record (n)	728	325	493	235	320	873
ED suitability (% of overridden cases)	82.3	77.8	89.4	91.4	90.9	78.3
% non-overridden ED suitability rate; chi-square; p-value	93.5; χ^2 (1)=22.905; p<0.001	86.3; χ^2 (1)=0.536; p=0.464	89.8; χ^2 (1)=1.147; p=0.284	85.1; χ^2 (1)=1.888; p=0.169	88.3; χ^2 (1)=0.068; p=0.794	84.2 χ^2 (1)=3.960; p=0.047
Admission (% of overridden cases)	63.5	33.3	36.4	66.7	36.4	58.9
% non-overridden admission rate; chi-square; p-value	67.4; χ^2 (1)=1.009; p=0.315	61.5; χ^2 (1)=2.930; p=0.087	71.5; χ^2 (1)=5.274; p=0.022	58.4; χ^2 (1)=1.513; p=0.219	70.6; χ^2 (1)=5.843; p=0.016	62.3 χ^2 (1)=0.760; p=0.383

The most common reasons for overriding the cases are shown in Table 23. ‘Possible deterioration within four hours’ and ‘stress level merits’ appear in all three triage guideline groups, followed by ‘no access to appropriate transportation’.

Table 23: Three most common reasons for overrides in the fever, chest pain/discomfort, confusion/disorientation, diabetes-related problems, neurological symptoms/TIA and nausea & vomiting triage guideline groups.

Triage guideline group	Most common override reasons	%
Fever	1.No access to appropriate transportation 2.Possible deterioration within four hours 3.Stress level merits	35.1 27.5 17.9
Chest pain/discomfort	1.Stress level merits 2.Possible deterioration within four hours 3.Caller demands ambulance	41.7 25.0 16.7
Confusion/disorientation	1. No access to appropriate transportation 2. Possible deterioration within four hours 3. Stress level merits	34.5 25.5 14.5
Diabetes-related problems	1.Possible deterioration within four hours 2.No access to appropriate transportation 3.Stress level merits	35.0 29.0 15.0
Neurological symptoms /TIA	1.No access to appropriate transportation 2.Possible deterioration within four hours 3.Doctors request	41.7 33.3 8.3
Nausea & vomiting	1. No access to appropriate transportation 2.Possible deterioration within four hours 3.Stress level merits	55.1 43.0 22.2

6.4.2.3 Increasing pain

This triage guideline group demonstrated moderately steady rates of ED suitability and decreasing rates of admission as pain increased (Table 16). A comparison of these cases to the population data is shown in Table 24. ED suitability was higher than for all RS cases (except in the moderate pain category) and Victorian ED presentations in all three categories, and admissions were higher in all three pain categories than for both the RS cases and Victorian ED presentations.

Table 24: Comparison of cases the triage system allocated to the emergency ambulance dispatch pathway and the cases the RS call-taker overrode to this pathway

	ED suitability rate		Admission rate	
	All RS cases referred to emergency ambulance	All Victorian ED presentations	All RS cases referred to emergency ambulance	All Victorian ED presentations
Mild pain (pain<3/10)	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$
Moderate pain (pain 3-6/10)	$p=0.186$	$p<0.001$	$p<0.001$	$p<0.001$
Severe pain (pain>6/10)	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$

The most common triage guideline groups for the pain categories can be seen in Table 25. Abdominal pain featured in all three categories; and back pain and flank pain featured in two of the three categories. Primary pain complaints made up the three most common triage guideline groups in the moderate and severe pain categories.

Table 25: Most common triage guideline groups and their outcomes for the three pain categories

	Most common triage guidelines	Mean age years (SD)	ED suitability %	Admission %
Mild pain (pain<3/10)	Dizziness and vertigo (12.9%; n=848)	68.3 (16.2)	80.5	62.1
	Psychiatric conditions (10.8%; n=712)	43.7 (19.0)	74.4	40.7
	Abdominal pain (10.7%; n=704)	57.7 (26.7)	71.7	48.6
Moderate pain (pain 3-6/10)	Abdominal pain (34.1%; n= 648)	51.7 (23.9)	74.4	54.9
	Back pain (18.2%; n= 346)	55.2 (21.3)	63.3	48.6
	Flank pain (5.4%; n= 102)	60.5 (18.0)	80.4	62.7
Severe pain (pain>6/10)	Abdominal pain (42.0%; n= 1774)	47.0 (21.8)	81.5	55.2
	Back pain (23.0%; n= 972)	51.1 (18.36)	69.0	52.0
	Flank pain (8.8%; n= 373)	50.5 (15.9)	89.3	58.7

RS call-taker override analysis

The overridden mild and moderate pain cases both demonstrated significantly lower ED suitability than those not overridden, and the admission rates were also significantly lower for the overridden mild and severe pain cases (Table 26).

Table 26: Comparison of cases the triage system allocated to the emergency ambulance dispatch pathway and the cases the RS call-taker overrode to this pathway

	Mild pain (< 3/10)	Moderate pain (3-6/10)	Severe pain (>6/10)
System disposition referral to emergency ambulance dispatch – % (n)	60.0 (6526)	44.0 (1174)	35.2 (1824)
Overridden to emergency ambulance dispatch – % of remaining cases (n)	64.0 (2785)	62.4 (934)	63.1 (2122)
Linked ED record (n)	5258	1902	4221
ED suitability (% of overridden cases)	73.4	70.2	78.3
% non-overridden ED suitability rate; chi-square; p-value	81.7; χ^2 (1)=75.875; p<0.001	77.9; χ^2 (1)=11.332; p=0.001	79.9; χ^2 (1)=1.600; p=0.206
Admission (% of overridden cases)	51.7	52.4	52.8
% non-overridden admission rate; chi-square; p-value	59.1; χ^2 (1)=39.464; p<0.001	57.6; χ^2 (1)=3.573; p=0.059	56.4; χ^2 (1)=5.518; p=0.019

The most common reason for RS call-taker overrides are given in Table 27.

Table 27: Three most common reasons for overrides in the pain categories.

	Most common override reasons	%
Mild pain	1. No access to appropriate transportation	30.7
	2. Possible deterioration within four hours	25.1
	3. Stress level merits	20.0
Moderate pain	1. No access to appropriate transportation	41.8
	2. Stress level merits	26.7
	3. Possible deterioration within four hours	14.9
Severe pain	1. No access to appropriate transportation	40.0
	2. Stress level merits	33.1
	3. Possible deterioration within four hours	13.4

6.5 Discussion

This was the first study to investigate ambulance-based secondary telephone triage for relationships between patient or case characteristics and ED suitability. Cases presenting at the ED by emergency ambulance following RS triage were investigated to attempt to identify relationships and particular case cohorts that might be suitable for further study. Age, pain and triage guideline group were related to ED suitability, with several categories within these variables demonstrating strong associations with this outcome.

Compared to 55–59 year olds, cases under 10 years of age were at least 38% less likely to be ED suitable, and cases over 60 years of age were at least 29% more likely to be ED suitable. International research shows both paediatric and geriatric patients have a propensity for high rates of ED presentations,[193,194] and a consistent inverse relationship between age and inappropriate health service has been detected in many studies.[154] The results presented here are consistent with these findings and suggest that a higher rate of ED presentations amongst the elderly is appropriate, however other care pathways could provide more appropriate care to young patients and their parents and alleviate some of the pressure on EDs. This could be achieved through the refinement of the RS paediatric triage guidelines. Specific paediatric telephone triage services are in operation internationally,[195] and a study investigating one such service found that cases referred to the ED following telephone triage were more appropriate than those presenting by other means.[195] The authors concluded that telephone triage was an appropriate 'gatekeeper' for managing health services.[195]

Investigation of the age–triage guideline group combinations revealed some combinations with higher risks of ED suitability than others. Whilst these results must be interpreted with caution given the small sample sizes, they suggest that further investigation of such sub-cohorts can identify cases suitable for alternative care pathways and identify potential gaps in the alternative care pathways the RS utilises currently. Furthermore, comparison of the RS paediatric triage guidelines to those of services specifically directed at the management of children may allow for better discrimination between cases suitable and unsuitable for the ED. Liaison with the surrounding children's hospitals and community-based child health services may also allow for an improvement in the care pathways available to the RS for paediatric cases.

For geriatric cases, drivers of ED presentation include the presence of comorbidities, access to care outside of the ED and social circumstances such as marital status and living alone.[154]

Whilst the number of comorbidities was not a significant predictor in this model, it is expected that it, along with the other drivers plays a role in the triage of these cases during the secondary telephone triage and the ED triage.[196,197] Upon presenting to the ED, these patients are often more acutely unwell,[198,199] undergo more diagnostic testing,[200] have longer ED stays[199,201] and higher admission rates than younger populations.[164,198,199,201] Despite there being many different measures of ED suitability in the literature,[154] most older adults have consistently been found to be appropriate for the ED.[154,164,197] The analysis of the age–triage guideline group sub-cohorts in this study detected no sub-cohort with an ED suitability rate below that of all Victorian ED presentations. Nonetheless, further work would be beneficial to establish whether community-based diagnostic testing could be conducted for some cases, or for direct hospital admission to be arranged by GPs, bypassing the ED. In metropolitan Melbourne hospitals, the rate of ED presentations for older adults increased by 72% compared to 59% for younger adults between 1999 and 2009, despite similar population growth rates.[201] Therefore, investigating the care pathways available to older adults will be a crucial component of managing ED demand.

The fever, confusion, chest pain, neurological symptoms, diabetes and nausea and vomiting triage guideline groups showed particularly strong positive associations with the ED suitability variable. All of these triage guideline groups had rates of ED suitability and hospital admission well above that of all Victorian ED presentations. An age-based sub-cohort analysis of these triage guideline groups was not possible due to the broad distribution of ages for patients in these groups, resulting in smaller populations for each age category and only a few categories with viable populations for analysis. It was interesting to note, however, that cases that had been triaged with musculoskeletal guideline groups (the back pain, hip non-injury, trauma and musculoskeletal other triage guideline groups) had lower ED suitability rates than those triaged using medical guidelines. This may reflect the chronic nature of many of these musculoskeletal problems.[131] Expanding the suite of alternative service providers to include allied health personnel such as physiotherapists equipped to respond to private residences (rather than the current structure, whereby hospital-based allied health personnel respond to aged care facilities only), may provide RS call-takers with more appropriate resources for patients with exacerbations of chronic musculoskeletal problems. Establishing the contribution of pain to the patient's rationale for contacting the emergency services should also be investigated for these cases. Studies have found that half of all the patients presenting at the ED with a history of chronic pain were primarily presenting due to exacerbation of this pain.[202,203] Whilst increasing pain was seen to improve the rate of ED suitability, the ability to manage chronic pain problems in the community would benefit both emergency ambulance and ED services.

It is well established that the ED is not the most appropriate setting for patients with chronic pain,[202,204-206] yet it is amongst the most common reasons for ED presentations.[203,204,206] It has been suggested that using the ED for this and other ongoing problems that could be managed in the primary care setting results in inconsistent care and adverse events,[131] and prevents the patient from linking with services that provide ongoing care.[154] Upon presenting in the ED, the ATS automatically triages patients presenting with severe pain to the second highest triage category to facilitate analgesia within 10 minutes, and patients presenting with moderate pain are triaged to the third triage category.[159] Therefore, in this study, any patient presenting to the ED with moderate or severe pain would have been categorised as ED suitable.

The analysis of the most common triage guideline groups for the pain variable identified that the back pain cases had lower rates of ED suitability than all Victorian ED presentations. This is supported in the literature, which shows that ED care for back pain cases is largely limited to diagnostic imaging and pharmacological therapy.[207] The range of non-pharmacological care options available in the primary care setting includes physiotherapy, massage and alternative medicines such as acupuncture,[207] and possibly offers improved outcomes for patients in the longer term. Despite the relationship between ED suitability and pain, further investigation of the ED management of pain cases such as back pain could allow for the identification of alternative care pathways suitable for use or inclusion in the RS suite of alternative pathways.

Override analysis was conducted to determine if the RS call-taker was identifying cases that were suitable for the ED. For all of the age categories, it was found that the overridden cases had the same ED suitability as the cases referred by the triage software. For the fever triage guideline group, the cases the RS call-taker chose to override to emergency ambulance dispatch were more suitable for the ED than those the software identified for this pathway; however, the opposite was true for the pain variable. It was found that the mild and moderate pain cases that the RS call-taker overrode to emergency ambulance dispatch were significantly less likely to be ED suitable, and the mild and severe pain cases were significantly less likely to be admitted, than the non-overridden cases. No difference was found in ED suitability or admission of overridden and non-overridden cases for the remaining pain groups. This suggests that the RS call-takers are responding to the patients' pain, rather than their clinical need for an ED. This was not surprising, given that pain reduction is a key performance indicator for both emergency ambulance paramedics and ED staff.[34,208] The analysis of reasons for the overrides shows little clinical basis for the overrides and suggests that logistical problems also play a role in patients' motivations for requesting an emergency ambulance and RS call-takers' decisions to refer cases for emergency ambulance dispatch. This finding requires further investigation, as it highlights that alternative care pathways that address logistical issues may be of benefit when attempting to reducing the demand upon emergency ambulances.

The limitations relating to the study design, secondary telephone triage systems and the modelling outlined in Study Four are also valid for this study. In addition, the formulation of the ED suitability outcome measure was a potential limitation. The strength of this measure was that it was constructed using multiple patient outcomes that occurred during the episode of care, therefore avoiding the problems seen in other studies such as expert opinion failing to achieve consensus.[67] Nonetheless, as with the ambulance treatment decision-making, each component in the measure is subject to the decision-making of the clinician during the patient assessment and treatment processes. Another weakness is that outcomes such as ED triage category were based on Australian guidelines, which may differ to those in other countries. These triage categories are often also automatically allocated based on a patient characteristic, such as pain, that may be suitable for management elsewhere. Moreover, the ED suitability variable does not consider the occurrence of ED treatment. There may have been cases that were categorised as ED suitable that did not receive ED treatment, and cases that were identified as unsuitable for the ED that were subsequently treated in the ED. Much of the treatment that occurs in the ED, such as analgesia and diagnostic tests, can be conducted in community-based settings, so including treatment was not seen as providing a definitive measure of suitability. Therefore, cases identified as ED suitable warrant further investigation to determine whether there are resources that could adequately manage them outside of the ED. The sample size for some of the sub-cohort analyses were small, undermining the validity of the results. Finally, the override reasons were chosen from a prescribed list of reasons, therefore no further details about the reasons for the override were available.

6.6 Summary

The two studies contained within this chapter addressed the gap in knowledge identified in the literature review by providing the first exploration of cases referred for emergency ambulance dispatch following secondary telephone triage, and investigating the relationships between a range of explanatory variables and the paramedic treatment and ED suitability outcomes. These studies also contribute to the general body of knowledge surrounding predictors of ALS paramedic treatment and ED suitability through the use of rigorous statistical methods that test the relationships of adjusted variables' with the outcome measures.

This work has fulfilled the objectives identified in the introduction of this chapter, and highlighted that there is potential for the optimisation of the RS through the investigation of specific case cohorts. This may allow for future work to reduce the margin of overtriage seen in RS cases referred for emergency ambulance dispatch.

Further research on the explanatory variables indicative of overtriage (that either showed a positive association with 'no paramedic treatment' or negative association with ED suitability) could provide valuable information, as could examination of the variables that indicated appropriateness. For example, chronic pain is one of the most common presentations for EDs[203,204,206] and for the RS,[143] yet it is largely seen as inappropriate for the ED.[202,204-206] Ambulance services would benefit from forming collaborations with healthcare services within their region to either align or create management pathways to manage such cases outside emergency care pathways.

The studies presented in this chapter form a foundation upon which other studies can be built. Future work can focus on areas touched on within these studies to provide more information that can contribute to the RS triage process. Whilst the outcome measures used in these studies were successful, they remain moderately crude, and a more granular investigation of the suitability of cases for emergency ambulance or ED presentation is needed. Investigating the potential of community-based healthcare services to manage many of these cases could provide benefits to the patients in terms of their continuity of care and access to care, and to EDs and ambulance services through a reduction in demand. The non-clinical reasons for overrides suggests that the rationale for contacting ambulance services is sometimes less related to clinical need than logistical problem-solving. Gaining a better understanding of patients' needs, and the management of these patients whilst in emergency ambulance and ED care, could allow for community-based alternatives to be identified.

The goal of future work should not be to eradicate overtriage, but to reduce the margin of overtriage. Triage systems have been designed to overtriage in order to identify as many cases presenting with life-threatening signs or symptoms as possible.[152,163,177] Secondary telephone triage should be the mechanism through which much of the overtriage seen in ambulance services is addressed. The studies in this chapter show that there may be case cohorts that can provide valuable information to refine triage questioning and inform the improvement and expansion of alternative care pathways.

CHAPTER SEVEN: DISCUSSION AND CONCLUSIONS

The continuing rise in demand for emergency ambulances internationally has prompted many ambulance services to explore alternative methods of providing patient care that either improve or have minimal impact upon their current resourcing capacity.[14-17] Secondary telephone triage has been trialled, in many different forms, in various ambulance services internationally with varying levels of impact.[21,30,93] All of the studies evaluating these systems have been small and of varying methodological quality.[30] The RS has operated in Melbourne, Australia, for over 10 years, and has demonstrated an impact on AV's operations and service provision.[143] The application of robust epidemiological techniques to study this service may allow for other ambulance services around the world to benefit from the success of this system, and provides valuable information for the implementation or optimisation of this or similar systems.

In this research, 34 months of data and over 100,000 cases were systematically analysed to describe – for the first time – a secondary telephone triage system, the RS, embedded within an ambulance service (Chapter Four). A large-scale data linkage exercise was carried out, uniquely linking four sets of data (Chapter Five), to analyse the appropriateness of the triage outcomes returning cases to emergency ambulances and the ED (Chapter Five). Finally, exploratory studies were conducted to identify key variables that could be manipulated in any future optimisation of the RS (Chapter Six).

The research presented in this thesis, to the author's knowledge, constitutes the first large-scale analysis of an ambulance-based secondary telephone triage service. It contributes new knowledge to the fields of ambulance service and emergency department demand management, and to the field of telephone triage.

This chapter presents the main findings of this program of research and a discussion of the implications for ambulance services and future research.

7.1 Key findings

This program of research successfully investigated the operation, impact and appropriateness of the AV RS. The key findings and contributions to knowledge are summarised in Figure 9.

- Identification of knowledge gaps in the literature – few studies of ambulance-based secondary telephone triage, and most were of poor methodological quality
- The RS had a measurable impact upon service delivery through the referral of 72.4% of cases away from emergency ambulance dispatch and 32.2% away from the emergency department
- Data linkage was possible between the de-identified RS and paramedic patient records and the hospital datasets
- The RS was able to appropriately identify cases that were suitable for emergency ambulances and for the ED
- A large proportion of overtriage remains following secondary telephone triage
- There are relationships between particular patient or case characteristics with paramedic treatment rates and ED suitability rates that may provide the opportunity for future optimization of the RS

Figure 9: Summary of key findings

In order to address this aim, five key objectives were investigated. They are listed below, with an explanation of how they were achieved.

I. *To describe the use, structure and impact of secondary telephone triage systems embedded into ambulance service operational structures through a systematic review of the literature.*

A systematic review of the literature identified a paucity of research, particularly quality research, on ambulance-based secondary telephone triage. It was identified that this demand management strategy had been trialled in various ambulance services around the world in response to increasing demand. The structure and function of these services varied, as did their patient care pathways.

The systematic review suggested that secondary telephone triage was safe, financially viable, and had the potential to impact upon ambulance demand. However, the small sample sizes, system variation and small number of studies hindered the ability for these findings to be generalised.

II. *To produce a detailed description of the Ambulance Victoria Referral Service and conduct a population-based epidemiological study of cases from the Referral Service to:*
    a. *describe the impact of this strategy on the demand for emergency ambulances;*
    b. *describe the patient population;*
    c. *identify the most common patients problems; and*
    d. *identify the utilisation rates of the final disposition pathways available to the Referral Service call-takers.*

This study contributed to the body of work describing ambulance-based secondary telephone triage services. It was the first large-scale study of its kind and described the patient population, their presenting problems and final dispositions and the impact of the overall system upon emergency ambulance dispatch rates. This research described the use of this system to managing frequent callers to ambulance services, and the benefit of having a suite of alternative service providers to assist in the provision of the most appropriate care for a patient's presenting problem.

III. *To conduct large-scale data linkage between secondary telephone triage patient records, paramedic care records, emergency department and hospital admission records.*

The data linkage process outlined in Chapter Five was the first time the RS records were linked to paramedic records, ED records and hospital admission records. This process revealed that whilst both the RS and paramedic records are the property of AV, there was no specific patient identifier assigned when a patients calls triple zero. The result of this was that extensive deterministic data matching and quality control was conducted to link the available RS and paramedic patient care records. This was successful with a 94.7% linkage rate.

This linked dataset was provided to the VDL unit who also used deterministic data matching to link the ED hospital admission data to the linked ambulance dataset (63.0% linkage for planned ED attendances). This resulted in a dataset that allowed a patient to be tracked from their RS triage right through to hospital admission (if applicable). This enabled the first assessment of the appropriateness of RS triage decisions to refer cases back to the emergency care pathways. This process also showed that some cases referred to the alternative care pathways presented in the ED within 48 hours of the RS triage.

IV. *To utilise the linked data to investigate the appropriateness of the referral of cases to the following emergency care pathways:*

    a. *The emergency department (ED) (via emergency ambulance, non-emergency ambulance or via self-presentation);*

    b. *Emergency ambulance*

Data linkage identified a cohort of cases that had been referred to the alternative care pathways and subsequently presented in the ED within 48 hours of the RS triage. These cases were termed 'unplanned ED presentations', as the triage intention was not for them to present in the ED. Comparison of these unplanned ED presentations to those dispatched to the emergency care pathways (the 'planned ED presentations') revealed that the latter were more ED suitable and had higher hospital admission rates than the former. Furthermore, the latter also displayed higher ED suitability and hospital admission rates than all Victorian ED presentations in the given timeframe. This suggested that the RS was appropriately identifying cases more suitable for the ED than the average Victorian ED presentation and those triaged to the alternative care pathways.

A between-group analysis of the emergency care pathways revealed a significant difference in ED suitability and ED treatment (although the latter had no clinical significance) between the cases triaged to the emergency ambulance pathway and non-emergency ambulance and those triaged to the self-present pathways. There was also a significant difference between all three pathways in admission rates, with the non-emergency ambulance pathway cases being older and having the highest rates.

Study Three found that cases referred for high-acuity emergency ambulance dispatch were different to cases referred for medium or low-acuity emergency ambulance dispatch. Cases referred for high-acuity emergency ambulance dispatch had a higher paramedic treatment rate than all Victorian ambulance cases, whereas medium or low-acuity emergency ambulance dispatch cases had rates similar to all Victorian ambulance cases. All of the dispatch acuity levels were more likely than the average Victorian ED presentation to be ED suitable and admitted to hospital, however only the high and medium-acuity emergency ambulance dispatch cases were more likely to be ED suitable than all Victorian ambulance cases. None of the acuity levels demonstrated any clinically significant difference in admission rate from that for all Victorian ambulance cases. Overall, the emergency ambulance pathway cases that presented in the ED were at least as appropriate for emergency ambulance as the average Victorian ambulance case. A good correlation between main presenting problem and hospital diagnosis for all of the care pathways added further support to the finding that the RS triage is appropriate.

Nearly half of the cases attended by emergency ambulance were not treated by paramedics, demonstrating a similar rate of overtriage to the primary triage process. This suggests that there some cases that are being incorrectly triaged to the emergency ambulance pathway. The overtriage rate for ED presentations was approaching 25%, also suggesting some patients would benefit from alternative care pathways.

V. To identify variables associated with paramedic treatment and ED suitability that may be useful in optimising the Referral Service triage process.

Several adjusted variables were found to have statistically significant relationships with paramedic treatment and ED suitability, including age, pain and triage guideline group. Further analysis of selected significant categories within these variables demonstrated that there is scope to optimise the RS triage process and reduce overtriage through further investigation of particular sub-cohorts.

7.2 Implications for ambulance services

The continued increase in demand for ambulance resources in many countries has resulted in some ambulance services trialling or implementing secondary telephone triage to divert low-acuity cases to more appropriate care pathways. However, the research suggests that no operational 'blueprint' has been universally applied. The program of research described in this thesis focused on a successful and established ambulance-based secondary telephone triage service. It demonstrated methodological approaches and preliminary outcomes relating to the analysis of the appropriateness of triage decisions and optimisation of this triage service. This information will be useful to ambulance service managers and policymakers when making decisions about whether secondary telephone triage would benefit their ambulance services.

Whilst most secondary telephone triage services, and the ambulance services within which they are embedded, vary in their operational structure, the work detailed in this thesis provides other investigators of secondary telephone triage with robust and flexible research methods. Total generalisability cannot be achieved due to differences in ambulance service operational structures, supporting community healthcare networks and general populations, but these methodologies enable the standardisation of the analysis of such systems.

This study of the AV RS indicates that its approach to managing low-acuity patients is feasible and improves the operational service delivery of ambulance services. Ambulance services considering implementing such a demand management strategy will need to engage with community-based healthcare services to create community-based care pathways that can not only reduce the demand for emergency ambulances, but improve care for low-acuity patients, who will be better aligned with more appropriate healthcare, and high-acuity patients, who should receive faster emergency ambulance responses.

7.3 Strengths and limitations of the research

The strengths and limitations of each of the studies presented in this thesis are discussed in their respective chapters. In this section, the broader strengths and limitations of the research conducted in this thesis are discussed.

The primary strength of the work presented in this thesis is the linkage of the four datasets. The linkage of the secondary telephone triage dataset to other ambulance and hospital datasets had never been attempted before and the deterministic process employed was successful. This enabled analysis of the AV RS not only in terms of a population-based descriptive epidemiology study, but also allowed for case types to be tracked from telephone contact into ambulances and then hospitals (if applicable). It allowed for RS triage decisions to be analysed with patient outcome data from their paramedic and hospital encounters (if applicable). However, this dataset also represented one of the greatest limitations for this program of research. The inability to follow-up unlinked cases meant that compliance with RS triage decisions could not be analysed. This inability to follow-up cases extended to cases that were referred to other pathways and services such as the non-emergency ambulance pathway, ASPs, the patient’s own healthcare providers, and simply following-up patients directly. Whilst follow-up was not within the scope of the research, and not possible in most cases with retrospective data, the ability to do so would have provided valuable information and potentially enriched the research findings.

The RS dataset itself was a source of strengths and limitations. Its strength lay in the fact that it included all cases that the RS triaged over a 34-month period. However the limitation of this and all of the datasets analysed was that the variables included were predefined, and therefore did not provide all of the information required to fully analyse all the aspects of the RS triage process. An example was identified in Chapter Six, whereby the RS call-takers' reasons for referring cases for emergency ambulance dispatch were recorded in a limited way. This limitation in the datasets was seen again in the model building processes detailed in Chapter Six, where it was identified that variables not available for analysis may have been significantly associated with the outcome variables.

The information contained within the RS dataset was dependent upon the communication between the RS call-taker and the patient. Because this information was provided over the telephone, the RS call-takers had no choice but to rely on the patient's account and could not gather the information available through visual cues (for example skin pallor).

Another strength of this program of research is that the work was conducted using rigorous, reproducible methods. Their publication will facilitate future ambulance demand and secondary telephone triage research in this and other ambulance service contexts.

The retrospective nature of the research represents a limitation. The AV RS is constantly changing in response to community demands. In recent years (after the study period), the service expanded to include the entire state of Victoria. Other case types are constantly being added to the list of cases suitable for secondary telephone triage and new ASPs are being recruited to broaden the ability to manage low-acuity cases in the community. One of the biggest changes has been the expansion of the non-emergency ambulance fleet and its scope of practice. All of these factors provide the RS call-takers with more options for managing the low-acuity cases. This also means that the results of the studies presented in this thesis, whilst still applicable, valuable and valid in terms of their contribution to ambulance-based secondary telephone triage knowledge, would be different if these studies were conducted again. However the methodological approaches showcased in this research could be employed to conduct any future analysis.

7.4 Recommendations for future research

Given the paucity of research in this area, the opportunities for future research are vast. Almost all of the work in this thesis is the first of its kind, so it is a foundation upon which future research can build.

Further investigations are recommended in all of the studies presented in this thesis. Listed below are broad areas for future work based on this program of research.

I. Follow-up studies for all of the care pathways

Some of the most important work that should follow the research outlined in this thesis is the investigation of cases referred to alternative care pathways who do not re-emerge in the emergency care system. Patient outcomes for these cases could provide valuable information about the appropriateness of the RS triage and the optimisation of its care pathways triage processes and reveal any adverse events that may occur for patients referred to the alternative care pathways.

II. Temporal trends in RS demand

Some ASPs are only available out of hours, and some are only available during business hours. An investigation of the use of these providers, when they are available, and the demand for these providers when they are not available will allow for optimisation of the care pathways.

III. Emergency department and ambulance management of RS cases

Mapping the care provided by paramedics and within the ED to community-based alternatives may reveal that some of the case types categorized as appropriate in this thesis, could be appropriately managed by community-based care pathways.

IV. Cases presenting with chronic pain

Future research around pain is mentioned in Chapter Six; it has considerable potential to impact upon emergency ambulance and ED workloads. The inclusion of pain management specialists into the suite of alternative service providers to provide both telephone and face-to-face consultations, and liaise with patients' healthcare workers, might substantially reduce the number of cases entering emergency care pathways.

V. Low-acuity patient identification

A consistent definition of low-acuity cases may never be achieved amongst researchers investigating emergency services. This is primarily because paramedics have different skill sets and resources available to them. In Victoria, for example, non-emergency ambulances carry a range of medications that enable officers to manage cases such as those with pain, mild shortness of breath and non-complicated trauma. However, in many other ambulance services, these cases would remain within the domain of emergency ambulances. Therefore local studies defining low-acuity cases could be conducted to allow for ambulance services to clearly identify cases that are suitable for particular resources. However this work would need to be regularly updated as skills and resources change.

7.5 Conclusions

This chapter provides reflections on the program of research described in this thesis. It outlines key findings, contains discussion of the implications of the research for ambulance services, and proposes recommendations for future research.

Since the year 2000, ambulance-based secondary telephone triage has emerged as a demand management strategy to alleviate the pressure on emergency ambulance resources. However, there was little quality research for ambulance managers and policymakers to utilise in making decisions about implementing such a strategy in their ambulance service or region. The research described in this thesis has contributed to filling the gap in knowledge about ambulance-based secondary telephone triage through a detailed analysis of a large, fully operational secondary telephone triage service. The results demonstrate that such a service can reduce ambulance demand and make appropriate triage decisions. The results include population-specific data that will assist further optimisation of this service.

The demand for ambulance resources is increasing in many countries, putting considerable strain on health care systems. The work presented in this thesis can inform the policies and operational strategies of ambulance services worldwide. It can be used to reduce the demand for emergency ambulances, whilst improving the quality of care ambulance services provide to their patients.

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APPENDICES

Appendix One Ethics Approvals

Ambulance Victoria and Monash University ethics and amendment approvals

Ambulance Victoria

15th March 2012

To Amee Morgans
Ambulance Victoria
375 Manningham Rd
Doncaster 3108

File Ref: R11-021

Dear Amee

Re: Research Proposal "R11-021 Referral Service Study"

I am pleased to inform you that Ambulance Victoria (AV) has approved participation in the above study **subject to ethics approval.**

Note, that any changes to the original application will require submission of a protocol amendment to the AV Research Committee for consideration. Please ensure that AV is informed of any protocol changes as soon as possible.

As a component of the ongoing communication processes, AV requires six-monthly progress reports and a final report on completion of the study. You will be emailed the progress report approximately four weeks prior to the due dates of 30 June and 31 December. Progress reports are required to be submitted by email.

We look forward to working with you on this important project.

Yours sincerely

DR KAREN SMITH
Manager Research and Evaluation
Ambulance Victoria
Karen.Smith@ambulance.vic.gov.au

R11-021 AV Research Letter Approval.doc

MONASH University

Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

Date:	**17 April 2012**
Project Number:	**CF12/0547 – 2012000215**
Project Title:	**Ambulance Victoria Referral Service Study**
Chief Investigator:	**Dr Amee Morgans**
Approved:	**From: 17 April 2012 To: 17 April 2017**

Terms of approval

1. The Chief investigator is responsible for ensuring that permission letters are obtained, if relevant, and a copy forwarded to MUHREC before any data collection can occur at the specified organisation. **Failure to provide permission letters to MUHREC before data collection commences is in breach of the National Statement on Ethical Conduct in Human Research and the Australian Code for the Responsible Conduct of Research**.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash University letterhead and the Monash University complaints clause must contain your project number.
6. **Amendments to the approved project (including changes in personnel):** Requires the submission of a Request for Amendment form to MUHREC and must not begin without written approval from MUHREC. Substantial variations may require a new application.
7. **Future correspondence:** Please quote the project number and project title above in any further correspondence.
8. **Annual reports:** Continued approval of this project is dependent on the submission of an Annual Report. This is determined by the date of your letter of approval.
9. **Final report:** A Final Report should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected date of completion.
10. **Monitoring:** Projects may be subject to an audit or any other form of monitoring by MUHREC at any time.
11. **Retention and storage of data:** The Chief Investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Ben Canny

Professor Ben Canny
Chair, MUHREC

cc: Dr Karen Smith, Ms Kathryn Eastwood

Postal – Monash University, Vic 3800, Australia
Building 3E, Room 111, Clayton Campus, Wellington Road, Clayton
Telephone +61 3 9905 5490 Facsimile +61 3 9905 3831
Email muhrec@monash.edu www.monash.edu/research/ethics/human/index/html
ABN 12 377 614 012 CRICOS Provider #00008C

MONASH University

Kathryn Eastwood <kathryn.eastwood@monash.edu>

MUHREC Amendment CF12/547 - 2012000215 - Ambulance Victoria Referral Service Study

2 messages

MRO Human Ethics Team <muhrec@monash.edu> 24 February 2014 12:09
To: kathryn.eastwood@monash.edu

PLEASE NOTE: To ensure speedy turnaround time, this correspondence is being sent by email only. MUHREC will endeavour to copy all investigators on correspondence relating to this project, but it is the responsibility of the first-named investigator to ensure that their co-investigators are aware of the content of the correspondence.

Dear Researchers

Thank you for submitting a Request for Amendment to the above named project.

This is to advise that the following amendments have been approved:

Changes to Project

- The Victorian Emergency Minimum Dataset (VEMD) will also be accessed and linked to the Victorian Ambulance Clinical Information System (VACIS) data, to review all of the cases transported to hospital by ambulance from 2008-2013.
- Date range for VACIS data collection will be expanded to include 2013.

Thank you for keeping the Committee informed.

Professor Nip Thomson
Chair, MUHREC

Human Ethics
Monash Research Office

Our aim is exceptional service

Monash University
Level 1, Building 3e, Clayton Campus
Wellington Rd
Clayton VIC 3800, Australia

Telephone: +61 3 9905 5490
Email: muhrec@monash.edu
Website: http://www.monash.edu.au/researchoffice/human
ABN 12 377 614 012 CRICOS Provider No 00008C

Ambulance Victoria

21st February 2014

To Kathryn Eastwood
Ambulance Victoria
375 Manningham Rd
Doncaster 3108

File Ref: R11-021

Dear Kathryn

Re: Research Proposal "R11-021 Referral Service Study"

I am pleased to inform you that Ambulance Victoria (AV) has approved the requested amendments to the above study **subject to ethics approval.**

Please note that any further changes to your application will require submission of a protocol amendment. Please ensure that AV is informed of any protocol changes as soon as possible.

We look forward to continuing this important project with you.

Yours sincerely,

Sue Cunningham

SUE CUNNINGHAM
General Manager Strategy, Research and Innovation
Chair - Ambulance Victoria Research Committee

MONASH University

Kathryn Eastwood <kathryn.eastwood@monash.edu>

MUHREC - Amendment - CF12/0547 - 2012000215 - Ambulance Victoria Referral Service Study
1 message

MRO Human Ethics Team <muhrec@monash.edu> 26 September 2014 11:12
To: "Kathryn Eastwood (Med)" <kathryn.eastwood@monash.edu>

PLEASE NOTE: To ensure speedy turnaround time, this correspondence is being sent by email only. MUHREC will endeavour to copy all investigators on correspondence relating to this project, but it is the responsibility of the first-named investigator to ensure that their co-investigators are aware of the content of the correspondence.

Dear Researchers

Thank you for submitting a Request for Amendment to the above named project.

This is to advise that the following amendment has been approved:

1. Other Changes: The Victorian Admitted Episodes Dataset (VAED) will also be accessed and linked to the Victorian Ambulance Clinical Information System (VACIS) data using a unique identifier (that maintains patient anonymity) to review all of the cases transported and admitted to hospital by ambulance from 2008-2013. Further variables from the VACIS dataset will be collected prior to linkage between the VACIS data, Victorian Emergency Minimum Dataset and the VAED dataset, including patient suburb, patient postcode and destination hospital.

Thank you for keeping the Committee informed.

Professor Nip Thomson
Chair, MUHREC
--
Human Ethics
Monash Research Office

New forms are now available, please ensure that you use the most recent version.

Souheir Houssami, PhD - Executive Officer - Tel: +61 3 9905 2052
Vanalysa Ly - Tel: +61 3 9905 5490
Alison Woods - Tel: +61 3 9905 1478
Erica MacNally - Tel: +61 3 9905 2076

Our aim is exceptional service

Monash University
Level 1, Building 3e, Clayton Campus
Wellington Rd
Clayton VIC 3800, Australia
Email: muhrec@monash.edu

Ambulance Victoria

22nd December 2014

To Kathryn Eastwood
Department of Community Emergency Health and Paramedic Practice
Monash University
Building H, Peninsula Campus
PO Box 527
Frankston VIC 3199

File Ref: R11-021

Dear Kathryn

Re: Research Proposal "R11-021 Referral Service Study"

I am pleased to inform you that Ambulance Victoria (AV) has approved the amendments to the above project, as outlined in the project protocol dated 24/11/2014, **subject to ethics approval.**

Please note that any further changes to your application will require submission of further protocol amendments. Please ensure that AV is informed of any changes as soon as possible.

Thank you for keeping AV informed and we look forward to continuing this project with you.

Yours sincerely,

SUE CUNNINGHAM
General Manager Strategy, Research and Innovation
Chair - Ambulance Victoria Research Committee

Department of Health Deed of Acknowledgement and Confidentiality

Schedule 1

Recipient: Monash University

Purpose: Research Project: The management of low-acuity ambulance patients entering the Emergency Department.

User: Kathryn Eastwood
Senior Lecturer, PhD Candidate, Monash University

Schedule 2 –Deed of Acknowledgment and Confidentiality

This Deed is made on the 13 day of October 2014

I, _Kathryn Eastwood_, am a researcher affiliated with Monash University.

I refer to the Deed of Acknowledgment and Confidentiality containing the Conditions of Release of Unit Record Data Sets from the Department of Health ("Conditions of Release") executed by the Recipient in relation to the Purpose/Research Project entitled [insert].

I acknowledge that the data sets released by the Department of Health to the Recipient are released subject to the Conditions of Release and I agree that I will comply with clauses 3 and 4 of the Conditions of Release as if I were the Recipient.

In particular, I acknowledge that the State of Victoria owns the copyright in the data sets and I agree only to use them in accordance with clause 3 of the Conditions of Release

I also agree that I will not communicate the data sets to any other person and I will not use, publish or disseminate the data sets in any way such that the identity of any individual patient, client, practitioners and private or public service provider is ascertainable.

I irrevocably authorise the Secretary to the Department of Health ("the Secretary") to enforce this undertaking and **I acknowledge** that the Secretary is entitled (in addition to any entitlement to damages) to seek an injunction or other equitable relief for any actual or threatened breach by me of this Deed:

(a) without the need for the Secretary to prove any special damage; and

(b) the Secretary need not provide any security in respect of any damages that I or anyone else might incur as a result of an injunction being granted.

Executed as a deed poll on the date set out at the commencement of this Deed.

SIGNED SEALED AND DELIVERED)
in the presence of:) ....
) Sign here

....
Signature of witness

JUST STOELWINDER
Name of witness (block letters)

DEPARTMENT OF HEALTH

DEED OF ACKNOWLEDGMENT AND CONFIDENTIALITY – RECIPIENT ORGANISATION

1. DEFINITIONS

"Department" means the Department of Health, a Government Department of the State of Victoria.

"Deed" means this Deed of Acknowledgment and Confidentiality.

"Recipient" means the Organisation named in Schedule 1 to whom the unit record data sets are released in accordance with the conditions set out in this Deed.

"Purpose" means the purpose specified in Schedule 1.

"User" means the user named in Schedule 1 who will use the unit record data sets for the Purposes.

"Secretary" means the Secretary to the Department of Health, a body corporate established under the *Public Health and Wellbeing Act 2008*.

2. CONDITIONS OF RELEASE OF DATA

2.1 These conditions relate to the release of data sets by the Department to the Recipient for use by the User, for the Purpose.

2.2 The data sets are released by the Department in reliance on the Recipient agreeing to abide by and ensuring that any other persons with access to the data agree to abide by, the conditions set out in this Deed.

2.3 The Recipient will ensure that the User executes the Deed of Acknowledgment and Confidentiality set out in Schedule 2.

3. COPYRIGHT

3.1 The State of Victoria owns the copyright in the Department's datasets. The Recipient(s) of these datasets agree not to reproduce, distribute or commercialise them, or any product or service derived from or incorporating them or part of them (whether or not amounting to copyright reproduction) other than as allowed by this Deed or with the prior written consent of the State of Victoria, or the Secretary on behalf of the State.

3.2 Where consent is sought for the purposes of clause 3.1, the State of Victoria reserves the right to set an appropriate charge or to require a revenue sharing arrangement.

3.3 The Recipient(s) is permitted to quote an insubstantial part of the statistical data contained in the datasets (whether or not copyright subsists in the datasets), providing that:

- an 'insubstantial part' means a fair dealing as defined in Sections 40, 41, 42 and 43 of the Copyright Act 1968;
- the Department is cited as the source of the data used;

- the terminology used is that used by the Department for describing data; and
- any analysis or transformation of the data is not attributed to the Department.

3.4 Where a dataset consists of data in computer readable form, or software, the State of Victoria authorises the recipient(s) to use on a non-transferable and non-exclusive basis, this data or software personally for the Purpose.

3.5 The Recipient is permitted to publish any analyses of the data but not the data itself, subject to the confidentiality conditions set out below. Any publication must be solely for the Purpose and the Department must be acknowledged as the data source. The Recipient undertakes to consult the Department about the validity and interpretation of any such analyses prior to submitting the results of any such analyses for publication. A copy of any such analyses will be provided to the Department for approval prior to submission for publication.

3.5 In these Conditions, 'commercialise' in respect of a product or derivative of that product, means to manufacture, sell, distribute, hire or otherwise exploit a product or process, or to provide a service incorporating the product or any other product or service derived from that product, or to license a third party to do any of these things.

4. CONFIDENTIALITY

4.1 The data must not be used, published or disseminated in a way that might enable the identity of any person or organisation to be ascertained, including individual patients, clients, practitioners and private or public service providers. In particular, statistical tables with cells showing between one (1) and four (4) cases must not be published.

4.2 The data file is provided solely to the Recipient for use by the User for the Purposes and must not be communicated to other persons or organisations, or linked with files of personal information of other sources.

4.3 The data will only be used for the Purpose or for other purposes approved in writing by the Department.

4.4 Data files are to be maintained and stored in a secure manner in an environment where they cannot be linked (either electronically or by personal inspection) with other patient/client records or unit record data or personal information.

4.5 When no longer required, the data files are to be destroyed and the Department is to be notified of such destruction, or returned to the Department.

5. LIMITATION OF LIABILITY

5.1 The State of Victoria gives no warranty other than guarantees provided by law, that the products are free from errors, are complete, have any particular quality, are suitable for any purpose or otherwise.

5.2 The State of Victoria's liability to the recipient(s) for any loss, damage or injury howsoever caused by the State of Victoria, whether due to negligence, failure to comply with a guarantee provided by law or otherwise, in relation to a product shall be limited to providing a replacement copy of that product.

6. INDEMNITY

6.1 The Recipient indemnifies and shall keep indemnified the State of Victoria and its servants, officers, agents and contractors against any action, claim, suit, demand, or damage, loss, expense or liability (including costs on a solicitor and client basis) caused by or flowing from:

(a) a breach by the Recipient, the User or any personnel employed or retained by the Recipient of the conditions on which this data is released;

(b) any wilful, negligent or unlawful act or omission of the Recipient in connection with this data.

6.2 It is not necessary for the State of Victoria to make or receive any payment before enforcing such an indemnity.

7. INSURANCE

7.1 The Recipient shall ensure that the research activity proposed to be undertaken by the Recipient and the User is, on and from the date of receiving this data, insured with:

(a) public liability insurance coverage with a limit of indemnity of at least $5 million for any one occurrence; and

(b) professional indemnity insurance coverage with a limit of indemnity of at least $2 million for any one claim.

with an insurer(s) authorised under the Insurance Act 1973, or alternatively an insurer that complies with the financial solvency regulations of the supervising authority of the country in which the insurance is transacted, and shall provide certificates of currency if the Department so requests.

7.2 The insurance policy may be in the Recipient's own name or in the name of an organisation with which the Recipient is affiliated, provided that the policy adequately covers the proposed research activity.

7.3 The Recipient shall maintain the same level of professional indemnity insurance coverage for no less than 6 years after the date on which the Recipient has notified the Department that the data is no longer to be used.

8. APPLICABLE LAWS

This Deed shall be construed in accordance with the law of the State of Victoria and the Recipient submits to the jurisdiction of the courts of Victoria (including the federal courts).

EXECUTED AS A DEED POLL

Dated: 4/11/14

SIGNED SEALED AND DELIVERED by:

Sean Meehan, Director, Contracts Management Office
Monash University

....
Signature

FURTHER INFORMATION

If the Recipient wishes to commercialise the product, or reproduce the product other than as permitted by these Conditions, or has any further questions related to these Conditions, they should contact:

Ying Chen
Manager, Research Services and Data Integration
Victorian Data Linkages
Health Strategy Branch
Strategy and Policy Division
Department of Health
GPO Box 4057
MELBOURNE 3001

Email: vdl@health.vic.gov.au
Telephone: (03) 9096 7623

The Recipient is reminded that additional Conditions of Sale or Release may apply to the Department's products.

Appendix Two: Data linkage instructions for the Victorian Data Linkages Unit

The management of low-acuity ambulance patients entering the emergency department – Data linkage instructions

Management of Low-Acuity Ambulance Patients Entering the Emergency Department

Kathryn Eastwood

Professor Just Stoelwinder

Associate Professor Karen Smith

Dr Amee Morgans

Variables to be used for Linkage in the Deterministic Linkage Exercise

The following tables describe the variables to be used in the linkage process and the variables for inclusion in the output file for analysis.

VACIS only and Merged VACIS & CECC dataset	VEMD & VAED (Linkage of VAED via VEMD linked data)	Referral Service (CECC) only
Ambulance Case Number	Ambulance Case Number	
	Arrival transport mode	
Destination Date	Arrival Date	Arrival Date (+48 hours)[1]
Hospital	Encrypted campus code[2]	
Date of Birth	Date of birth	Date of Birth
Age		Age
Patient Postcode	Patient postcode	Patient Postcode
Patient Locality (Suburb)	Patient Locality (suburb)	Patient Locality (suburb)
Patient Gender	Patient Gender	Patient Gender
Medicare Prefix (MedSuffix)[3]	Medicare Prefix	

Table One: Variables to be used for Linkage in the Deterministic Linkage Exercise

Datasets being supplied for linkage (will be sent as a single dataset)

1 =+ 48 hours means that the VDL was asked to search CECC cases up to 48 hours following the CECC date to see if these patients presented within the days following the RS triage

2 =The hospital campus at wich the ED presentation occurred

3 =The first three characters of the patient's first given name

Note: A single dataset will be sent to the VDLU unless otherwise required. A variable called 'DATASET' will be included which will identify the cases as per the coding above for the three data types involved.

Summary of Table Two

- Linkage variables include:
    1. Case date (CaseDate)
    2. Case number(CaseNumber)
    3. Suburb Name (SuburbName)
    4. Medicare prefix (MedSuffix)
    5. Post code (PostCode)
    6. Date of birth (DateofBirth)
    7. Age (Ageyears)
    8. Gender
    9. Hospital name (HospitalName)
- Case date (CaseDate) to be returned as two separate variables:
    1. Case month
    2. Case year
- Three variables to be stripped:
    1. Case number (CaseNumber)
    2. Medicare prefix (MedSuffix)
    3. Date of Birth (DateofBirth)

		Linkage variable	Variables to be returned to researchers	To be altered then returned to researchers	To be stripped from returning dataset
1.	CaseDate			Y -month / Y- year	
2.	CaseNumber	Y			Y
3.	SuburbName	Y	Y		
4.	MedSuffix	Y			Y
5.	PostCode	Y	Y		
6.	DateofBirth	Y			Y
7.	Ageyears	Y	Y		
8.	Gender	Y	Y		
9.	HospitalName	Y	Y		
10	Arrival_at_ED_time	Y	Y		
11	DATASET		Y		
12	Patient_recode		Y		
13	Number_of_calls_on_same_date		Y		
14	PtTransportedIndicator		Y		
15	DestinationReason		Y		
16	DestinationDate		Y		
17	ReferralCode		Y		
18	SceneSuburbName		Y		
19	HighestTransportCode		Y		
20	NoTransportReason		Y		
21	DeceasedIndicator		Y		
22	TreatmentIndicator		Y		
23	HighAcuityFlag		Y		
24	GCS		Y		
25	Temperature		Y		
26	RespiratoryRate		Y		
27	Pulse		Y		
28	BP		Y		
29	SPO2		Y		
30	MinPain		Y		
31	IntialECG		Y		
32	FinalECG		Y		
33	CaseNature		Y		
34	FinalPrimaryAssessment		Y		
35	TimeOnCase		Y		
36	MICA		Y		
37	Monitoring		Y		
38	Extrication_Assistance		Y		
39	First_Aid_Intervention		Y		
40	Airway_Ventilation_Management		Y		
41	Perfusion_Cardiovascular_Management		Y		
42	Mental_Health		Y		

43	Venous_Access		Y		
44	Analgesics		Y		
45	Antiemetics		Y		
46	Intubation_Drugs		Y		
47	Sedation_Not_Intubation		Y		
48	Cardiovascular_Drugs		Y		
49	Respiratory_Drugs		Y		
50	Volume_Expanders		Y		
51	Other		Y		
52	NoPHx		Y		
53	UnknownPhx		Y		
54	Time_of_day_VACIS		Y		
55	CaseDuration		Y		
56	Intervention_Level		Y		
57	Time_of_day_CECC		Y		
58	RS_Session_Duration		Y		
59	Operator_ID_Qual		Y		
60	LGA		Y		
61	Guideline_Title		Y		
62	Question_Text		Y		
63	System_Disposition_Code		Y		
64	Overide_Disposition _Code		Y		
65	Overide _REASON_Desc		Y		
66	Outcome		Y		
67	Broader_Outcome		Y		
Total Variables		9	408	2	3
To be returned in the output data to researchers			408	2	

Table Two: Use of the Variables during linkage process from the dataset provided. CaseDate has been requested to be returned as two variables – arrival month and arrival year.

VEMD VAED data linkage specifications

VEMD	VAED
Linkage Variables • Ambulance Case Number • Arrival transport mode • Arrival Date (Destination Date) • Encrypted campus code • Date of birth • Patient postcode • Patient Locality (suburb) • Patient Gender • Medicare Prefix	*Linkage through VEMD-VACIS linked data*
***VEMD Variables** to be included in the dataset returned to researchers* • Arrival Month • Arrival Year • Arrival Transport Mode • Did not wait flag • Length of stay in ED • Treated in target time • Time to treatment (in minutes) • Triage category • Five year age group • Sex • Statistical local area • Departure month • Departure year • Departure Status • Referred to on Departure • Campus code • Procedures • ICD-10-AM Diagnosis	***VAED Variables** to be included in the dataset returned to researchers* • Admission Date • Admission Time • Separation month • Separation year • Length of stay • Sameday separation flag • Local government area • Hospital in the home length of stay • Hospital in the home separation • Intention to readmit • Patient type • Clinical specialty • Separation mode • ICD-10-AM Diagnosis • ICD-10-AM Procedure

Table Three: Variables from the VEMD and VAED datasets to be Included in final linked data provided to researchers

- 18 additional variables added to the dataset from the VEMD data
- 15 additional variables added to the dataset from the VAED data

CaseDate was requested to be returned as two variables –Arrival Month and Arrival Year.

In total the dataset returning to the researchers is expected to have 410 variables returned from the original data supplied to the VDLU, plus the 33 additional variables outlined in Table Three. Therefore the final dataset should contain 443 variables with 111,893 rows of data.

Appendix Three: Supplementary documents associated with the dataset preparation

- Data dictionary
- Table: Coding of paramedic variables provided in the AV VACIS dataset

Data dictionary

RQ158 Stoelwinder-Eastwood AV Referral Service Data Study

Data Dictionary to accompany SPSS dataset

Key	
Definition	A brief explanation of the variable
Reported for	The dataset from which the variable originated
Code set	Any coding that was applied to the variable
Categorisation	As outlined in Section 3.3.1 of the Chapter Three, where coding has been applied, this identifies whether the coding was an established or widely accepted form of coding for this variable ('Standard'), or whether the coding was constructed by the researcher ('Researcher defined').

Dataset	
Definition	The original dataset from which the data was taken
Reported for	Merged (CECC-VACIS) dataset CECC dataset VACIS dataset
Code set	1 = Merged CECC-VACIS dataset 2 = CECC dataset 3 = VACIS dataset
Categorisation	Researcher defined
Victorian Ambulance Clinical Information System (VACIS) –Emergency Ambulance Data	
Case Date	
Definition	The date upon which the patient made contact with the service which is currently being provided.
Reported for	All cases received by the Referral Service and those receiving an ambulance response
Code set	DD-MMM-YYYY
Categorisation	Standard
Case Number	
Definition	The unique identifier assigned to the case by Ambulance Victoria.
Reported for	All ED presentations arriving by ambulance All Referral Service cases

Code set	Victorian Ambulance Case Numbers in this dataset should be between: 01001 to 01999 70001 to 79999 Case numbers will renew at midnight each day based on dispatch time
Categorisation	Standard
Suburb Name	
Definition	The suburb of residence for the patient.
Reported for	VACIS cases only
Code set	-
Categorisation	-
Medicare Suffix	
Definition	The first three characters of the patients first given name
Reported for	All VACIS cases
Code set	-
Categorisation	-
Post Code	
Definition	The postcode of the suburb of residence for the patient
Reported for	VACIS cases only
Code set	-
Categorisation	-
Date of Birth	
Definition	Patient's date of birth
Reported for	All VACIS and CECC cases
Code set	DD-MMM-YYYY
Categorisation	Standard
Age	
Definition	Patient's age at the time of their interaction with Referral Service and paramedics
Reported for	All cases
Code set	0. 0-04 1. 05-09 2. 10-14 3. 15-19 4. 20-24 5. 25-29 6. 30-34 7. 35-39 8. 40-44

	9. 45-49 10. 50-54 11. 55-59 12. 60-64 13. 65-69 14. 70-74 15. 75-80 16. 80-84 17. 85+
Categorisation	Researcher defined
Age in Years	
Definition	Patient's age at the time of their interaction with Referral Service and paramedics
Reported for	All cases
Code set	Years
Categorisation	Standard
Gender	
Definition	The biological distinction between male and female
Reported for	All cases
Code set	1 = male 2 = female
Categorisation	Standard
Hospital Name	
Definition	The name of the hospital to which the patient was transported by AV paramedics
Reported for	VACIS cases transported to hospital
Code set	-
Categorisation	-
Private or Public	
Definition	The destination hospital entered in the VACIS record according to whether it is a publicly funded hospital or a privately funded hospital
Reported for	All VACIS cases
Code set	0. private hospital or a service/hospital with no ED 1. public hospital with an ED 2. missing
Categorisation	Researcher defined
Arrival at ED time	
Definition	The time the ambulance arrived at the ED

Reported for	All VACIS cases
Code set	24hr clock
Categorisation	Standard
Destination Reason	
Definition	Ambulance Victoria options for choice of hospital
Reported for	VACIS cases transported to hospital
Code set	23 options 1. Clinic or medical facility 2. Closest available ED –bypass 3. Closest available ED –HEWS 4. Closest public ED 5. Closest public ED unavailable –Bypass 6. Closest public ED unavailable –HEWS 7. Closest trauma service –patient in immediate life threat 8. Guardian choice 9. Highest level service –Major Trauma Service Est travel >30min 10. Inter Hospital Transfer 11. Major Trauma Service –Estimated travel <30 min 12. Mental health unit 13. Obstetric unit 14. Oncology unit 15. Other 16. Other clinical guideline 17. Patient residence 18. Physician referral 19. Police/coroner request 20. Patient choice 21. Patient past history at destination 22. Renal unit 23. Specific trauma service –specific patient condition
Categorisation	Standard
Destination Date	
Definition	The date the paramedics noted as arriving at the ED after transporting patient
Reported for	VACIS cases transported to hospital
Code set	DD-MMM-YYYY
Categorisation	Standard
Time of day VACIS	
Definition	The time of day the call was received
Reported for	All VACIS cases
Code set	24 hour clock
Categorisation	Standard

Scene Suburb Name	
Definition	The name of the suburb the case was in
Reported for	All VACIS cases
Code set	-
Categorisation	-
Referral Code	
Definition	The code assigned by Referral Service call-takers at the completion of the triage indicating the urgency of response that an emergency ambulance should response These codes align with the primary triage dispatch codes
Reported for	All CECC cases returning for emergency ambulance dispatch
Code set	REF00 –urgent lights and sirens response (eg. For cardiac arrest) REF01 –urgent lights and sirens response (eg. For cardiac chest pain) REF02 –expedient response abiding by road laws (attendance within 30 minutes) REF03 –response within 1 hour abiding by road laws
Categorisation	Standard
Patient Transported Indicator	
Definition	Indicator of whether the patient was transported to hospital by the paramedic crew in attendance
Reported for	VACIS cases only
Code set	Y = yes N = no
Categorisation	Standard
Highest Transport Code	
Definition	The code for ambulance dispatch that cases referred for ambulance dispatch are sent on.
Reported for	Cases referred for ambulance dispatch only
Code set	○ 1 –urgent lights and sirens response ○ 2 –expedient response abiding by road laws (attendance within 30 minutes) ○ 3 –response within 1 hour abiding by road laws ○ 4 –Non-emergency transports to ED
Categorisation	Standard
No Transport Reason	
Definition	The reason documented by paramedics for not transporting patients following assessment
Reported for	All VACIS cases for which patients were not transported to hospital.
Code set	○ 1 = transported

	○ 2 =cancelled after arrival ○ 3 =patient dead on arrival ○ 4 = patient dead at scene ○ 5 = patient for palliative care only ○ 6 = patient not found/absconded ○ 7 =referred to LMO/LOCUM (home visiting doctor) ○ 8 =referred to other provider ○ 9 =Transported by air ambulance from scene ○ 10 = Transported by AP road team ○ 11 = Transported by MICA road team ○ 12 = Transported by Non-emergency ambulance ○ 13 = Transported by other means ○ 14 = Transported by private vehicle ○ 15 = Transported not required ○ 16 = Transported required – patient refused ○ 17 =No reason given
Categorisation	Standard
High Acuity Flag	
Definition	Indicator of whether the patient was considered high acuity according to a series of interactions within the following categories: ○ Primary survey ○ Potential Major Trauma ○ Cardiac Rhythm ○ Final Primary Assessment ○ Secondary Survey ○ Management ○ Perfusion Status ○ Respiratory Status ○ VSS ○ Transport code Time critical
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Standard
Deceased Indicator	
Definition	Whether the patient was deceased whilst in paramedic care or following initial assessment
Reported for	All VACIS cases
Code set	○ Y = yes ○ N =no
Categorisation	Standard
Glasgow Coma Score (GCS)	
Definition	The lowest GCS exhibited by the patient during care

Reported for	All VACIS cases
Code set	○ 0 = <10 ○ 1 = 10-13 ○ 2 = >13
Categorisation	Researcher defined
Temperature	
Definition	Patient temperature (most extreme measure taken)
Reported for	All VACIS cases
Code set	○ 0 = T<28C ○ 1 = 28-31.9C ○ 2 = 32.0-34.9C ○ 3 = 35.0-37.5C ○ 4 = 37.6-39.5C ○ 5 = T>39.6C
Categorisation	Researcher defined
Respiratory Rate	
Definition	Patient respiratory rate (most extreme measure taken)
Reported for	All VACIS cases
Code set	○ 0 = RR<8 ○ 1 = 8-20 ○ 2 = RR>20
Categorisation	Researcher defined
Pulse	
Definition	Patient heart rate (most extreme measure taken)
Reported for	All VACIS cases
Code set	○ 0 = HR<55 ○ 1 = 55-99 ○ 2 = HR>100
Categorisation	Researcher defined
Blood Pressure	
Definition	Patient blood pressure (most extreme measure taken)
Reported for	All VACIS cases
Code set	○ 0 = BP<100 ○ 1 = 100-139 ○ 2= BP>139
Categorisation	Researcher defined
Pulse Oximetry	
Definition	Blood oxygen saturation (most extreme measure taken)

Reported for	All VACIS cases
Code set	○ 0 = SpO2<85% ○ 1 = 85-93% ○ 2 = SpO2>93%
Categorisation	Researcher defined
Pain	
Definition	The minimum pain the patient reported during the episode of care
Reported for	All VACIS cases
Code set	○ 0 = pain <3 ○ 1 = 3-6 ○ 2 = pain >6
Categorisation	Researcher defined
Electrocardiogram (ECG)	
Definition	The patient's ECG, consolidated down into broader categories
Reported for	All VACIS cases
Code set	○ 0 = Asystole /PEA ○ 1 = AF, Aflut, Narrow complex regular/irregular ○ 2 = bizarre/ other ○ 3 = bradycardia, sinus arrest ○ 4 = idioventricular, wide complex regular/irregular ○ 5 = paced rhythm ○ 6 = VF ○ 7 = Sinus tachycardia, SVT, tachycardia ○ 8 = VT ○ 9 = sinus rhythm ○ 10 = sinus arrhythmia
Categorisation	Standard
Time On Case	
Definition	The time between ambulance dispatch and clear time in minutes
Reported for	All VACIS cases
Code set	Minutes
Categorisation	Standard
Time On Case Grouped	
Definition	The time between ambulance dispatch and clear time grouped into categories
Reported for	All VACIS cases
Code set	○ 0 = 1 (minute) ○ 1 = 2-10 minutes ○ 2 = 11-30 minutes ○ 3 = 31-60 minutes ○ 4 = 61-120 minutes

	○ 5 = 121-180 minutes ○ 6 = 181-240 minutes ○ 7 = 241-300 minutes ○ 8 = 301-360 minutes ○ 9 = 361-420 minutes ○ 10 = 421-480 minutes ○ 11 = 481-540 minutes ○ 12 = 541-600 minutes ○ 13 = 601-660 minutes ○ 14 = 661-720 minutes ○ 15 =721+ minutes
Categorisation	Researcher defined
MICA	
Definition	Indicator of whether MICA attended the case
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Treatment Indicator	
Definition	Was an intervention provided by paramedics (monitoring and extrication were not considered an intervention)
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Monitoring	
Definition	Indicator of whether cardiac monitoring was conducted during the episode of care
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Extrication Assistance	
Definition	Extrication assistance was given to the patient
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
First Aid Intervention	

Definition	Basic first aid interventions provided ○ Compression Bandage ○ Splint ○ Position ○ Reassurance ○ Dressing ○ Icepack ○ Haemorrhage control ○ Irrigation ○ RICE ○ Spinal Immobilization ○ warming
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Airway Ventilation Management	
Definition	Airway intervention or management provided
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Perfusion/Cardiovascular Management	
Definition	Cardiovascular intervention or management provided
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Mental Health	
Definition	Mental health intervention or management provided
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Venous Access	
Definition	Intravenous, intraosseous or central venous access gained
Reported for	All VACIS cases
Code set	○ 0 = No

	○ 1 = Yes
Categorisation	Researcher defined
Analgesics	
Definition	The patient was given a pharmaceutical analgesic intervention
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Antiemetics	
Definition	The patient was given a pharmaceutical antiemetic intervention
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Intubation Drugs	
Definition	The patient was given a pharmaceutical drugs in preparation for intubation
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Sedation –Not for Intubation	
Definition	The patient was given pharmaceutical sedation but not in preparation for intubation
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Cardiovascular Drugs	
Definition	The patient was given a pharmaceutical drugs to manage cardiovascular problems
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Respiratory Drugs	

Definition	The patient was given a pharmaceutical drugs to manage respiratory problems
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Volume Expanders	
Definition	The patient was given fluid via a venous route
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Other Drug	
Definition	The patient was administered Glucose, glucagon or ceftriaxone
Reported for	All VACIS cases
Code set	○ 0 = No ○ 1 = Yes
Categorisation	Researcher defined
Intervention Level	
Definition	Indicator of the level of intervention (linked to the qualification level required to provide that intervention) provided to patients by paramedics during the episode of care
Reported for	All VACIS cases
Code set	○ 0 =Minimum ALS qualification ○ 1 =minimum ambulance attendant (non-emergency qualification) ○ 2 =no intervention
Categorisation	Researcher defined
Total comorbidities	
Definition	The total number of comorbidities listed for each patient
Reported for	All VACIS data
Code set	-
Categorisation	-
Care Enhance Call Centre (CECC) –Referral Service Data	
Patient Recode	

Definition	A de-identified code allocated to individual patients so they can be tracked without researcher identification
Reported for	All CECC data
Code set	-
Categorisation	-
Case Duration	
Definition	The time from the beginning of the RS session to the clear time for the ambulance in minutes
Reported for	All CECC-VACIS linked and VACIS cases
Code set	Minutes
Categorisation	Standard
RS Session Duration	
Definition	The duration of the RS triage session in minutes
Reported for	All CECC cases
Code set	Minutes
Categorisation	Standard
RS Session Duration Grouped	
Definition	The duration of the RS triage session grouped into categories
Reported for	All CECC cases
Code set	○ 0 = 1 (minute) ○ 1 = 2-10 minutes ○ 2 = 11-30 minutes ○ 3 = 31-60 minutes ○ 4 = 61-120 minutes ○ 5 = 121-180 minutes ○ 6 = 181-240 minutes ○ 7 = 241-300 minutes ○ 8 = 301-360 minutes ○ 9 = 361-420 minutes ○ 10 = 421-480 minutes ○ 11 = 481-540 minutes ○ 12 = 541-600 minutes ○ 13 = 601-660 minutes ○ 14 = 661-720 minutes ○ 15 =721+ minutes
Categorisation	Researcher defined
Number of Calls Same Date	
Definition	The number of times an individual patient encountered RS on a particular date
Reported for	All CECC cases

Code set	-	
Categorisation	-	
Local Government Area (LGA)		
Definition	The Local Government Area in which the patient was when triaged by the Referral Service or attended by the paramedics	
Reported for	All CECC cases	
Code set	Numerical order	Alphabetical order
	Wyndham =0 Melton =1 Hobsons Bay =2 Brimbank =3 Hume =4 Maribyrnong = 5 Moonee Valley =6 Moreland =7 Whittlesea =8 Melbourne =9 Yarra =10 Darebin =11 Port Phillip =12 Stonnington =13 Boroondara =14 Banyule =15 Manningham =16 Nillumbik =17 Glen Eira =18 Monash =19 Whitehorse =20 Moroondah =21 Kingston =22 Greater Dandenong =23 Knox =24 Frankston =25 Casey =26 Cardinia =27 Mornington Peninsula =28 Yarra Ranges =29 Bayside =30 Macedon Ranges =31 Moorabool =32 Warrnambool =33 Mitchell =34 Greater Geelong =35 Latrobe =36 Ballarat =37 Greater Shepparton =38 Northern Grampians =39 Colac Otway =40	Alpine =41 Ararat =56 Ballarat =37 Banyule =15 Bass Coast =43 Baw Baw =49 Bayside =30 Boroondara =14 Brimbank =3 Buloke =71 Campaspe =57 Cardinia =27 Casey =26 Central Goldfields =66 Colac Otway =40 Corangamite =60 Darebin =11 East Gippsland =45 Frankston =25 French Island =42 Gannawarra =67 Glen Eira =18 Glenelg =63 Golden Plains =72 Greater Bendigo =46 Greater Dandenong =23 Greater Geelong =35 Greater Shepparton =38 Hepburn =69 Hindmarsh =64 Hobsons Bay =2 Horsham =52 Hume =4 Indigo =70 Kingston =22 Knox =24 Latrobe =36 Macedon Ranges =31

	Alpine =41 French Island =42 Bass Coast =43 Moira =44 East Gippsland =45 Greater Bendigo =46 Queenscliffe Borough =47 Swan Hill Rural =48 Baw Baw =49 Wellington =50 Mansfield =51 Horsham =52 Wodonga =53 Pyrenees =54 Moyne =55 Ararat =56 Campaspe =57 Surf Coast =58 Murrindindi Shire =59 Corangamite =60 Towong =61 Mildura =62 Glenelg =63 Hindmarsh =64 Yarriambiack =65 Central Goldfields =66 Gannawarra =67 Southern Grampians =68 Hepburn =69 Indigo =70 Buloke =71 Golden Plains =72	Manningham =16 Mansfield =51 Maribyrnong = 5 Melbourne =9 Melton =1 Mildura =62 Mitchell =34 Moira =44 Monash =19 Moonee Valley =6 Moorabool =32 Moreland =7 Mornington Peninsula =28 Moroondah =21 Moyne =55 Murrindindi Shire =59 Nillumbik =17 Northern Grampians =39 Port Phillip =12 Pyrenees =54 Queenscliffe Borough =47 Southern Grampians =68 Stonnington =13 Surf Coast =58 Swan Hill Rural =48 Towong =61 Warrnambool =33 Wellington =50 Whitehorse =20 Whittlesea =8 Wodonga =53 Wyndham =0 Yarra =10 Yarra Ranges =29 Yarriambiack =65
Categorisation	Standard	
Metropolitan regions grouped		
Definition	The metropolitan local government areas were grouped into metropolitan regions	
Reported for	All CECC	
Code set	0 = South Western Melbourne 1 = North Western Melbourne	

	2 = Inner North Melbourne 3 = North Melbourne 4 = Inner East Melbourne 5 = Bayside 6 = Eastern Melbourne 7 = South Eastern Melbourne 8 = Frankston Mornington Peninsula 100 = Regional Melbourne
Categorisation	Standard
Income level	
Definition	The median income level for each LGA in 2011
Reported for	All CECC cases
Code set	0 = $38,000 1 = $43,000 2 = $44,000 3 = $45,000 4 = $47,000 5 = $48,000 6 = $49,000 7 = $51,000 8 = $52,000 9 = $53,000 10 = $54,000 11 = $57,000 12 = $63,000 13 = $65,000 14 = $67,000 15 = $70,000
Categorisation	Researcher defined
Operator Qualification	
Definition	The qualification level of the RS call-taker
Reported for	All CECC cases
Code set	○ 0 = RN ○ 1 = MICA ○ 2 = Ambulance Paramedic
Categorisation	Researcher defined
Guideline Title	
Definition	The title of the CECC guideline being used to triage the patient
Reported for	All CECC cases
Code set	• Abdominal Pain - Female (Paediatric) • Abdominal Pain - Male (Paediatric) • Developmental Disorders (Social): Dx • Difficult Caller (Paediatric)

	• Abdominal Pain / Discomfort • Abdominal Pain, Pregnant • Abdominal Swelling, Bloating • Abdominal Injury • Abrasions/Lacerations/Puncture Wounds • Ankle Injury • Bruises (Paediatric) • Burns • Burns (Paediatric) • Chest Injury • Cuts and Lacerations (Paediatric) • Elbow Injury • Face Injury • Finger / Fingernail Injury • Foot Injury • Forearm Injury • Hand Injury • Lower Leg Injury • Mouth / Lip / Teeth Injury • Sexual Assault / Rape • Sexual Assault or Rape (Paediatric) • Shoulder Injury • Thigh Injury • Toe / Toenail Injury • Trauma - Arm (Paediatric) • Trauma - Face (Paediatric) • Trauma - Head (Paediatric) • Trauma - Leg (Paediatric) • Trauma - Mouth (Paediatric) • Trauma - Neck (Paediatric) • Trauma - Tailbone (Paediatric) • Trauma, Pregnant • Upper Arm Injury • Wrist Injury • Abortion <20 Wks--Threatened/Spontaneous • Abortion--Therapeutic/Elective; Sx Post • Ectopic Pregnancy; Known / Suspected • Foetal Movement - Decreased, Pregnant • Oedema, Pregnant • Postpartum - Common Problems • Fluid Intake Decreased (Paediatric) • Frequent Caller (Patient) • Heat Exposure • Hives (Paediatric) • Insect Bites (Paediatric) • Newborn Rashes & Birthmarks (Paediatric) • No Guideline Available: Triage and Advice per Reference Book (Paediatric) • No Guideline or Reference Available (Paediatric) • No Guideline/Advice Per Reference (Adult) • Rash / Hives / Eruptions • Rash, Purple Spots or Dots (Paediatric) • Rashes - Widespread, on Drugs (Paediatric) • Rashes, Localised, Cause Unknown (Paediatric) • Rashes, Widespread, Cause Unknown (Paediatric) • Skin / Rash, Pregnant • Skin Lesions / Skin Irritation • Sleep, Increased (Paediatric) • Snakebite (Paediatric) • Spider Bite (Paediatric) • Sunburn • Bloody Urine (Haematuria) • Breast Symptoms - Female • Breastfeeding Questions (Paediatric) • Dysmenorrhoea • Endometriosis; Known / Suspected • Genital Lesions - Female • IUD; Symptoms • Pelvic Pain / Dyspareunia • Penis Problems / Sexual Problems • Scrotum or Groin Swelling/Pain: Male (Paediatric) • Scrotum / Testicles Symptoms

- Preterm Labour, 20-37 Weeks Gestation
- Ruptured Membranes, Pregnant
- Signs of Labour, Pregnant
- Vaginal Bleeding and >20 Weeks Gestation
- ADHD/ADD: Dx
- Alcoholism: Known / Suspected
- Anxiety: Mild to Moderate
- Anxiety: Severe / Panic
- Bipolar Disorder--Manic Type: Dx
- Conduct Disorders: Diagnosed
- Dementia: Diagnosed / Suspected
- Depression / Mood Disorders
- Depression: Post natal
- Eating Disorders: Anorexia/Bulimia: Dx
- Phobias
- Post-Traumatic Stress Disorder: Dx
- Schizophrenia: Diagnosed
- Sleep Disorders
- Stress Response
- Substance Abuse (Paediatric)
- Substance Abuse: Diagnosed / Suspected
- Suicidal, Homicidal, or Harmful Behaviour
- Suicide Concerns (Paediatric)
- Withdrawal Symptoms
- Allergic Reaction Severe; Known / Suspected
- Allergies / Hay Fever Symptoms
- Anaphylaxis (Paediatric)
- Ankle Non-Injury
- Arm Joint, Swelling of (Paediatric)
- Arm Pain (Paediatric)
- Elbow Non-Injury
- Face Pain / Swelling - No Injury
- Face, Swelling of (Paediatric)
- Finger / Fingernail Non-Injury
- Foot Non-Injury
- Foot or Ankle, Swelling of (Paediatric)
- Forearm Non-Injury
- Uterine Prolapse; Diagnosed/Info
- Vaginal Bleeding - Menopausal, no HRT
- Vaginal Bleeding (Premenopausal) -- Abnormal
- Vaginal Discharge / Irritation
- Vaginal Foreign Body; Known / Suspected
- Bluish Skin (Cyanosis) (Paediatric)
- Chest Pain (Paediatric)
- Fontanelle, Bulging (Soft Spot) (Paediatric)
- Pale Skin (Paediatric)
- Palpitations / Irregular Heartbeat
- Breathing Problems
- Chest Pain / Discomfort
- Chickenpox (Paediatric)
- Chickenpox: Known / Suspected Exposure
- Colds (Paediatric)
- Flu-Like Symptoms
- Flu-Like Symptoms, Pregnant
- Scarlet Fever (Paediatric)
- Swollen Glands
- Wound Infection (Paediatric)
- Coma / Stupor
- Confusion - Delirium (Paediatric)
- Fatigue
- Seizure
- Seizure - with Fever (Paediatric)
- Seizure - without Fever (Paediatric)
- Seizure, Pregnant
- Confusion / Disorientation / Agitation
- Constipation (Paediatric)
- Constipation / Rectal Symptoms
- Dehydration

- Hand Non-Injury
- Leg Joint, Swelling of (Paediatric)
- Leg Pain (Paediatric)
- Limp (Paediatric)
- Muscle Ache / Pain
- Muscle Jerks, Tics and Shudders (Paediatric)
- Neck Lump / Swelling
- Shoulder Non-Injury
- Toe / Toenail Non-Injury
- Tremor
- Upper Arm Non-Injury
- Wrist Non-Injury
- Anus Symptoms (Paediatric)
- Hepatitis; Known / Suspected
- Hernia, Inguinal (Paediatric)
- Swallowed Foreign Body (Paediatric)
- Swallowing Difficulty
- Swallowing, Difficulty (Paediatric)
- Tooth, Gum and Jaw Symptoms
- Umbilical Hernia (Paediatric)
- Weight Loss
- Asthma Attack (Paediatric)
- Breath-Holding Spell (Paediatric)
- Breathing Difficulty - Severe (Paediatric)
- Bronchiolitis: Follow-Up Call (Paediatric)
- Choking (Inhaled Foreign Body) (Paediatric)
- Cough - Adult
- Cough (Paediatric)
- Croup (Paediatric)
- Nose, Foreign Body (Paediatric)
- Nosebleed - With and Without Injury
- Sore Throat (Paediatric)
- Sore Throat / Hoarseness
- Sore Throat / Hoarseness, Pregnant
- Upper Respiratory Tract Infections / Colds
- Wheezing - Other than Asthma (Paediatric)
- Back Pain (Paediatric)
- Diabetes: Diagnosed, Pregnant
- Diabetes: Foot Problems
- Diabetes: GI Problems
- Diabetes: Out of Control
- Diabetes: Respiratory Problems
- Diarrhoea (Paediatric)
- Diarrhoea / Change in Bowel Habits
- Dizziness (Paediatric)
- Dizziness / Vertigo
- Ear - Hearing Symptoms
- Ear - Pain/Injury/Foreign Body
- Ear Congestion (Paediatric)
- Ear Discharge (Paediatric)
- Ear Infection Follow-Up Call (Paediatric)
- Earache (Paediatric)
- Eye - Foreign Body in (Paediatric)
- Eye - Red without Pus (Paediatric)
- Eye Condition - No Injury / Vision Change
- Eye Infection / Irritation
- Eye Injury / UV Light Exposure
- Eye, Swelling of (Paediatric)
- Eye; Other Problems
- Vision Loss or Change (Paediatric)
- Fainting
- Fainting (Paediatric)
- Falls
- Fever
- Fever (Paediatric)
- Flank Pain
- GI Bleeding
- Head Injury
- Headache
- Headache (Paediatric)
- Hip Injury
- Hip Non-Injury
- Hypertension; Diagnosed, Pregnant

	• Back Symptoms - Upper / Lower • Back Symptoms, Pregnant • Bee Sting (Paediatric) • Bite, Animal or Human (Paediatric) • Bites - Animal / Human • Bites and Stings - Insects / Spiders • Bites and Stings - Marine Life • Carbon Monoxide Exposure; Kn./Susp. • Chronic Diseases (Paediatric) • Cold Exposure • Crying Baby Under 3 mo (Paediatric) • Crying Child > 3 mo (Paediatric) • Domestic Violence; Dx/Suspected • Emergency Symptoms - ADULT	• Hypertension; Known / Suspected • Knee Injury • Knee Non-Injury • Lower Leg Non-Injury • Nausea / Vomiting • Nausea / Vomiting, Pregnant • Vomiting (Paediatric) • Neck Pain (Paediatric) • Neck Pain or Injury • Neurological Symptoms / TIA • Numbness / Tingling • Poisoning • Poisoning - Ingestion (Paediatric) • Postoperative Problems • Thigh Non-Injury • Urinary Symptoms - Female • Urinary Symptoms / Prostate Problems • Urination, Pain - Female (Paediatric) • Urination, Pain - Male (Paediatric) • Weakness (Paediatric) • Weakness / Paralysis
Categorisation	Standard	
Guidelines grouped		
Definition	The CECC guidelines grouped using the ICD-10-AM coding system	
Reported for	All CECC cases	
Code set	1 = Cardiovascular 2 = Respiratory 3 = Gastrointestinal 4 = Genitourinary 5 = Psychiatric 6 = Musculoskeletal 7 = Neurological 8 = Infectious 9 = Endocrine 10 = Eye and Ear 11 = Pain 12 = Obstetric 13 =Other	
Categorisation	Standard	

Question Text	
Definition	The question within the CECC triage guideline that the patient answered 'yes' to
Reported for	All CECC cases
Code set	-
Categorisation	-
System Disposition Code	
Definition	The disposition the CECC software has recommended following triage
Reported for	All CECC cases
Code set	○ activate 000 ○ attend ED immediately ○ see own healthcare provider within 4 hours ○ see own healthcare provider within 24 hours ○ see own healthcare provider within 72 hours ○ follow up with healthcare provider within 2 weeks ○ home/self-care advice –including from poisons
Categorisation	Standard
Override Disposition Code	
Definition	The disposition to which the RS call-taker overrides the case based on their clinical judgement
Reported for	All CECC cases
Code set	○ 0 =Activate 000 ○ 1 =NECTOM ○ 2 =Attend ED ○ 3 =Healthcare provider 4 hours ○ 4 =Healthcare provider 24 hours ○ 5 =Healthcare provider 72 hours ○ 6 =Poisons line ○ 7 =No override
Categorisation	Standard
Override Reason Description	
Definition	The reason, selected from a pre-defined list, for the decision to override the system disposition
Reported for	All CECC cases
Code set	• Caller demands ambulance • Child care issues • Doctor's request • No access to appropriate means of transport • No access to day locum (home visiting doctor)

	• No ASP available • Not appropriate for non-emergency ambulance • Person disconnected –ambulance dispatched • Person poor historian of symptoms • Possible deterioration < 4 hours • Possible deterioration <2 hours • Potential life threatening symptoms • Unable to follow instructions
Categorisation	Standard
Outcome	
Definition	The resultant action to which the patient was allocated
Reported for	All CECC cases
Code set	0 = Hospital Outreach 1 = ASP Locum (home visiting doctor) 2 = ASP Nursing 3 = ASP Other 4 = ASP Poisons 5 = ASP Psych 6 = Care Advice 7 = CTS 8 = Code 1 9 = Code 2 10 = Code 3 11 = Heat Wave –Pandemic 12 = Care plan 13 = NETCOM 14 = Self-present 15 = Triage aborted
Categorisation	Standard
Broader Outcome	
Definition	The resultant actions consolidated down into broader categories
Reported for	All CECC cases
Code set	0 = All ASPs 1 = Care Advice 2 = Care Plan 3 = Non-emergency transport 4 = Paramedic attendance 5 = Referred to ED 6 = Triage Aborted
Categorisation	Standard
Time of Day -CECC	
Definition	The time of day the CECC encounter commenced
Reported for	All CECC cases

Code set	24 hour clock
Categorisation	Standard
Care Pathway	
Definition	The pathway to which the case is referred following RS triage. The emergency care pathway refers to cases that will ultimate result in an ED presentation: • Emergency ambulance; • Non-emergency ambulance; • Self-presentation at the ED. The alternative care pathway refers to cases that have been referred away from an ultimate presentation at an ED. This includes referral to: • Alternative service provider; • Own healthcare professional; • Managed as per care plan; • Self-care advice for management at home.
Reported for	All CECC cases
Code set	0 = Alternative care pathway 1 = Emergency Care pathway
Categorisation	Researcher defined
Victorian Emergency Minimum Dataset –Emergency Department Data	
Arrival Transport Mode	
Definition	Arrival transport mode
Reported for	All VEMD cases
Code set	1. Air ambulance –fixed wing 2. Helicopter 3. Road ambulance service 6. community/public transport (includes council/philanthropic services) 8. Police vehicle 9. undertaker 10. Ambulance service –private ambulance car –AV contracted 11. Ambulance service –private ambulance car –hospital contracted 99. Other 100. ED record missing
Categorisation	Standard
Referred By	
Definition	Source from which patient was referred to this ED
Reported for	All VEMD cases
Code set	**0** Staff from this campus **1** Self, family, friends

	2 Local medical officer, includes local GP/Doctor **4** Private specialist **6** Staff from another campus (includes both admitted and non-admitted transfers. Also record Transfer Source) **8** Correctional Officer / Police **14** Nurse on Call **15** Other Nurse **16** Mental health telephone assessment/advisory line **17** Telephone advisory line, not otherwise specified **18** Other mental health staff **19** Other **20** Other community services staff
Categorisation	Standard
Triage Category	
Definition	Classification according to urgency of need for medical and nursing care using the National Triage Scale
Reported for	All VEMD cases
Code set	**1** Resuscitation (immediate attention) **2** Emergency (within 10 minutes) **3** Urgent (within 30 minutes) **4** Semi urgent (within 60 minutes) **5** Non urgent (within 120 minutes) **6** Dead on arrival **100** ED record missing
Categorisation	Standard
Departure Status	
Definition	Patient destination or status on departure from the ED
Reported for	All VEMD cases
Code set	**Departure before treatment completed:** **11** Left at own risk, without treatment **10** Left after clinical advice regarding treatment options **30** Left after clinical advice regarding treatment options – GP Co-Located Clinic **5** Left at own risk, after treatment started **7** Died within ED **8** Dead on arrival **Procedure room at this campus:** **27** Cardiac catheter laboratory **28** Other operating theatre/procedure room **Ward Setting at this hospital campus:** **15** Intensive Care Unit – this campus **22** Coronary Care Unit – this campus **25** Mental Health Observation/Assessment Unit

	3 Short Stay Observation Unit **14** Medical Assessment and Planning Unit **26** Other Mental Health Bed – this Campus **18** Ward not elsewhere described **Transfers to another hospital campus:** **17** Mental Health bed at another Hospital Campus **20** Another Hospital Campus – Intensive Care Unit **21** Another Hospital Campus – Coronary Care Unit **19** Another Hospital Campus **Returning to usual residence:** **23** Mental health residential facility **24** Residential care facility **12** Correctional/Custodial Facility **1** Home
Categorisation	Standard
Referred To	
Definition	The agency to which the patient was referred to for continuing care
Reported for	All VEMD cases
Code set	**1** Review in ED - scheduled **2** Review in ED - as required **3** Outpatients **4** LMO **5** Medical Specialist **6** Other Specialist Health Practitioner **7** Home Nursing Services **9** Aged Care Assessment Service **10** Drug and Alcohol Treatment Service **11** Mental Health Community Service **12** Other community service **16** No referral **17** Not known **18** Other **19** Not applicable
Categorisation	Standard
Diagnosis	
Definition	The diagnosis established at the conclusion of the patients attendance in the ED to be mainly responsible for the occasioning attendance following consideration of the clinical assessment. Additional diagnoses are those which: • Existed at the time of presentation • Arose while patient was in the ED • Are expected to affect treatment plan or LOS in the ED
Reported for	All VEMD cases
Code set	ICD-10-AM codes used One primary diagnosis and up to two additional diagnoses given

Categorisation	Standard
Procedure	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients. Up to 30 procedures recorded.
Reported for	All VEMD cases
Code set	**01** Peripheral IV catheter **02** Central/other line **03** Intraosseous infusion **04** Arterial line **05** Venous cutdown **11** Infusion IV fluid (excluding blood products) **12** Transfusion of blood products **13** Thrombolysis **14** Tetanus prophylaxis **15** IV/IM/SC injection **16** IV drug infusion **17** Oral/sublingual/topical/rectal drug admin **18** Nebulised medication **21** Dressing **22** Plaster of Paris **23** Other splint **24** IV regional block **25** Digital or other nerve block **26** Reduction (fracture or dislocation) **27** Suture steristrip glue **28** Nasal pack **29** Incision drainage **30** Removal of cast splint brace **31** Removal of sutures **32** Removal of foreign body **41** X-ray **42** Ultrasound **43** CT scan **44** Nuclear medicine **45** Venepuncture **46** Arterial blood gases **47** Spirometry **48** Pleural aspiration **49** Pericardiocentesis **50** Echocardiogram **51** 12 lead ECG **52** ECG monitoring **53** Full Ward test urine **54** Suprapubic aspiration specimen of urine **55** Random blood glucose **56** Lumbar puncture **57** Peritoneal lavage/abdominocentesis

	58 Proctosigmoidoscopy **59** Venom detection kit **60** Breath alcohol estimation **71** Urinary catheter **72** Nasogastric tube **73** Endotracheal intubation and ventilation **74** Gastric lavage **75** Gastric charcoal **76** Chest drain **77** Enema manual removal **78** Tracheostomy/cricothyroidotomy **79** Peritoneal dialysis **80** Mask continuous pos. airways pressure **81** Cardioversion defibrillation **82** Cardiopulmonary resuscitation **83** Eye examination **84** Head injury observation **85** Walking assist devices **91** Other investigations or procedures **99** No investigation or procedure
Categorisation	Standard
Wait Time	
Definition	Time to treatment is the difference between Arrival Time and Treatment Time in minutes for patients who waited for treatment.
Reported for	All VEMD cases
Code set	Recorded in minutes
Categorisation	Standard
Wait Time Grouped	
Definition	Time to treatment is the difference between Arrival Time and Treatment Time in minutes for patients who waited for treatment. This time has been grouped into categories.
Reported for	All VEMD cases
Code set	0 = 1 (minute) 1 = 2-10 minutes 2 = 11-30 minutes 3 = 31-60 minutes 4 = 61-120 minutes 5 = 121-180 minutes 6 = 181-240 minutes 7 = 241-300 minutes 8 = 301-360 minutes 9 = 361-420 minutes 10 = 421-480 minutes 11 = 481-540 minutes 12 = 541-600 minutes 13 = 601-660 minutes

	14 = 661-720 minutes 15 =721+ minutes
Categorisation	Researcher defined
Treated in Target Time	
Definition	Flag to indicate if patient treated within target time for the relevant Triage Category. (Triage Cat 1 <= 1 min; Cat 2 <= 10 min; Cat 3 <= 30 min; Cat 4 <= 60 min: Cat 5 <=120 min)
Reported for	All VEMD cases
Code set	Yes/no
Categorisation	Standard
Did Not Wait	
Definition	Text string indicating if patient did not wait for treatment.
Reported for	All VEMD cases
Code set	0 = waited 1 = Did not wait 100 = ED record missing
Categorisation	Standard
ED Stay	
Definition	Length of stay of patient in Emergency Department (calculated in minutes) includes ALL departure status classes.
Reported for	All VEMD cases
Code set	minutes
Categorisation	Standard
ED Stay Grouped	
Definition	Length of stay of patient in Emergency Department includes ALL departure status classes grouped into categories.
Reported for	All VEMD cases
Code set	0 = 1 (minute) 1 = 2-10 minutes 2 = 11-30 minutes 3 = 31-60 minutes 4 = 61-120 minutes 5 = 121-180 minutes 6 = 181-240 minutes 7 = 241-300 minutes 8 = 301-360 minutes 9 = 361-420 minutes 10 = 421-480 minutes 11 = 481-540 minutes 12 = 541-600 minutes 13 = 601-660 minutes

	14 = 661-720 minutes 15 =721+ minutes
Categorisation	Researcher defined
Arrival Date	
Definition	The date patient was first registered by clerical officer or triaged by a triage nurse or doctor (whichever comes first) in the Emergency Department
Reported for	All VEMD cases
Code set	A de-identified coded date has been provided by the VDL
Categorisation	Standard
Departure Date	
Definition	The date the patient physically leaves the clinical area of the Emergency Department.
Reported for	All VEMD cases
Code set	A de-identified coded date has been provided by the VDL
Categorisation	Standard
Arrival Month	
Definition	The month patient was first registered by clerical officer or triaged by a triage nurse or doctor (whichever comes first) in the Emergency Department
Reported for	All VEMD cases
Code set	1-12
Categorisation	Standard
Departure Month	
Definition	The month the patient physically leaves the clinical area of the Emergency Department.
Reported for	All VEMD cases
Code set	1-12
Categorisation	Standard
Arrival Year	
Definition	The year patient was first registered by clerical officer or triaged by a triage nurse or doctor (whichever comes first) in the Emergency Department
Reported for	All VEMD cases
Code set	2009-2012
Categorisation	Standard
Departure Year	

Definition	The year the patient physically leaves the clinical area of the Emergency Department.
Reported for	All VEMD cases
Code set	2009-2012
Categorisation	Standard
Procedure –Peripheral Intravenous Cannulation (IV)	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Central or Other Line	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Intraosseous Infusion	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Arterial Line	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Venous Cutdown	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases

Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –IV Fluid Administration	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Blood Transfusion	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Thrombolysis	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Tetanus	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Injection	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used

Procedure –IV Drug Infusion	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Oral Topical Rectal Drug Administration	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Nebulised Drug Administration	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Dressing	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Plaster	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Splint	

Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –IV Regional Block	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Digital or Other Nerve Block	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Reduction of Fracture or Dislocation	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Procedure –Suture Steristrip Glue	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Nasal Pack	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type

	1 = This intervention was used
Categorisation	Researcher defined
Procedure –Drainage	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Foreign Body Removal	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –X Ray	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Ultrasound	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –CT Scan	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined

Procedure –Nuclear Medicine	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Venepuncture	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Arterial Blood Gas	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Pleural Aspiration	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –12 Lead ECG	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –ECG Monitoring	

Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Urine Test	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Suprapubic Urine Aspiration	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Random Blood Glucose	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Lumbar Puncture	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Peritoneal Lavage Abdominocentesis	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases

Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Blood Alcohol Estimation	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Urinary Catheterization	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Nasogastric Tube	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Intubation and Ventilation	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Enema	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined

Procedure –Continuous Positive Airway Ventilation	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Cardioversion	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Eye Examination	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Head Injury Observation	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Walking Assistance Devices	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –Other Investigations or Procedures	

Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = No intervention of this type 1 = This intervention was used
Categorisation	Researcher defined
Procedure –No Procedure	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 = An Intervention occurred 1 = No intervention occurred
Categorisation	Researcher defined
Procedure –Missing Entry	
Definition	Specific interventions/treatments performed in the Emergency Department for the diagnosis and/or treatment of patients.
Reported for	All VEMD cases
Code set	0 =There was a procedural entry (indicating that there either was or was not a procedure) 1 = There was no entry to indicate whether the patient underwent a procedure in the ED
Categorisation	Researcher defined
ED Treatment Indicator	
Definition	Was the patient in receipt of any interventions/treatments in the ED
Reported for	All VEMD cases
Code set	0 = not treated in the ED 1= treated in the ED 100= ED record missing
Categorisation	Researcher defined
ED General Practitioner (GP) Triage Category	
Definition	In the Australian hospital statistics 2011-2012 document there is a section on “GP-type presentations”. One of the factors used to define whether a case was suitable for a GP was if it was triaged as a CAT 4 or 5. I used this to break down the triage categories into groups as below so the suitability of a case for ED versus a GP can be commented upon
Reported for	All VEMD cases
Code set	0 = CAT 4 or 5 1 = CAT 1, 2, or 3 2 = dead on arrival 100= ED record missing

Categorisation	Researcher defined
Not ED Suitable	
Definition	A modification of the 'potentially avoidable GP-type presentations to emergency departments' variable reported by the Australian Institute of Health and Welfare (Australian Government). Cases were considered unsuitable for the ED if they were: • Triaged as a category 4 or 5 according to the Australian Triage Scale upon arriving in the ED; • Were not admitted to the hospital or referred to another hospital, or • Did not die.
Reported for	All RS cases that had a corresponding VEMD and VAED record
Code set	0 = Not ED suitable 1 = ED suitable
Categorisation	Researcher defined
Victorian Admitted Episodes Dataset (VAED) –Hospital Admission Data	
Admission	
Definition	Whether the patient was admitted to the hospital after passing through the ED
Reported for	All VAED cases
Code set	0 = Not Admitted 1 = Admitted
Categorisation	Researcher defined
Locum (home visiting doctor) Doctor Visit Dataset	
Presenting Symptoms	
Definition	The presenting problem for GP locums taken from the free text of the RS triage report sent to the GP locum service
Reported for	ASP –Locum (home visiting doctor) cases
Code set	-
Categorisation	-
Suitable Referral	
Definition	The determination of whether the referral from the RS was suitable. Completed upon handover from the RS to the locum service.
Reported for	ASP –Locum cases
Code set	0 = No 1 = Yes 2 = Not entered
Categorisation	Standard

Referral Cancelled	
Definition	The reason for which the locum service was cancelled
Reported for	ASP –Locum cases
Code set	0 = Patient Refused Services 1 = No Longer Required 2 = Cancelled 3 = Unable to contact/confirm patient 4 = Patient is ‘Do Not Attend’ 5 = Unable to Service location 6 = Administrative
Categorisation	Standard
Managed Outcome	
Definition	The recommendation by the GP or final outcome of the GP locum visit
Reported for	ASP –Locum cases
Code set	0 = Advice given 1 = Drug Administration 2 = Minor procedure (IDC, wound dressing, disimpaction) 3 = Script Written 4 = Verification of Death (VOD) 5 = Referred to GP 6 = Referred to ED 7 = Non-emergency ambulance 8 = Emergency Ambulance
Categorisation	Standard
Comments	
Definition	Free text entered by the visiting GP locum
Reported for	ASP –Locum cases
Code set	-
Categorisation	-
Locum Service	
Definition	The locum service dispatched to the case
Reported for	ASP –Locum cases
Code set	MMDS –Melbourne Medical Deputizing Service ALMS –Australian Locum Medical Service
Categorisation	Standard

Coding Of Paramedic Variables Provided In The Ambulance Victoria VACIS Dataset

Variable	Coding Sub-Categories	Researcher defined sub-category or Standard sub-category*	Researcher defined rationale
Case date	Used for linkage	Standard	N/A
Case number	Used for linkage	Standard	N/A
Date of birth	Used for linkage	Standard	N/A
Age	Years	Standard	N/A
Gender	Male, female	Standard	N/A
Final Event Type Code	REF01, REF02, REF03 (RS urgency level set by the RS call-taker; REF01 is equivalent to a code 1 dispatch)	Standard	N/A
Scene suburb	Sorted into the following Local Government Areas[209] • Wyndham • Melton • Hobsons Bay • Brimbank • Hume • Maribyrnong • Moonee Valley • Moreland • Whittlesea • Melbourne • Yarra • Darebin • Port Phillip • Stonnington • Boroondara • Banyule • Manningham • Nillumbik • Glen Eira • Monash • Whitehorse • Moroondah • Kingston • Greater Dandenong • Knox • Frankston • Casey • Cardinia • Mornington Peninsula • Yarra Ranges • Bayside	Standard	N/A
Highest Transport code	Code 1, code 2 or code 3 return to hospital	Standard	N/A
Patient transport (Tx) indicator	Yes, No	Standard	N/A

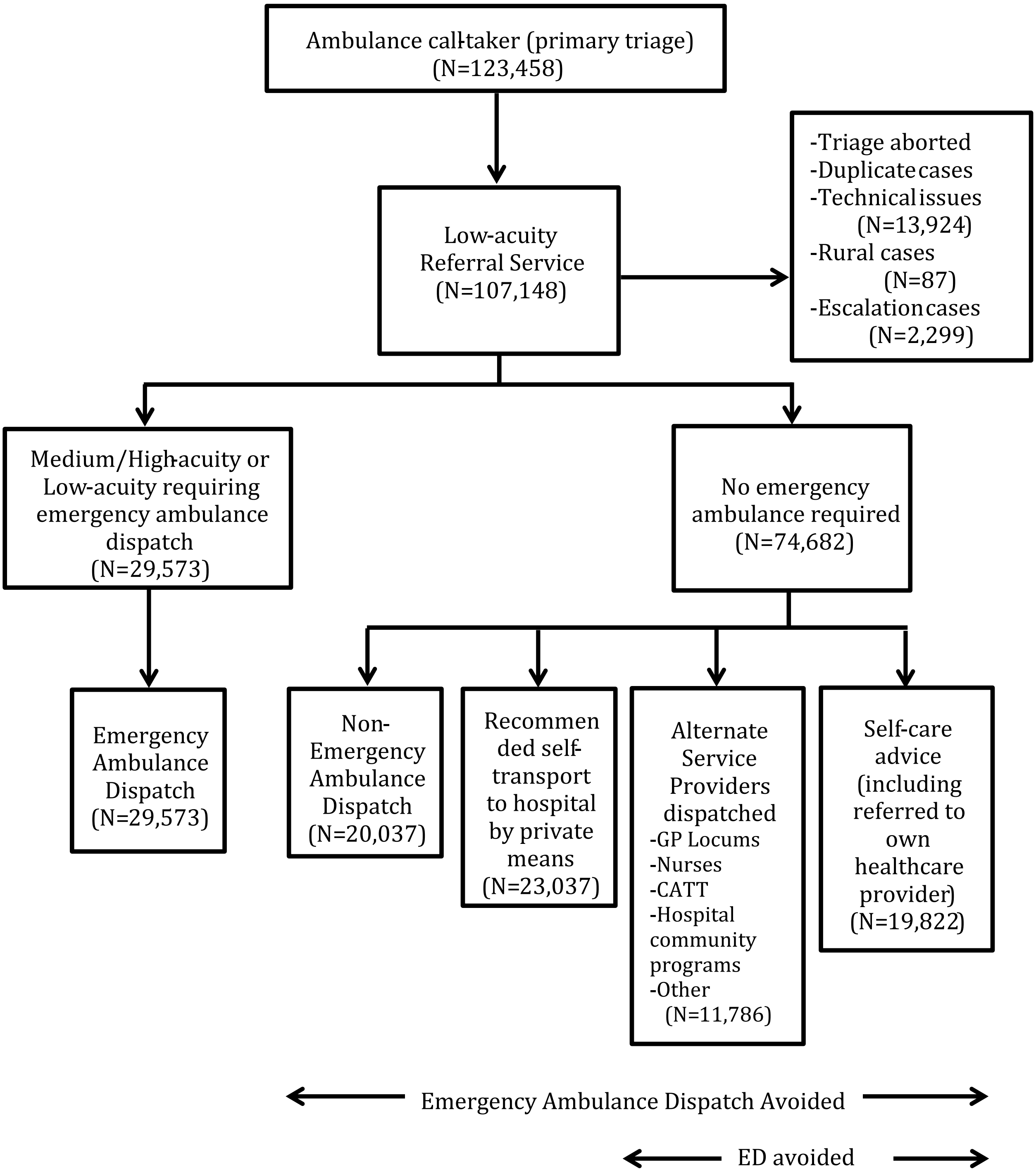
<table>
<tr><td>Not transported reason</td><td>transported
bariatric
cancelled after arrival
dead on arrival
dead at scene
for palliative care only
not found/ absconded
referred to LMO/LOCUM
referred to other provider
Tx by ambulance paramedic (AP) road team</td><td>Tx by air ambulance from scene
Tx by mobile intensive care ambulance (MICA) road team
Tx by Non-emergency ambulance
Tx by other means
Tx by private vehicle
Tx not required
Tx required – patient refused
No reason given</td><td>Standard</td><td>N/A</td></tr>
<tr><td>Deceased indicator</td><td colspan="2">Yes, No</td><td>Standard</td><td>N/A</td></tr>
<tr><td>Treatment indicator</td><td colspan="2">Yes, No</td><td>Standard</td><td>N/A</td></tr>
<tr><td>High acuity indictor</td><td colspan="2">Yes, No</td><td>Standard</td><td>N/A</td></tr>
<tr><td>Call received time</td><td colspan="2" rowspan="3">Used
to establish time of day
to establish length of care episode by paramedics
for linkage to hospital data</td><td rowspan="3">Standard</td><td>N/A</td></tr>
<tr><td>At scene time</td><td>N/A</td></tr>
<tr><td>Clear time</td><td>N/A</td></tr>
<tr><td>Glasgow Coma Scale (GCS)</td><td colspan="2">GCS<10; GCS 10-13; GCS 14-15.</td><td>Researcher defined</td><td>-AV intubate at GCS<10
-AV consider GCS<13 time critical</td></tr>
<tr><td>Pulse</td><td colspan="2">Heart rate (HR) 0-54; HR 55-99; HR 100-130; HR>130.</td><td>Researcher defined</td><td>-AV and hospital assessment or MET call ranges</td></tr>
</table>

Blood Pressure (BP)	BP 0-89; BP 90-139; BP >140.	Researcher defined	-AV and hospital treatment ranges
Pulse Oximetry (SpO_2)	SpO_2 0-89%; SpO_2 90-93%; SpO_2 94-100%.	Researcher defined	-AV SpO_2<90% time critical -AV treat SpO_2 <94%
Respiratory Rate (RR)	RR 0-7; RR 8-20; RR 21-30; RR>30.	Researcher defined	-AV and hospital assessment or MET call ranges
Pain Score	Minimal Pain <3; Moderate Pain 3-6; Severe Pain 7-10.	Researcher defined	-AV treatment for require pain>2
Electrocardiogram (ECG) Rhythm	Initial and final ECG rhythms were noted. They were categorised into the following categories: • Asystole/PEA • Atrial Flutter/Fibrillation, narrow complex rhythm – regular/irregular • Bizarre/other • Bradycardia/sinus arrest • Idioventricular/ wide complex –regular/irregular • Paced • Ventricular Fibrillation (VF) • Sinus tachycardia/Supraventricular Tachycardia (SVT)/ tachycardia • Ventricular Tachycardia (VT) • Sinus rhythm • Sinus arrhythmia	Standard	N/A
Temperature (T)	T <28°C; T 28.0-31.9°C; T 32.0°C-34.9°C; T 35.0°C-37.5°C; T37.6°C-39.5°C; T>39.6°C.	Researcher defined	-AV treatment ranges
Comorbidities	Past history (comorbidities) was broadly categorised into the following	Standard	N/A

	categories. Within each category, the patients' past histories were further subdivided down using the International Statistical Classification of Diseases, 10th Revision (ICD-10).[185] Particular medical conditions, such as acute myocardial infarction, were further broken down to a level that identified whether the particular event occurred within the previous 13 days, 2-8 weeks or 3 – 12 months. The comorbidity list is contained within the Data Dictionary in this Appendix (Appendix Three). The broad categories are listed below. • Diseases of the circulatory system • Diseases of the respiratory system • Neoplasms • Diseases of the digestive system • Diseases of the genitourinary system • Mental and behavioural disorders • Diseases of the musculoskeletal system and connective tissue • Diseases of the nervous system • Certain infectious and parasitic diseases • Endocrine, nutritional and metabolic diseases • Diseases of the eye and ear • Pain • Pregnancy, childbirth and the puerperium • Other o Burns, poisonings (eg. Envenomation -not overdose), external		

	causes ○ Diseases of the skin and subcutaneous tissue ○ Congenital malformations ○ Palliative care • No known history • Unknown history		
Paramedic Treatment name	The paramedic treatment was grouped into one of the following categories • Monitoring • Extrication • First Aid Intervention • Airway Ventilation Management • Perfusion Cardiovascular Management • Mental Health Management • Venous Access	Standard	N/A
Treatment name	• Analgesics • Antiemetics • Intubation drugs • Sedation drugs (not for intubation) • Cardiovascular drugs • Respiratory drugs • Volume Expanders • Other	Standard	N/A
Paramedic skill level	MICA, AP	Standard	N/A

Appendix Four: Supplemental flowchart outlining cohort populations for RS care pathways



Appendix Five: Chapter Six -consolidation of triage guidelines

	Emergency ambulance outcome		Total	Consolidation of groups (Triage Guideline Groups)
	Treated	Not treated		
Abdominal Pain - Female (Paediatric)	43	53	96	Abdominal pain (N=4319)
Abdominal Pain - Male (Paediatric)	53	65	118	
Abdominal Pain / Discomfort	2738	889	3627	
Abdominal Pain, Pregnant	132	48	180	
Abdominal Swelling, Bloating	205	93	298	
Abdominal Injury	18	9	27	Trauma (N=418)
Abrasions/Lacerations/Puncture Wounds	17	14	31	
Ankle Injury	19	11	30	
Bruises (Paediatric)	0	1	1	
Burns	6	4	10	
Burns (Paediatric)	3	0	3	
Chest Injury	42	11	53	
Cuts and Lacerations (Paediatric)	1	0	1	
Elbow Injury	2	1	3	
Face Injury	4	4	8	
Finger / Fingernail Injury	1	0	1	
Foot Injury	3	11	14	
Forearm Injury	3	3	6	
Hand Injury	4	2	6	
Lower Leg Injury	28	23	51	
Mouth / Lip / Teeth Injury	2	3	5	
Sexual Assault / Rape	0	1	1	
Sexual Assault or Rape (Paediatric)	0	1	1	
Shoulder Injury	39	9	48	
Thigh Injury	41	21	62	
Toe / Toenail Injury	0	1	1	
Trauma - Arm (Paediatric)	1	0	1	
Trauma - Face (Paediatric)	1	0	1	
Trauma - Head (Paediatric)	2	11	13	
Trauma - Leg (Paediatric)	3	4	7	
Trauma - Mouth (Paediatric)	0	1	1	
Trauma - Neck (Paediatric)	5	3	8	
Trauma - Tailbone (Paediatric)	0	1	1	
Trauma, Pregnant	1	0	1	

Upper Arm Injury	7	3	10	
Wrist Injury	9	3	12	
Abortion <20 Wks--Threatened/Spontaneous	10	6	16	Obstetrics other (N=133)
Abortion--Therapeutic/Elective; Sx Post	6	4	10	
Ectopic Pregnancy; Known / Suspected	8	1	9	
Foetal Movement - Decreased, Pregnant	0	4	4	
Oedema, Pregnant	1	0	1	
Postpartum - Common Problems	38	9	47	
Preterm Labour, 20-37 Weeks Gestation	12	13	25	
Ruptured Membranes, Pregnant	2	4	6	
Signs of Labour, Pregnant	7	7	14	
Vaginal Bleeding and >20 Weeks Gestation	1	0	1	
ADHD/ADD: Dx	0	1	1	Psychiatric conditions (N=1127)
Alcoholism: Known / Suspected	12	37	49	
Anxiety: Mild to Moderate	11	80	91	
Anxiety: Severe / Panic	18	116	134	
Bipolar Disorder--Manic Type: Dx	9	84	93	
Conduct Disorders: Diagnosed	0	5	5	
Dementia: Diagnosed / Suspected	5	60	65	
Depression / Mood Disorders	15	152	167	
Depression: Post natal	0	3	3	
Eating Disorders: Anorexia/Bulimia: Dx	4	7	11	
Phobias	0	2	2	
Post-Traumatic Stress Disorder: Dx	0	11	11	
Schizophrenia: Diagnosed	7	205	212	
Sleep Disorders	0	2	2	
Stress Response	1	6	7	
Substance Abuse (Paediatric)	1	2	3	
Substance Abuse: Diagnosed / Suspected	6	20	26	
Suicidal, Homicidal, or Harmful Behaviour	22	182	204	
Suicide Concerns (Paediatric)	0	4	4	
Withdrawal Symptoms	14	23	37	
Allergic Reaction Severe; Known / Suspected	46	95	141	Allergies (N=223)
Allergies / Hay Fever Symptoms	4	14	18	
Anaphylaxis (Paediatric)	8	56	64	
Ankle Non-Injury	6	13	19	Musculoskeletal other (N=313)
Arm Joint, Swelling of (Paediatric)	0	1	1	
Arm Pain (Paediatric)	2	0	2	
Elbow Non-Injury	3	4	7	
Face Pain / Swelling - No Injury	7	14	21	
Face, Swelling of (Paediatric)	1	6	7	

Finger / Fingernail Non-Injury	2	1	3	
Foot Non-Injury	34	23	57	
Foot or Ankle, Swelling of (Paediatric)	0	1	1	
Forearm Non-Injury	4	8	12	
Hand Non-Injury	6	14	20	
Leg Joint, Swelling of (Paediatric)	1	1	2	
Leg Pain (Paediatric)	8	5	13	
Limp (Paediatric)	1	0	1	
Muscle Ache / Pain	11	8	19	
Muscle Jerks, Tics and Shudders (Paediatric)	0	1	1	
Neck Lump / Swelling	3	3	6	
Shoulder Non-Injury	38	13	51	
Toe / Toenail Non-Injury	1	1	2	
Tremor	8	17	25	
Upper Arm Non-Injury	20	14	34	
Wrist Non-Injury	5	4	9	
Anus Symptoms (Paediatric)	1	0	1	Gastrointestinal other (N=93)
Hepatitis; Known / Suspected	0	1	1	
Hernia, Inguinal (Paediatric)	1	2	3	
Swallowed Foreign Body (Paediatric)	2	22	24	
Swallowing Difficulty	8	43	51	
Swallowing, Difficulty (Paediatric)	2	4	6	
Tooth, Gum and Jaw Symptoms	2	2	4	
Umbilical Hernia (Paediatric)	1	1	2	
Weight Loss	0	1	1	
Asthma Attack (Paediatric)	1	6	7	Respiratory other (N=141)
Breath-Holding Spell (Paediatric)	0	1	1	
Breathing Difficulty - Severe (Paediatric)	3	9	12	
Bronchiolitis: Follow-Up Call (Paediatric)	1	2	3	
Choking (Inhaled Foreign Body) (Paediatric)	3	27	30	
Cough - Adult	18	13	31	
Cough (Paediatric)	2	11	13	
Croup (Paediatric)	2	6	8	
Nose, Foreign Body (Paediatric)	0	1	1	
Nosebleed - With and Without Injury	1	2	3	
Sore Throat (Paediatric)	0	3	3	
Sore Throat / Hoarseness	5	14	19	
Sore Throat / Hoarseness, Pregnant	0	1	1	
Upper Respiratory Tract Infections / Colds	4	1	5	
Wheezing - Other than Asthma (Paediatric)	2	2	4	
Back Pain (Paediatric)	8	5	13	Back pain (N=2345)
Back Symptoms - Upper / Lower	1809	500	2309	

Back Symptoms, Pregnant	18	5	23	
Bee Sting (Paediatric)	0	4	4	Miscellaneous (N=769)
Bite, Animal or Human (Paediatric)	0	1	1	
Bites - Animal / Human	2	1	3	
Bites and Stings - Insects / Spiders	22	24	46	
Bites and Stings - Marine Life	0	2	2	
Carbon Monoxide Exposure; Kn./Susp.	1	1	2	
Chronic Diseases (Paediatric)	0	1	1	
Cold Exposure	1	7	8	
Crying Baby Under 3 mo (Paediatric)	1	7	8	
Crying Child > 3 mo (Paediatric)	1	24	25	
Developmental Disorders (Social): Dx	0	2	2	
Difficult Caller (Paediatric)	0	1	1	
Domestic Violence; Dx/Suspected	0	2	2	
Emergency Symptoms - ADULT	36	28	64	
Fluid Intake Decreased (Paediatric)	0	1	1	
Frequent Caller (Patient)	4	17	21	
Heat Exposure	3	8	11	
Hives (Paediatric)	2	12	14	
Insect Bites (Paediatric)	0	1	1	
Newborn Rashes & Birthmarks (Paediatric)	0	1	1	
No Guideline Available: Triage and Advice per Reference Book (Paediatric)	3	8	11	
No Guideline or Reference Available (Paediatric)	1	9	10	
No Guideline/Advice Per Reference (Adult)	164	266	430	
Rash / Hives / Eruptions	9	40	49	
Rash, Purple Spots or Dots (Paediatric)	0	6	6	
Rashes - Widespread, on Drugs (Paediatric)	0	4	4	
Rashes, Localised, Cause Unknown (Paediatric)	0	1	1	
Rashes, Widespread, Cause Unknown (Paediatric)	0	20	20	
Skin / Rash, Pregnant	0	1	1	
Skin Lesions / Skin Irritation	2	6	8	
Sleep, Increased (Paediatric)	0	1	1	
Snakebite (Paediatric)	1	1	2	
Spider Bite (Paediatric)	0	7	7	
Sunburn	1	0	1	
Bloody Urine (Haematuria)	11	13	24	Genitourinary other (N=208)
Breast Symptoms - Female	0	1	1	
Breastfeeding Questions (Paediatric)	0	2	2	
Dysmenorrhoea	4	5	9	
Endometriosis; Known / Suspected	3	0	3	

Genital Lesions - Female	1	0	1	
IUD; Symptoms	8	3	11	
Pelvic Pain / Dyspareunia	10	2	12	
Penis Problems / Sexual Problems	6	5	11	
Scrotum or Groin Swelling/Pain: Male (Paediatric)	6	1	7	
Scrotum / Testicles Symptoms	56	16	72	
Uterine Prolapse; Diagnosed/Info	9	2	11	
Vaginal Bleeding - Menopausal, no HRT	1	2	3	
Vaginal Bleeding (Premenopausal) -- Abnormal	21	11	32	
Vaginal Discharge / Irritation	3	5	8	
Vaginal Foreign Body; Known / Suspected	1	0	1	
Bluish Skin (Cyanosis) (Paediatric)	3	6	9	Cardiovascular other (N=94)
Chest Pain (Paediatric)	0	1	1	
Fontanelle, Bulging (Soft Spot) (Paediatric)	0	1	1	
Pale Skin (Paediatric)	0	1	1	
Palpitations / Irregular Heartbeat	32	50	82	
Breathing Problems	190	111	301	Breathing Problems (N=301)
Chest Pain / Discomfort	319	187	506	Chest Pain / Discomfort (N=506)
Chickenpox (Paediatric)	0	1	1	Infectious other (N=36)
Chickenpox: Known / Suspected Exposure	1	1	2	
Colds (Paediatric)	0	1	1	
Flu-Like Symptoms	9	15	24	
Flu-Like Symptoms, Pregnant	0	3	3	
Scarlet Fever (Paediatric)	0	1	1	
Swollen Glands	0	1	1	
Wound Infection (Paediatric)	1	2	3	
Coma / Stupor	5	2	7	Neurological other (N=120)
Confusion - Delirium (Paediatric)	2	3	5	
Fatigue	18	12	30	
Seizure	26	27	53	
Seizure - with Fever (Paediatric)	2	12	14	
Seizure - without Fever (Paediatric)	2	8	10	
Seizure, Pregnant	0	1	1	
Confusion / Disorientation / Agitation	276	487	763	Confusion / Disorientation / Agitation (N=763)
Constipation (Paediatric)	0	3	3	Constipation (N=135)
Constipation / Rectal Symptoms	72	60	132	

Dehydration	59	52	111	Dehydration (N=111)
Diabetes: Diagnosed, Pregnant	0	2	2	Diabetes related problems (N=325)
Diabetes: Foot Problems	1	5	6	
Diabetes: GI Problems	105	90	195	
Diabetes: Out of Control	52	67	119	
Diabetes: Respiratory Problems	3	0	3	
Diarrhoea (Paediatric)	1	15	16	Diarrhoea (N=313)
Diarrhoea / Change in Bowel Habits	115	182	297	
Dizziness (Paediatric)	2	3	5	Dizziness (N=1581)
Dizziness / Vertigo	682	894	1576	
Ear - Hearing Symptoms	1	5	6	Eye/Ear problem (N=121)
Ear - Pain/Injury/Foreign Body	3	2	5	
Ear Congestion (Paediatric)	0	1	1	
Ear Discharge (Paediatric)	0	1	1	
Ear Infection Follow-Up Call (Paediatric)	0	1	1	
Earache (Paediatric)	0	3	3	
Eye - Foreign Body in (Paediatric)	0	1	1	
Eye - Red without Pus (Paediatric)	0	2	2	
Eye Condition - No Injury / Vision Change	37	44	81	
Eye Infection / Irritation	0	3	3	
Eye Injury / UV Light Exposure	7	6	13	
Eye, Swelling of (Paediatric)	0	1	1	
Eye; Other Problems	1	1	2	
Vision Loss or Change (Paediatric)	1	0	1	
Fainting	145	191	336	Fainting (N=382)
Fainting (Paediatric)	14	32	46	
Falls	125	144	269	Falls (N=269)
Fever	418	515	933	Fever (N=1082)
Fever (Paediatric)	12	137	149	
Flank Pain	578	93	671	Flank Pain (N=671)
GI Bleeding	88	44	132	GI Bleeding (N=132)
Head Injury	89	75	164	Head Injury (N=164)
Headache	492	331	823	Headache (N=846)
Headache (Paediatric)	6	17	23	
Hip Injury	241	86	327	Hip Injury (N=327)
Hip Non-Injury	413	116	529	Hip Non-Injury (N=529)
Hypertension; Diagnosed, Pregnant	2	7	9	Hypertension (N=372)
Hypertension; Known / Suspected	121	242	363	
Knee Injury	81	26	107	Knee Injury (N=107)
Knee Non-Injury	104	64	168	Knee Non-Injury (N=168)

Lower Leg Non-Injury	154	145	299	Lower Leg Non-Injury (N=299)
Nausea / Vomiting	635	584	1219	Nausea/ vomiting (N=1343)
Nausea / Vomiting, Pregnant	16	7	23	
Vomiting (Paediatric)	8	93	101	
Neck Pain (Paediatric)	6	15	21	Neck pain (N=173)
Neck Pain or Injury	101	51	152	
Neurological Symptoms / TIA	192	247	439	Neurological Symptoms / TIA (N=439)
Numbness / Tingling	45	70	115	Numbness / Tingling (N=115)
Poisoning	20	59	79	Poisoning (N=116)
Poisoning - Ingestion (Paediatric)	3	34	37	
Postoperative Problems	181	80	261	Postoperative Problems (N=261)
Thigh Non-Injury	78	49	127	Thigh Non-Injury (N=127)
Urinary Symptoms - Female	45	48	93	Urinary problems (N=366)
Urinary Symptoms / Prostate Problems	158	109	267	
Urination, Pain - Female (Paediatric)	0	3	3	
Urination, Pain - Male (Paediatric)	3	0	3	
Weakness (Paediatric)	1	10	11	Weakness (N=913)
Weakness / Paralysis	345	557	902	
	13098	10598	23696	