MONASH University

Online Information Searching Behaviour during the practice of Evidence-Based Medicine (EBM) among EBM Practitioners at a Neonatal Intensive Care Unit (NICU)

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Notice 1

Notice 2

Abstract

The advancement of technology has changed the practice of Evidence-Based Medicine (EBM) especially in the transition towards online EBM. Knowledge and skill gaps exist in the practice of online EBM, specifically during the online EBM searching process. This is because searching for information during the practice of EBM by EBM practitioners differs from non-EBM practitioners. This research study aims to understand how EBM practitioners perform online information searching during the practice of EBM. The methods used by EBM practitioners in evaluating the validity of information and the challenges faced during the practice of online EBM are also analysed. Detailed aspects of the search sessions are observed to examine the search behaviour among the types of EBM practitioners: final year medical students, house officers (trainee doctors), medical officers and specialists, all who are involved in the practice of EBM. Search sessions are further categorized into the background (BG) and foreground (FG) searches when analysing the querying activity, result viewing activity, and the sources accessed by EBM practitioners during online EBM searching. An interactive information retrieval (IIR) methodology comprising of Information-Seeking with Information Retrieval (IR) System and Information-Seeking Behaviour in context is used to study the online information searching behaviour within the context of EBM. Ninety-nine search sessions conducted by a total of forty-seven participants were screen recorded in this study. Participants have searched for information based on the clinical queries faced during the practice of EBM which could reflect true search behaviour. Apart from the recorded searches, pre-search interview and post search interview were also administered. The pre-search interview is used to collect information on the details of search tasks/search purposes carried out by EBM practitioners. The post-search interview is used to gather information on the search outcomes along with the appraisal activity and challenges faced during the online EBM searching. Results revealed different search behaviours demonstrated by different categories of participants. The search behaviour of participants observed in this study is dissimilar from the findings of previous studies. This indicates a need for the identification of different search behaviour profiles among different types of EBM practitioners. Without such profiles in place, future initiatives in improving information retrieval strategies may not be useful. Results have also revealed that the majority of the searches were BG type searches (83%) and instructed searches (71%). This

indicates that the participants are not ready in practising online EBM without being instructed. Furthermore, results revealed that participants have not performed a critical appraisal on the recorded searches. This is crucial as the practice of EBM encourages EBM practitioners to perform critical appraisal of information in the practice to ensure that only validated and reliable information is retrieved. The results presented in this study can be used to inform better information retrieval strategies within the context of EBM. The need for a better design in the returned results page, query and result viewing refining assistance are important in minimizing the unproductive search behaviour demonstrated by EBM practitioners. This would help searchers in refining their searches in terms of queries and result viewing to ensure specific answers to their information needs are retrieved. Overall, this research study provides an understanding of the online searching behaviour of EBM practitioners during the practice of EBM.

Selvarajah, V

Declaration

I declare that this thesis is an original work of my research and 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.

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Abbreviations and Terminology

- **EBM** – Evidence-Based Medicine
- **ONLINE EBM** - Online Evidence-Based Medicine (the practice of searching for evidence via the Internet)
- **EBM Practitioners** – EBM practitioners (specialists, trainee doctors and medical doctors) and final year medical students who are involved in this study.
- **NICU** – Neonatal Intensive Care Unit
- **MSs** – Medical Students
- **HOs** – House Officers
- **MOs** – Medical Officers
- **FG** – Foreground
- **BG** – Background
- **MeSH** – Medical Subject Headings
- **Neonates** – The term used to indicate a newborn in their first four weeks of life.
- **Clinical Decisions** – Medical decisions made by EBM practitioners for their patient conditions.
- **Optimal Clinical Decisions** – Best medical decisions made by EBM practitioners for their patients taking into the consideration of best outcomes through searching.
- **Medical Domains** – Online medical search engines/sites
- **Querying Behaviour** – The behaviour and patterns in issuing queries in search domains.
- **Query Length** – The number of terms issued within a single query.
- **Medical Queries** – Queries that contain medical terms as mapped onto the MeSH library.
- **Medical Terms** – The medical terms used within a single query issued as mapped onto the MeSH library.
- **Ineffective Queries** – Queries issued that did not result in clicking or viewing any sites online.
- **Result Viewing Behaviour** – The behaviour and patterns in clicking results thereafter a query is issued.
- **Number of Results Clicked** – The number of sites clicked/opened after queries are issued.
- **Sub Links** – The links clicked/opened within a site/result clicked.
- **Tabs** – The new tabs/windows opened within a search browser.
- **Control Functions** – Functions that are used to customize viewing or information extractions, usually accessible via the CTRL key followed by function key in the keyboard.
- **Appraise / Appraisal** – The process of ensuring information is validated and reliable.
- **Appraisal Behaviour** – The behaviour and patterns in how the appraisal is done.

- **Un-appraised** – The term used to indicate the evaluation on the validity of information was not conducted.
- **Online Source of Information** – Online sites, websites, domains, search engines, categorized by different domains/websites.

Chapter 1 Introduction

"User study people," as we are called, at least in the information retrieval community, are the minority, but our numbers continue to grow. This perspective is critical, and it has been exciting to watch its importance increase during the past 18 years, in part because of all the hard work of information and library scientists, who have been paying attention to users all along." - Diane Kelly, 2015

The above saying highlights the growth of research studies in the area of user-centred Interactive Information Retrieval (IIR), which motivated this study. This study focused on understanding the online information searching behaviour of users within a specific user perspective and context – the practice of Evidence-Based Medicine (EBM). Studies on the information searching behaviours increased significantly since early 21st century due to the existence of the Internet, which has been causing information overload, especially in the health sector (Klerings et al., 2015). The increase in health-related information online led to a substantial rise in online medical information searching (Fox & Jones, 2009; Infoplease, 2008; Statista, 2016). Ordinary searchers perform online medical information searching to obtain information regarding their medical conditions whereas medical experts apply this practice to assist them in making informed clinical decisions for their patients (Dolan, 2010; Klerings et al., 2015; Kritz et al., 2013). Information searching by medical experts is part of the process to locate the best available evidence in the practice of EBM (Sackett et al., 1996).

The term EBM was first coined by David Sackett in 1996 as *"the conscientious, explicit and judicious use of the current best evidence in making decisions about the care of patients"* (Sackett et al., 1996). Due to the limited human brain capacity and the need to stay updated on the best available information (McDonald, 1976; Weed, 1997), *EBM practitioners*[1] adopt the practice of EBM for them to make decisions based on validated and reliable evidence. This practice has been known to improve the overall quality of the healthcare industry in ensuring the consistency of care delivered to patients through informed clinical decisions (Briner et al., 2009; Lewis & Orland, 2004).

A study showed that the practice of EBM requires EBM practitioners to integrate three important aspects during clinical decision making: (I) the clinical expertise of the EBM practitioners, (II) the best available evidence obtained from multiple resources and (III)

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[1] Someone who practices medicine or is involved with work that is principally concerned with the discipline of medicine (doctors, specialists), available at http://www.aihw.gov.au/medical-practitioner-related-definitions/.

the consideration of patient values and preferences (Briner et al., 2009). The critical need for the best available evidence to support clinical decisions requires extensive searching for medical information during the practice of EBM. Searching for information in this context is different from searching for information in general. The searching process requires a medical expert to comprehend the best available evidence through their experience, medical expertise and ability to relate the information to accommodate patient's conditions. In terms of general searching, the reason for conducting information search may be to gain more information instead of making informed clinical decisions. Only EBM practitioners and allied health experts who have undergone EBM training are able to practise EBM (Sackett et al., 1996). Previous studies indicated that the inclusion of EBM as part of the training in pre-clinical years of medical school improved the practice of EBM (Acharya et al., 2017; Karagiannis, 2019; Pammi et al., 2017), as EBM practitioners reported gaining knowledge and are aware of the importance of EBM. In spite of that, a recent study indicated that EBM practitioners still lacked EBM training and skills, and seldom used EBM in their practice (Hisham et al., 2016a). This issue requires crucial attention as the improper practise of EBM in obtaining the most reliable and validated information may lead to the retrieval of wrong or inappropriate information (Kelly et al., 2015), which could affect the clinical decisions made. Any inappropriate clinical decisions might, unknowingly, impose threats and risks to patients' lives (Greenhalgh et al., 2015). The advancement of technology has altered the practice of EBM. The transition of EBM from offline searching to online searching has changed the way EBM is being practised (Masic et al., 2008). Such a shift requires EBM practitioners to acquire new skills in retrieving the most relevant and updated evidence online (Masic et al., 2008).

Since the introduction of EBM, studies on the online searching process among EBM practitioners have been limited. Previous studies focused mostly on online medical searching via predefined search tasks and self-perceived studies (Diao et al., 2018; Inthiran et al., 2012; Lykke et al., 2012; Yilma et al., 2019). Existing studies that explore 'true' searching patterns were conducted by analysing logs sent to search engines, which would then contain queries derived from medical and non-medical experts (Herskovic et al., 2007; Hong et al., 2002; Hoogendam et al., 2008; Silvestri, 2010; Yoo & Mosa, 2015). Although the results reported from such studies are interesting, these outcomes are not capable of fully reflecting the true searching behaviour of EBM

practitioners during the practice of EBM. Instead, it is of added importance to study EBM practitioners' searching behaviour when practising EBM based on real search tasks or clinical queries that arise during patient consultations. Findings from such a study would result in a better understanding of the practice of online EBM and serve as an initiative to suggest improvements to the current practice of EBM among EBM practitioners.

Several guidelines have been established to guide EBM practitioners on how to practise EBM (Guyatt, 2008; Isaacs, 2014; Sackett, 2000; Straus et al., 2005; Tenny & Varacallo, 2018). These guidelines focus on methods in selecting the right type of information following a hierarchy of the most reliable information such as randomized control trials, systematic reviews and others when searching for information (Isaacs, 2014; Tenny & Varacallo, 2018). Other aspects such as querying behaviours, result viewing behaviours and the appraisal of online information during the practice of EBM have not been attempted. The exploration of these areas would contribute to 'new knowledge', which is required by EBM practitioners as part of the transition towards the implementation of online EBM (Masic et al., 2008).

Among the guidelines established, the most common guideline used in medical schools to date is Sackett's five-step approach, which includes the components: 'Ask', 'Access', 'Appraise', 'Apply' and 'Assess' (Sackett et al., 2000). However, it was instituted before the transition of offline EBM to online EBM. It is considered as a general approach in practising EBM yet its effectiveness in the practice of online EBM remains unknown.
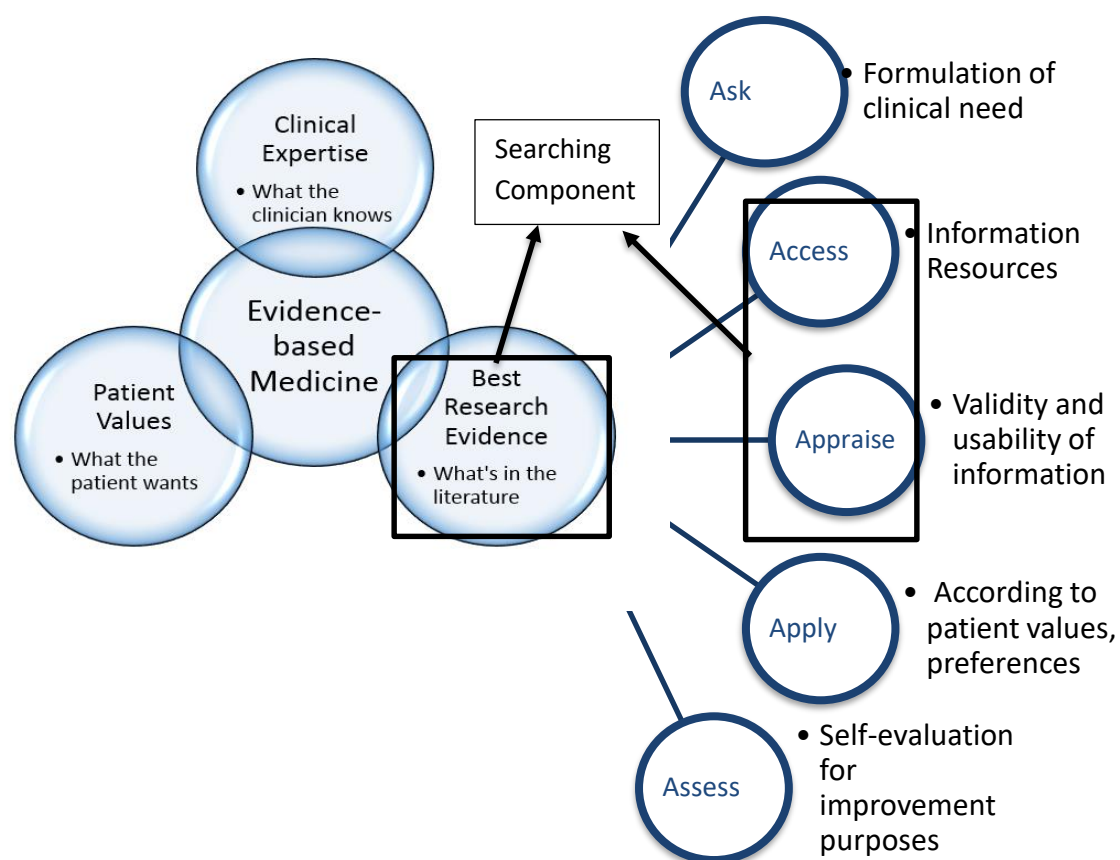
Figure 1: The recommended practice of EBM (Sackett et al., 1996; Sackett et al., 2000)

Figure 1 illustrates the recommended approach to guide EBM practitioners in making informed clinical decisions by considering patient values, the clinical expertise of the searcher and the best research evidence available. In the acquisition of the best research evidence available online, Sackett's five-step approach is recommended. Although the practice of EBM has moved towards online EBM, one possible way to understand the online searching behaviour of EBM practitioners is to concentrate on the searching component within the recommended practice (as seen in Figure 1).

It is compelling to study the online information searching behaviour from the users' perspective (EBM practitioners) during the practice of EBM (via actual search tasks). This would lead to the understanding of the current practice of online EBM and subsequently formulate strategies to improve the practice in-patient consultations even after the transition towards online EBM has taken effect. The searching component will be the focus of the online searching process, which includes the appraisal step that ensures only reliable and validated information is retrieved. As the

online searching process was explored within the context of EBM, an information searching model was necessary to guide this study. Since the recommended approach is centred on the entire practice of EBM, Carol Kuhlthau's Information Searching Process (ISP) was used to understand the online information searching process in the practice of EBM (Kuhlthau, 1991). The ISP model was selected among other searching models because it consists of similar processes within the steps involved in practising EBM. Further exploration of the use of the ISP model to define the searching process in the practice of EBM is described in Chapter 2 (Section 2.1).

1.1. Justification of the Study

The practice of EBM has been cultivated in the medical curriculum to ensure that clinical decisions are made based on proper justifications from the clinical expertise of medical professionals backed by the search of evidence, as well as patient values and preferences. Although the practice of EBM was established more than two decades ago, it remains as merely a knowledge gained by medical professionals with only a few who actually apply EBM in their medical practice (Hisham et al., 2016b). Previous studies reported similar findings indicating the lack of knowledge and experience in putting the practice into proper use (Kortekaas et al., 2015; Lafuente-Lafuente et al., 2019; Zwolsman et al., 2012). This indicates that even after years of research and development carried out in this area, the challenges in practising EBM are still notable.

The reason for performing this study was the need to obtain validated and reliable evidence to support medical decisions of EBM practitioners, where they are required to search through multiple resources (Sackett et al., 1996). Initially, EBM practitioners were encouraged to rely on facts derived from books and printed materials as their primary sources of health information in the practice of EBM (Hay et al., 2008). In the recent years, however, medical information has been deployed and searched through online resources via Information and Communication Technology (ICT) (Addison et al., 2013; Bennett et al., 2005; Brennan et al., 2014; MacWalter et al., 2016; Morgan, 2010) indicating a shift in the way EBM is practised, that is, from being offline to online. This also shows that there is 'new knowledge' that EBM practitioners need to equip themselves with before practising EBM with full confidence, specifically when retrieving information online. ICT has catered to the practice of online EBM by providing access to online medical information (Amante et al., 2015; Aronson, 2004; Druss & Marcus, 2005; Nicholai, 2015). Nevertheless, the effectiveness in ensuring

the practice of EBM is well-executed among EBM practitioners remains unknown. This resulted in medical practitioners who are knowledgeable yet lacking the experience in the execution of EBM in their medical practices.

The emergence of the Internet and the World Wide Web led to the creation of numerous online medical search domains and medical databases. They are designed with built-in customized search features to assist the user in searching for relevant medical information in the shortest time possible. Examples of such online medical search domains are PubMed, UpToDate and the British Medical Journal (BMJ). EBM practitioners claimed that specialized medical information retrieval systems and technologies were useful, reduced the time required to search for information and made searching easier to be incorporated into their medical workflow processes (Bennett et al., 2005; Dogan et al., 2009; Dolan, 2010; Gold, 2014; Rothschild et al., 2002). However, even with the availability of such search features in specialized medical information systems, it is still uncertain whether they are useful in the online searching process in the practice of EBM. This is in line with the reported findings in previous studies, which were conducted through self-perceived methods (Bennett et al., 2005; Dogan et al., 2009; Dolan, 2010; Gold, 2014; Rothschild et al., 2002). The 'true' search behaviour of EBM practitioners in the practice of EBM has not been determined as of yet.

Apart from highlighting the gap between the knowledge gained and the practice of EBM itself, EBM practitioners have been continuously reporting the challenges they were facing during online EBM searching. The said challenges included limited access to resources and the lack of: (I) skills and experience in searching, (II) role models in practising EBM and (III) time to practise EBM (Al-Motairy & Al-Musa, 2013; Anwar et al., 2014; Dans & Dans, 2000; Sriganesh, 2005). These challenges were faced prominently in developing countries (Al Omari et al., 2009; Anwar et al., 2014; Chan & Teng, 2005; Dans & Dans, 2000; Olok et al., 2015; Sriganesh, 2005). One possible reason being the inadequate resources to adapt and improve the practice of EBM in developing countries (Hisham et al., 2016b; Sahapong et al., 2009). Although the studies that were conducted in developed countries may recommend solutions to these challenges, the recommendations may not be effective and applicable to the situations in developing countries (Puustjärvi & Puustjärvi, 2015). This indicates that the practice of EBM in developing countries is still at a growing stage and therefore is

worth exploring. The exploration of this area could prove advantageous as approximately 85% of the world's population resides in developing countries (United Nations, 2001), which means that majority of the health practitioners/patients are located in these regions as well.

The review of existing studies in developing countries showed that many of these studies relied on self-perceived methods to study the searching behaviour of EBM practitioners (Chan & Teng, 2005; Kouhpayehzadeh et al., 2006; Lai, 2009, 2013; Sherin, 2014; Zaidi et al., 2009). Studies that mainly use self-perceived methods are based on the participants' feelings or beliefs at the point of response and hence, cannot be regarded as perfect finding (Khan, 2014). Although self-perceived studies are useful, findings from such studies may not reflect the actual searching behaviour of practitioners. This may lead to the formulation of ineffective solutions to overcome challenges. As a result, it would be worthwhile to conduct a study that can reflect the 'true' online searching behaviour of EBM practitioners in a developing country to support the practice of EBM instead of relying on self-perceiving outcomes. This would also provide a better understanding of the challenges faced by practitioners in the practice of EBM.

Malaysia is one of the developing countries that encourages the practice of EBM in medical practices. A survey study was conducted to determine the perception of primary care doctors in Malaysia towards the practice of EBM (Chan & Teng, 2005). The study revealed that despite a high number of participants who were aware of the practice of EBM and the Cochrane Database Systematic Review, only 6.7% of them conducted literature searches on Medline (Chan & Teng, 2005). This indicates a gap between the awareness of the practice and cultivating an appropriate practice of EBM in their work process. In addition to being one of the participating countries in the SEA-ORCHID project, Malaysia also took part in the major intervention project conducted across the South East Asia (SEA) countries from 2005 till 2008 (Henderson-Smart et al., 2007). The purpose of the SEA-ORCHID project was to study how evidence-based teaching and practice were conducted in the department of pregnancy and childbirth (Henderson-Smart et al., 2007). A recent study also reported that training fourth-year medical students (MSs) in applying the practice of EBM resulted in positive feedback (Manan et al., 2017). However, the focus of the study was only revolved around the teaching and understanding of practising EBM but not the evaluation of the actual

practice itself. Despite having such interventions, recent studies in Malaysia continued to report challenges in terms of the knowledge and skills required to search for information during the practice of EBM (Anwar et al., 2014; Hisham et al., 2016b; Hisham et al., 2018b). This indicates that although EBM interventions have been conducted for more than a decade, the challenges faced by EBM practitioners remain prominent.

As a result, it would be valuable to explore how EBM practitioners are searching for medical information online during the practice of EBM. This study was carried out in the Neonatal Intensive Care Unit (NICU) of a public teaching hospital in Malaysia. The NICU was chosen as the research setting of this study due to the following reasons: (I) it is within a public teaching hospital in Malaysia that encourages the practice of EBM, (II) they have readily available computer resources that facilitate the practice of EBM during clinical rounds and (III) the patients are neonates (premature babies) who do not actively interfere the practice of EBM during the clinical rounds. The findings from this study have helped to interpret how EBM practitioners search for information online when practising EBM. This study also reported the 'true' searching behaviours of EBM practitioners, which contributes to the formulation of the search behaviour profiles and strategic initiatives to improve the practice of online EBM. Moreover, this study has also contributed towards improving the healthcare quality in Malaysia and supporting similar situations in other developing nations.

1.2. Research Aim, Objective and Research Questions

This study aimed to explore the online information searching process during the practice of EBM among EBM practitioners (house officers [HOs; also known as trainee doctors], medical officers [MOs; also known as medical doctors] and specialists) and final year MSs[2], who are actively involved in the practice of EBM during the morning clinical rounds (where most of the patients' clinical decisions are made daily) in the NICU.

Objective: To critically describe the EBM online searching behaviour

Research questions associated with the research objective are:

  I. What are the querying patterns of EBM practitioners when performing EBM searches in the NICU?

 II. What are the result viewing patterns of EBM practitioners when performing EBM searches in the NICU?

III. How do EBM practitioners critically appraise search results when performing EBM searches in the NICU?

IV. What online sources do EBM practitioners access during the practice of EBM in the NICU?

 V. What challenges do EBM practitioners face when searching for information during the process of EBM in the NICU?

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[2] Final year medical students were included in this study as they are involved in the morning clinical rounds and in the making of informed clinical decisions as part of their practical requirement before graduating to become fully qualified doctors.

1.3 Research Approach

A naturalistic approach combined with the user-centred IIR was used to conduct and answer the research questions of this study. This approach allowed the investigation of the online searching behaviour among EBM practitioners by exploring their online searching activities based on the clinical questions that arise during the practice of EBM. The IIR approach used in this study is further discussed in Section 2.4. The selected IIR approach enables a better understanding of the online searching process as searchers can explain their search activities within the context of EBM. Explanations provided by searchers are essential in understanding the online EBM searching process of EBM practitioners.

The EBM practitioners participated in this study are those who actively involved in the practice of online EBM at the public teaching hospital. They represent the typical searchers who practise EBM and at the same time involved in making of informed clinical decisions. Final year MSs were included in this study as they practise EBM in the clinical rounds, which they take part in during their practical year (final year).

A detailed quantitative analysis was performed based on the data collected during the online searching process among different categories of EBM practitioners. The relationships between querying behaviours, result viewing behaviours and the online sources used were investigated. Additionally, qualitative analysis was also performed to understand the descriptions of searches, the methods used to evaluate the validity of information and the challenges faced by the participants. The participants were requested to describe their search purposes based on their derived clinical queries, the methods used to evaluate the validity of information and the challenges faced throughout the searching process. These data enabled the interpretation of the types of searches conducted by the participants, the evaluation methods used and the search challenges experienced by them to report the 'true' behaviour of the participants.

1.4 Organization of the Thesis

Chapter 2 of this thesis presents a review of literature related to the context of this study. It begins with the introduction of the ISP model, which was used to describe the online ISP in the practice of EBM. It is then followed by identifying previous works and gaps in the online searching process during the practice of EBM among EBM practitioners. A review of the search challenges experienced by EBM practitioners is provided to understand the previously reported challenges faced in the implementation of EBM. Finally, a review of the IIR approach used in this study is provided at the end of the chapter.

Chapter 3 provides the research methodology used in this study. It includes the detailed approach, the data collection instruments and the data analysis methods used in this study.

Chapter 4 presents the results of this study. The results presented are in line with the findings from previous studies on online searching behaviour during the practice of EBM. The results also answered the research questions presented in Section 1.3.

Chapter 5 discusses the results of this study. It is then followed by the research contributions.

Chapter 6 concludes this study by providing a summary of the research contributions, followed by the conclusion and limitations of this study. Possible future works are also highlighted at the end of this chapter.

Chapter 2 Literature Review

This chapter explains the searching process using the ISP model. The reason for introducing the ISP model is to set the stage for this study as it represents a similar searching process practised during the application of online EBM. Following the description of the ISP model, a review of previous studies describing the relevant online searching behaviours of EBM practitioners (specialists, doctors and MSs) is provided. The purpose of reviewing the literature is to synthesize practitioners' online searching behaviours, identify gaps and set the direction of this study. Then, a summary of the search challenges faced during online information searching in the practice of EBM is provided to identify areas of improvement. Finally, a review of the existing Information Retrieval (IR) studies is included to explain the approach used in this study.

2.1 Information Searching Process (ISP) in the Practice of EBM

To date, studies that explicitly define the online ISP within the practice of online EBM are still limited. These studies either reported the searching behaviours as part of the EBM practice or guidelines on how to practise EBM in terms of selecting the right content/evidence through critical appraisals (Geddes, 1999; Green, 1999, 2000; Guyatt, 2008; Isaacs, 2014; Sackett, 2000; Straus et al., 2005; Tenny & Varacallo, 2018). Furthermore, the medical curriculum today continues to rely on Sackett's five-step approach when teaching EBM. This situation prompts the need to redefine the practice of online EBM, which is achievable through the understanding of the online searching process among EBM practitioners. One possible method to understand the ISP in the practice of EBM is through applying the ISP model defined by Carol Kuhlthau (1991).

The ISP model is a ground-breaking theory that models a holistic experience of a typical searcher when searching for information online (Kuhlthau, 1991). The model includes three aspects in determining a searcher's behaviour. These aspects include the affective (feeling), cognitive (thinking process) and physical (actions) domains of the searcher in the six stages of the ISP model (Kuhlthau, 1991). The six stages are initiation, selection, exploration, formulation, collection and presentation (Kuhlthau, 1991). The main aspect highlighted in this study was the physical domain, where the searchers' actions were studied. The affective and cognitive aspects were not

reviewed in this study as the primary focus was to target the online information searching behaviours of EBM practitioners, which emphasizes their actions during the searching process in EBM. Intrinsically, it is the closest and most relatable model to explain the ISP within the practice of online EBM. The description of the six stages in the ISP model is as below:

    I.   Initiation

The initiation phase is when the need for information by a searcher appears. It includes the discussion that relates the need for information with past experiences and the existing knowledge of the searcher, and lead to a possible approach in searching for information.

    II.   Selection

The selection phase is when the tasks are taken by a searcher to identify general topics and the available approaches in pursuing their information need. In this phase, the searchers are weighing the topics of interest and criteria before moving on to the exploration phase.

    III.   Exploration

The exploration phase is when a searcher investigates the information to extend the personal understanding of the subject matter. The actions in this phase include locating information, reading and relating new information to what is already known.

    IV.   Formulation

At this stage, the information need is narrowed down as the searching process becomes more specific and personalised to a topic. Construction of information/topics becomes clearer to the searcher, and possible reconstruction of information need takes place in this phase.

    V.   Collection

The collection phase is a searcher interacting with information systems. The actions within this phase include gathering information and performing comprehensive searches for relevant information by accessing all the available resources. The

reformulation of searches that leads to the retrieval of focused information regarding their information need also takes place in this phase.

VI.   Presentation

After the searching process is completed, the information gathered is then processed and summarized to be used. Actions involved in this phase include outlining, summarizing and applying the information retrieved.

The six stages of the ISP model can be used to describe the online searching process during the practice of EBM. Nevertheless, there are similarities and differences between the ISP model and the practice of online EBM. The suggested relationship between the ISP model and the practice of online EBM is illustrated in Figure 2.
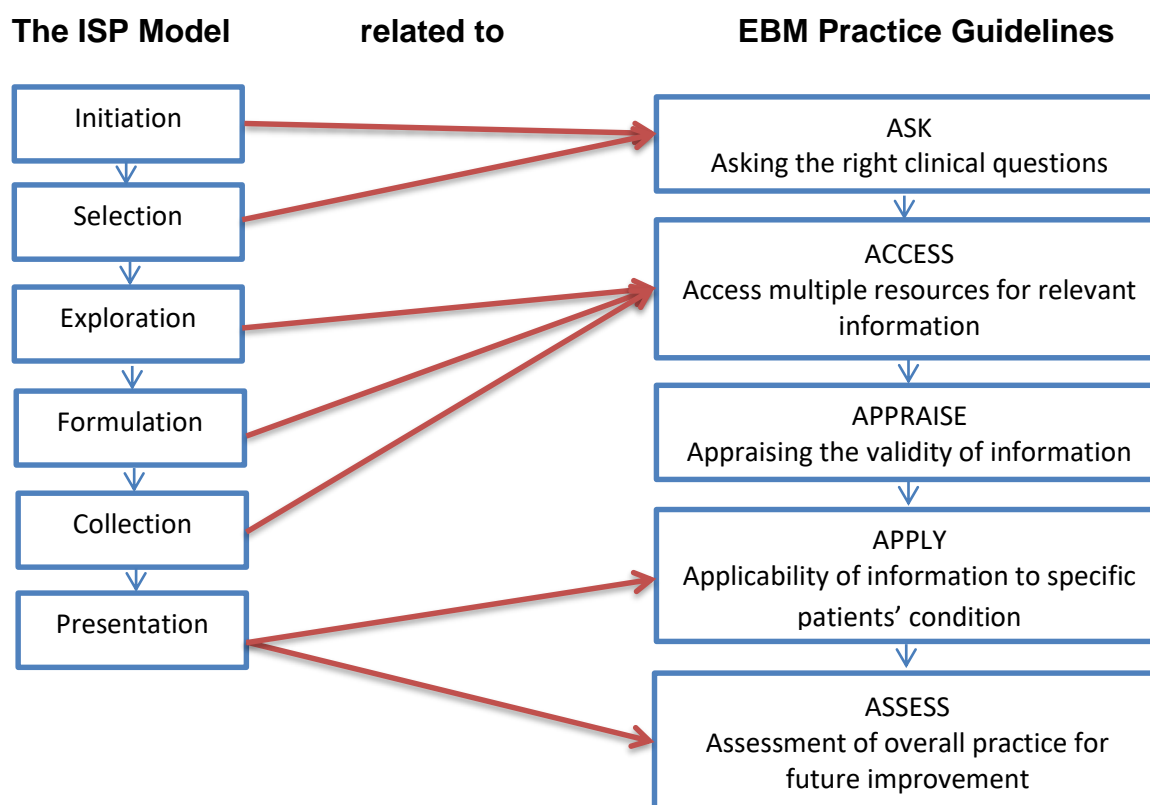
Figure 2: The suggested relationship between the ISP model and the practice of EBM

The practice of EBM focuses on searching for evidence in justifying EBM practitioners' clinical decisions and should adhere to the recommended approach in retrieving reliable and validated information. The following subsections describe the suggested

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relationship between the ISP model and the searching behaviours during the practice of online EBM:

(I) Asking the right clinical questions

Asking the right clinical question is the first process in the practice of EBM. In this phase, it is imperative that EBM practitioners comprehend their information need to an answerable question. Since the establishment of EBM, studies were carried out to investigate the conversion of EBM practitioners' information needs into clinical questions (Geddes, 1999; Richardson et al., 1995). Information need during the practice of EBM can be formed into two types of clinical questions. They are categorised as (1) Background questions and (2) Foreground questions. Background questions are questions concerning knowledge that are further divided into two parts: (I) question root and (II) disorder, test, treatment or other aspects of healthcare (Anon., 2014; Geddes, 1999). On the other hand, foreground questions are more focused questions related to the patients' conditions and the outcomes of these questions will directly influence the making of clinical decisions (Geddes, 1999; Richardson et al., 1995). Foreground questions are usually formulated into the PICO format that classifies the clinical questions into four sections: **P**atient (types of the patient or the problem involved), **I**ntervention (treatment/diagnosis/prognosis), **C**omparison (with an alternative) and **O**utcome (expected result) (Richardson et al., 1995; Sackett et al., 2000; Straus et al., 2005). This practice eliminates unnecessary information and narrows down the scope of the information needed before the online searching process is initiated (Richardson et al., 1995; Sackett et al., 2000; Straus et al., 2005).

The first two stages of the ISP model (Initiation and Selection) are related to the 'Ask' phase in the practice of EBM. The initiation phase of the ISP model describes the recognition of information need whereas the selection phase describes the approach taken or the readiness to search for information (Kuhlthau, 1991).

(II) Accessing multiple resources for relevant information

The second step within the practice of EBM guides the searcher in accessing multiple resources to retrieve the best available information. Even so, the descriptions on how to access resources are limited to those regarding manual resources instead of online ones, as depicted in the Sackett's model. The inclusion of the online searching process is better mapped by the three stages in the ISP model (Exploration, Formulation and Collection) (Kuhlthau, 1991). The exploration stage describes the start of the

interaction between a searcher and information systems, which is then followed by the formulation of searching strategies through information systems to obtain the desired information (Kuhlthau, 1991). The actions involved in this stage include query formulation, which is used in IR systems until desirable information is retrieved. This is then proceeded by the collection stage where the searcher collects information essential in answering their clinical questions (Kuhlthau, 1991). The actions involved in this stage are result viewing and the selection of information through various online resources. Different online resources are explored until a conclusive answer is obtained. The 'Access' phase in the Sackett's model was established over two decades ago, yet there are studies that still attempt to describe the online searching strategies in the practice of EBM (Ho et al., 2016; Masic et al., 2008). Nevertheless, it would be worthwhile to explore the inclusion of these three stages in the ISP model into the practice of EBM as these stages depict the online searching behaviours of a typical searcher. The mapping of the ISP model into the 'Access' phase will serve as a guide in reviewing the literature on online searching behaviours during the practice of online EBM. This includes the review of pertinent literature components such as querying behaviours, result viewing behaviours and the online sources accessed by EBM practitioners.

(III)   Appraising the validity of information

The appraisal step is the most crucial step in the practice of EBM as it evaluates the reliability and validity of the information retrieved before using the information to make clinical decisions for a specific patient (Sackett et al., 2000). Previous studies reported the recommended appraisal guidelines to be applied when retrieving information during the implementation of EBM (Guyatt, 2008; Isaacs, 2014). Specific to this case, however, there is no appraisal component in the ISP model as it focuses more on a general searcher context. In the practice of EBM, the evaluation of the reliability and validity of information is a vital component and hence, indicates a notable gap in the ISP model.

(IV)   Applicability of the information to specific patients' conditions

Similar to the previous step, this step is also dedicated to the practice of EBM. Information searched within the practice of EBM is appraised and then applied in clinical decision making for patients (Sackett et al., 2000). Similarly, this step is related

to the 'Presentation' stage in the ISP model, which describes the use of retrieved information for a specific purpose presented.

(V)   Assessment of overall practice for future improvement

The final step in the practice of EBM is to assess the overall process for future improvement of the practice (Sackett et al., 2000). This step focuses more on the overall process of EBM right from the formulation of a clinical question up to the final step instead of the searching process alone. The final stage of the ISP model 'Presentation' is also similar to the 'Assess' step in EBM by which both are referring to the completion of a search (Kuhlthau, 1991). However, the actions under this stage also include the presentation and the use of the retrieved information (Kuhlthau, 1991).

The suggested mapping of the ISP model highlights the ability to use it to understand the practice of online EBM. Despite this, a major gap exists in the mapping of the ISP and EBM model in terms of the appraisal activity. The appraisal activity, which is lacked in the ISP model, is a significant determinant in interpreting the practice of online EBM as only validated and reliable information should be retrieved and applied in the making of clinical decisions. As such, it is valuable to further explore the online searching behaviours of EBM practitioners in terms of querying behaviours, result viewing behaviours and the types of online sources accessed as an effort towards the future establishment of a more suitable guideline for the practice of online EBM and search behaviour profiling of EBM practitioners.

2.2 Online Searching Behaviours in the Practice of EBM

This subsection reviews online searching behaviours among EBM practitioners during the practice of EBM. The targeted participants in this section were specialists, medical doctors and final year MSs who are actively involved in the practice of EBM. The inclusion of MSs in this context is because the practice of EBM usually commences in the final year of medical studies during the MSs' practical year/residency year (Lai & Nalliah, 2010). Next, the key areas of the online searching process are also presented: (I) querying behaviours, (II) online sources accessed and (III) result viewing behaviours. These areas were adapted from the understanding of the ISP model to explain the ISP process during the practice of online EBM. Additionally, a review of the appraisal behaviour among EBM practitioners is also included as it is an integral part of the online searching process in practising EBM.

2.2.1 Querying Behaviours Among EBM Practitioners

There were only a handful of studies on the querying behaviours of EBM practitioners and this area is slowly gaining popularity. Previous studies used different approaches to explore the querying behaviours during the practice of EBM such as self-perceived instruments (questionnaire and surveys) (Hisham et al., 2018b; Kortekaas et al., 2015), log analysis of medical domains (Herskovic et al., 2007; Hoogendam et al., 2008; Yoo & Mosa, 2015) and query analysis through the exploration of predefined search tasks (Inthiran et al., 2012; Lykke et al., 2012; Yilma et al., 2019). There were studies reported that methods like self-perceived instruments and predefined search tasks were unable to reflect the 'true' querying behaviours of EBM practitioners during the naturalistic practice of EBM. Such methods are used to explain only the behaviour in context as gathering querying behaviours in a real setting can be time-consuming and difficult to assess. Besides, previous studies analysed medical search engines such as PubMed that are commonly used among medical experts and non-medical experts (Dogan et al., 2009; Herskovic et al., 2007; Hoogendam et al., 2008; Yoo & Mosa, 2015), which makes identifying behaviours during the practice of EBM difficult. Table 1 indicates the research findings on querying behaviours among EBM practitioners from previous studies.

Table 1: Querying behaviours among EBM practitioners

Research Study	Findings	Research Methods
Hoogendam et al., (2008)	• 2 – 3 terms per query issued. • The use of stop words in queries could be an obstacle in searching desired information • Use of abbreviation in queries is more effective	• Analysis was conducted on a single domain (PubMed). • Other aspects of querying behaviour were not included. (Eg. No. of queries issued per search task.
Sahapong et al., (2009)	• Use of Medical terms and MeSH terms in queries is recommended. • Use of keywords and Boolean operator 'AND' in queries.	• Self-perceived study
Davies (2011)	• Use of MeSH terms in queries is recommended. • Use of Boolean operator 'AND' in queries.	• Self-perceived study
Lykke et al., (2012)	• Search failures were caused by vocabulary problems and the use of Boolean operators. • 1-3 terms per query issued.	• Study based on predefined search tasks
Kortekaas, Bartelink, Boelman, Hoes, & de Wit, (2015)	• Average 0.8 searches were conducted on each query	• Data collected via logs recorded by participants.

| Yilma et al. (2019) | • The use of stop words in queries could be an obstacle in searching desired information | • The study reported a context-based health information searching behaviour |

Table 1 summarizes the querying behaviours among EBM practitioners, who are qualified doctors/physicians and MSs. Previous studies lacked further examination on queries issued in foreground (FG) and background (BG)-type searches, query reformulation and re-issuance of queries and ineffective queries issued during the practice of EBM, which all of these if have been investigated, may provide a better understanding of querying activities of a typical searcher. These areas are relevant in determining the querying patterns of searchers, which may affect the overall online EBM searching process. The studies displayed in Table 1 were mostly using self-perceived methods. Studies that reported querying patterns on actual search tasks were reported almost a decade ago. Provided this fact, it would be worthwhile to explore the current situation of querying practices among EBM practitioners. Studies on the querying behaviours among final year MSs, who actively participate in the practice of EBM, were also limited. Previous studies on the querying behaviours of MSs, in general, did not specify whether a particular study was conducted within the context of EBM (Brennan et al., 2014; Friederichs et al., 2014; Inamdar & Rotti, 2004; O'Carroll et al., 2015). Given the shift in the practice of EBM from offline to online, there is a need to explore the current practice of online EBM.

2.2.2 Online Sources Accessed

In line with the issues reported in the studies on querying behaviours, online sources accessed by EBM practitioners were also derived from self-perceived methods where the participants indicated their most preferred online sources when EBM is practised. Generally, EBM practitioners are more likely to emphasize the best quality resources that are easily accessible (Brennan et al., 2014). Before digitization, EBM practitioners were more likely to rely on manual resources for information. Acquisition of medical-related information was achieved through professional meetings, printed medical literature, textbooks and *Index Medicus*[3] (Allan et al., 2012; Hay et al., 2008; Kosteniuk et al., 2013; McAlister et al., 1999; Sahapong et al., 2009; Shelstad & Clevenger, 1996). The only digital forms of resources available then were audio and videotapes (Shelstad & Clevenger, 1996).

This pattern changed when the reliance on textbooks for information declined in the second decade after the emergence of EBM. The advancement of technology plays a significant role in supporting the practice of online EBM through the integration of online resources, which also make information from manual sources relatively unreliable in assuring the quality of patient care (Lai, 2009). EBM practitioners turn to online information sources over books and printed materials due to the need for the most up-to-date and advanced information when making informed clinical decisions (Brennan et al., 2014; Morgan, 2010). Nevertheless, studies reported that evidence of continuous reliance on manual resources were due to the unwillingness of EBM practitioners to accept new forms of information retrieval methods and this is particularly seen among senior practitioners (Allan et al., 2012; Kosteniuk et al., 2013).

A recent study reported that 40% out of the 15,000 participants, who were EBM practitioners in Europe, resorted to Wikipedia when searching for information (Kritz et al., 2013; O'Carroll et al., 2015). Unreliable online sources are often utilised, especially by MSs, because of their open access and the novice explanation level of the information presented (Kritz et al., 2013; O'Carroll et al., 2015). Accessing information via unreliable sources requires crucial attention as it is not recommended within the practice of EBM. This is critical especially among MSs who will eventually become doctors involved in the clinical decisions of patients.

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[3] Index Meiscus is the bibliographic index of medical journals.

Studies also revealed that EBM practitioners have been relying on their colleagues or senior counterparts for immediate information (Addison et al., 2013; Allan et al., 2012; Hay et al., 2008; Kosteniuk et al., 2013; Lai & Nalliah, 2010; McAlister et al., 1999; Morgan, 2010). Despite the practice of online EBM urging EBM practitioners to search for information online, EBM practitioners still primarily referred to a colleague for information without considering a secondary source of information (Allan et al., 2012). A similar situation was also observed among senior MSs (Lai & Nalliah, 2010) whereby the information obtained from colleagues was neither evidence-based nor reliable in making clinical decisions. This defeats the purpose of online EBM and indicates that retrieved information should be backed by proper evidence and justification before engaging in any clinical decision making.

Table 2 summarizes the types of online sources accessed during the search for online medical information among EBM practitioners. Previous studies reported that EBM practitioners prefer targeted/specialized medical sites instead of general search engines (Chambliss & Conley, 1996; De Leo et al., 2006; Lafuente-Lafuente et al., 2019). However, recent studies claimed the opposite (Addison et al., 2013; Allan et al., 2012; Eysenbach & Köhler, 2002; Kritz et al., 2013; MacWalter et al., 2016; Sillence et al., 2004).

Table 2: Summary of online sources accessed among medical professionals during online searching

Preferred Online Resources	Examples of Online Sites	Reasons	Research Study
General Search Engine	• Google • Yahoo	• Familiarity and priority	(Addison et al., 2013; Eysenbach & Köhler, 2002; Sillence et al., 2004)
Specialized Medical Search Engine	• *British Medical Journal* [4] (BMJ) • National Institute of Health and Care Excellence (NICE) • GP Notebook • Cochrane • PubMed • Medline • *UpToDate*[5] • *P*eer-reviewed journals • National Guideline Clearing house	• Reliability of information from such sites. • Location of practice. For example, in Italy (Programme Nazionale Linee Guida (PNLG)) and Scotland (Scottish Intercollegiate Guidelines Network (SIGN)) are preferred	(Addison et al., 2013; Bennett et al., 2005; Davies, 2011; De Leo et al., 2006; Kritz et al., 2013; MacWalter et al., 2016; Sahapong et al., 2009; Salinas, 2014; Ugolini et al., 2014)

During the practice of EBM, practitioners are recommended to access validated online sources to retrieve the most reliable and validated information (Isaacs, 2014). The studies presented in Table 2 indicate a variety of specialized medical search engines that are used in searching for information. Several reasons for this include the geographical location of the searcher and the perceived reliability of such sites. The studies in Table 2 were conducted among medical professionals concerning their overall preference in online sources accessed during information searching. It is unclear whether the sources mentioned in the studies were derived during the practice of EBM. Hence, this study also emphasized on identifying the online sources accessed by EBM practitioners in the process of online EBM.

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[4] British Medical Journal is one of the earliest weekly peer reviewed general medical journal available at www.bmj.com

[5] UpToDate is an evidence based clinical decision support resources which contains over 77,000 pages of original peer-reviewed resources that are constantly updated, available at www.uptodate.com

2.2.3 Result Viewing Behaviour Among EBM Practitioners

Another fundamental area of online searching behaviours that has been under-explored is the result viewing behaviours during the practice of EBM. Previous studies on result viewing behaviours were carried out almost a decade ago, which may no longer reflect the current behaviours of EBM practitioners (Hoogendam et al., 2008; O'Sullivan et al., 2014; Rosenbaum et al., 2008). Moreover, previous studies were mainly focused on the issues faced during result viewing (Rosenbaum et al., 2008), the viewing behaviours of the retrieved content (Hoogendam et al., 2008; Rosenbaum et al., 2008) and the types and placements of results retrieved after queries were issued (Dogan et al., 2009; Hoogendam et al., 2008; Kritz et al., 2013; O'Sullivan et al., 2014). Table 3 shows the findings reported by previous studies on the result viewing behaviours in the practice of online EBM.

Table 3: Summary of result viewing behavior reported in previous studies

Result Viewing Behaviour	Findings	Research Study
Preferred Result Page	First result page	Hoogendam et al. (2008)
Selection of Results (Website)	First few results placed within the result list	Dogan et al. (2009), O'Sullivan et al. (2014)
	Recent and up to date results	Kritz et al. (2013)
Preferred Section of Information Content	Abstract and conclusion	Rosenbaum et al. (2008), Hoogendam et al. (2008)
	Full text, background, results	Hoogendam et al. (2009)

The studies listed in Table 3 indicated that the result viewing behaviours among EBM practitioners involved mainly the selection of results retrieved during online searching and content specific viewing. In spite of that, the behaviours reported in self-perceived studies may not reflect the actual situation when EBM is being practised (Hoogendam et al., 2008; Kritz et al., 2013). Furthermore, most studies reported their findings based on only a single search domain (Hoogendam et al., 2008; Rosenbaum et al., 2008). One particular study reported the lack of a proper method in indicating the endpoint of a search interaction, and the participants' used the selection or viewing of the abstract or reading of the full text of an article as the indication that sufficient search interaction had taken place (Hoogendam et al., 2008). This method may not be adequate and thus, it is a key area to be explored under the result viewing behaviours as EBM practitioners may have retrieved a large amount of content during a particular search,

which might turn out to be unnecessary. The need to focus on the different types and number of results viewed have not been fully explored.

A recent study on the result viewing behaviours among MSs (Inthiran et al., 2012) reported useful findings on the number of results clicked and sub-links clicked during online medical information searching. However, the study was carried out within the context of medical information searching among MSs but not EBM. Nevertheless, the methods used by Inthiran et al. (2012) were applied in this study to explicitly explore the result viewing behaviours among EBM practitioners. In reference to the study by Inthiran et al. (2012), examples of result viewing activity that are essential in exploring the result viewing behaviours include the number of results clicked, sub-links clicked and the usage of control functions.

2.2.4 Appraisal Behaviours of EBM Practitioners

The critical appraisal activity is crucial in the practice of EBM (Sackett et al., 1996; Sackett et al., 2000). Several guidelines have been established to ensure the retrieval of reliable and validated information in the practice of EBM through critical appraisal (Al-Jundi & Sakka, 2017; Isaacs, 2014; Straus et al., 2005; Tenny & Varacallo, 2018). Training and interventions such as the Critical Appraisal Skill Programme and board qualification programme are aiming to enhance critical appraisal skills among EBM practitioners (Al-Motairy & Al-Musa, 2013; Burls, 2014; Thangaratinam et al., 2009). EBM practitioners have shown significant improvements in the necessary skills needed to evaluate and appraise evidence during the practice of EBM through such training interventions (Al-Motairy & Al-Musa, 2013; Godwin & Seguin, 2003; MacRae et al., 2004; Shehata et al., 2015; Taylor et al., 2004).

In spite of that, studies also reported that even EBM practitioners had improved their knowledge on how to appraise evidence, they did not apply it in their practice (Coomarasamy et al., 2003; Lafuente-Lafuente et al., 2019; Odierna et al., 2015). EBM practitioners claimed that learning to apply critical appraisal skills in the practice of EBM was more difficult and time-consuming as opposed to just learning the skills needed to retrieve relevant information (McCluskey & Lovarini, 2005). One possibility for this could be due to the lack of good quality training interventions that can significantly improve critical appraisal skills (Horsley et al., 2011).

As such, previous studies, which involved surveys and questionnaires, revealed that the participants in their study continued to have difficulties in appraising information, indicating their poor or lack of critical appraisal skills (Amin et al., 2009; Brennan et al., 2014; Horsley et al., 2011; Rosenbaum et al., 2008; Scurlock-Evans et al., 2014; Sriganesh, 2005). Given the lack of skills and confidence in performing appraisals, EBM practitioners tend to neglect the critical appraisal step during the practice of EBM (Ramos et al., 2003).

Even though previous studies attempted to study the appraisal behaviours of the participants (Amin et al., 2009; Brennan et al., 2014; Horsley et al., 2011; McAlister et al., 1999; Rosenbaum et al., 2008; Scurlock-Evans et al., 2014; Sriganesh, 2005), they did not tackle the effective approach in exploring the appraisal methods used to evaluate the validity and reliability of information during the practice of EBM (Godwin

& Seguin, 2003). Whilst there is abundant information available over the Internet, validation and reliability check in practising EBM remains as an integral part of the overall practice. Previous studies on appraisal skills among EBM practitioners were regarded as 'low quality' given the methodology used in the studies (Taylor et al., 2000). Considering the lack of attention in this area, there could be an explanation as to why training interventions do not reflect the actual practice of EBM. Also, the current recommended practice may not be fully applicable in different EBM settings due to the time constraints faced by EBM practitioners.

Hence, a possible way to pursue the study on EBM practitioners' critical appraisal activity is to explore the methods used by EBM practitioners in evaluating the reliability and validity of retrieved information. Following this, the findings could be used to analyse the current appraisal behaviours and strategically improve the critical appraisal skills during the practice of EBM.

2.3 Summary of Search Challenges Faced by EBM Practitioners

This section summarizes different types of search challenges reported by EBM practitioners during the practice of online EBM. One of the most reported issues affecting the initiation and the overall searching process was the lack of necessary skills required to search for medical information online (Andrews et al., 2005; Bennett et al., 2005; Zwolsman et al., 2012; Zwolsman et al., 2013). Searching through multiple online information sources for answers can be a difficult and complicated process, which requires sophisticated skills (Andrews et al., 2005; Bennett et al., 2005; Casebeer et al., 2002; Zwolsman et al., 2012; Zwolsman et al., 2013). This implies that not only the lack of necessary skills remains a challenge over the years, but it has yet to be rectified as well (van Dijk et al., 2010; Zwolsman et al., 2012). Not to mention, the overloading of health-related information online also contributes to the factors impeding the practice of EBM (Bennett et al., 2005; Casebeer et al., 2002; Klerings et al., 2015).

A systematic review revealed how excessive health-related information had influenced the search of information by healthcare professionals (Klerings et al., 2015). The proliferation of online health information is paced to the growing existence of the World Wide Web and the increased use of digital communication. Within the practice of EBM, the proliferation of online health information is due to the increasing amount of published studies concerning patients and medical conditions, and by the time practitioners have updated themselves on the latest information, newer studies/information would have been published (Bastian et al., 2010; Smith, 2010). Online health-related information continues to grow exponentially, leaving practitioners to feel overwhelmed by their inability to keep up-to-date (Bastian et al., 2010; Smith, 2010). Although evidence is synthesised regularly to aid health care decision making, the progress of evidence synthesis has lagged far behind that of the primary literature, due to the lengthy and tedious processes of developing a systematic review (Doshi et al., 2013; Klerings et al., 2015). This is on account of the fact that getting a systematic review published is time-consuming and the context of raw research studies, which are included in the review, may not apply to the practitioners' clinical questions. Advanced searching skills are required to evaluate the proper selection of studies for systematic review based on the metadata included in raw research studies. With the exponential growth of online health-related information,

practitioners are required to be adequately equipped with appropriate skills to be able to process and filter information in a short period (Klerings et al., 2015). If not, practitioners will experience certain challenges like lack of time, lack of skills to search effectively and lack of integration in processing information with their workflow (Clarke et al., 2013). A potential solution in overcoming this issue would be by increasing the health information literacy among medical practitioners during the practice of EBM (Clarke et al., 2013; Cullen et al., 2011; Duran-Nelson et al., 2013; Johnson, 2014; Klerings et al., 2015). This includes the necessary skills in identifying, searching and evaluating relevant information when engaging in the practice of online EBM.

Another obstacle reported by EBM practitioners was lacking in literature searching skills especially in locating articles online (Al-Motairy & Al-Musa, 2013; McAlister et al., 1999; Rosenbaum et al., 2008; Sriganesh, 2005). Similar findings were reported in both developed and developing countries (Al-Motairy & Al-Musa, 2013; McAlister et al., 1999; Rosenbaum et al., 2008; Sriganesh, 2005). This indicates that EBM practitioners from both developed and developing countries face similar difficulties in locating evidence. Aside from that, the lack of EBM related skills in administering the practice of EBM remains prevalent among EBM practitioners, including senior MSs (Lafuente-Lafuente et al., 2019; Lai & Nalliah, 2010; Tomatis et al., 2011; Ugolini et al., 2014). Recent studies reported that EBM practitioners continued to lack EBM knowledge when searching for information during the practice of EBM (Lafuente-Lafuente et al., 2019; Ugolini et al., 2014). The findings from the same study revealed that 83.5% of the respondents had never attended any EBM related course whereas 23% of the overall participants had ignored all proposed EBM terms (Ugolini et al., 2014). From the perspective of developing countries, EBM practitioners reported having insufficient experience and unpreparedness in incorporating EBM into their medical information searching due to inadequate resources and strategies in practising EBM (Tomatis et al., 2011). Table 4 shows the detailed summary of search challenges reported among EBM practitioners.

Table 4: Detailed summary of the search challenges reported by EBM practitioners

Search Challenges	Findings	Research Study
Online Searching Skills	Information overload, Lack of specific/directed information to the search	Casebeer et al. (2002), Bennett et al. (2005) Klerings et al. (2015)
	Difficulty in searching for relatable information, Lack of information on how to perform specified searches	Andrews et al. (2005), Bennett et al. (2005), Sriganesh (2005), Shelstad and Clevenger (1996), Rosenbaum et al. (2008), van Dijk et al. (2010), Zwolsman et al. (2012), Zwolsman et al. (2013), Al-Motairy and Al-Musa (2013), Hisham et al. (2016)
	Not sure when to stop searching	van Dijk et al. (2010), Zwolsman et al. (2013)
	Limited/No access to online information resources	Sriganesh (2005), Zwolsman et al. (2012)
EBM related Skills	Lack of basic EBM skills and knowledge (e.g. vocabulary, terms)	McAlister et al. (1999), Al Omari et al. (2009), Oude Rengerink et al. (2011), Zwolsman et al. (2012), Zwolsman et al. (2013), Al-Motairy and Al-Musa (2013), Ugolini et al. (2014)
	Lack of experiences in EBM practice	van Dijk et al. (2010), Tomatis et al. (2011)
	Unsure of online EBM sources	Ugolini et al. (2014)

Having inadequate skills in searching may result in a poor formulation of queries, failure of searching for appropriate information and the retrieval of a broader outcome (Lau et al., 2010; Zwolsman et al., 2012; Zwolsman et al., 2013). Being competent in these skills is crucial during the practice of EBM as EBM practitioners require immediate and reliable information to aid them in making clinical decisions. Inconclusive information retrieved online along with inadequate skills directly affects search outcomes and clinical decisions made (Bennett et al., 2005).

In conclusion, literature findings presented under the search challenges reported by EBM practitioners have surfaced almost a decade ago and continue to remain a challenge in the process of EBM. With the proliferation of online health-related information, it is necessary to ensure that EBM practitioners' online health information literacy is adequate to retrieve desirable evidence within a short timeframe. As such, it is worthwhile to conduct a study, which based on actual search tasks when practising EBM, on how EBM practitioners search for information during the practice of EBM.

This would lead to the identification of the online searching behaviours and challenges faced by EBM practitioners. It is important to obtain this information as to date, reports on search challenges were mainly constructed on the basis of questionnaires and surveys. The results of this study informed the search challenges that occur during the actual practice of EBM. A review of existing IR studies is presented in the next section.

2.4 Review on Existing Information Retrieval Studies

Information Retrieval[6] (IR) studies are divided into three distinct categories: (I) system-focused studies, (II) archetypical studies and (III) human-focused studies (Kelly, 2009). Each category is further divided into one or more sub-categories. The sub-categories within the system-focused studies include: (I) the study of Text Retrieval Conference (TREC)-style, (II) user-relevant assessment studies and (III) filtering and Selective Dissemination of Information (SDI). The sub-categories under the archetypical studies include: (I) log-based studies, (II) TREC interactive studies, (III) the study of experimental information behaviours and (IV) information-seeking behaviours along with IR system (Kelly, 2009). While the human-focused study has only one sub-category, that is, the study of Information-Seeking Behaviour in Context.

Table 5 shows a summary of studies on IR. The differences across these studies were the level of interest in different aspects of IR as well as the involvement of users' search experiences, behaviours and interactions with the systems being studied.

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[6] Information Retrieval studies focus on system evaluations without the consideration of user interactions (Kelly, 2009).

Table 5: Summary of research studies in IR

Types of IR studies		Advantages	Disadvantages	Example of Research Studies	User Involv-ement
System Focused Studies	**TREC-Styles Studies**	• Emphasizes on performances, precision and recall of a TREC approved systems	• No user involvement	(Voorhees, 2001)	-
	Users' Relevant Assessment	▪ Evaluation of systems and documents based on search tasks ▪ Addresses issues not addressed by TREC-style studies	▪ Users are only involved to provide feedback to build infrastructures ▪ Conclude users' information needs through the examination of systems	(Teevan et al., 2004)	-
	Filtering and SDI	• Emphasizes on understanding how to best represent information need and present documents to users	• Users did not engage in searching. • Lack of focus on interactive searching	(Luhn, 1958).	-
Arche-typical Studies	**Log Analysis**	• Focused on user behaviour and interaction based on common traits found within log files • Observable interaction such as: query behaviours, search results and click-through behaviours	• Information needs and search intentions are not known • Lack of information on the type of users involved in the searches	(Agichtein et al., 2006; Bilenko & White, 2008; Jansen & Spink, 2006).	✔
	TREC Interactive	• Uses users to evaluate a system or interface features • Relating cognitive activities to searches such as sense-making	• Focuses mainly on the psychological aspect of searching	(Joho & Jose, 2008; White et al., 2007).	✔
	Experimental Information Behaviour	• Focuses on information behaviour with manipulation and control over what to present to the users	• Isolate and study individual aspects of the searching process instead of the entire process • Does not reflect the actual searching process	(Arapakis et al., 2008; Kelly et al., 2008; Smith & Kantor, 2008)	✔
	Information Seeking with IR systems	• Focuses on the general information searching behaviour and user interactions in their natural electronic environment • Fundamental benefits to the development of better IIR systems	• Not driven by system concerns	(BystrÖm, 2002; Kellar et al., 2007; Kim & Allen, 2002).	✔
Human Focused Studies	**Information Seeking Behaviour In Context**	• Focuses on users, their real information needs and behaviours in a specific context • Uses qualitative techniques such as observations and interviews to explore actual searching behaviour	• May be used to inform better designs of IIR systems but it is not the main goal	(Hirsh & Dinkelacker, 2004)	✔

The system-focused studies are the oldest type of studies, which focused mainly on evaluating retrieval algorithms and indexing techniques (Clough & Sanderson, 2013). They evaluate the performance of the system, specifically in terms of the effectiveness and efficiency of IR systems during information retrieval instead of emphasizing the interactions that take place in a system. Therefore, the system-focused studies are not suitable for exploring users' online information searching behaviours during the practice of EBM. This further highlights the limitation of this methodology and hence, it was not considered in this study.

Next, the archetypical studies focus on real users' interactions and system evaluations, which indicates the emergence of IIR studies. The study of information seeking with IR systems is classified under archetypical studies, which was used in this study. This is because IIR study is widely used in naturalistic studies to investigate the true natural behaviours of the user when searching for information on the Internet (Kelly, 2009). As the focus of this study dwelled upon the searching process and not so much on the IR system, this type of methodology helps to provide a better understanding of users' natural search behaviours with no restrictions on which IR system is used to perform searches.

Subsequently, information-seeking behaviours in context is the only sub-category under the human-focused study. This type of study is also categorised under IIR studies as it focuses on users by exploring their information needs and behaviours when searching for information. It is important to ensure that users' information needs are studied, especially when there are no restrictions on the search tasks used to search for information. As a result, this type of IIR study is also appropriate in exploring EBM practitioners' searching behaviours during the practice of EBM, based on real search tasks arising in a clinical setting. A reflection of the literature review of this study is provided in the next section.

2.5 Reflection of Literature Review

With regard to the approach applied in this study, the ISP model was used to explore the online searching behaviours of EBM practitioners. The practice of EBM surfaced more than decades ago and has yet to reach an acceptable model in describing the EBM process catering to the shift from offline to online EBM. The ISP model consists of six steps outlining the approach of a typical searcher when searching for information online (Kuhlthau, 1991). The use of the ISP model is adaptable to the practice of EBM, but not taking into consideration the emotional state and thought process within the model. This is because the focus is to understand the online searching process within the practice of EBM with the thoughts and emotional state of a searcher excluded. In this context, the ISP model is insufficient as the practice of EBM can only be practised by medical professionals within the field and hence, requires the pre-possession of medical-related knowledge and skills such as the formulation of clinical questions and the appraisal of searches carried out (Sackett et al., 1996; Sackett et al., 2000). The guidelines of EBM has been established over the years. Even so, the guidelines are mainly for the selection of proper online contents (Isaacs, 2014; Straus et al., 2005; Tenny & Varacallo, 2018). The online searching skills such as queries, result viewing and online sources were neglected in the past. This further proved the importance of this study in exploring the online searching behaviours of EBM practitioners during the actual practice of EBM.

Previous literature was also reviewed for the reported online information searching process. Although numerous studies on online searching behaviours were conducted, the majority of them utilised questionnaire, interview and survey-based instruments to report behaviours. Such studies reported self-perceived behaviours and hence, highlighted the need for a study on the actual practice of EBM itself. Furthermore, studies focusing on the online searching process are limited (Inthiran et al., 2012; Krahn et al., 2006; Lykke et al., 2012). Despite reporting the actual behaviours of the participants, these studies used predefined search tasks within the context of medical information searching but not EBM (Inthiran et al., 2012; Yilma et al., 2019). While useful insights were generated by these studies, such information within the context of EBM among EBM practitioners remains unavailable. This further accentuates on the need for this study to explore the behaviours within the context of EBM as guided by previous literature.

Another notable finding was that the previous studies on online searching behaviours in EBM were conducted almost a decade ago and may no longer represent the current behaviours. Given that, the challenges during the present practice of EBM were explored in this study. Previous search challenges among EBM practitioners revealed that the lack of searching skills and EBM related skills remained prominent for more than two decades after EBM was first introduced in 1996 (Kortekaas et al., 2015; Lafuente-Lafuente et al., 2019; O'Carroll et al., 2015; Sriganesh, 2005). Regardless of the interventions designed over the years, online searching skills continues to be an area that has not been thoroughly explored in the practice of EBM. In accordance with this, the exploration of EBM practitioners' searching behaviours during the practice of online EBM would promote greater comprehension of the practice alongside providing the possibility of formulating better strategies to overcome the reported challenges.

Chapter 3 Research Methodology

This chapter presents the details of the research methodology implemented in this study. The research methodology was referencing the study by Kelly (2009) on the methods of evaluating IIR systems among users. This section begins with a discussion on IIR and the relevance of IIR to this study to examine the different approaches used in IIR studies, which leads to the selected methodology of this study. Then, the research approach, description of the study setting, sampling technique and selection of participants are presented. Consecutively, details of the data collection process comprising the explanatory statement, data collection techniques and procedures are also discussed. The data management and analysis tools, followed by the data analysis plan are then described. Lastly, the details of the pilot study and the measures taken to increase the reliability and validity of this study are placed at the end of this chapter.

3.1 Interactive Information Retrieval (IIR)

As mentioned in Section 2.4, the emergence of IIR studies began with the archetypical studies where both systems evaluate the interactions between the user and IR systems (Kelly, 2009). The IIR is the combination of both IR and *Human-Computer Interaction*[7] (HCI) studies (Kelly, 2009). In spite of that, there were no strong evaluations and experimental frameworks to study IIR in comparison to that of classic IR studies (Kelly, 2009). This indicates the possibility of flexible approaches in study designs, focusing on both systems and the searching behaviours of the searchers. Hence, the IIR approach was considered to fulfil the objectives of this study.

3.1.1 Relevance of IIR to This Study

The IIR approach was used to explain the interactions among EBM practitioners when performing searches based on real search tasks via online IR systems when practising EBM. This approach allows the exploration of the search interactions between the searcher and the system employed during information search (Kelly & Ruthvan, 2011). It also focuses on the types of searchers and the different search tasks within the context of EBM. Figure 3 displays the IIR continuums selected to carry out this study. The selected continuum was Information-Seeking with IR system under the

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[7] Human-Computer Interaction studies focuses on the behaviours of an individual who interacts with a system (Kelly, 2009).

archetypical study. Whereas under the human-focused study, Information-Seeking Behaviour in Context was selected.

The Information-Seeking with IR system was chosen to study the information searching process on various IR systems online. There were no set restrictions on specific IR systems to permit users to search for information on any IR system online as explained in Section 2.4. The querying behaviours, result viewing behaviours and sources of information used were explored under this category. The Information-Seeking Behaviour in Context was applied to study the searching behaviours of EBM practitioners focusing on real search tasks that arise during the practice of EBM. The types of search tasks prior to EBM training experiences, challenges experienced, information usage and their appraisal behaviours were explored under this continuum. Details on the research approaches used to conduct this study are provided in the next section.
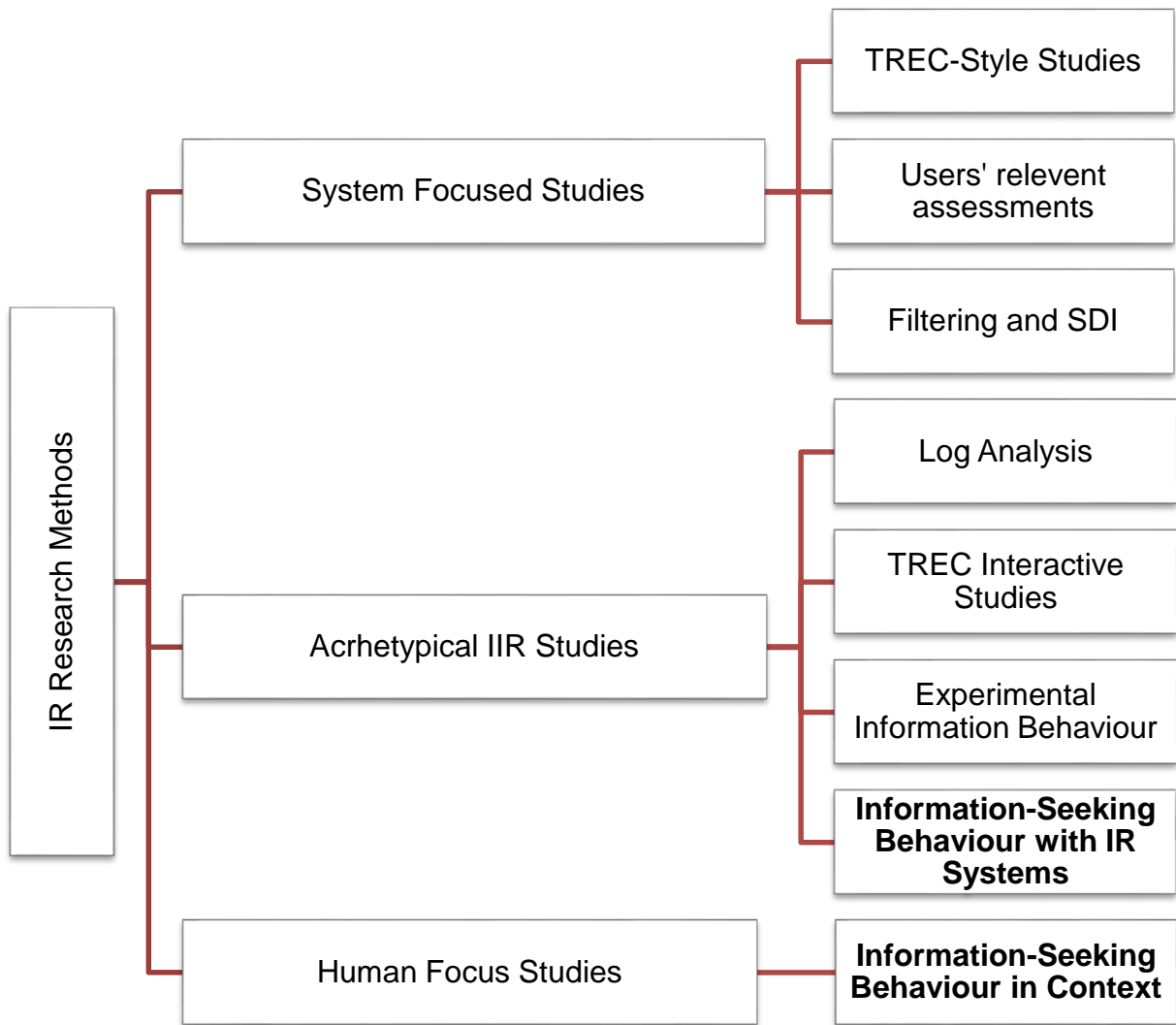
Figure 3: IR Methodologies (Kelly, 2009)

3.2 Research Approach

Research approaches that are widely used in IR research are (I) laboratory approach and (II) naturalistic approach (Kelly, 2009). Studies that are utilising the laboratory approach are conducted in laboratories, being specifically useful in studying the impact of one or more variables upon the other variable. Such studies increase the control over the situations but the outcomes are artificial and may not represent real-life situations (generalization) (Kelly, 2009). On the other hand, studies that are using the naturalistic approach are capable to examine IIR in the setting where the actual practice occurs (Kelly, 2009). Naturalistic studies are capable of capturing true behaviours that are comparable to real-life situations and in this way are less biased in terms of the study design and environment (Kelly & Ruthvan, 2011). Nevertheless, a naturalistic study has lesser control over the situation and makes it hard to compare the behaviours within the study (Kelly, 2009). Based on this justification, the naturalistic approach was used in this study as the objectives of this study were focusing on the exploration of online information searching behaviours among EBM practitioners in the actual practice of EBM.

The searching behaviours captured through the naturalistic approach were then analysed using the exploratory approach. The exploratory approach is usually used to explore the natural phenomenon that arises through the naturalistic approach (Kelly, 2009). It is also extensively applied in studies that intend to perceive the existing phenomenon from a wider or new angle. In this study, the objective was to look at the online information searching behaviours displayed by EBM practitioners when performing searches based on the real clinical questions that arise in the clinical setting.

3.3 Description of the Study Setting

This study was conducted in the NICU of a public teaching hospital in Malaysia. The description of this study setting was reported based on the initial observation of the selected NICU before this study was carried out. At the NICU, there were a total of 25 baby cots and six ventilators, which were used to treat babies who were admitted to the unit. At the point of observation, approximately 30 premature babies were admitted to the NICU monthly with the most common complication reported as Respiratory Distress Syndrome (RDS). Critical care was required to monitor the progress of the babies in the NICU at all times. A team of EBM practitioners conducted clinical rounds in the NICU twice a day, in the morning and evening, respectively. The morning clinical rounds were also known as the grand clinical rounds that were conducted to monitor the progress and status of each baby admitted to the NICU on a daily basis. It was led by a team of one consultant/specialist, one lecturer, three MOs, two HOs and a nurse in charge. The evening clinical rounds were carried out to monitor babies who are critically ill and in need of strict monitoring only.

The clinical rounds conducted in the NICU were primed for the practice of EBM. The morning clinical round was where most of the clinical decision making for patients occur. The second clinical round, which occurs in the evening, was where the patients' progress were monitored by the final year MSs. There were two portable laptops placed on a movable trolley inside the NICU and five stationary desktop computers (two placed in the discussion room, two at the administration table and one at the NICU nurses' station) were provided to support the process of searching for clinical information. Based on the initial observation during the pilot study, EBM practitioners were more likely to search for information using the available portable laptops preloaded with online medical libraries such as Cochrane and PubMed during the grand clinical rounds. In addition, EBM practitioners were required to practice mandatory hand hygiene practices before touching the babies. Similarly, they were required to clean their hands as a precaution before touching their patients after conducting every search using the portable laptops to ensure that their hands were germ-free. To fulfil the objectives of this study, the data was collected during the grand clinical rounds carried out in the mornings where the practice of EBM was more likely to take place.

3.4 Sampling Technique

The most commonly discussed sampling techniques under IIR studies consist of probability sampling and non-probability sampling (Kelly, 2009). Probability sampling is used when adequate information regarding the participants are known. For instance, probability sampling is used to create the same variety of characteristics of a population to enhance the generalizability of the results (Kelly, 2009). In contrast, non-probability sampling is used when all the elements of the participants are not known or when there is limited access to the participants and resources (Kelly, 2009). The focus of this study was to explore the online searching behaviours among EBM practitioners during the implementation of EBM. As the study was conducted in a NICU of a public teaching hospital, the participants were limited to EBM practitioners who were involved in the grand clinical rounds. The outcome of this study may not be generalizable to the population of EBM practitioners. Rather, it represents a smaller subset of the intended population (Kelly, 2009).

Examples of non-probability sampling include purposive/judgemental sampling, quota sampling and convenience sampling (Kelly, 2009). Purposive/judgemental sampling is applicable when a specific trait or characteristic of the participants needs to be included or excluded in a study (Kelly, 2009). Whereas quota sampling is a technique where a tailored sample is taken from a proportion of a population of interest with specific characteristics (Kelly, 2009). While the first two sampling methods under non-probability sampling are practical for recruiting participants with desired traits and characteristics, convenience sampling was used to recruit participants for this study. The utilisation of this technique is necessitated when the participants of a study are limited and difficult to access (Etikan, 2016). The participants involved in this study were the EBM practitioners who were constantly operating on busy schedules and thus, may not be available at all times. In line with this, the convenience sampling method was used to recruit participants that were available during the data collection and when they were searching for information when practising EBM during the morning clinical rounds in the selected study setting.

3.5 Selection of Participants

All the EBM practitioners who were involved in the grand clinical rounds in the NICU were taken into consideration for this study except nurses in particular. Nurses were excluded from this study as they tend to only assist the EBM practitioners, who were involved in most of the clinical decisions for their patients, but not involved directly in the decision making process. Through the initial observation, the specialists, MOs and HOs were involved in the major clinical decisions, whereas the final year MSs mainly performed duties in the monitoring of patients' conditions throughout their admission.

As a result, the data was collected when the participants found the need to search for information due to the clinical questions that arose during the practice of EBM. The participants in this study include the (I) specialists (medical consultants), (II) MOs, (III) HOs and final year MSs who were involved in the practice of EBM during their morning clinical rounds. Data was not collected from the nurses to ensure that the findings from the study lie within the range of EBM practitioners who practise EBM during patient consultations to make informed clinical decisions.

3.6 Explanatory Statement and Participant Consent

This study dealt with the participants who provided information regarding online information searching behaviours during the practice of EBM. Therefore, ethics approval of a low-risk project involving humans was obtained from the Monash University Human Research Ethics Committee (Appendix A). Simultaneously, ethics approval was also obtained from the Medical Ethics Committee of the selected public teaching hospital in Malaysia.

An explanatory statement was given to brief the participants on the overall description of this study. Information such as the title, description of the study, the researchers involved in the study and the contact information of the lead researcher were provided in the explanatory statement. A consent form was also distributed among the participants before the commencement of this study to obtain their consent to participate in this study. The explanatory statement and consent form are attached under Appendix B and C, respectively, at the end of this thesis.

3.7 Data Collection Techniques

A mixed method was used in this study, whereby both qualitative and quantitative data were collected and analysed. The data collection techniques used in this study were questionnaire (Section 3.7.1), pre-search interview (Section 3.7.2), structured observation (Section 3.7.3) and post-search interview (Section 3.7.4).

3.7.1 Questionnaire

A questionnaire was designed to collect the demographic details of the participants in this study. Such details were composed of years of the medical and general search experiences, preferences on different sources of information, commonly visited search domains in the past, frequency of EBM searches conducted and preferred location of the search. The questionnaire was designed to be a single page questionnaire for the participants to fill in before moving on to the searching process. The information gathered from this section was applied to understand the demographic details of the participants. The research questionnaire used in this study is provided in Appendix D.

3.7.2 Pre-Search Interview

Interviews are conducted to collect open-ended information as a means to elicit individualized information from participants. This mode of instrument is commonly used in naturalistic studies to obtain information such as opinions, feedback and informal responses from participants (Kelly & Ruthvan, 2011). Interviews need to be properly structured to effectively gather the necessary information, as time-consuming interviews are inappropriate during clinical rounds and patient consultations (Darvers, 2014). Hence, a pre-search interview consisted of both structured and semi-structured interviews were used to gather qualitative information before the initiation/conduction of the search.

The pre-search interview was conducted to understand the information need of the participants before they began searching. The semi-structured questions were shaped to elicit various information such as motives, purposes and factors leading to the search. This was done to understand what the participants intended to search for as there were no predefined search tasks provided for the participants. Due consideration was taken in minimising bias in the participants' search practices. Since the participants were not directly asked for their search tasks, two questions were asked instead: (I) Why are you doing this search and (II) What initiated you to do this search,

as part of an effort to reduce participants' bias. Furthermore, to reduce the bias, the responses gathered through these questions were reviewed by two medical experts to categorise the types of search into BG- and FG-type searches.

The structured interview questions were included to collect information on how search tasks can be categorised, search initiation (self-initiated or instructed) and whether the participant intends to search individually or collaboratively. The interviews were recorded using a voice recorder to ensure that the time taken to interview the participant was kept at a minimum. The pre-search interview questions of this study are provided in Appendix E.

3.7.3 Observation

Observations are known to be one of the suitable approaches for naturalistic and exploratory studies (Kelly, 2009). There are two forms of observations depending on their method of gathering information (Kelly, 2009). The first form of observation involves real-time note-taking during the observation. This method is not particularly feasible since the observations may be affected by numerous factors and limitations such as the overlooking of important events and the stress level of the observer. Furthermore, human senses are limited, suggesting that there is a possibility where the observer may have missed out important information during the performance of their observation (Kelly, 2009).

Another form of observation utilises an additional video camera recording on-screen capturing software to aid the analysis of the collected data (Kelly, 2009). This is also referred to as a structured observation. Previous studies also engaged in such a method to capture the search behaviours of the participants in different contexts (Inthiran et al., 2012; Yilma et al., 2019). The benefit of this method of observation is that it aids in capturing the observations in a video recording and saves it for playback view at a later time. In this study, video recordings were the best instrument to obtain direct observations of variables including queries issued and result viewing behaviours. One major drawback of this method is that it is incapable to capture indirect observations such as participant's cognitive thinking, expression and emotions during the session. However, the main focus of this study was to explore the online searching behaviours of the participants during the practice of EBM. Hence, indirect observation elements can be neglected as a consequence (Bogdewic, 1992).

The direct observation on a playback recording method was used to observe the searching behaviours of the participants in this study. This is to guarantee that the search activities of the participants such as the queries issued, result viewing behaviours and the types of online sources accessed were recorded for analysis. On that note, this playback recording method did not require any additional time during the data collection as the playback recording could be accessed at another time without interrupting the participants for more information during the search. As such, the search sessions were recorded by a key-logging software that captures the screen activity of the participant when they proceed to search for information in the process of online EBM via the provided laptop. The laptop that was used to search for clinical information was pre-installed with the TechSmith's Morae Recorder version 3.3.3, which enables screen and key-logging activities. Screen activities such as mouse clicks, mouse trails, navigation, user interactions, screen recording, think-aloud audio recording and key logs were recorded using the software (TechSmith Corporation, 2015). Under this study, the Morae recorder was used to record (I) querying activities, (II) result viewing activities of the participants and (III) the online sources accessed. In addition, audio recordings were also administered to enable the application of the think-aloud approach, which provides a better understanding as well as being effective in discovering emerging phenomenon to aid the analysis process of the screen recordings (Charters, 2003; Young, 2005).

The time taken to complete the search session including both querying and result viewing activities, was recorded to examine the length of the search session, that took place during the searching procedure. Under the querying activities, the following were observed: (I) the total number of queries issued per search session, (II) query length (number of terms used in a query), (III) query operators used, (IV) the usage of stop words, (V) the number of ineffective queries (queries that did not result in any viewing of results), (VI) query re-issuance and (VII) medical queries (queries that contain medical terms that are found in the *Medical Subject Headings (MeSH)*[8] medical vocabulary database. These elements under the querying activities were recorded to provide a better understanding of the participants' querying behaviours during the searches. Additionally, under the result viewing activities, the following were observed:

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[8] Medical Subject Headings (MeSH) is a comprehensive controlled vocabulary that is used to index medical journal and articles for PubMed, available at www.ncbi.nml.nih.gov/mesh.

(I) the number of links/results clicked, (II) revisiting results, (III) the number of sub-links clicked, (IV) viewing results beyond the first result page and (V) commands usage such as Ctrl-F. The observations of the elements stated under the result viewing activities were to provide a detailed understanding of the result viewing behaviours of the participants. These elements are crucial in the sense that they encourage comprehension of different querying behaviours and result viewing behaviours among various participants during the practice of EBM. A checklist of the observable variables that aid the process of analysis is provided under Appendix F.

3.7.4 Post-Search Interview

The post-search interview was conducted after the participants had completed their search, which was recorded by the key-logging software, through a structured interview. The main purpose of this interview was to collect the participants' feedback and opinions on the search. There were two major sections under the post-search interview, both focusing on distinct aspects of the search. The first section comprised of a structured interview, which highlighted the outcome of the search, the use of information resulting from the search session and how appraisal[9] was conducted throughout the search. The outcome of the search was recorded based on the self-perceived feedback from the participants regarding whether they had found the answer they were looking for and if otherwise, the reason for failing to search for answers to their information needs. Additionally, the participants were also required to explicitly describe their appraisal activity during the search session, as well as disclose the information on how and why the appraisal of the information was conducted. If there was no report on the appraisal activity in the study, the participants were required to explain why the appraisal was not carried out during the process of searching. Finally, the participants were asked to report on the search challenges faced.

The second section of the post-search interview aimed to collect the information on the ICT related challenges faced during the search. The semi-structured questions were incorporated to allow the participants to provide feedback on the network and devices used to search for clinical evidence. The participants were required to provide a list of network and devices used during the search sessions and also their impression on the resources used throughout the searching process. The ICT related challenges

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[9] A self-evaluation to determine the validity of the information retrieved.

faced during a particular search session were obtained at this stage. The information gathered in this section would be consequently used to formulate better strategies to overcome the ICT related challenges in the future. The post-search interview is provided in Appendix G.

3.8 Data Collection Procedure

This section describes how the data was collected within the study setting. A total of 99 search sessions were recorded during the data collection process. Every search session was recorded coherently with the pre-search and post-search interviews. As such, there were a total of 99 search sessions, pre-search interviews and post-search interviews conducted among the 47 participants who were EBM practitioners. The data was collected from the participants during the grand clinical rounds in the NICU. The data collection process began as soon as the participants identified the need to search for medical information online during the grand clinical rounds. Before the commencement of this study, the explanatory statement was delivered to each participant to introduce this study. Subsequently, they were given the consent form to obtain their consent in participating in this study.

After the consent form is signed, a questionnaire was given to each participant to collect their demographic information. Then, the pre-search interview was administered. After completing the pre-search interview, the participants began the searching process based on their information needs using the given laptop. The laptop utilised for the searching process was a HP Pavilion dm4 running on an Intel Core i5 processor with the speed of 2.67 GHz, a usable Random Access Memory (RAM) of 3.80 Gigabyte (GB), Windows 7 Enterprise operating system (OS) and other necessary software that comes with the OS.

The participants were allowed to use their preferred web browser for the search. Additionally, there was no allocated time limit for each searching process. The end of a search session was indicated by the participant when the desired information had been obtained or when the participant had conducted exhaustive searching and decided to end the search. The post-search interview was then administered at the end of each searching process. Figure 4 represents the diagrammatic representation of the data collection procedure implemented in this study.

A special code was assigned to each set of data recorded, the same code was used to match each search session recorded by the key-logging software to its respective responses in the pre-search and post-search interviews. This was to ensure that the data collected was based on a *de-identified*[10] study to protect the privacy of the information. The data collection continued until theoretical saturation was achieved. Theoretical saturation is termed as such when the research reach saturation in the data collected or when there is 'no new information' to be analysed (Aldiabat & Navenec, 2018). In this study, the theoretical saturation was measured using the categories listed under the Data Analysis Plan (Subsection 3.10). It was achieved when there were no new patterns of search behaviours emerging. Figure 4 shows the diagrammatic view of the data collection procedure.

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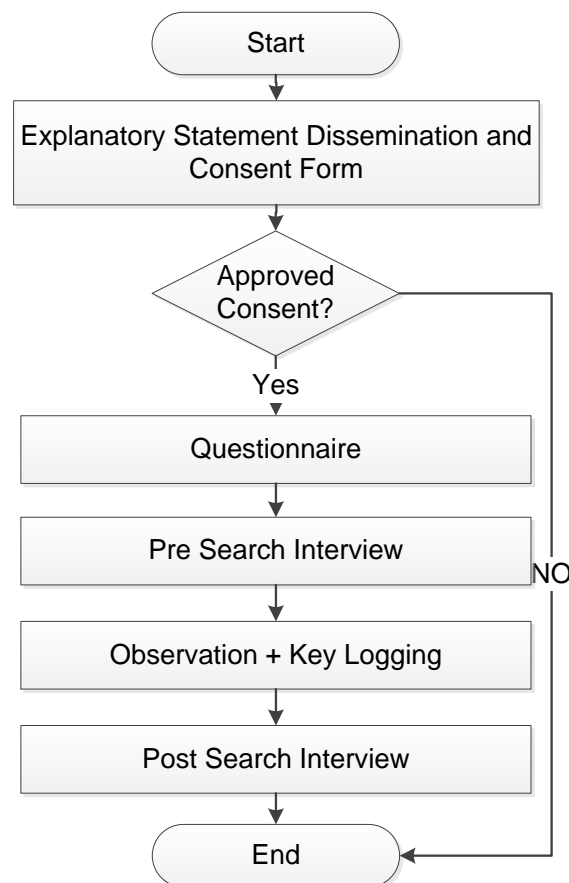
Figure 4: Diagrammatic representation of the data collection procedure

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[10] A process that prevents the identification of a person, or to be revealed or connected with the information they provided.

3.9 Data Management and Analysis Tools

The data obtained from the questionnaires were keyed into IBM's statistical software SPSS version 22 for further analysis. The elements collected were analysed based on the demographic details of the participants. The video recordings of screen capturing from the Morae key-logging recorder were copied for backup and recovery purposes. The copies of the recordings were stored in three storage devices including a password protected local hard drive, an external hard drive and a storage server. The Morae Manager was used to code and transcribe the recordings recorded via the Morae Key-Logging Software. The transcribed data such as the number of queries issued, the number of results viewed, the average number of terms used in queries and medical terms used derived from the transcription of the recorded search sessions were analysed quantitatively using IBM's SPSS Software version 22. Moreover, the qualitative information was collected from the audio recordings of pre-search and post-search interviews. These audio recordings were transcribed using a QSR NVivo 10 software for qualitative data analysis. In the upcoming section, the description of the data analysis plan for both the qualitative and quantitative data are described.

3.10 Data Analysis

The results from this study were analysed using the exploratory and explanatory approaches. The exploratory analysis approach was performed to explore new and interesting outcomes from the data collected within the actual practice of EBM in this study. This includes exploring the emerging patterns of online searching behaviours among the participants during the practice of EBM. The quantitative variables were analysed using the descriptive (mean, min, max, standard deviation [SD] and percentage) and inferential statistics. The inferential statistics were used to determine the probability of search behaviours being dependent or occurring by chance in the study. The inferential statistics used in this study consisted of the Mann Whitney's U test, the Kruskal Wallis's test and the Pearson's test. The Mann Whitney U test and Kruskal Wallis test were carried out to support an unequal number of samples in each grouping variable under circumstances where the dependent data was non-parametric. For the independent variables consisting of only two categorical groups, Mann Whitney's U test was used. While the independent variables exceeding two categorical groups required the application of the Kruskal Wallis test. The Mann Whitney's U test and Kruskal Wallis test were also used to study the effect of

independent variables on the querying activities, result viewing activities and the number of online sources accessed in the recorded search sessions to answer the research questions I, II and IV in an exploratory manner. Additionally, Pearson's test was implemented when the distributions of both independent and dependent variables were non-normal and continuous. The Pearson's Test was also utilised to evaluate the correlation between the number of queries issued and the number of results clicked by the participants, indicating the associations between the querying and result viewing behaviours of the participants.

Apart from the quantitative analysis, the qualitative responses gathered served as tools in understanding the types of searches performed in line with the participants' clinical questions, appraisal behaviours and challenges faced throughout their search. The qualitative responses were analysed using the narrative analysis to construct the search behaviours of the participants from their gathered responses. The pre-search interview was analysed by two medical experts in the field to categorise the clinical questions into FG- and BG-type questions. The responses gathered from the post-search interview were analysed narratively. The use of narrative analysis enabled the construction of stories (search behaviours) from the participants' responses. The narrative analysis was also applied in the interpretation of the searching behaviours of the participants in terms of the types of search tasks, appraisal behaviours and the challenges faced by the participants in the practice of EBM. Figure 5 below illustrates the diagrammatic view of the quantitative analysis and methods employed in the analysis of the data collected from this study.
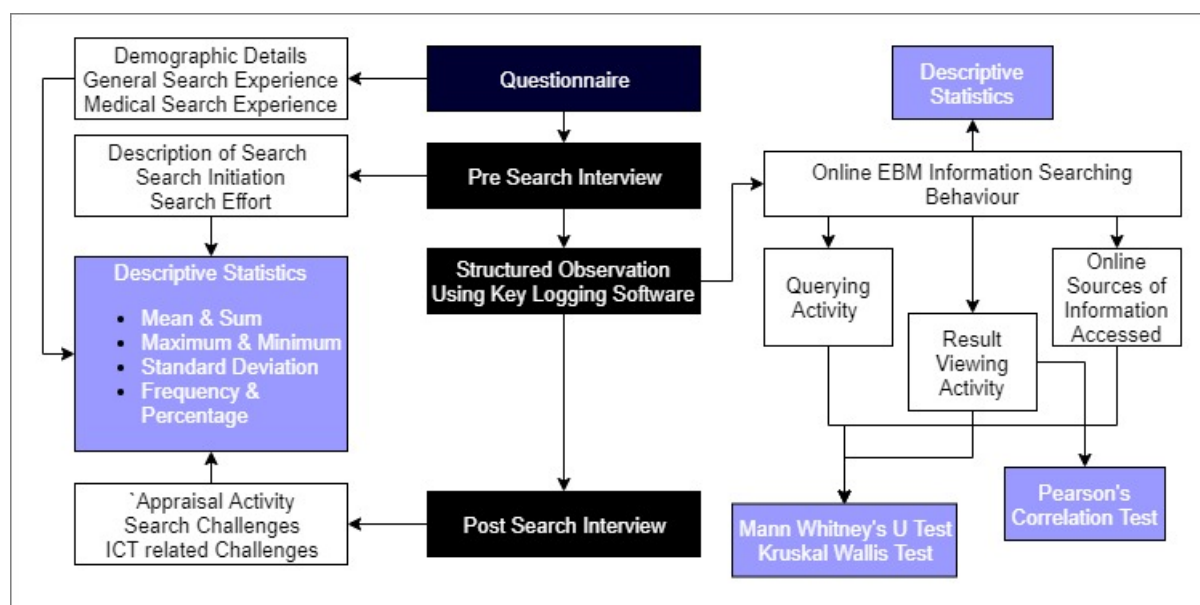
Figure 5: Schematic Diagram of the Quantitative Data Analysis Procedure and Methods

3.11 Pilot Test

A pilot test was conducted to test the experiment procedure, pre-search interview, observation and post-search interview. A total of three specialists, three MOs and three HOs were included in the pilot test. The outcomes of the pilot test helped in the fine-tuning of the questionnaire and post-search interview. The questionnaire was modified to a single-sheet questionnaire to avoid taking up too much of the participants' time in filling up the questionnaire. The post-search interview was amended to include the questions on why the appraisal activity was not done and how was the appraisal activity, if any, was carried out by the participants. These changes were made to comprehend the methods used in the appraisal as well as investigate the reason as to why the participants have not performed the appraisal activity in the scenario where no appraisal was conducted. Overall, there were no issues reported by the participants after the first pilot test, which indicated the end of the pilot test that involved a total of nine participants. The outcomes of the pilot test were not reported in this study since the sample size was insufficient to conclude whether the information collected from the participants was sufficient to fulfil the objectives of this study.

3.12 Reliability and Validity of Research

The measures that were taken to ensure the reliability and validity of this study are discussed in this section. From the viewpoint of the internal validity of this study, the data collection was conducted in the NICU during the grand clinical rounds in which

the participants were primed to practise EBM. The participants were not obliged to conduct a search when administering crucial care to their patients in the NICU. Instead, the participants took part in the study whenever they discovered a need to search for information online on the account of the clinical questions that arose during the grand clinical rounds. This established the grounds for increasing the internal validity of the results as the participants were not pressured to search, but only doing so at their convenience at any time within the grand clinical rounds. During the search session in recording, the participants' search may be interrupted due to the need to attend to their patients. In this case, the participants may opt to end the search to provide care to their patients or accomplish their work commitments. Such searches under this condition were not included in this study as they were considered as incomplete searches. However, this situation did not occur often and thus, the validity of the results was maintained.

The participants who were included in this study were limited to the EBM practitioners conducting the grand clinical rounds in the NICU. Since the grand clinical rounds were carried out daily by a team of the same doctors, the participants may be implicated in more than one search during the data collection process. To minimise the frequency of repeated searches by the same participant, each participant was limited to search for a different search task/clinical question in each search conducted. In other words, the participants were allowed to search for a single search task in each search session conducted/recorded. In spite of that, there was no repeated search with identical search tasks recorded by the same participant throughout this study. Furthermore, issues such as exhaustion, time constraints and work commitment may present themselves due to the number of patients that were involved in the grand clinical rounds as well as the long shift schedule. Nevertheless, the participants were allowed to conduct the searches at their aspiration and convenience during the grand clinical rounds. This arrangement was able to increase the internal validity of the results. In addition to that, the data collection continued until theoretical saturation was achieved, that was, at 50 search sessions recorded. However, to reinforce the reliability and the validity of the results from this study, the data collection process was prolonged until adequate samples were obtained. A total of 99 search sessions were recorded from the 47 participants. From this, it was found that the number of participants in the different participant categories and the number of searches recorded was unequal.

Out of the 47 participants who took part in this study, there were 15 final year MSs, 19 HOs, eight MOs and five specialists who performed 32, 51, 19 and 6 searches, respectively. As such, to increase the validity of the results acquired in this study, the reported results were analysed and presented based on the searching behaviours of the participant categories.

The pilot test was conducted before the administration of the actual data collection process. The pre-search and post-search interviews were verified and fine-tuned by two independent professionals, namely an IR researcher and a medical professional. Also, the search tasks collected in this study were limited to actual clinical queries faced by the participated EBM practitioners during the practice of EBM in the grand clinical rounds. To increase the validity of the search tasks, they were categorised into BG and FG questions by the two EBM experts in the medical field. Last but not least, the analysis and findings presented in this study were verified more than once by the researcher-in-charge and an appointed research assistant to enhance the reliability.

Chapter 4 Research Findings

This chapter presents the findings of this study. A total of 47 EBM practitioners, which include specialists, MOs, HOs and final year MSs, have participated in this study and produced 99 search session recordings from the practice of EBM in the NICU of a public teaching hospital. Firstly, the demographic details of the participants are presented. Consequently, a description of the search purpose is presented. In this section, the categories of clinical questions searched by the participants are provided. Next, the elements of the online searching behaviours are presented under the search session details. The sections include (I) querying activity, (II) result viewing activity, (III) online sources of information accessed and (IV) appraisal activity. After this section, the challenges faced by the participants in this study are reported. The challenges were divided into Search Challenges and ICT Related Challenges. Finally, a summary of the collated results derived from the individual sections is presented.

4.1 Demographic Details of the Participants

The demographic details are presented to report the characteristics of the participants who were involved in this study. A total of 47 EBM practitioners (fifteen MSs, nineteen HOs, eight MOs and five specialists) have participated in this study. The basic demographic details of the participants are presented in Table 6, and the general search experience and medical search experience of the participants are presented in Table 7.

Among the participants, there were more female participants than male participants in which 29 (61.7%) of the total participants were females. The mean age of the participants was 27.2 years. The participants who were specialists have reported a mean age of 35.2 years, which is considerably young owing to the participation of younger specialists who were in the midst of completing their practical years of becoming a fully-fledged specialist. Although all the participants were able to communicate in English, only 14 (29.8%) out of the overall participants reported English as their first language, while the rest of the participants indicated Malay, Chinese dialects (Hokkien and Mandarin) and Tamil as their first language. Out of the total participants, only one participant was an Egyptian while the remaining participants were Malaysians.

In terms of the education level, only 10 out of the 15 participated MSs indicated pre-university certification as their highest level of education. These 10 participants were MSs who were in their final year, whilst the remaining 5 participants were MSs who had just completed their medical studies and have yet to graduate. The remaining participants have achieved an undergraduate degree (57%) and a postgraduate degree (11%) as their highest level of education. Meanwhile, the participants who were specialists had indicated undergraduate degree (40%) and postgraduate degree (60%) as their highest level of education. The underlying reason for the specialists who had indicated degree as their highest qualification is because they were in their specialist training (practical) year when this study was conducted and still in the process of completing their postgraduate degree.

Table 6: Basic demographic details of the participants

Variables		MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
		f	%	f	%	f	%	f	%
Gender	Female	6	40	12	63.2	7	87.5	4	80
	Male	9	60	7	36.8	1	12.5	1	20
Age (Years)	Minimum	23		24		26		28	
	Maximum	24		32		39		41	
	Mean	23.4		26.4		31.8		35.2	
	SD	0.6		1.9		4.1		5.7	
First Language Spoken	English	1	5	7	40	2	25	4	80
	Malay	6	40	10	50	3	37.5	1	20
	Chinese	7	50	2	10	2	25	-	-
	Tamil	1	5	-	-	1	12.5	-	-
Nationality	Malaysian	Malaysian						4	80
	Egyptian							1	20
Highest Level of Education	Pre-University	10	66.7	-					
	Degree	5	33.3	18	94.7	7	87.5	2	40
	Postgraduate Degree	-		1	5.3	1	12.5	3	60

(Note: n-number of participants, f-frequency, SD-Standard Deviation)

Table 7 shows the participants' general search experience and medical search experience. Out of the 47 participants, the majority (89%) preferred searching for information at both their workplace and home. From the perspective of the search experience, the participants had reported a mean of 11.5 years of general search experience and 7.1 years of medical search experience. The participants' medical search experience was further divided into the duration of medical information search per day and the average duration for a single medical information search. The

participants spent a mean of 2.3 hours per day for medical information searching, whereas the mean duration for a single medical information search was 21 minutes. Table 7 shows the participants' searching experience based on the participant categories.

Table 7: General search experience and medical search experience of the participants

Variables		MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
		f	%	f	%	f	%	f	%
Preferred Location of Search	Home	1	6.7	2	10.5	1	12.5	-	
	Work Place	2	12.3	1	5.3	1	12.5	-	
	Both	12	80	16	84.2	6	75	5	100
General Search Experiences (Years)	Minimum	5		5		5		10	
	Maximum	17		20		20		20	
	Mean	8.7		11.7		13.8		15.4	
	SD	3.4		3.7		4.7		4.6	
Medical Search Experience (Years)	Minimum	3		3		5		10	
	Maximum	7		10		12		20	
	Mean	4.7		6.3		8.9		14.4	
	SD	0.9		2.1		2.7		4.8	
Duration of medical information searching per day (Hours)	Minimum	1		0.5		0.75		1	
	Maximum	8		18		3		4	
	Mean	2.9		2.3		1.5		1.9	
	SD	1.9		3.9		0.9		1.2	
The average duration of per medical information search (Minutes)	Minimum	1		2		10		1.5	
	Maximum	60		60		60		60	
	Mean	22.4		17.8		19.1		30.3	
	SD	17.6		17.7		16.8		27.9	

(Note: n-number of participants, f-frequency, SD-Standard Deviation)

4.2 Analysis of Search Tasks

The search tasks were analysed to interpret the purpose/aim of each search conducted. The purpose/aim of the searches was formulated by the participants based on the clinical questions the participants had in mind during the practice of EBM in the study setting. The participants were asked in the pre-search interview to describe the purpose of the search being conducted and the conditions that led them to perform the search. The details of the search description from the participants are presented under Appendix H. A total of 99 independent searches were collected from the 47 participants. Based on the description of the searches given by the participants, the searches were identified and grouped into FG- and BG-type searches by a medical specialist and a professor majoring in paediatrics. The details of the searches were

further divided into search initiation, search effort and search outcome. The details of search initiation were used to determine whether a particular search was self-initiated or instructed by an instructor. In terms of search effort, it was referring to the individual search effort, which means only a single participant was involved in a search session, and collaborative search effort that indicates the search was conducted by a single participant but also assisted by another counterpart during the searching process. Regarding the subject of the search outcome, the success of a search was indicated by the successful retrieval of desired information by the participants. The participants were asked if they had found their desired information during the search, whereby a search was recorded as successful if the participants were able to retrieve their desired information and fulfil the purpose of the intended search.

Out of the 99 searches, the HOs accounted for the most number of searches (51 searches), followed by the MSs (32 searches), MOs (10 searches) and specialists (6 searches). Table 8 presents the details of the searches recorded in this study. In total, there was a higher number of BG-type searches (83%) as compared to FG-type searches. The participants who conducted BG-type searches had indicated that they wanted to gain in-depth knowledge regarding a specific condition in the patients. Furthermore, majority of the participants reported being instructed by a senior practitioner/physician to search for information when a clinical question was raised with only 29% of the total search being self-initiated by the participants themselves. The participants also preferred to search for information individually. Only 10% out of the total searches were conducted collaboratively with another counterpart. In terms of the success rate of the searches, majority of the searches (77%) were successful where the participants managed to retrieve their desired information to fulfil the purpose/aim of their search tasks. As for the searches that failed (23%), the participants reported being unable to retrieve the information they were looking for.

Table 8 presents the search descriptions that were grouped into BG- and FG-type searches. Based on the results presented in Table 8, the junior participants, who were MSs and HOs, were more frequent searchers as compared to the MOs and specialists. The junior participants were more likely to be instructed to search rather than initiating the searches themselves.

Table 8: The description of searches

Search Type	Search Description		MSs (s=32)		HOs (s=51)		MOs (s=10)		Specialists (s=6)	
			f	%	f	%	f	%	f	%
BG	Total Searches		26		45		8		3	
	Search Initiation	Self-Initiation	9	34.6	10	22.2	4	50	2	66.7
		Instructed	17	65.4	35	77.8	4	50	1	33.3
	Search Effort	Individual	24	92.3	41	91.1	6	75	3	100
		Collaborative	2	7.7	4	8.9	2	25	-	-
	Search Outcome	Success	24	92.3	31	68.9	7	87.5	2	66.7
		Failure	2	7.7	14	31.1	1	12.5	1	33.3
FG	Total Searches		6		6		2		3	
	Search Initiation	Self-Initiation	1	16.7	-	-	-	-	3	100
		Instructed	5	83.3	10	100	2	100	-	-
	Search Effort	Individual	6	100	5	83.3	2	100	2	66.7
		Collaborative	-	-	1	16.7	-		1	33.3
	Search Outcome	Success	6	100	4	66.7	1	50	1	33.3
		Failure	-	-	2	33.3	1	50	2	66.7

(Note: s-number of searches, f-frequency)

4.3 Search Session Details

In this section, the details of the online searching behaviours recorded in the 99 online search sessions are provided. The results from the Morae recording of the online searching process are presented in this section. This section is divided into four components: (I) querying activity, (II) result viewing activity, (III) online sources of information accessed and (IV) appraisal activity of the participants.

4.3.1 Querying Activity

This subsection presents the analysis of the participants' querying activity in attempts to answer the first research question of this study. The querying activity represented the participants' querying patterns during the search sessions. The queries were issued by the participants to search for information about their search tasks. Their queries were observed and recorded through the Morae recordings whenever a query was entered into the URL box of the web browser or the search box of the search engines used to search for information. The results of the querying activity were presented in terms of the participant categories and search types (FG/BG). The results were further divided into the number of queries issued, the average query length, the use of medical terms in queries, the use of stop words and operators in queries, queries with spelling errors, the issuance of ineffective queries and the re-issuance of the same query. The number of queries issued and the average query length are presented in Table 9, and the use of medical terms in the queries issued are presented

in Table 10. Whereas the use of stop words and operators are presented in Table 11, and the issuance of queries with spelling errors, ineffective queries and the re-issuance of the same query are presented in Table 12.

The participants issued a total of 311 queries with a mean of 3.14 (SD=2.6) queries. The participants who were HOs (61%) issued the highest number of queries compared to the MOs (11.25%), MSs (21%) and specialists (6.75%) out of the total queries issued. The average number of queries issued by all the participants were between two to four queries. The mean values for the average number of queries issued in BG- and FG-type search categories showed a minor difference whereby the mean value for FG-type searches was 3.5 (SD=2.7), which was slightly higher than BG-type searches with recorded 3 queries (SD=2.6).

The queries issued by the participants were then examined for query length. The length of a query issued was obtained by calculating the number of terms/words used in a single query. The mean query length was 3.9 (SD = 1.76) in this study. Specifically, FG-type searches showed a mean query length of 5.2 (SD=2.6), being higher than that of the BG-type searches with a mean of 3.71 (SD=1.4). The query length of the queries issued by the participants comprised of the HOs and MOs were similar. A mean of 3.6 and 3.7 terms in a query were issued by the HOs and MOs, respectively.

Table 9: Number of queries issued and average query length of the queries issued

Variables	Participants (Number of participants)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
	Type of Search (Number of Searches)	BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Queries Issued	Min	1	1	1	2	1	2	1	1
	Max	5	4	14	9	7	5	5	9
	Sum	54	11	160	30	28	7	9	12
	Mean	2.08	1.83	3.56	5	3.5	3.5	3	4
	SD	1.1	1.17	3.2	2.8	2.3	2.1	2	4.4
Average Query Length	Min	2	5	1.5	2.6	1.7	3	5	1
	Max	6	12	8	5	6	6	7	9.6
	Sum	98.6	42	159.1	23.4	28.7	9	18.2	14.6
	Mean	3.8	7	3.5	3.9	3.6	4.5	6	4.9
	SD	1	2.6	1.4	1	2.3	2.1	1	4.4

(Note: n-Number of participants, s-Number of searches, SD-Standard Deviation)

However, the participants who were MSs and specialists had issued queries with longer query length. The mean query length issued by the MSs and specialists were 4.4 and 5.5, respectively. The results from the Mann Whitney U–test indicated that higher query lengths were issued in FG-type searches as compared to BG-type searches (p=0.009). Table 9 represents the details of the number of queries and the average query length of queries issued by the participants in this study.

4.3.1.1 The Use of Medical Terms

The analysis of the medical terms in queries revealed that 70% of the total queries issued were medical queries. Medical queries are queries examined through the cross-checking of query terms with the medical terms used in the MeSH library.

In this study, the number of medical terms issued within a query was examined via cross-checking the terms with medical terms in the MeSH library. The results showed that 218 (70%) out of the total of 311 queries issued were medical queries, which included some medical terms. There were a total of 307 medical terms used by the participants with an average of 1.4 medical terms among the total medical queries recorded. The results also reported that the participants who frequently included medical terms in the queries were the HOs, with an average use of 3.7 medical terms in the queries issued, as compared to the MSs, MOs and specialists with an average number of 2.3, 3.5 and 2.3 medical terms, respectively. The evidence from the verbal utterance indicated that the participants had included medical terms in their queries to retrieve more relevant results. The results from the Mann Whitney's test also indicated that the number of queries issued in a search increased significantly with the use of medical terms (p=0.001). Furthermore, the results from the Kruskal Wallis's test indicated that the participants with a medical degree as their highest level of education (HOs and MOs) issued more medical queries than their counterparts (MSs and specialists) (p=0.044). This indicates that higher medical querying activity was seen among the HOs and MOs instead of the junior (MSs) and senior (specialists) participants. Table 10 displays the details on the medical terms used in the queries issued by the participants.

Table 10: Details of the use of medical terms in the queries issued

Variables	Participants (Number of participants)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
	Type of Search (Number of Searches)	BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Medical Terms	Min	0	0	0	0	0	1	0	0
	Max	8	3	16	13	12	3	6	7
	Sum	59	7	166	28	28	4	7	8
	Mean	2.3	1.2	3.7	4.7	3.5	2	2.3	2.7
	SD	2.2	0.9	4.2	4.9	4.2	1.4	3.2	3.8
Number of Queries with Medical Terms	Min	0	0	0	0	0	1	0	0
	Max	4	1	11	7	6	2	4	7
	Sum	35	5	125	19	18	3	5	8
	Mean	1.4	0.8	2.8	3.2	2.3	1.5	1.7	2.7
	SD	1.1	0.4	2.8	2.8	2.1	0.7	2.1	3.8
Queries with Medical Terms	Yes	29 (73.1%)	5 (83.3%)	39 (86.7%)	4 (66.7%)	7 (87.5%)	Yes	2 (66.7%)	2 (66.7%)
	No	7 (26.9%)	1 (16.7%)	6 (13.3%)	2 (33.3%)	1 (12.5%)		1 (33.3%)	1 (33.3%)

(Note: n-Number of participants, s-Number of searches, SD-Standard Deviation)

4.3.1.2 The Use of Stop Words and Boolean Operators

The analysis showed that the use of stop words was apparent in only 65% of the searches conducted. The result of this study was dissimilar to the result of previous studies (Davies, 2011; Sahapong et al., 2009). Previous studies reported higher usage of stop words, with stop words usage in 80% of the searches conducted (Davies, 2011; Sahapong et al., 2009). The remaining searches did not have stop words in their queries and the majority were from BG-type searches. When examining the number of stop words used in the queries, FG-type searches had queries with a higher number of stop words (one to four stop words) compared to BG-type searches (one to three stop words). The types of stop words used in this study were "in", "of", "on", "is", "for", "and" and "with".

In terms of Boolean operators, the participants from this study did not demonstrate frequent use of Boolean operators in their queries. Among the searches recorded in this study, only four searches had queries issued with Boolean operators, which were issued by the HOs. The operators used in this study were the double quotes ("..."), brackets and the "AND" operator. Further analysis indicated that the number of queries (p=0.003), the number of medical queries issued (p=0.03) and the number of medical terms used in a query (p=0.012) in a search increased significantly with the usage of

query operators. These results were derived from the Mann Whitney's test. Table 11 presents the details of the stop words and operators used in the queries issued.

Table 11: The use of stop words and operators in the queries issued

Variables	Participants (Number of participants)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
	Type of Search (Number of Searches)	BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Stop Words Used	Min	0	0	0	1	0	0	2	0
	Max	5	4	18	14	6	3	10	17
	Sum	37	16	92	34	9	3	20	17
	Mean	1.4	2.7	2	5.7	1.1	1.5	6.7	5.7
	SD	1.5	1.6	3.2	5	2	2.1	4.2	9.8
Queries with Stop words	Yes	17 (65.4%)	5 (83.3%)	26 (57.8%)	Yes	4 (50%)	1 (50%)	Yes	1 (33.3%)
	No	9 (34.6%)	1 (16.7%)	19 (42.2%)		4 (50%)	1 (50%)		2 (66.7%)
Queries with Operator	Yes	No		2 (4.4%)	2 (33.3%)	No			
	No			43 (95.6%)	4 (66.7%)				

(Note: n-Number of participants, s-Number of searches, SD-Standard Deviation)

4.3.1.3 Spelling Error, Ineffective Queries and Re-Issuance of the Same Query

In terms of spelling errors found in the queries issued, only 21 (6.75%) out of the 311 queries issued had spelling errors. Most of the spelling errors were found in the queries for BG-type searches. A total of 11 searches were affected by queries with spelling errors. There were spelling errors in a total of 16 queries issued in nine BG-type searches whereby the remaining five queries resulted from two FG-type searches. An example of spelling error found in the query was when the participant issued "hyponatramia in preterm", which did not produce any desirable result whatsoever. The participant was then issued another query right after the failed endeavour, this time with the correct spelling issued as "hyponatremia in preterm". This scenario resulted in higher querying activities, which in turn, delayed the searching process. Also, the results from the Mann Whitney's test indicated that there was a higher issuance of queries whenever spelling errors appeared in the queries issued (p=0.003).

Ineffective queries are queries that did not lead the searcher into clicking or viewing any of the results provided to them. In this case, not all the ineffective queries resulted

from the issuance of a query with spelling errors. In this study, 41 searches that had at least one ineffective query issued. From the ineffective queries issued, 33 were BG-type searches and eight were FG-type searches. During the analysis of the re-issuance of the same query, the participants were seen to reissue the same query within a single search session. This situation was prominent in 18 searches, most of which were conducted by the HOs. The results from the Mann Whitney's test indicated that the number of queries issued increased significantly in searches that had ineffective queries issued ($p=0.000$). Table 12 shows the details of ineffective queries and the number of queries issued with spelling errors.

Table 12: The issuance of queries with spelling error and ineffective queries

Variables	Participants (Number of participants) / Type of Search (Number of Searches)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
		BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Queries with Spelling Error	Yes	2 (7.7%)	No	5 (11.1%)	2 (33.3%)	1 (12.5%)	No	1 (33.3%)	No
	No	24 (92.3%)		40 (88.9%)	4 (66.7%)	7 (87.5%)		2 (66.7%)	
Number of Ineffective Queries	Yes	8 (30.8%)	1 (16.7)	19 (42.2%)	4 (66.7%)	4 (50%)	Yes	2 (66.7%)	1 (33.3%)
	No	18 (69.2%)	5 (83.3)	26 (57.8%)	2 (33.3%)	4 (50%)		1 (33.3%)	2 (66.7%)

(Note: n-Number of participants, s-Number of searches)

4.3.2 Result Viewing Activity

This section presents the analysis used to answer the second research question of this study, specifically the result viewing activity of the participants when searching for information during the practice of EBM. Under this subsection, the observed number of results and sub-links clicked, the number of tabs used to view results and the control functions used in searches are presented.

The number of results clicked was demonstrated when a specific link or webpage was accessed by the participants through the search engine after the queries were issued. The results of this study indicated that a total of 377 results were clicked when searching for information. Among the total results clicked, 302 results clicked were from the BG-type searches whereas the remaining were observed in the FG-type searches. The mean number of results clicked throughout this study was 3.81 (SD=3.11). Based on the data, the mean number of results clicked was higher in the FG-type searches, which was 4.41 (SD=3.043) as compared to the mean number of results clicked in the BG-type searches with a mean number of 3.68 (SD=3.13). This indicates that a higher result viewing activity was seen when searching for FG-type information. The results from the Mann Whitney test indicated that the number of results clicked/viewed had significantly increased when query operators were used in the queries issued (p=0.01). As for the results from the Kruskal Wallis test, a significant increase was shown in the number of results clicked/viewed by the participants who had indicated a medical degree as their highest level of education (p=0.013). The participants who had a higher number of queries issued were more likely to have a higher number of results clicked/viewed. In line with this statement, the results from Pearson's Correlation test between the number of queries issued and the number of results clicked were significant (p=0.000, r=0.678).

In terms of the number of sub-links clicked, it was recorded when the participants proceeded to click on the links presented in the result clicked/webpages visited. The mean number of the sub-links clicked in this study was 1.27 (SD 2.43) with the mean value also being higher in the FG-type searches, which was 1.82 (SD=3.067) as compared to the BG-type searches with a mean of 1.16 (SD=2.29). Through the verbal utterance of the participants, it was found that the participants clicked on the sub-links during the FG-type searches due to the progressive searching within a result/webpage to obtain a further understanding of the subject matter being searched. The results

from the Mann Whitney's test indicated a significant increase in the number of sub-links clicked by the male participants (p=0.011). This is an interesting finding, which demonstrates that male participants were more likely to perform progressive searching in accessing sub-links relative to female participants. Table 13 presents the details of the number of results and sub-links clicked by the participants.

Table 13: Details of the number of results clicked and the number of sub-links clicked during result viewing activity

Variables	Participants (Number of participants) Type of Search (Number of Searches)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
		BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Results Clicked	Max	6	6	16	14	5	3	10	7
	Min	1	2	0	5	1	1	2	1
	Mean	2.69	3.83	4.4	6.5	2.38	2	5	3
	SD	1.64	1.33	3.73	3.67	1.3	1.41	4.35	3.5
Number of Sub-Links Clicked	Max	6	7	13	3	4	N/A	N/A	11
	Min	0	0	0	0	0			0
	Mean	0.81	2.17	1.42	1.17	1.25			3.67
	SD	1.47	2.79	2.77	1.47	1.75			6.35

(Note: n-Number of participants, s-Number of searches, SD-Standard Deviation)

In the analysis of the result viewing activity, an interesting pattern was observed in the use of multiple tabs during searching. The number of tabs is the number of windows opened within a search browser when viewing results. Out of the total searches observed, 65.6% of the searchers had used more than one tab to view their results. Overall, the mean number of tabs used was 3.15 (SD=2.86). The mean number of tabs was higher in the FG-type searches with a mean of 4.29 (SD=3.53) as compared to the BG-type searches with a mean number 2.91 (SD=2.66). This indicates that a higher number of tabs were opened during the result viewing process in the FG-type searches as compared to for the BG-type searches. The results from the Mann Whitney's test also indicated that a higher number of results were viewed when using multiple tabs (p=0.000) and when sub-links were clicked (p=0.022).

The analysis of the result viewing activity of the participants also revealed the usage of control functions when viewing results/webpages. The participants who had used control functions in their searches were asked in the post-search interview regarding their reasons for doing so. Their responses were: "*To improve the searching process*"

and "*To skim through important content only*". Only four BG searches by a MO and three MSs had used control functions in their result viewing activity. The control functions used in this study were Control-F (in two searches) and Control + (in two searches). The Control-F function was used to search for terms such as "defin", "1P", "size", "mm" and "pda" within the information presented in the result page. Whereas the Control + function was used as a zoom-in function for better viewing of images and texts in the results presented. All four searchers who used control functions indicated that they were successful in searching for their desired information. Table 14 presents the details of the number of tabs opened and control functions used by the participants during the result viewing activity in this study.

Table 14: The details of the number of tabs opened and control functions used during result viewing activity

Variables	Participants (Number of participants)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
	Type of Search (Number of Searches)	BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Tabs Opened	Max	6	9	17	15	4	2	12	5
	Min	1	1	1	1	1	2	1	2
	Mean	2.81	4.33	3	5.67	2	2	5	3
	SD	1.55	2.81	3	5.05	1.2	0	6	1.73
Usage of Tab during search	Single Tab	7 (26.9%)	1 (16.7%)	22 (48.9%)	1 (16.7%)	4 (50%)	No	1 (33.3%)	No
	Multiple Tabs	19 (73.1%)	5 (83.3%)	23 (51.1%)	5 (83.3%)	4 (50%)	Yes	2 (66.7%)	Yes

(Note: n-Number of participants, s-Number of searches, SD-Standard Deviation)

4.3.3 Online Sources of Information Accessed

In this subsection, the following analysis was to answer the fourth research question of this study. The number of online sources[11] accessed by the participants is first presented and then followed by the description of the online sources accessed by the different participant categories.

The number of online sources accessed by the participants was observed by calculating how many different online sites, webpages, results and medical libraries were accessed by the participants during the searching process. Each type of online source accessed was considered as one type of source regardless of how many times the participants had accessed the source in a single search session. The mean number of sources accessed in a search session was 3.23 (SD=2.4). Majority of the searches (s=63) had the participants accessing between one to three sources per search session. Meanwhile, the maximum number of sources accessed was 12 in a single search. ̶Despite this observation trend, the results of this study also indicated that there were search sessions in which no sources were accessed throughout the search session (s=2). This study showed that the mean numbers of the online sources accessed by each participant categories were 2.5 (MSs), 3.9 (HOs), 2.2 (MOs) and 3.0 (specialists). The Kruskal Wallis's test results indicated that there was a significant increase in the number of online sources accessed by the participants who had indicated a medical degree as their highest level of education (p=0.01). Additionally, the results from the Mann Whitney's test indicated a significant increase in the number of online sources accessed when ineffective queries were issued (p=0.033), multiple tabs were used in searching (p=0.01) and when no query operators were used (p=0.007). Table 15 presents the details of the number of online sources accessed by the participants.

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[11] Each type of webpage/result clicked/site accessed within a particular search was recorded only as one type of source, regardless of how many times it had been accessed within a particular search session.

Table 15: The descriptive analysis of the number of sources used

Variables	Participants (Number of participants)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
	Type of Search (Number of Searches)	BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Number of Source Accessed	Max	6	4	0	11	5	2	6	5
	Min	1	2	12	3	1	1	2	1
	Mean	2.35	3.17	3.69	5.67	2.38	1.5	3.33	2.67
	SD	1.52	0.98	2.91	2.73	1.30	0.71	2.31	2.08

(Note: n-Number of participants, s-Number of searches, SD-Standard Deviation)

The types of online sources accessed by the different participant categories were further examined. Different participant categories had different preferences of online sources accessed in finding their desired information during the practice of EBM. In this study, the most preferred/accessed online sources when searching for information in the practice of EBM (BG- and FG-type searches) by different participant categories were also reported.

4.3.3.1 Description of Online Sources Accessed by MSs

The participants who were MSs accessed a total of 13 different online sources in their FG-type searches (s=6). Among the 13 sources, the most preferred source of information was Medscape (most appeared source, appearing in 3 different searches) followed by PubMed, PubMed Central, Online Library Wiley and Google Images (each appeared in two different searches).

In terms of their BG-type searches (s=26), a total of 41 different online sources were accessed. The participants had accessed Google Images (appeared in six searches) more frequently than other sources. This was followed by Medscape and PubMed (appeared in five searches), and PubMed Central (appeared in four searches). Furthermore, there were five other sources (Rcog.org, aapublication, UptoDate, Wikipedia and WebMD), which appeared in only two different searches each while the remaining sources (32 sources, 78%) were only accessed in one search session throughout.

In the entire study, PubMed, Medscape and Google Images were more commonly used by the MSs when searching for information during the practice of EBM. The results also showed that the MSs had accessed Wikipedia for information. The

participants who accessed Wikipedia for information were asked in the post-search interview on what made them access Wikipedia for information. Several responses included having a lack of experience in critical appraisal and the desire for an easier explanation based on the language used and content presented in Wikipedia. The details of the online sources accessed by the MSs in this study are presented under Appendix I.

4.3.3.2 Description of Online Sources Accessed by HOs

The participants who were HOs turned to Medscape and PubMed as their primary source of information in their FG-type searches (s=6). Medscape and PubMed were accessed in more than one search whereas the remaining sites were accessed only once throughout the study. The remaining sites were inclusive of but not limited to PubMed Central, MayoClinic, UptoDate, NEJM.org and other neonatal sites[12].

On the other hand, the HOs had accessed more online sources in their BG-type searches with a total of 75 online sources accessed. This was because the number of BG-type searches conducted by the HOs being high as well (s=45). Among the 75 online sources accessed, 70% of the sources appeared in more than one search, while the remaining were accessed online in one search session each. The most frequently accessed online sources were UpToDate, Medscape and PubMed.

Nevertheless, there were two searches carried out by the HOs where no source was accessed. In these two searches, one failed and the other was reported successfully retrieving their desired information. In the post-search interview, the participants were asked why no online sources were accessed. The participant who experienced the failed search session reported having other priorities whereby the search had to be terminated, while the other participant reported having found the desired information by reading the list of results itself. Further examination showed that the desired information was "*to determine the value of conversion units for the calculation of baby feeding milk*". The results also showed that two of the BG-type searches had resulted in the HOs accessing Wikipedia for information. A similar response was obtained in the post-search interview with the MS participants, that was, Wikipedia was accessed due to the ease of understanding the search information. The details of the online

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[12] Specialized sites online that are related to neonates.

sources accessed by the HOs are presented in Appendix J. Figure 6 illustrates the details of the online sources accessed by the HOs in their BG-type searches.

Number of Online Sources Accessed in BG Type Searches among HOs

■ UpToDate	13
■ Medscape	12
■ Pubmed	11
■ PubMed Central	6
■ BMJ, AAFP.org	5
■ Google Images	4
■ Radiopedia, Science Direct, Google Images, Aapublication	3
■ MedLine, MayoClinic, Pathology Outlines, Biomed Central, WordPress, MIMS.org, CDC.gov, Mpaweb.org	2
■ Others	1
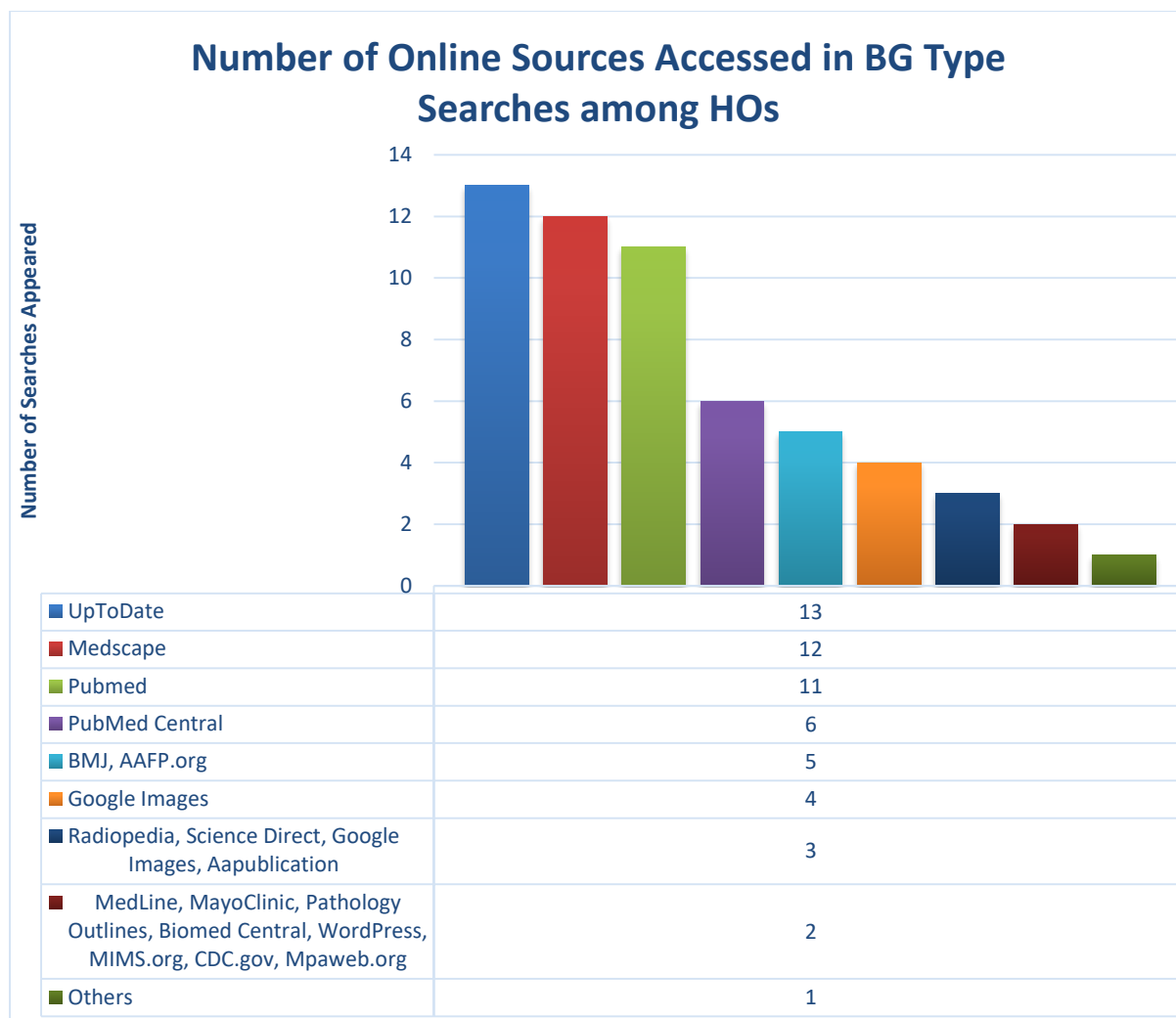
Figure 6: Details of the online sources accessed by the HOs in BG-Type searches

4.3.3.3 Description of Online Sources Accessed by MOs

The total number of searches carried out by the MOs were 10 searches (two FG-type searches, eight BG-type searches). The MOs had only accessed PubMed and UpToDate when searching for FG-type searches. Whereas in terms of BG-type searches, a total of 10 different online sources were accessed. The participants accessed UpToDate more frequently (appeared in 50% of their searches) when searching for BG-type searches, this being followed by PubMed, Medscape and aapublication, which appeared in at least two of their searches. The remaining online sources were accessed once by the MOs out of their total searches recorded. The details of the online sources accessed by the MOs are presented in Appendix K.

4.3.3.4 Description of Online Sources Accessed by Specialists

The total number of searches carried out by the specialists were six searches (three FG-type searches, three BG-type searches). In terms of the FG-type searches, the participants had accessed six different online sources and had accessed these sources only once. The online sources accessed in the three FG-type searches were ResearchGate, rehabmart.com, Google Images, Web of Sciences, Science Direct and Springer. When searching for FG-type information, these participants primarily accessed research-based sites as compared to other medical search engines and databases, which were accessed by other participant categories.

With regard to the BG-type searches, there were eight different sources accessed by the participants. The participants accessed PubMed in two of their searches whereas the remaining seven sources were only accessed once. The remaining sources accessed in the BG-type searches were Cochrane, Comidamed.de, mpaweb.org, Medscape, sons.org, adhb.govt.nz and nuh.nhs.uk. It was observed that the online sources accessed by the specialists were similar in the BG-type searches, which were Medscape and PubMed. Apart from that, the sources accessed by the specialists were predominantly research-based sites (ResearchGate, Web of Science, Springer and Science Direct), systematic reviews (Cochrane) and product-related sites (rehabmart.com and comindamed.de).

4.3.4 Appraisal Activity

The appraisal activity of the participants was analysed to answer the third research question of this study. The appraisal activity of the participant categories is presented in this subsection. The results of the appraisal activity were based on the participants' feedback recorded in the post-search interview. The participants' feedback on the appraisal were self-perceived based on their evaluation of the validity of the information retrieved. The participants were asked if they had performed an appraisal on the results during the search conducted. The participants who had indicated that the searches conducted were appraised were further asked on how the appraisal was performed. On the contrary, the participants who had indicated that appraisal was not done during the search session (un-appraised search) were requested to provide a reason for that as well. Under this subsection, the details of the appraisal activity on different types of searches are first presented and followed by the details of the appraisal activity among the participant categories.

Among the 99 searches, more than half of the searches consisted of un-appraised[13] searches (53, 53.5%) while the remaining were appraised. Based on the description of the appraisal activity reported by the participants, there was no actual appraisal of information conducted during the recorded searches. The reports on the participants who had indicated that appraisal activity was conducted were based on self-perceived responses. The analysis of the recorded responses indicated that the MSs and HOs had appraised majority of the FG-type searches in comparison to their BG-type searches. In spite of appraisal being reported, these were not the actual appraisal activities recommended by established guidelines. Table 16 presents the details of the appraisal activity by the participants in different types of searches conducted.

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[13] Searches in which the retrieved information was not appraised by the participants.

Table 16: Details of appraisal activity of participant in different search types conducted

Variable	Participants (Number of participants)	MSs (n=15)		HOs (n=19)		MOs (n=8)		Specialists (n=5)	
	Type of Search (Number of Searches)	BG (s=26)	FG (s=6)	BG (s=45)	FG (s=6)	BG (s=8)	FG (s=2)	BG (s=3)	FG (s=3)
Appraisal Behaviour	Yes	11 (42.3%)	4 (66.7%)	18 (40%)	4 (66.7%)	4 (50%)	1 (50%)	2 (66.7%)	2 (66.7%)
	No	15 (57.7%)	2 (33.3%)	27 (60%)	2 (33.3%)	4 (50%)	1 (50%)	1 (33.3%)	1 (33.3%)

(Note: n-Number of participants, s-Number of searches)

The analysis of how the appraisal was conducted as reported by the participants in their post-search interview is presented. The participants who had appraised their searches provided feedback on how the appraisal was carried out during the searches. Whereas the participants who did not appraise their search provided feedback on why the appraisal was not carried out during the searches.

4.3.4.1 Description of Appraisal Activity Among MSs

A total of 15 out of the 32 searches carried out by the MSs were appraised searches. Through their responses in the post-search interview, the MSs reported "*using the trusted site/trusted information source such as journal/research papers when searching for information*". Furthermore, the participants had also indicated that their appraisal activity was applied based on their previous experiences in medical searching. Additionally, the participants had also indicated methods such as checking the metadata of the information (such as the date and publisher) and searching through the content to look for abstracts and conclusions as their appraisal activity conducted during searching.

In the cases where the information retrieved was not appraised, the participants had stated the lack of appraisal skills as one of their common reasons. The participants had also reported "*they were not instructed to appraise*" as one of their reasons for un-appraisal. Other reasons included *"looking for a quick answer"* and *"used common sense and logic".*

4.3.4.2 Description of Appraisal Activity among HOs

Out of the 51 searches conducted by the HOs, only 22 searches were reported as appraised searches in the post-search interview. The HOs had reported utilising

similar methods to those used by the MSs when appraising their information. The results also revealed that the HOs had appraised their retrieved information through the discussion of information with a colleague and performed a quick comparison of information with other studies during their searches. In terms of searches where appraisal of information was neglected, the participants reported: *"lack of time"*, *"time constraints"* and *"looking for a quick answer"* as the reasons for not appraising their retrieved information.

4.3.4.3 Description of Appraisal Activity Among MOs

The participants who were MOs had appraised 50% of their total searches conducted (s=10). As similar to the MSs, they reported appraising their retrieved information via trusted sites, journals, research papers and *"using the international classification of Disease"*. Similar to the responses gathered from the HOs, time constraint was reported as a common reason by the MOs for not being able to perform the appraisal of information during searches.

4.3.4.4 Description of Appraisal Activity Among Specialists

The specialists performed a total of six searches in this study, where four out of the total were appraised searches. The analysis of the responses gathered from the specialists in the post-search interview revealed that the specialists used similar methods to the MSs, HOs and MOs in appraising information during searching. Additionally, they also relied on *"pre-appraised information from systematic review"* when searching for information. The appraisal was not conducted whenever the participants were unable to retrieve any related information to their search. Further examination of the data revealed that the participant was searching for product-related information and failed to retrieve any related information. Hence, no appraisal activity was carried out. As such, the specialists in this study had appraised the information in all of their searches except in situations where there was no information related to the searched matter.

4.4 Challenges Faced by Participants

The challenges reported by the participants in the post-search interview are presented in this section. The analysis presented in this section was to answer the fifth research question of this study. The results presented in this section were divided into two sections: (I) search challenges and (II) ICT related challenges.

4.4.1 Search Challenges

The search challenges reported by the participants were divided into three areas: (I) search queries, (II) searching strategies and (III) the outcomes/content of search. In this subsection, the challenges reported are presented based on the participant categories and a summary of the search challenges are presented at the end of this subsection.

4.4.1.1 Search Challenges Reported by MSs

In this study, the participants who were MSs had reported challenges in all three areas. In terms of the search queries, the participants had reported not knowing the right search queries to use for a particular search. Examples of such responses by the participants include:

"Basically, I am not sure if my keywords are correct." (Respondent 1)

"Not sure what I have typed exactly." (Respondent 2)

"I really don't know what to type, I just randomly type based on my questions."
(Respondent 3)

In terms of searching strategies, the participants had reported not knowing which results to click on or where they should begin. Examples of such responses include:

"I randomly choose the result presented to me." (Respondent 1)

"I don't know how to find; I know the very basics only." (Respondent 2)

"I don't know how to search, or where to start searching. "(Respondent 3)

The results also indicated that the participants were not confident in their appraisal skills. By mode of verbal utterance, the participants had reported that this was one of the reasons why they found it difficult in selecting which reliable source of information to proceed with the search. Responses in this regard include:

"I don't know how to appraise, so I do not know which trustable sites, so I just randomly take from well-known ones." (Respondent 4)

"I find it hard to identify reliable sources." (Respondent 5*)*

The analysis on the responses also showed that the participants had difficulties in searching for the desired information due to the placements of results being too far at the end of the page or requiring the need of going through the hassle of searching multiple resources before achieving their desired information. Examples of such responses were as follows:

"I have to go through multiple sites before finding the answer I want." (Respondent 6)
"The results presented to me were not direct, selecting the result was the problem, I had to scroll multiple times." (Respondent 7)
"I had to search thoroughly before getting to my answer, the result could improve in the way results were presented to us." (Respondent 8)

In terms of challenges in search outcomes/content presented to the participants, the MSs had reported having many resources to go through. Furthermore, each resource was having a combination of medical and non-medical content. The participants had to spend more time skimming through the content before finding their answers. Examples of such responses were:

"*There are too many resources to go through."* (Respondent 1)
"I have to carefully read through and find my answer after reading it, it was found in the abstract." (Respondent 2)
"Many unrelated information from non-medical sites." (Respondent 3)
"*Website and Images presented could improve readability*." (Respondent 4)

The participants had also reported difficulties in understanding the medical information presented on some websites. The level of English used in some sites was too sophisticated for them to understand, especially among the participants whose native language was not English. An example of such a site was Medscape. Examples of such responses were as follows:

"I can't seem to understand the related language used is too deep, I can't understand well." (Respondent 5)
"*Too many jargon and medical words used, I am looking for best explanation."*
(Respondent 6)

*"Language used in Medscape quite tough, PubMed is easier to understand in terms of language." (*Respondent 7*)*

4.4.1.2 Search Challenges Reported by HOs

The HOs reported facing search challenges in all three aspects of search queries, searching strategies and outcomes/content of searches. In terms of the search queries, the participants reported being unable to find the right keyword to search with, either because they did not know what to type, made spelling errors in queries or were unsure whether the queries typed were accurate. Examples of such responses among the HOs were as follows:

*"I typed a query and it responded as error in spelling." (*Respondent 1*)*

*"I don't know what to type exactly in queries." (*Respondent 2 and 4*)*

"I am not sure what to type, and I do not know which keyword to type appropriately."
*(*Respondent 3*)*

The HOs also reported facing challenges in the results presented to them right after a query was issued. The participants reported facing difficulty in retrieving any related results from an issued query. The results presented were instead focused on general sites/sources rather than medical-based websites. Examples of responses in this regard were as follows:

"I have no problem with issuing queries; however, it did not return any answers."
*(*Respondent 5*)*

*"I typed my queries expecting a more medical focused website; however, it gave more general kind of website. So, I had to retype my queries before getting the sites I want." (*Respondent 6*)*

In terms of searching strategies, the participants had stated their lack of knowledge in conducting the searching procedure. Similar to the MSs, the HOs claimed that they did not know where to start searching or how the searching should evolve after the queries were issued. Hence, they had turned to Wikipedia for answers instead. Examples of such responses were as follows:

*"How to start finding is the main problem." (*Respondent 1*)*

*"I don't really know where to go, I do know Wikipedia is reliable but others I don't know." (*Respondent 2*)*

"I think I lack of searching strategy, I generally put problems in and click whichever links that shows some keywords of it." (Respondent 3)

In addition, the participants had indicated that limited results were presented to them during a search in specific areas. Further examination of the search indicated that the results related to products were limited. As a result, the participants faced difficulty in continuing their search due to the limited studies available. Examples of such responses were as follows:

"*I find it difficult to find what I really want." (*Respondent 4*)*

"*Only one type of study was returned to me for what I have searched." (*Respondent 5)

"I had one study only to prove my problem; I feel that there should be more resources to prove my findings." (Respondent 6)

*"No appropriate sites to my problems." (*Respondent 7)

Incorrect placement of results was reported among the HOs when searching for quick information. The participants claimed that they had to keep searching and scrolling to find their answer, which was placed far below in the results list or on the next page. Examples of such responses were as follows:

*"The answers shown to me are not direct; I have to do a lot of unnecessary findings." (*Respondent 8)

*"There were too many unwanted results; most are not medically customized enough." (*Respondent 9)

"I had to scroll all the way down where the answer I was looking for is placed; relatable answers were not at the top." (Respondent 10)

In terms of search outcomes, limited access to sites was of a major issue. For instance, access to such sites requires paid subscriptions, which hindered the participants from accessing related articles to their searches. Through the verbal utterance of the participants, an example of a subscription site was UpToDate. Examples of such responses were as follows:

*"Requires ID and login." (*Respondent 1)

"Journal subscription." (Respondent 2)

"*Search domain isn't free, requires access." (*Respondent 3)

"Access and subscription issues." (Respondent 4)

The reports on inconclusive outcomes were common in this study. One notable issue was that the required information was scattered across several websites and as a result, the participants were unable to make their final decisions. The participants had reported there were too many resources and articles to go through, as well as expressing that the explanations provided on several sites were contradicting on certain subject matters. Examples of such responses were as follows:

*"Results are too general, not very specific to neonates." (*Respondent 5)

*"No outcome that I was looking for." (*Respondent 6)

*"Lack of relatable and specific information." (*Respondent 7)

"Not very informative, I had to search multiple sites" (Respondent 8)

"Too many generalized answers, not specific enough, there is probably a way to do it, but I am not sure". (Respondent 9)

The difficulties in determining the quality of the contents retrieved were also reported, which include the lack of information on the source of content (i.e., metadata such as date of publication, demographical/geographical content of research conducted) for determining the validity of the retrieved content, the in-depth high level of English used in the content and studies on the subject matter is derived from a single specific demographic zone, which was not generalizable to their respective patient's situation. Examples of such responses were as follows:

"Took me a while to understand what was in the article, the language used too in-depth." (Respondent 10)

"Had no time to search in-depth." (Respondent 11)

"Different explanation & different sites, can't seem to understand the language used too deep, I can't understand well." (Respondent 12)

"There were several websites but too few references, not enough information on trusted site." (Respondent 13)

"Inadequate information based on only one zone." (Respondent 14)

4.4.1.3 Search Challenges Reported by MOs

The participants who were MOs did not face any challenges in the first two areas of search queries and searching strategies. However, these participants faced difficulties in access and subscription issues on certain sites and the retrieval of too much information resulted in information overload. Examples of the responses from the participants were as follows:

"No access to Uptodate" (Respondent 1)

"Access and subscription issues are prominent." (Respondent 2)

"My answers are usually not specific enough for the information that I find, there are too many examples of unrelated things." (Respondent 3)

4.4.1.4 Search Challenges reported by Specialists

The participants who were specialists had no difficulty in issuing search queries. However, in terms of searching strategies, the participants reported that the pieces of information to their queries were often separated and were found in multiple sources. Examples of participants' responses were as follows:

"Piece of information are everywhere, and I end up reading something else."

(Respondent 1)

"The information shown on Google are based on ranks, maybe that's why pieces of information are everywhere." (Respondent 2)

The participants claimed that the related information was not presented in an orderly manner, often resulting in time-consuming searches through multiple sources to obtain the desired information. In terms of the search content, limited access and subscription requirements were reported. Examples of responses include:

"Manufacture websites are everywhere, but I can't find any appraisal for the milk content. Hence, I will be looking for help in forums." (Respondent 1)

"Inconclusive answers, there are no evidence of the information I want, there is insufficient trial info. "(Respondent 2)

"The sites require subscriptions; there are very limited freely available articles that I can view without subscription." (Respondent 3)

4.4.1.5 Summary of Search Challenges

This subsection summarizes the search challenges reported by the participants during the process of online searching when practising EBM. Table 17 presents the details of the search challenges, which were categorised into three major areas: search queries, searching strategies and search outcomes/content.

Table 17: Summary of Search Challenges Reported by Participants

Search Challenges	MSs	HOs	MOs	Specialists
Search Queries				
Difficulty in issuing appropriate search queries, keywords	√	√		
Queries returning unrelated information		√		
Searching Strategies				
Lack of searching skills	√	√		
Lack of Appraisal Skills	√	√		
Result placement Issues	√	√		√
Search Outcomes/contents				
Information overload (too much information, words)	√	√		
Quality of Content (Difficulty understanding the level of English used)	√	√		
Lack of information (on certain topics)		√		√
Subscription and access issues		√	√	√
Inconclusive Outcomes		√	√	

Based on the details presented in Table 17, the participants who were HOs and MSs reported facing a variety of difficulties during searching. As for more experienced participants such as HOs, MOs and specialists, these groups reported facing a variety of difficulties in interpreting the search outcomes presented to them.

4.4.2 ICT Related Challenges

The results on the ICT related challenges faced by the participants are presented based on their responses gathered from the post-search interview. Based on the analysis of the responses gathered from the participants, the ICT related challenges in this study were divided into three areas: (I) network issues, (II) computer/laptop issues and (III) peripheral device issues.

In terms of network issues, the participants had reported facing challenges in 20 (20.2%) out of the 99 searches recorded. Further examination on the participants' responses revealed that challenges such as "unstable Internet", "no network connection" and "slow internet connections" were prominent. Despite this study being held in a public teaching hospital that was primed to practice EBM, Internet issues occurred in 20% of the searches recorded causing delayed and interrupted searching.

Secondly, the participants had reported having laptop issues on the laptops used to practice online searching during EBM, which affected the searching process in two out of the total searches recorded. Further examination on their responses revealed that device issues such as "Computer too slow" and "Computer is lagging" were prominent. This indicates that the processing power of the searching device was not able to accommodate the participants' preferred searching speed.

In spite of the common ICT challenges reported by the participants in this study, the results in this study had also revealed that the ICT challenges occurred in the peripheral devices used along with the primary search device as reported by the participants. Based on the participants' responses, issues such as the confusion in using a multiple-computer mouse on the laptop and limited battery life of the laptop that could not sustain itself until the grand clinical round was over were evident.

4.5 Summary of Collated Results

The results from the individual sections (search session details) are presented in a unified view. Table 18 shows a blended view of the online searching behaviours and appraisal behaviours across the participant categories.

Table 18: Collated view of online searching and appraisal behaviour demonstrated by different participants.

Category of Participants	Medical students (MSs)	House Officers (HOs)	Medical Officers (MOs)	Specialists	Overall Participants
Preferred Search Type	BG	BG	BG	BG	BG
Initiation of Search	Instructed	Instructed	Self-Initiated	Self-Initiated	Instructed
Querying Activity	A higher number of queries issued in BG type searches, Longer Query Length	A higher number of queries issued in FG type searches, Shorter Query Length, Use of Boolean operators	A similar number of queries issued in BG and FG type searches, Shorter Query Length	A higher number of queries issued in FG type searches, Longer Query Length	Use of operators significantly increased: • The number of queries issued, • The number of medical queries issued • The number of medical terms used in queries. The number of queries issued was significantly higher when: • Queries with spelling errors were issued • Ineffective queries issued.
Result Viewing Activity	Lower average number of results clicked	Higher average number of results clicked	Lower number of results clicked	Higher number of results clicked	• The number of sub-links clicked significantly higher among male participants. • The use of tabs when viewing results significantly increased the number of sub-links and results clicked.
Preferred Online source of information	Medscape, PubMed, Google Images	Medscape, UpToDate, PubMed	PubMed, UpToDate, Medscape	PubMed, Research-based sites such as ResearchGate, Web of Science, Cochrane	The number of online sources accessed by participants increased significantly: • By participants whose highest level of education is a medical degree • the issuance of ineffective queries • the use of multiple tabs • when no query operators are used
Method of Appraisal	Used trusted sites, metadata, search through content during the appraisal	Used trusted sites, metadata, search through content during the appraisal	Used trusted sites, journals, international classification of Disease, metadata, search through content during the appraisal	Rely on pre-appraised evidence, and trusted sites.	Almost half of the searches were appraised searches. More frequently appraised by MSs and HOs on the information gathered during FG type searches.
Reason for not appraising searches	they were not instructed to do so, looking for a quick answer	Time constraints	Time constraints	Not Applicable, all information were appraised except searches which did not return any information	

Based on the collated results presented in Table 18, the participants demonstrated similar behaviours in the preferred search type, the preferred source of information and appraisal methods used in evaluating the validity of the information. In terms of querying activity of the participants, only the MSs demonstrated a higher number of queries issued in the BG-type searches whereas the rest of the participants issued a higher number of queries in the FG-type searches. The participants who were MSs and specialists demonstrated higher result clicking activity when searching for information as compared to the participants who were HOs and MOs. With regard to their preferred online source of information, all the participants frequently accessed PubMed. Out of these, the specialists demonstrated a common preference towards research-based sources. The participants had also demonstrated similar behaviours when performing the appraisal of information except for the specialists who frequently relied on pre-appraised content during their searches. The discussion of the results and potential impacts of this study are presented in the next chapter.

Chapter 5 Discussion and Research Contribution

In this chapter, the results obtained from the recorded search sessions concerning the online searching behaviours of the EBM practitioners during the practice of EBM are discussed. This is then followed by the discussion of the appraisal behaviours of the EBM practitioners recorded in the search sessions. The chapter then concludes with the discussion of the theoretical and practical contributions of this study.

5.1 The Online Searching Behaviour of EBM Practitioners

In this section, the results of the overall online searching behaviours are provided. Subsequently, the online searching behaviours demonstrated by the final year MSs, HOs, MOs and specialists during the practice of EBM are presented. The summary of the online searching behaviours is provided based on a direct comparison with previous studies (e.g. online searching behaviours when searching for EBM related information). The discussion of the overall searching behaviours of the EBM practitioners is provided first. This is then followed by the online searching behaviours of the final year MSs, HOs, MOs and specialists.

In the past, only limited studies investigated the online searching behaviours of EBM practitioners based on the actual practice via search tasks that arise in a hospital setting. Previous studies relied on self-perceived methods in identifying EBM practitioners' online EBM searching behaviours (Chan & Teng, 2005; Davies, 2007; Davies, 2011; Hisham et al., 2018a; Hisham et al., 2016b; Hisham et al., 2018b; Hoogendam et al., 2008; Lai & Nalliah, 2010; Lykke et al., 2012; Sahapong et al., 2009). A total of 47 EBM practitioners were involved in a total of 99 search sessions (BG- and FG-type searches). The results of this study indicated that there were higher BG-type searches recorded (83%). Majority of the searches were instructed searches (71%) with a total of 77% of the total searches resulting in successful outcomes based on the self-perceived responses from the participants. This indicates that the online searching behaviours demonstrated by the majority of the EBM practitioners in this study were instructed behaviour, which had resulted in a higher number of successful outcomes. The findings from this study can be used as a reference for new searching behaviours of EBM practitioners when searching for EBM related information online.

The results indicated that there were longer query lengths and higher use of tabs in the FG-type searches in comparison to the BG-type searches. This could be due to

the complexity of the FG-type search, which includes the PICO format that requires more terms to be included in the query issued (Richardson et al., 1995; Sackett et al., 2000; Straus et al., 2005). Furthermore, the results of this study indicated that the majority of the questions were BG-type searches instead of FG-type searches. The possible reasons for this being the poor formulation of FG-type questions and the higher confidence practitioners had in searching for BG-type searches. More tabs were used in the FG-type searches to view several different results on a single query issued. Moreover, when query operators were used, the number of queries, the number of medical terms used in a query and the number of results clicked were significantly increased. One possible reason could be due to the improper/unfamiliar use of query operators, which requires query reformulation/refining resulting in a higher number of queries issued. When a higher number of queries were issued, the number of results clicked increased. This was reflected in the Pearson's Correlation test, which indicated a positive correlation between the number of queries issued and the number of results clicked. In terms of the online sources accessed, the EBM practitioners accessed a significantly higher number of online sources when ineffective queries were issued at a higher rate as well as when multiple tabs were used to search for information. This could be due to the issuance of ineffective queries leading to the clicking and retrieval of unnecessary results and information. This search behaviour is unproductive as it leads to wastage of resources and time. Therefore, this indicates a need for better information retrieval strategies based on the description of online searching behaviours among the EBM practitioners in this study. Such initiatives would minimise unproductive behaviours to improve the frequency of successful outcomes in online EBM searching and these initiatives are presented in Section 5.3.1. Nevertheless, the results of this study were dissimilar to the results from previous studies, which were focused on self-perceived methods. Hence, the findings from this study indicated a need for a new search behaviour profile based on the current description of the EBM practitioners' searching behaviours in the practice of online EBM. In the next subsection, the online searching behaviours of different EBM practitioner categories are discussed.

5.1.1 Final Year Medical Students (MSs)

The MSs performed a higher number of BG-type searches as compared to the FG-type searches. The rate of successfully searching for the desired information was

93.75% out of the total searches initiated by the MSs. The MSs demonstrated lower querying activity as compared to the HOs, MOs and specialists (Table 9, Section 4.3.1). Previous studies supported the average query length issued by the MSs in this study (Hoogendam et al., 2008; Lykke et al., 2012). However, the MSs demonstrated novice behaviours in other aspects of querying activity (the highest average query length issued in the FG-type searches, the highest number of queries with stop words, the lowest number of medical terms used in queries and the lowest number of queries with medical terms issued). There was a study indicated that the use of stop words in queries could be an obstacle in searching for the desired information (Yilma et al., 2019), while in contrast, the increased usage of medical terms in queries increased the chances of retrieving the desired information (Davies, 2011; Sahapong et al., 2009). The results from these previous studies were contradicting with the behaviours in the querying activity, which led to successful search outcomes, of the MSs in this study.

In terms of result viewing activity, no previous studies reported any finding on the result clicking behaviour among MSs. In this study, the MSs demonstrated a higher usage of search tabs when searching for FG-type information. The MSs also demonstrated the highest usage of multiple tabs during searching as compared to the HOs, MOs and specialists. The control functions were also utilised when viewing the results clicked. With regard to the number of sources accessed, the MSs had accessed the lowest number of sources in the BG-type searches. This could indicate that the ease of information retrieval strategies was applicable to the BG-type searches by the MSs. From the conducted searches, the MSs had also indicated PubMed and Medline as their most preferred sources of information. Previous studies also reported PubMed as one of the most accessed sources (Brennan et al., 2014; Lai & Nalliah, 2010; Manan et al., 2017; O'Carroll et al., 2015). Even so, the findings from this study have also reported the use of Wikipedia by the MSs. This result was also somewhat similar to the findings from previous studies (Kritz et al., 2013; O'Carroll et al., 2015). Besides, the MSs accessed Google Images frequently during their searches. Google Images were accessed to obtain a better understanding/view of the intended search given the novice experience level among the MSs. As such, a new search behaviour profile is needed for MSs, as this will lead to better information retrieval strategies to assist novice searchers in searching for EBM related information.

The minimal usage of queries with medical terms, searches with longer query length and the access to unreliable sources of information have reflected the MSs' search challenges in query formulation and searching strategies as reported in this study. On account of this fact, there is a need for the formulation of new strategies to encourage MSs in issuing more queries with medical terms, shorter query length and aid them in accessing reliable and validated online sources. These strategies are necessary for MSs to develop so as to improve their practice of online EBM. These strategies are discussed in Section 5.3.2.

5.1.2 House Officers (HOs)

The HOs demonstrated the most active search behaviours in this study. The overall searches conducted by the HOs were the highest (54.5% out of the total searches recorded in this study) compared to the MSs, HOs and specialists. The HOs demonstrated the highest querying activity during searching (the highest average number of queries issued, the highest number of stop words used in queries issued for the FG-type searches, the highest number of queries issued with spelling errors and issued the most ineffective queries). The results from this study are not congruent with the findings from previous studies, which indicated a lower number of queries issued when participants were searching for EBM related information (Hoogendam et al., 2008; Lykke et al., 2012; Sahapong et al., 2009). Essentially, a higher number of ineffective queries and queries with spelling errors are regarded as unproductive search behaviours. This indicates a need to develop specific information retrieval strategies to reduce these unproductive search features. Throughout this study, only 68% out of the searches carried out by the HOs were reported as successful in retrieving the desired information. Thus, such strategies are important for the HOs in enabling them to complete their searches successfully.

With regard to the result viewing activity, the HOs demonstrated the highest number of results clicked in the FG-type searches, whereas in the BG-type searches, the highest number of sub-links were clicked. This indicates that the HOs are more comfortable in clicking sub-links during BG type searches whereas, in FG-type searches, different results links are clicked without progressive reading. The highest number of online sources were accessed when the participants were searching for both the BG- and FG-type information, which indicates active searching through online sources to obtain the desired information. However, the results in this study have also

revealed that the HOs managed to obtain their desired information without clicking on any of the result links. Instead, information was obtained based on the descriptions of the result presented to them in the result page. Aside from that, the HOs also demonstrated further reading practices by downloading online materials. The downloaded materials were in the form of .pdf and .ppt, where they were saved to a local/cloud drive for future reading. This shows that the HOs are not only active searchers but also demonstrating additional search actions in further reading. As such, there is a need for new search behaviour profiles based on the online EBM searching behaviours of the HOs in this study. A new search behaviour profile will be able to provide relevant assistance to relay information retrieval strategies to active EBM practitioners. These initiatives are discussed further in Section 5.3.1.

5.1.3 Medical Officers (MOs)

The search behaviours demonstrated by the MOs in this study was simple. The MOs had performed a total of 10.1% of the total recorded searches, of which 80% resulted in successful outcomes. The MOs demonstrated simple search behaviours in issuing a higher average number of queries and a high average query length in their querying activity. The MOs had also issued the lowest number of stop words in both their FG- and BG-type searches, with no spelling errors in all the queries issued as well as included medical terms in the queries issued in all the FG-type searches. While the MOs were the most active in issuing queries, they have demonstrated problematic searching behaviours (the highest number of ineffective queries in all their FG-type searches, the most number of queries without clicks, the lowest number of results clicked, no sub-links clicked in their FG-types searches, the lowest number of tabs opened and the lowest average number of online resources accessed, especially in the BG-type questions). The MOs have demonstrated uneven querying behaviours versus result viewing behaviours. This indicates the non-uniform searching behaviours among the MOs to be prevalent during online EBM searches.

Although the simple search behaviours demonstrated by the MOs were effective in producing successful outcomes of the search, the results from this study are not congruent with the findings from previous studies. Previous studies reported a lower number of queries and a shorter query length in queries issued (Hoogendam et al., 2008; Lykke et al., 2012; Sahapong et al., 2009). In light of this, the need for new searching behaviour profiles based on the current search descriptions of online EBM

searching is indicated. In terms of the results clicking behaviour and the online sources accessed, a simple result viewing behaviour in accessing a lower number of results and online resources was demonstrated. On the basis of these results, the existing methods in selecting the best online EBM resources were sufficient to support MOs in searching for relevant results and online resources (Guyatt, 2008; Isaacs, 2014; Sackett et al., 2000). Hence, there is no need to develop new search behaviour profiles for MOs in terms of result viewing activity.

5.1.4 Specialists

The specialists have demonstrated two types of searching behaviours in this study. The types of searching behaviour observed were uncertain and expert behaviours. The uncertain behaviour demonstrated by the specialists were reflected in their querying activity. The specialists issued the highest number of queries in the FG-type searches compared to the BG-type searches, the highest average query length in the BG-type searches, the lowest number of medical terms used in the FG-type searches and the highest number of stop words used in all the BG-type searches. The specialists had also issued a higher number of ineffective queries in their BG-type searches as compared to the FG-type searches. Such behaviours demonstrated by the specialists were classified as uncertain and were dissimilar from previous studies, which reported lower queries issued, a higher number of medical terms used and the use of stop words obstructing the searcher from searching for their desired information (Davies, 2011; Hoogendam et al., 2008; Lykke et al., 2012; Sahapong et al., 2009; Yilma et al., 2019). Only half of the searches conducted by the specialists in this study resulted in successful outcomes. This uncertain behaviour of the specialists indicates a need for the formulation of better information retrieval strategies to improve their online searching behaviours during the practice of EBM.

In terms of expert searching behaviour, the specialists had demonstrated experienced searching behaviour in the areas of result viewing activity and the online sources accessed. The specialists' expert searching behaviour was proven by minimal spelling errors in the queries issued (no spelling errors in the FG-type searches), recording the highest number of links clicked in the BG-type searching, the highest number of sub-links clicked in the FG-type searches and having accessed only medical-based/research-based sites for information. Apart from that, the specialists also demonstrated progressive searching in the FG-type searches, which was indicated by

the higher number of sub-links clicked. In addition, only medical-based/research-based sites were accessed for information, indicating the retrieval of valid and pre-appraised information. Such behaviour was considered as an expert and was in line with the guidelines established by previous studies (Guyatt, 2008; Isaacs, 2014; Sackett et al., 2000). The results of this study were focused on the different types of searches. Hence, this indicates a need for a new search behaviour profile based on the search description of the specialists in this study when performing online EBM searches. The initiatives are discussed further in Section 5.3.1. Appraisal behaviour is presented in the next section.

5.2 Appraisal Behaviour

The EBM practitioners had reported challenges in the appraisal activity (evaluation of the validity of retrieved information). Majority of the participants had indicated the lack of time and looking for a quick answer as reasons for not performing the appraisal during the search sessions. The results from this study indicated that the EBM practitioners who were MSs, HOs and MOs evaluated the validity of the information retrieved in most of their FG-type searches in comparison to the BG-type searches. The specialists evaluated the validity of the retrieved information in all of their searches except when the information was unavailable. From what was observed, the EBM practitioners applied different methods in evaluating the validity of the retrieved information. The results indicated that the EBM practitioners based their searches on trusted sites, journals and research papers and checking the metadata of the information when searching for information. Furthermore, the EBM practitioners had reported evaluating the validity by performing a quick comparison with other similar studies.

The appraisal behaviour of the EBM practitioners in this study was dissimilar from the practices recommended by the guidelines in previous studies (Isaacs, 2014; Sackett et al., 1996; Sackett et al., 2000; Straus et al., 2005). In fact, no actual appraisal was conducted in this study as compared to the participants' self-perceived methods reported. Although previous studies reported improvement in the appraisal skills among EBM practitioners (Al-Motairy & Al-Musa, 2013; Burls, 2014; Thangaratinam et al., 2009), the results from this study indicated that the EBM practitioners were not following the recommended practice. The methods used in ensuring the validity of information were more straightforward in this study, in contrast to the techniques that

are recommended. It must be noted, however, that the practice of ensuring the validity of information is no longer a standalone process. The results indicated that the methods used by the EBM practitioners in ensuring the validity of information were initiated as soon as they started searching. It was an ongoing process where the EBM practitioners ensure that the retrieved information was derived from trusted online sources, research papers/journals, as well as by performing comparisons among several studies and the examination of the metadata. Even so, these were not the same as the recommended practice of appraisal activity.

This indicates a major gap in the current practice of online EBM as the practice of critical appraisal is of paramount importance and needs to be immediately addressed. This could also indicate the need for a refined appraisal/evaluation method among EBM practitioners to be applied in performing quick searches during the practice of EBM. The recommended guidelines in previous studies were time-consuming and not applicable to the practice of online EBM. In the next section, the research contributions of this study are presented.

5.3 Research Contributions

This section presents the research contributions of this study. The research contributions were divided into theoretical and practical contributions. Firstly, theoretical contributions are presented. This is then followed by practical contributions.

5.3.1 Theoretical Contributions

The results obtained from the recorded search sessions, pre-search interview and post search interview provide several contributions in comprehending the online searching behaviours of EBM practitioners during the practice of EBM. It also provides a better understanding of the online EBM searching behaviours across different types of EBM practitioners. The contributions are further interpreted below.

5.3.1.1 Identification of the Searcher

The EBM practitioners in this study demonstrated different search behaviours when searching for EBM related information online. The search behaviours were categorised into novice (MSs), active and unproductive (HOs) and simple (MOs). The search behaviours demonstrated by the specialists were further divided into two search behaviours: uncertain and expert. The MSs demonstrated the lowest querying activity, minimal usage of medical terms, longer query length and the lowest number

of online sources accessed when searching for information. The MSs have also accessed Wikipedia and Google Images for simple answers that provide a clearer understanding of the searched information. On the other hand, the HOs demonstrated the most active search behaviours in issuing the highest average number of queries and the number of results clicked. The active search behaviours among the HOs were also seen when the relevant online contents/materials were downloaded in the form of .pdf and .ppt for further reading. On another note, the HOs also demonstrated unproductive search behaviours in issuing the highest number of queries with spelling errors and ineffective queries issued.

The MOs demonstrated simple search behaviours and fewer searches as compared to the MSs and HOs. The simple search behaviours were demonstrated by the MOs in issuing queries with no spelling errors and including medical terms in all the searches conducted. Nevertheless, this study observed the problematic searching behaviours demonstrated by the MOs in terms of issuing the highest number of ineffective queries in the FG-type searches, issuing the most number of queries without any results clicking and no sub-links clicked in their FG-type searches. This indicated uneven search behaviours in the querying activity versus the result viewing activity. On the other hand, the specialists demonstrated uncertain searching behaviours in issuing the longest query lengths in the BG-type searches, the highest number of queries as well as the lowest number of medical terms used in the FG-type searches and a higher number of ineffective queries in their BG-type searches. Despite this, the study results found that expert searching behaviour was demonstrated by the specialists in issuing minimal queries with spelling errors, having the highest number of sub-links clicked in the FG-type searches and based on the online sources they had accessed (accessing only medical-based/research-based sites for information.

The findings confirmed the differences in search practices and proficiency among the different subgroups of participants. The study added to the findings of previous studies, which mostly focused on self-perceived search competencies, by demonstrating observed search (Inthiran et al., 2012; Lykke et al., 2012; Yilma et al., 2019). The findings of this study provided an additional dimension of information for the development of further strategies in improving the online searching design and skills implemented during the practice of EBM.

5.3.1.2 Identification of Search Types

The EBM practitioners had performed both the BG- and FG-type searches in this study. Previous studies highlighted the emergence of BG- and FG-type searches in the practice of EBM (Geddes, 1999; Richardson et al., 1995; Sackett et al., 2000; Straus et al., 2005). In this study, the EBM practitioners had searched for more BG-type searches (83%) than FG-type searches (Table 8, Section 4.2). The searches were mostly instructed searches indicating the EBM practitioners are not primed to practice online EBM on their own. Nevertheless, the results from this study revealed that the online EBM searches were more focused on BG-type searches among all categories of EBM practitioners. The average queries issued in the BG- and FG-type searches were similar. However, the average query length for the FG-type searches was noticeably longer. This could be due to the nature of FG-type searches that are more specific to patients' condition and include the recommended use of the PICO query formulation guideline. Ineffective queries and queries with spelling errors were more prominent in the BG-type searches. In terms of result viewing activity, a higher number of results clicked, search tabs used and sub-links were clicked in the FG-type searches. The number of online sources accessed by the MSs and HOs was higher in the FG-type searches.

This study found that the online searching process among the EBM practitioners was more actively engaged when searching for FG-type information. In spite of that, the frequency of the EBM practitioners searching for FG-type information was lower when compared to BG-type searches. The identification of different types of searches during the practice of EBM is essential as this could lead to the improvement of searching strategies used by EBM practitioners, based on different types of searches conducted (BG or FG). This could also result in minimising the unproductive search behaviours in the result viewing activity of FG-type searches.

5.3.1.3 Evaluation on the Validity of Retrieved Information

The EBM practitioners had demonstrated different methods of evaluation on the validity of the retrieved information. The results of this study found that the methods used were dissimilar to the recommended critical appraisal practices in previous studies (Burls, 2014; Horsley et al., 2011; Isaacs, 2014). No evidence of proper critical appraisal being conducted throughout the recorded searches. Nevertheless, the EBM practitioners who were MSs, HOs, and MOs demonstrated similar evaluation methods

in the majority of their FG-type searches (Section 4.3.4). Whereas only the participants who were specialists have reported appraising all their BG- and FG-type searches. The key methods used by the participants in evaluating the validity of the retrieved information in this study were by utilising information gathered from trusted sites/online sources, journal and research papers and the quick check on the metadata of the retrieved information. Furthermore, the EBM practitioners had also reported performing a quick comparison of the retrieved information from multiple sources to ensure the validity of the information. Recommended practices of appraisal from previous studies were not used in ensuring the validity of information in this study. The EBM practitioners had indicated the lack of time in performing critical appraisal and expressed the need to search for quick information during the practice of EBM in the NICU.

This indicates that the critical appraisal of information was not being practised in the implementation of EBM. Not only that, but the recommended appraisal practices from previous studies also may not apply to and be feasible in the practice of EBM at patients' bedside in the NICU. The identification of the methods used to evaluate the validity of information in this study is necessary to understand how the EBM practitioners are performing appraisals when as a matter of fact, the actual practice of critical appraisal is not properly implemented. The understanding of the methods used by the participants to validate the information in this study could be applied to design a better critical appraisal guideline for situations when immediate information is needed.

5.3.1.4 Identification of Online Search Behaviour Pattern During the Practice of EBM

The EBM practitioners in this study had demonstrated different online search behaviour patterns during the practice of EBM. The results from this study were dissimilar from the recommended five steps in EBM practice established by Sackett et al. (1996). Where in this study, the EBM practitioners demonstrated only four major steps in practising EBM: Ask, Access, Decision Making and Assess. The appraisal/evaluation of information validity occurred concurrently during the access and decision-making phases. The 'Ask' phase remained similar to the recommended EBM practice by Sackett et al (1996), where the EBM practitioners began searching as soon as the clinical queries were raised during the practice of EBM. The querying

activity, result viewing activity and online sources accessed were within the 'Access' phase of the searching behaviours. After the desirable information was retrieved, the EBM practitioners proceeded to the decision-making phase. In this phase, the retrieved information was mapped to the patients' condition taking into consideration the patients' values and preferences along with the medical expertise of the EBM practitioners (this includes the consultation and expertise of a more experienced practitioner). Throughout the retrieval of information and decision-making processes, the evaluation of information validity/appraisal was carried out. The final phase in the search behaviour pattern in this study was the 'Assess' phase. The 'Assess phase' was demonstrated by the EBM practitioners in the form of taking notes/information and downloading the content retrieved from searching. This phase was mostly demonstrated by the junior EBM practitioners consisting of MSs and HOs. The diagrammatic representation of the overall online search behaviour patterns is listed in Appendix M.

The identification of the online EBM searching behaviours demonstrated by the EBM practitioners in this study indicated dissimilar patterns compared to those recommended by previous studies (Isaacs, 2014; Sackett et al., 2000). The identification of the online EBM searching behaviours highlighted that the recommended practices might not be useful in the real practice of EBM. Without the identification of this search pattern, the effectiveness and usefulness of the recommended practices in previous studies are unattainable. As such, the results of this study are capable of informing the key criteria in transitioning the practice of EBM towards the practice of online EBM.

5.3.1.5 Identification of Search Domains

All the EBM practitioners resorted to Google on the first query of their search. Google is a general search engine and is not recommended in searching for EBM related information. Google may not be able to support or return specialized information to EBM practitioners who might need more specific and validated information. Although PubMed and Medscape were frequently used as their major sources of information, this study found that the MSs were accessing Wikipedia as one of their online sources for straightforward information. Wikipedia is known to be unreliable as it is a general-purpose site comprising of unreliable information that can be easily modified by anyone.

Proper guidance should be instilled into EBM practitioners to ensure that queries are issued in medical-related/specialized sites in order to obtain validated and content-specific information. An example of this was observed in a study prompting the teaching of online EBM for their students (Rohwer et al., 2013). Such online guidance has been proven to enhance the knowledge and skills of practising EBM. Another example was seen in a study promoting the practice of online EBM to their participants through exercises (Lewin et al., 2014). The results from the study indicated that the majority of the participants were able to apply the online EBM exercises into their practice.

5.3.1.6 Identification of the Challenges in Online EBM Searching

The challenges reported by the EBM practitioners were divided into two areas: search challenges and ICT related challenges. In terms of search challenges, the novice (MSs) and active (HOs) searchers had reported having difficulties in three key areas: (I) search queries, (II) searching strategies and (III) search contents presented to them. The MSs and HOs reported difficulties in issuing appropriate search queries and keywords, lacking searching and appraisal skills, difficulty in judging the quality of information, too much of unrelated information to wade through and the intensity of language used in the content that was difficult to grasp. Whereas for the simple (MOs) and expert (specialists) searchers, the difficulties faced were in terms of insufficient/inconclusive outcomes, result placement issues and limited access to subscription-based sites. Ensuring sufficient training and skills enhancement could present a possible way to overcome the challenges reported in terms of issuing the right keywords/queries and searching strategies. In terms of results placement and information overload, online systems' design improvement could aid searchers in minimising this challenge. One such improvement could be by programming the system to display related queries and the most relevant information on the top of the result page to prevent searchers from having to wade through enormous irrelevant content. This issue could also be resolved by providing the searcher information on how to evaluate the information presented to them in order to limit retrieval to strictly high-quality information.

With regard to the ICT challenges reported, the EBM practitioners possess the sufficient skills in using the ICT due to their education and experiences in university, which would have equipped them with the necessary skills in using the Internet for

academic purposes. As such, only 20% of the total searches had Internet-related issues. The issues reported were unstable Internet connection and a slow network connection. One way to minimise this challenge is to ensure the hospitals are equipped with a proper and stable Internet connection to guarantee uninterrupted use. The EBM practitioners had also reported speed issues in the devices used to search for information. Hospitals should ensure that the facilities provided for information search are well maintained and upgraded periodically to avoid such issues from prevailing. Issues in the setup of computer peripherals were also known to have caused ICT related challenges in this study. Example of such issues was the limited battery life of the laptops on the moveable trolley and the confusion of peripheral devices (mouse) experienced by the searchers. Proper design/setup of laptops and computers with sufficient battery life should be available at all times for EBM practitioners to ensure that facilities are ready when there is a need to search for EBM related information online.

5.3.2 Practical Contributions

The practical contributions for the establishment of improved information retrieval strategies when searching for online EBM information are provided. Specifically, these contributions are relevant to the online searching behaviours demonstrated by EBM practitioners during the practice of EBM.

5.3.2.1 The Need for Better Query Refining Assistance

This study found that the issuance of ineffective queries in the EBM searches was high (41%). The issuance of ineffective queries did not prompt the participants to click on any result links presented to them. Furthermore, the queries issued with stop words appeared in at least 65% of the searches recorded. The use of stop words is recognised as an obstacle to retrieving desired information (Yilma et al., 2019). Furthermore, the findings from this study have also indicated that the EBM practitioners frequently issue queries with spelling errors. Such queries are common during EBM searches due to the medical terms used in the queries. Some medical terms are too sophisticated and resulted in spelling errors. A better query refinement and expansion assistance are required to overcome these issues. EBM practitioners issue queries based on their clinical queries, which arise during the practice of EBM. A query refining system should be developed to ease the querying activity of EBM practitioners. An example of this was seen in a study that attempted to redefine queries

by expanding terms using query context (Crimp & Trotman, 2018). Such a method has been proven to reduce the retrieval of unrelated results and increase query performance. This should be applied in the retrieval of health-related information during the practice of EBM. Several studies reported the use of query refining and query expansion to improve the querying activity in the retrieval of health-related information (Hariharan & Francis, 2018; Xu et al., 2019). Such systems should be in place even before EBM practitioners begin to search. A query refining system should be able to generate proper queries and relevant keywords to guide EBM practitioners in selecting appropriate terms to be issued in queries. This method would minimise the unproductive querying activity such as issuing unnecessary queries with spelling errors and ineffective queries during EBM searches to return the most plausible results to the users.

5.3.2.2 The Need for Better Design of Result Page

The EBM practitioners in this study had reported facing difficulties in wading through too much information to find their answers. All the EBM practitioners initiated the searching process through Google, which is a general search engine. As a consequence, some of the information presented to them were general and non-specific to the queries issued. The EBM practitioners who were specialists demonstrated result viewing behaviour in viewing results beyond the first results page. This could indicate a poor design in the presentation of results in the results page where desirable and important search results were placed beyond the first result page.

An enhanced design of the result page is required to overcome this issue. An example of an improvement to the search results page is to ensure the page returns the most relevant results based on the query interpretation. A study that focused on re-ranking results based on relevancy and document density reported improving the precision of retrieval and faster execution of search tasks (Klouche et al., 2017). Such interventions should be implemented in the retrieval of EBM related information. A possible method is for general search engines to provide both a specialised and general view of information. The specialised view should only return results from specialised medical sites, pre-appraised information and research-based sites. Whereas the general view of the search engine can include information derived from articles, news, forums and other similar information, which are not pre-appraised or validated. The purpose of the general view could cater for searchers who only want to gain knowledge on the

searched matter and are not to be used to make clinical decisions for patients. In contrast, the purpose of the specialised view is to provide information for both general searchers and medical professionals, especially the EBM practitioners who are searching for information to make informed clinical decisions. This would provide a comprehensive view of information that caters to the searching needs of EBM practitioners in both BG- and FG-type searches.

5.3.2.3 The Need for Result Refining Assistance

The EBM practitioners in this study faced difficulties in viewing the results presented to them (Table 17, Section 4.4.1.5). The EBM practitioners who were MSs and HOs faced difficulties in searching skills when deciding on which results to choose from the queries issued due to limited experience in the practice of online EBM. On the other hand, the EBM practitioners who were MOs and specialists had reported knowing which results to view from their queries issued. However, they faced challenges when wading through heaps of information, some were of poor quality and irrelevant and led to inconclusive outcomes of the searched matter. The MOs and specialists deemed reaching inconclusive outcomes even after searching through heaps of information as unproductive.

One approach is to provide result refining features in the returned results to the EBM practitioners. Result refining features can be done in several ways. Firstly, the returned results should be presented in an orderly manner where EBM practitioners are given the choice to filter the most relevant results. Relevant results should be presented based on the most up to date information. Keywords from queries should be highlighted in the text to allow rapid reading. This would minimise the time taken for EBM practitioners in reading through the entire content of returned information. Secondly, building on the specialised view (Section 5.3.2.2), searchers should be allowed to rate scores on the information presented. Scores rating should be based on the most relevant, high-quality information and feedback given by previous searchers on a particular result. For example, voting systems such as "likes", star ratings, reviews and comments should be enabled for searchers who are medical experts to present their opinion on the returned results. This would give the searcher a chance to report on limited or inconclusive findings on the search matter. In this way, EBM practitioners may obtain further information on the returned results to judge the quality and relevance of information presented without having the need to go through

the entire content. Also, the inconclusive outcomes can be immediately identified so that EBM practitioners could resort to other means of solving their clinical queries without investing too much time on a particular search. Lastly, statistical findings on medical studies should be highlighted and indicated at the top of each retrieved information. This minimises the need for EBM practitioners to go through the content in searching for statistical findings in the situation when quick and reliable answers are needed. These strategies would encourage EBM practitioners into deciding the need for further investigation on the returned results, thus minimising the time spent that would have otherwise been invested in going through heaps of information.

5.3.2.4 The Need for Better Information Retrieval Skill Enhancement Strategies
The EBM practitioners in this study had reported challenges in searching and appraisal skills. In terms of searching, the EBM practitioners demonstrated different searching behaviours such as novice, active, problematic, unproductive, simple, uncertain and expert. The EBM practitioners who were MSs and HOs faced difficulties in this area and required immediate attention. Initiatives in improving the practice of EBM should focus on offering searching skills based on reflective tasks simulations (Lewin et al., 2014; Rohwer et al., 2013). This would require further investigation on the types of simulated scenarios to provide an example to EBM practitioners on the effective methods of retrieving desirable results. This could also be applied to enhance the appraisal/methods used to evaluate the validity of returned results. The findings from this study revealed that the methods used by the participants to evaluate the validity of results were dissimilar from the methods suggested by previous studies. This could be an indicator of the need for a simpler yet effective method of appraisal that can be applied when searching for information during the practice of EBM to minimise the time taken in appraising evidence. The improvement to existing appraisal methods is required to enhance EBM practitioners' searching skills and this may encourage the practice of appraisal when practising EBM. This option would allow EBM practitioners to equip themselves with the necessary skills required in both knowledge gained and in practice. In the next chapter, the conclusion from this research study is provided.

Chapter 6 Conclusion

This chapter first presents a conclusion of this study, followed by the limitations and future works.

This study aimed to investigate the online information searching process during the practice of EBM among the EBM practitioners who were final year MSs, HOs, MOs and specialists. A total of 99 search sessions issued by a combined total of 47 EBM practitioners were recorded. The search tasks recorded in this study were based on the EBM practitioners' clinical queries faced during the practise of EBM in the NICU. The findings showed that there were a higher number of BG-type searches (83%) recorded in this study when compared to FG-type searches. Majority of the searches were instructed searches (71%) with an overall 77% of the searches resulting in successful outcomes. The results indicated that different search behaviour profiles were derived from different types of EBM practitioners, which were MSs, HOs, MOs and specialists.

The MSs demonstrated novice search behaviours during searching. Lower querying activity (lowest queries issued) was seen among the MSs, which was in line with the findings from previous studies (Hoogendam et al., 2008, Lykke et al., 2012). The EBM practitioners who were HOs demonstrated the most active search behaviours in this study. Meanwhile, the MOs demonstrated simple search behaviours. The search sessions recorded by the MOs were only 10% out of the total searches recorded with 80% of these searches being successful in retrieving the desired information. Uncertain and expert search behaviours were demonstrated by the specialists in this study. Even numbers of BG- and FG-type searches were carried out by the specialists.

The findings on the search behaviours among the EBM practitioners indicated uneven and different search behaviours demonstrated by different types of EBM practitioners, which were MSs, HOs, MOs and specialists. This indicates a need for different search behaviour profiles highlighting the various search behaviours among the different types of EBM practitioners. These initiatives are presented under Section 5.3.1.2. Furthermore, the findings from this study reported the search behaviours among different EBM practitioners in both the BG- and FG-type searches, which contribute to the identification of different search types in the practice of EBM. The contributions on the search behaviours in different search tasks are presented under Section 5.3.1.2.

Previous studies reported on the overall searching behaviours during the practice of EBM without considering BG- and FG-type searches. In this case, the findings from this study have explored the overall searching behaviours and enabled the identification of search behaviours among different types of EBM practitioners. The contributions of the overall searching behaviours are presented under Section 5.3.1.

In addition to the online searching behaviours, the appraisal activity (evaluation of the validity of information) indicated dissimilar patterns of appraisal of information in this study. The EBM practitioners in this study had reported using trusted sites (specialised medical sites), journals and research papers to retrieve information.– Additionally, quick comparisons were done between several sites and practitioners engaged in checking the metadata of the retrieved information. These methods comprised only some parts of the recommended practice, as the recommended appraisal practice is more sophisticated and may not be applicable in situations when quick information is needed. This indicates a need for a better method for validity evaluation to be applied by EBM practitioners in ensuring that the validity and reliability of information are retained during the practice of information searching. Such initiatives are discussed in Section 5.3.1.3 and 5.3.2.

The challenges faced during the online searching process when practising EBM were also identified. The EBM practitioners reported facing search challenges in terms of the (I) search queries, (II) searching strategies and (III) search outcomes. The challenges reported were similar to previous studies (Andrews et al., 2005; Bennett et al., 2005; Zwolsman et al., 2012; Zwolsman et al., 2013). This indicates that search challenges remained prominent among EBM practitioners when searching for information online during the practice of EBM and this requires attention. The identification of challenges and the initiatives in overcoming such challenges during the practice of online EBM are presented under Section 5.3.1.6. In the next subsection, the limitations of this study are provided.

6.1 Limitations

The searches recorded in this study were based on the clinical queries faced by the EBM practitioners, which was an attempt to reflect the participants' 'true' search behaviours. The results presented in this study indicated that different online searching behaviours were observed during the practice of EBM among different types of EBM practitioners. The EBM practitioners had searched for a higher number of BG-type searches as compared to FG-type searches with an overall 77% of the searches having succeeded in retrieving the desired information.

Although the results of this study presented multiple interesting findings, there were certain limitations that need to be acknowledged. The results obtained from this study cannot be generalized. It is limited to the unique population involved in this study, which is within the practice of EBM in the NICU of a public teaching hospital. The search purposes (search tasks) recorded were based on the clinical queries faced by the EBM practitioners and these varied in each search. The search tasks/purposes were derived from the self-perceived responses of the participants in the pre-search interview. These search tasks were categorized into BG- and FG-type searches. Nevertheless, none of the participants conducted more than one search with the same search task. Majority of the searches conducted by the MSs, HOs and MOs were instructed searches whereas only the FG-type searches conducted by the specialists were self-initiated. This is due to the nature of the setting being a public teaching hospital where junior participants were mostly instructed by their superiors to search for information.

The study observed the actual search purpose to reflect the 'true' search behaviours within the context of EBM. The different demographics of the participants may also influence their searching strategies. The participants have issued at least one search, while multiple searches (with different search tasks) from a single participant existed throughout this study. One way to overcome this situation is to ensure that only one search per participant is to be recorded in future research. However, this is not applicable in this setting as the number of EBM practitioners involved in the clinical rounds were limited.

The number of searches recorded among different types of EBM practitioners, which were MSs, HOs, MOs and specialists, was uneven. Due to the nature of this study in

recruiting participants through convenience sampling, the number of searchers and participants in different categories was different. As such, statistical analysis cannot be performed due to insufficient and uneven sample distribution among different participant categories. Despite this limitation, the overall searching behaviours were analysed with consideration of different participant categories. It was derived based on the overall online searching behaviours of all the participants where statistical analysis was applied.

Several modifications are necessary to improve the methods utilised in this study, especially during the post-search interview. During the post-search interview, the participants were asked to describe the methods used in appraising/evaluating the validity and reliability of the information. This was done after the search was completed and the participants were unable to fully describe/explain what techniques were used and may have missed out important information. Furthermore, the appraisal methods reported in this study indicated that there was no actual critical appraisal of information. Instead, the participants had reported that critical appraisal of information was done based on peer-to-peer information and the retrieval of information from trusted sites. As such, the findings from the analysis of the appraisal activity of the participants in this study only stated the methods used to ensure the validity and reliability of the information but not the actual suggested critical appraisal methods. One possible method to overcome this is to prompt the searcher in explaining their searching strategies, appraisal methods, and challenges faced throughout the search session instead of explaining at the end of each search session. This would allow the eliciting of detailed information of the searching behaviours of EBM practitioners and discover what criteria EBM practitioners apply in retrieving desirable information. This information would be necessary to design better querying and result viewing strategies during the practice. In addition, the participants in this study were unable to describe the use of the retrieved information. This is because the post-search interview was designed to collect information at the end of the search session. Hence, the participants were only able to describe whether they had successfully obtained their desired information but not how the information was utilised in practice. Future improvements could be made in designing a method in obtaining how participants have utilised the information presented. The information obtained could be used to

understand the effectiveness of information retrieved to design better strategies in the practice itself.

The results obtained from this study can be applied to suggest research directions in the use of new and existing data. The existing data collected in this study can be used further to examine the types of queries issued by EBM practitioners during online EBM searching. The queries can then be further examined for query reformulation, addition and deletion qualitatively. This can be used to further understand the types of queries issued and the transition of queries during a particular search. Furthermore, the search purposes (search tasks) in this study were self-perceived (based on the clinical queries faced by the EBM practitioners) during the practice of EBM. While the search purposes may be able to reflect the 'true' search behaviours of participants, it would be interesting to analyse the types of search tasks done by participants. Instead of categorising the searches into BG- and FG-type searches, the searches could be further categorised into the diagnosis-, prognosis- and treatment-type searches. Analysing existing results using such a method would offer an extensive view of the search behaviours in different search tasks.

The result viewing activity of the participants in this study was based on the number of links, sub-links and number of tabs opened during a search. Additional analysis could be done on the types of results that were clicked by participants (e.g. websites, journal papers and articles) as well as to understand the reasons why such results were clicked. In terms of tabs opened, the identification of the types of information and whether participants had viewed all the opened tabs should also be taken into consideration. This information would be necessary to elicit a more detailed understanding of online search behaviours during the practice of EBM. Information obtained through this method would be useful in understanding the search patterns to determine better strategies in improving the practice of online EBM.

Lastly, the search sessions recorded in this study were limited to the morning clinical rounds in the NICU of the selected public teaching hospital. The data was not collected from the clinical rounds that take place in the evening. This is a limitation as there may be different search patterns that were not captured in the evening clinical rounds.

6.2 Future Work

The main focus of this research study was limited to the online searching process during the practice of EBM. Another interesting method is to understand the information-seeking behaviours of EBM practitioners. The information-seeking behaviours would provide an understanding of how EBM practitioners re-search for information, using other search intermediaries such as mobile phones, tablets, medical libraries, peers and colleagues during the search sessions. New data would be derived to comprehensively understand online information searching during the practice of EBM. Similarly, study designs can be modified to include the investigation of factors influencing the searching behaviours in the practice of EBM. In this study, the exploration of EBM practitioners' 'true' search behaviours was conducted to understand the online searching behaviours. The factors influencing the search behaviours were neglected. It would be motivating to examine the factors that affect the searching behaviours of EBM practitioners, causing participants to demonstrate different searching behaviours. This could also include the examination of behaviours among successful and unsuccessful searches to determine the different search patterns and factors that contribute to the outcome of searches.

Future work involving designing and developing the research contributions under Section 5.3.2 are of paramount importance. The development of research contributions under Section 5.3.2 is divided into several steps. Most importantly, there is a need to provide better query and results refining methods. The EBM practitioners in this study had reported uneven, uncertain and some unproductive patterns in both result viewing and querying activities (Section 5.1). The design of querying and result viewing refining assistance would minimise these issues. In terms of returned result pages, there is a need to provide an extensive view of results in a general and more specialised manner. This would enable searchers to utilise search features in selecting validated, reliable and most up-to-date information during searching.

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Appendix

A. Human Ethics Certificate of Approval

MONASH University

Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project Number:	CF14/16 - 2014000006
Project Title:	The Practice of Online Evidence Based Medicine amongst Physicians in Malaysia: Is There Evidence at Point of Care
Chief Investigator:	Dr Anushia Inthiran
Approved:	From: 7 January 2014 To: 7 January 2019

Terms of approval - Failure to comply with the terms below is in breach of your approval and the Australian Code for the Responsible Conduct of Research.

1. The Chief Investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
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 include your project number.
6. Amendments to the approved project (including changes in personnel): Require 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.

Professor Nip Thomson
Chair, MUHREC

cc: Dr Jayantha Rajapakse, Prof Nathorn Chaiyakunapruk, Assoc Prof Nai Ming Lai, Mr David Chong

B. Explanatory Statement

31st March 2015

Research Title:

Online Information Searching Behaviour during the practice of Evidence Based
Medicine (EBM) among EBM Practitioners at a Neonatal Intensive Care Unit (NICU)

This information sheet is for you to keep. My name is Vinesha Selvarajah and I am
conducting a research project in collaboration with Dr.Anushia Inthiran, Professor
Nathorn Chaiyakunapruk and Mr. David W.K. Chong from Monash University
Malaysia, and Associate Professor Dr. Lai Nai Ming, Associate Professor Dr. Rishya
Manikam, Dr. Azanna Binti Ahmad Kamar and Dr. Choo Yao Mun from UMMC.
Through this project, I will be writing several conferences and journal papers for
publication.

You have been selected as a participant for this research study as it is conducted at
the Department of Trauma UMMC and Department of Neonatal ICU. You will be
identified as a research subject with the possibility of performing online Evidence-
Based Medicine Search. This study aims to report the state of online evidence based
medicine and to further improve the quality of evidence-based medicine practised by
medical doctors. This research study takes the ICT resources and services used to
perform Evidence Based Medicine into account, as well as make suggestions to better
facilitate the practice of Evidence Based Medicine from the perspective of Information
Communication Technology (ICT). By participating in this survey you agree to help
provide input and suggest enhancements to the practice of Evidence Based Medicine.

This study involves several tasks such as pre and post-experiment interviews,
collection of search activity logs, a non-intrusive observation of user search behaviour
and the participation in a focus group discussion. The total time taken for the entire
process will not exceed 1 hour. Also, there is no inconvenience or harm related to you
throughout your participation in this research.

Your participation is voluntary and you are under no obligation to consent to participate. However, if you consent to participate, you may only withdraw before the *start of the search activity of the recorded search session*. Your name will not be associated with any information that you provide. It is not possible for you to be identified in any subsequent publications or presentations. Storage of the data collected will be adhered to the University's regulations and is kept on University's premises in a locked cupboard/filing cabinet for a total duration of 5 years. Reports of the study may be submitted for publications, individual participants will not be identifiable in such reports. No information will be released to any other parties.

If you would like to be informed of the aggregate research finding, please contact Vinesha Selvarajah at vinesha.selvarajah@monash.edu
Thank you.

| If you would like to contact the researchers about any aspect of this study, please contact the Chief Investigator:

Ms. Vinesha Selvarajah
Tel : 603- 5514 6090
Fax: 603- 5514 6129
Email: vinesha.selvarajah@monash.edu | If you have a complaint concerning the manner in understanding medical information searching research is being conducted, please contact:

Project Number:
MEC ID: 201311-0506 (UMMC)
CF14/16 – 2014000006 (Monash University) |

C. Consent Form

Title: Online Information Searching Behaviour during the practice of Evidence Based Medicine (EBM) among EBM Practitioners at a Neonatal Intensive Care Unit (NICU)

NOTE: This consent form will remain with the researcher for their records

I agree to take part in this research project specified above. I have had the project explained to me, and I have read the Explanatory Statement, which I keep for my records. I understand that agreeing to take part means that:

List all procedures
I agree to be interviewed (pre and post)   ☐ Yes   ☐
No

I agree for activities to be logged, observed and audio recorded   ☐ Yes   ☐
No

I agree to take part in the focus group activity   ☐ Yes   ☐
No

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw before the start of the project without being penalized or disadvantaged in any way. I understand that there is no risk involved to be by taking part in this research study.

I understand that any data that the researcher extracts from the pre and post-experiment interview /focus group/keylogging activities are for use in reports or published findings will not, under any circumstances, contain names or identifying characteristics.

I understand that any information I provide is confidential and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party.

I understand that data from the interviews, keylogging activities, transcripts from the focus group activity and observation logs will be kept in secure storage and access to the research team. I also understand that the data will be destroyed after 5 years unless I consent to it being used in future research.

Participant's name:

Signature: Date:

D. Questionnaires

Please note that no patient details/data will be collected
This is a de-identified interview/focus group

Demographic Details

Age: _____   Native Language: _____   Gender: M/F   Education: _____   Position: Medical Officer / Medical Student/ House-Officer / Specialist in Training /   Specialist / Nurse / Others: *Medical Year (medical student): _____   *Years of Medical Practice: _____   Nationality: _____   Duration of General Search Experience: _____   Month(s) / Year(s)   Duration of Medical Search Experience: _____   Month(s) / Year(s)   Frequently used domains for medical search: _____   Time spent searching for medical information per day: _____ Minutes/Hours   Time take for one search: _____Minutes/Hours   What are the usual conditions that lead you to do a search?   _____   Location of Search: Home / Work (Hospital)/Both/Others: _____

EBM Related Experiences

1. When did you first hear about EBM?

   _____ Months / Years ago, During: _____

2. How long have you been practising EBM? _____ Months / Years

3. What do you remember learning in your EBM course?

4. What other trainings in **searching** have you learnt? (apart from the above)

5. Any difficulties with faced when practising EBM?

E. Pre-Search Interview

1. Why are you doing this search? (Description / Purpose)

2. What initiated you to conduct the search mentioned above?

   2.1. **Category of Problem:** Background / Foreground
   2.2. **Search Nature:** Instructed Search / Self-Initiated Search
   2.3. **Types of Search:**

   Medical therapy / drug therapy / diagnosis / treatment / prognosis / Justification

   Others:

3. **Conducting Search:** Individual effort / collaborative effort
4. Were there any **OTHER DEVICES USED** in the search apart from the main computer?

F. Video Analysis Checklist (Logged by Morae and Audio Recorded)

1.1. Start time:
1.2. The domain used to perform the search
1.3. Did the domain usage require a special login ID
1.4. Was the domain accessed directly or accessed through a search engine
1.5. The number of queries issued throughout the whole experiment.
1.6. List of queries issued
1.7. Length of the query
1.8. Number of ineffective queries
1.9. Queries with Spelling errors
1.10.   Reissuance of the same query
1.11.   Medical terms in the query
1.12.   List of medical terms used
1.13.   Number of query operators used
1.14.   Number of stop words used
1.15.   Types of stop words used
1.16.   Use of Control Functions
1.17.   Number of results clicked
1.18.   Number of Sub-Links Clicked
1.19.   Viewing results beyond the 1st results page
1.20.   Number of different online sources accessed
1.21.   List of online sources accessed
1.22.   Task Completion Time

(END)

G. Post-Search Interview

1. Results: Found / Not Found

    If FOUND,
     How did you find it?

    If NOT FOUND,
     Why?

    Others:
     Explain:

2. Did you **APPRAISE** the result?

    If **YES,**

    Describe how?

    If NO,

     Why?

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Information and Communication Technology Used During the Search Process

1. What devices were used to perform the search?

    1.1. Device(s) was: Personal Device / Provided by: _____

    1.2. Please name the device used (model)

2. What networks were used to perform the search?

    2.1. Network was: Personal Data Plans / Provided by: _____

    2.2. Please name the network used.

3. Are you happy with the searcher devices/networks provided to you? If
       Yes/No, Why

  Slow, Screen to Small, Network Not Stable

  Other:

4. What are the difficulties faced when conducting **THIS** search?
During the Search Queries?

(Exp: I don't know what to type, Spelling errors)

  During the searching strategy?

(Exp: I don't know where to find, what to click)

  During the outcome of the Search?

(Exp: Evidence found but it doesn't make sense to me, I can't find evidence.)

  Others:

(END)

H. Description of Search Tasks

Participant	Type of Search (BG/FG)	Conditions Leading to Search	Description and Purpose of Search
MS	**BG**	Doctor got to know the problem through screening	retina of prematurity
		Instructed and questioned by physician, curious to find the answer	What is martin apnea prematurity
		Was given a lecture question by physician, requiring them to search for answers	What is the diet for lactating mother? Educating the patient (mother) Is important to educate them
		Patient having that problem	To know what is hydrofetalis?
		To know the definition and relation of the problem, to understand, and patient having this problem	PPHD and pulmonary hypoplasia?
		Suddenly remembered yesterday's problem, a patient born prematurely in ER, lower section lung section because of reverse diastolic flow	What is inverse diastolic flow
		Bronchopulmonary Pulmonary Dysplasia	Lack of knowledge, patient diagnosed prompted to find more, first time in NICU. Particular common condition here.
		Definition of certain diseases, pathophysiology and etiology. Clinically and pathologically of defining disease. Criteria, cases, how.	One of patient was having this disease.
		To know neonan syndrome.	Read this symptom in case file not sure what is it.
		Pathogen; formula milk, what the content, usage	Doctor talked about for patient
		Symptoms/signs if heart failure in neonates	Relevant to case
		Normal range For heart rate/respiratory for neonates	Relevant to patient to check whether patient normal
		To understand more about OAE and Bera hearing test, why is it done, indication, function of test	going to test on patient hearing
		definition of small for gestational age	Plot a growth chart for premature baby, was asked to define
		Large gestational for neonates	Patient having s.g.a, Dr. asked about L.G.A
		Why a female baby can have g6pd deficiency.	Confused on how g6pd is a x link inherited disease. Rare for baby to get g6pd deficiency
		G6PD deficiency In female(newborn)	To understand the g6pd in female, the patient is female, g6pd definition homozygote definition
		Diff tyoes of twins and complications of twins pregnancy	Twin patient babies had low birth weight, wanted to know other complications of twin pregnancy
		Neopuff, what it is and usage	Read in the notes, one of the management was neopuff, wanted to know what it is
		Prematurity with BPD - What to know under BPD	from patient, written on the notes, wanted to know why
		Normal range of blood sugar for neonates academic	asked by lecturer, patient related
		Definition & description of BPD	Patient has it
		New bullet score - wanted to know the components and how to evaluate the maturate of babies	Patient premature, would like to know whether baby is preterm or not based on new ballat score.
		digestion problems in neonates, possible causes	Baby had persistent diarrhea ,wanted to find out other causes

		sites/location for edema in neonates	Relevant to case, complication of the PDA
		Wanted to find the causes & prognosis in hydrocephalus baby	Patient had it, curious to know
	FG	Table of sensitivity and specification of test	my specialist calculate term of that formula, i learn it before but not sure, discussing about WBC and CRP is it sensitive and neonate is developing sepsis
		To find the specific value for WBC and CRP specify to decide whether neonatal sepsis	During the discussion, should justify based on these antibiotics, whether should trust
		About when to correct a transposition of great artery defect in neonates	Examining a patient had procedure on balloon artery septostomy. Continuing plan is a corrective surgery so deciding when
		To find out the mechanism of prostaglandin to open ductus arteriosus	For better understanding, patient is TGA and is on prostaglandin to keep pda open
		Preterm formula vs. standard infant formula, different in context	Patient preterm but she is on infant formula
		What treatment is the best for RDS	Patient had RDS, wanted to know all about treatments available
HO	BG	What are the functions of domperidone	The function of domperidone and why is it given to patient
		Patient has congenital heart disease, finding the cause of the disease. There may be a difference in the disease in adults and children.	Learning process, prefers searching than asking.
		Question raised by physician, to test the student/ justify the question	causes of tachycardia in neonates , symptoms
		Wanted to know more about a particular Syndrome that they suspected a patient may have diagnosed with it.	Edward Syndrome, when to do scan and gestation at what age, physical examinations of Edward Syndrome
		Knows the topic generally, but never knew the clinical and practical practice of the disease in neonate. Correlating with patients.	Congenital heart disease, outcome of disease in newborn
		Requested by physician, patient was on that treatment. Ask to find the right way to do that treatment	Umbilical Vein Catheter Umbilical vein catheter (treatment)
		Found unusual rare conditions from baby	To find out everything, origin, effect and treatment of the condition
		Procedure before discharging patient, didn't know what was the optimum weight gain in preterm before discharging them	To find out what is the optimum weight gain in preterm baby before discharge. Before this they know about term babies but preterm they do not know
		For learning process, planned to look for previously (day before), saw the word TGA in one of the folders. Wondering what TGA was	What is TGA / Transposition of the great arteries means?
		Unsure of baby age, one of the method for earlier scan	To find out early scan pregnancy (the age of baby)
		From the search done earlier	To see the difference in content of ravin enema and glycerin
		to do differential diagnosis for patient	differential diagnosis of congenital hydrothorax
		Differential diagnosis	To find out the causes of congenital chlyrothorax-differential diagnosis
		For patient treatment	To find out the optimal dose for treatment
		Patient with the condition	To understand the cause and how to diagnose patient with red reflux
		Suspect patient with that particular disease	To find out about g6pd deficiency transmission
		The outbreak of false alarm in the ward	to understand what and how alarm fatigue works

			To find the value of conversion units for calculation of baby feeding milk
		From patient weight gain chart	To find answer for how many grams of weight gain on babies per day. Should increase per kilogram, to find out average weight gain for babies in premature.
		Patient had the condition	Wanted to understand more about this condition hypernatremia
		Found this condition, searched about it before. Wanted to understand further	To search for possible causes of hypernatremia in neonates that is found in baby
		To understand hpe findings in placenta, histology and etc.	Based on patient who turn to the doctor for inquiry
		edema prematurity, causes and treatment	premature patients
		instructed by physician	To know more about what I don't understand scleremic
		try to explain exact cause for diagnosis (meconium stained liquor in preterm babies)	Patient diagnosis
		Knowledge purpose, medical in thrombocytopenia in down syndrome	baby is thrombocytopenia symptom, wanted to know about consequences, causes
		To get about patient's condition searching leading to.	Patient's condition
		To find information on weight gain in preterm, application weight gain to change treatment	Lack of knowledge, lecturer instructed for teaching purpose
		Want to identify baby present suspect neonatal botulism, but no evidence that baby has it, neonatal botulism suspect but can't confirm	how to identify if baby has neonatal botulism
		Asymmetrical iugr causes, rule out causes for further information, manage	Notes, to search for patient.
		Oxygen delivery in neonates. Differences in terms of optiflow and mesocast, fio2 in delivery, want to know how they wind down respiratory resuscitation.	A lot of babies requires respiratory support
		Saw diagnosis from patient	Diagnosis of patient bronchiole cysts Not sure what it was, what it is what causes.
		Direct hyperbilirubinemia, what percentages is considered high, what causes it, pathophysiology	Patient had symptoms, slight high 19% of hyperbilirubinemia
		Biliary atresia, everything what it is, treatment causes.	Probably cause of previous search
		Viral induced wheezes comparison to asthma in babies	Directly researching about asthma in prone to this.
		Med info, neonan syndrome, heart defect	Unsure about heart defect with patient, questioned by specialist. Happening on patient, determining on cardio review
		Iron supplementation in neonates, why do we start iron on day 14	Random
		To understand erythropoiesis in premature babies	Saw this condition in one of the patients
		Iron nutrition in newborn, when to start, duration of therapy	Specialist, related to patient treatment. Anemia wondering when to start
		Stages of necrotizing enterocolitis	the patient suspected/trying to rule out possibility
		Nonnutritive sucking, why we doing it, importance.	Patient condition, we encourage the patient to have this
		ROP- retinopathy of premature, stage, criteria for screening	curiosity, doing ROP in patients, wanted to know more

		Complications of infants of diabetic mother	Patient has the conditions, wanted to know complications As it would influence management
		radio graphical treatment of NEC case study, to know more about the radio graphical diagnosis of	X-ray on patient, NEC out of the complications of
	FG	Mortalogy of microorganism	Patient most probably infected- but not certain
		didn't know the answer	Effect of folate deficiency in pregnancy to the baby while doing chemotherapy. To know whether chemotherapy contraindicates in breastfeeding
		Tried using glycerin on optimal dose but no release on abdomen distress. To find other treatment on the internet	to see whether anemia can be used to treat constipation among infant among preterm, to see whether it is internationally used so that it is available here
		finding suitable treatment for patient	To know how good avastin is compared to laser.
		Thyroid function premature babies	What's the relevant of repeating thyroid function for premature babies despite normal cord PSH
		Treatment at neonatal jaundice(phototherapy),specially billy blanket which is better billy blanket overhead	Patient has jaundice, placed on a billy blanket
		G6pd inheritancem - how she got this disease.	Patient has low g6pd levels, more common in boys. Wanted to know why happening in her
MO	BG	Patient wanted therapy for preplus disease.	Wanted to know more of preplus & plus disease of a retina in a premature baby
		To find out signs and side effect of PDA, to learn. Saw condition on patient	How large is it, echo result pattern
		Based on patient condition wanted to know more about the pathophysiology and staging process	To understand more about NEC
		To find out the definition, saw from patient	meaning of posterior shelf in coar
		Patient with the condition	To find out the causes of congenital chlyrothorax
		To know first heard wolf hisrchorn syndrome, to know the inheritance, feature of disease, mode of inheritance	Patient in the ward the sibling has problem
		definition	just to know
		causes of hypoglycemia in polycythemia baby	asked by a question from patient, an episode of hypoglycemia
	FG	requested by physician, saw condition on patient, limited knowledge on the matter	to find out the complications on wrongly placed UVC
		to know what medication the patient is on	to find out the effect of PCOS associated fetal anomaly
Specialist	BG	To find out how to give paracetamol for patent ductus arterios (PDA) in neonates.	TO find out how to give paracetamol for patent ductus arterios (PDA) in neonates.
		Looking for formula, want to figure content protein.	Patient on that, hypoallergenic formula but not diagnosis yet, so want to check protein coming from where, backward working to know where the baby has GIT
		Extra information long term complications of prostaglandin for delayed OP	One child on premature (2 weeks old) looking through side effect of spironolactone
	FG	Symptom from patient	to check whether holoprosencephaly associated with polycystic ovarian

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		To search for medical treatment for patient	to find what was the best product to increase consistency of food and liquid for infant. Has 'Thixer' in mind then through clinical experience of physician chooses carobel
		Medical conditions, managements, available options in management (outcome/comparison of problem faced in managing condition)	find best choice for your patient

I. Online Sources Accessed by MSs

BG Searches		FG Searches	
Sources	No. of Searches	Source	No. of Searches
Google Images	6	medscape	3
Medscape	5	googleimage	2
Pubmed	5	pubmed	2
PubMed Central	4	Pubmed Central	2
rcog.org.uk	2	onlinelibrarywiley.com	2
aapubliction.org	2	uams.edu	1
uptodate	2	standford childrens.org	1
Wikipedia	2	ucsf.edu	1
webmd	2	cochrane	1
Chw.org	1	aafp	1
Heart.org	1	uptodate	1
Chidrenshospital.org	1	nhs.uk	1
epomedcine	1	nhilbi.nih.gov	1
G6pddeficiency.org	1		
academic.oup.org	1		
newbornscreening.ph	1		
aafp.org	1		
omicsohlire.com	1		
BabyMed.com	1		
Americanpregnancy.org	1		
ucsf.edu	1		
neoresus.org	1		
blogspot.respiratorytheraphycave	1		
nhlbi.nlm.gov	1		
rcjournals	1		
ballardscore.com	1		
urmc.rochester.edu	1		
netce.com	1		
medscore.com	1		
ncbi/health.com	1		
latin-dictionary.net	1		
ghr.hlm.nih.gov	1		
nhs.uk	1		
meadjohnson.com	1		
mayoclinic	1		
google scholar	1		
ipokrates.info	1		
babycentre.com	1		
mom365.com	1		
medline	1		
radiopedia	1		

J. Online Sources Accessed by HOs

BG Searches		FG Searches	
Sources	No. of Searches	Source	No. of Searches
uptodate	18	medscape	2
medscape	17	Pubmed	2
Pubmed	16	Uptodate	2
PMC	6	g6pddeficiency.org	1
aafp.org	5	Pubmed Central	1
BMJ	5	Mayoclinic	1
Google image	4		
peadiatric.aapublication.org	3		
radiopedia	3		
Science Direct	3		
Google Scholar	3		
Medline	2		
mayoclinic	2		
Wikipedia	2		
pathologyoutlines.com	2		
health.nsv.gov.au	2		

biomedcentral.com	2		
wordpress	2		
mims.com	2		
cdc.gov	2		
mpa.web.org	2		
breastfeeding.asn.au	1		
www.scielo.br	1		
medline plus	1		
Hopkinsmedicine.org	1		
health.vic.gov.au	1		
intechopen.com	1		
www.ndss.org	1		
www.ds-health.com	1		
verywell.com	1		
learningradiology.com	1		
wikidictionary.org	1		
modern medicine.com	1		
clinicaltrials.gov	1		
motherchildrennutrition.org	1		
healthychildren.org	1		
conversantbiocom	1		
kidshealth.org	1		
adhb.gov	1		
fphcare.fr	1		
NCBI	1		
lifeinthefastlane.com	1		
druginformationonline.org	1		
healthline	1		
NHS Choices	1		
swchildren	1		
mykentuckyheart.com	1		
Neonatal Handbook	1		
Journal of Clinical Neonatology	1		
sgm.journals	1		
bacterio.net	1		
babycentre.com	1		
oxfordjournals.org.	1		
standfordchildren.org	1		
cincinnatichildren.org	1		
muttchildren.org	1		
madeformum.org	1		
medical_explorer.com	1		
prescriptiondrugs.com	1		
fetalsono.com	1		
CEH journal	1		
ghr.nlm.gov	1		
G6pddeficiency.org	1		
cocn.org	1		
research gate	1		
neonatology.hug-ge.ed	1		
msdmanuals.com	1		
tttsfoundation.org	1		
placentajournal.org	1		
neonatology.org	1		
NEJM	1		
Medhelp.org	1		
premes.about.com	1		
prematurebabycare.com	1		
healthofchildren.com	1		

K. Online Sources Accessed by MOs

BG Searches		FG Searches	
Sources	No. of Searches	Source	No. of Searches
Uptodate	5	PubMed	2
Pubmed	2	Uptodate	1
aaPublication	2		
Medscape	2		
NEJM	1		
raredisease.oeg	1		
Google Scholar	1		
BMJ	1		
JAMA	1		
AAP	1		

L. Online Sources Accessed by Specialists

BG Searches		FG Searches	
Sources	No. of Searches	Source	No. of Searches
PubMed	2	Research Gate	1
Cochrane	1	RehabMart.com	1
comidamed.de	1	Google Images	1
mpaweb.org	1	WebofScience	1
medscape	1	Science Direct	1
www.sons.org	1	Springer	1
adhb.govt.nz	1		
www.nuh.nhs.uk	1		

M. The Online EBM Searching Behaviour Pattern