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Economics and Communicable Diseases: An Overview of Issues

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Table of Contents

Abstract	i
1 Introduction: Why does economics have a role?	1
2 Systemic behaviour: economic epidemiology	2
Burden of Disease and Optimal Policy.....	2
Evidence.....	3
Economic policy and bacterial resistance.....	4
3 Micro level analysis and economic evaluation	4
Burden of Disease.....	6
Economic Evaluation.....	7
4 Conclusions	9
References	10

List of Tables

Table 1	'Utility' scores for Health States associated with Infectious Disease.....	5
Table 2	BoD: Disability Adjusted Life Years (DALYs).....	6
Table 3	Selected Cost-effectiveness Ratios	8

Abstract

Infectious diseases are the largest cause of mortality world-wide and in 1997 were responsible for one third of total deaths. Despite this, there has been little discussion of infectious disease by health economists. This undoubtedly reflects the concentration of infection related deaths in developing countries and their relative unimportance in the west. Partly because of the AIDS epidemic there has been increasing interest in the area and a number of recent studies have examined the unique issues arising from 'economic epidemiology'. This literature is reviewed. Infectious diseases have also been the subject of on going cost effectiveness analyses and, in the second half of the paper, these and associated issues are discussed. The need for methodological standardisation in these studies is noted. It is argued that the priority accorded to studies of infectious diseases may be illegitimately compromised if priority setting is based upon the total burden of each disease and that this error may be the result of an excessive focus upon interventions for diseases associated with designated areas of national priority.

Economics and Communicable Diseases: An Overview of Issues

1 Introduction: Why does economics have a role?

As a discipline, economics seeks to explain the allocation of resources and to indicate how these may best be used to maximise social welfare or wellbeing. In the context of communicable diseases, as elsewhere, three sets of issues must be considered; first, what programs and services will achieve this ultimate objective; secondly, how will consumer/patients and providers respond to various financial and other incentives and, given the above, which policies should governments adopt to achieve maximum social wellbeing. Each of these issues is addressed below.

In the unregulated competitive marketplace, the answer to the three questions is, in principal, simple and elegant. Well informed individuals demand goods and services whenever the benefit they receive exceeds the price paid: each consumer performs a private “cost benefit analysis”. Competitive forces ensure that this price is the lowest possible; and any mismatch between supply and demand will result in a change in price and profit margins, which will create the incentives necessary to correct the temporary market failure. Individuals’ self-interest ensures that each person maximises their own wellbeing and, given the distribution of resources, social welfare cannot then be increased. In this sense, the competitive market is “efficient”. Government policy is only needed to preserve the competitive environment and to redistribute income for reasons of social justice.

In the absence of a competitive market and well informed consumers, individual decisions concerning the use of free or heavily subsidised services will not result in such “efficiency”. In the health sector and elsewhere, economists have therefore developed a variety of methodologies for assessing costs and benefits. In the context of health care, these techniques - discussed in Section 4 below - are incomplete, but nevertheless, have the potential to significantly improve decision making. This potential is largely unrealised.

While competitive markets do not exist, there is still a supply and demand for health services, with the equilibrating mechanism being the residual patient co-payment, queuing, or the direct management of demand, and these issues have been the subject of theoretical and empirical research by health economists. In the case of infectious diseases, there is an additional variable, which has given the aggregate or systemic analysis of infectious diseases, an unique character. This is the extent to which individuals systematically change their behaviour or seek services to prevent a disease or to mitigate the likelihood of acquiring it. This is the pivotal variable which drives the sometimes counter-intuitive results in the system level economic analysis of infectious disease, which has recently been described as “economic epidemiology”.

2 Systemic behaviour: economic epidemiology

In the theory of “rational epidemics” individuals who are at risk or susceptible to an avoidable disease are increasingly likely to undertake preventive measures - to “demand protection” - as the prevalence of the disease increases. In the jargon of economics, there is a “price elastic demand for prevention” (PEDP). This leads to three key differences between “economic” and “biological” epidemiology (Philipson, 2000). These concern: (i) short and long-run behaviour and disease incidence; (ii) the relative burden of different diseases; and (iii) the appropriate policy response. The latter two issues are discussed later.

The first difference occurs as a direct consequence of PEDP. In biological epidemiology the probability of infection rises with disease prevalence, i.e. the probability of transmission is proportional to the number of infectious cases. This, however, takes no account of the response of rational individuals. Economic epidemiology postulates that as a result of increased protection - PEDP - the likelihood of infection and disease incidence will eventually fall with rising prevalence. As a consequence, a cyclical pattern may emerge. Rising prevalence induces preventive behaviour, which eventually leads to declining infection and disease incidence and prevalence. This, in turn, leads to less preventive measures, resurgent infection and the commencement of a new disease cycle.

In the seminal study, Geoffard and Philipson (1995), assumed a steady state population structure and perfect immunity from protective measures. This was used to demonstrate the improbability of disease eradication, when prevention is voluntary and the likelihood of the cyclical behaviour described above. More recently, Delfino and Simmons (1999) have explored the consequences of imperfect protection. This makes the dynamics of system behaviour significantly more complex. They demonstrate the possibility of multiple “steady states”, some stable, some unstable, as defined by the rate of infection and protection. Optimal regulatory and subsidy policies may be complex. For example, a “pro-cyclical” policy of vaccinating when prevalence is high and immunity imperfect, is preferable to a low prevalence policy or policy of constant vaccination. However, with full and permanent immunity, a low prevalence policy of vaccination is found to be better.

Burden of Disease and Optimal Policy

Both the measurement of the burden of disease (BoD) and the appropriate policy response to it, are affected by PEDP. In biological epidemiology and most economic analyses, the BoD depends upon mortality and disease incidence. Drawing upon the theory of optimal taxation and the associated concept of an “excess burden” arising from attempts to avoid taxation, it is argued that during the “rational epidemic” described above, an increase in disease prevalence will eventually be associated with declining incidence and, consequently, a decreasing BoD, as conventionally measured. However, this is associated with increasing efforts to avoid infection and this will inflict a personal cost. According to Philipson (2000), this may cause an additional “excess burden”, which could exceed the magnitude of the more conventional BoD and alter the disease ranking in a BoD league table. To date, the only plausible example cited in the literature, is the change in the number and range of sexual encounters resulting from the AIDS epidemic and it is not clear that a similar excess burden could arise in cases where prevention is achieved by a single medical service and vaccination.

The implications of PEDP for policy are potentially more significant. Economic theory suggests that complete disease eradication, even when technically feasible, would not normally be desirable. With low disease prevalence, the cost of a further reduction in disease incidence is likely to be very high and the benefits small ¹. The usual policy objective, therefore, is to ensure that preventive measures are carried out as long as social benefits exceeds costs. However, this will not occur spontaneously and, indeed, in orthodox health economics theory, infectious disease is one of the standard examples of an “externality”. Neither the harm inflicted by an infected individual, nor the benefits from vaccination are “internalised” in the market: individuals are harmed/benefited without compensation/reward. The standard “solution” to this problem is to tax the undesirable or subsidise the desirable activity (a so-called “Pigouvian subsidy”). This later action reduces the net price until individuals are encouraged to adopt the socially optimal level of prevention.

Policy commonly targets particular groups and not the entire susceptible population. Under these circumstances, the effect of PEDP is potentially very significant. Increasing protection and reducing disease prevalence in the targetted group will reduce the demand for prevention in the remainder of the population and, in part or whole, offset the beneficial effects of the subsidy and reduce the effective “price elasticity of prevention”. Thus, in his U.S. study of measles vaccination, Philipson (1996) concludes that because of PEDP, the partial relationship between a vaccine price and demand overstates the true or net price elasticity of demand by a factor of at least 2.5, which implies a corresponding decrease in the effectiveness of a simply policy of subsidised vaccinations.

The effectiveness of policy is also affected by its timing. Early in the disease cycle, when prevalence is low, a tax financed subsidy may be “pareto optimal” - a win/win strategy. Beneficiaries include taxpayers who achieve greater protection because of the increased immunity of the population. Later in the cycle, increased prevalence and a protection subsidy have offsetting effects and the benefits may no longer be obtained by the taxpayer.

Evidence

Direct testing of the predictions of abstract models is difficult and to date, the plausibility of these models depends upon the evidence supporting the key assumption of a prevalence elastic demand for protection. Because of the newness of the subject matter, even this is limited. In his survey of the field, Philipson (2000) identifies a significant body of evidence rising from the analysis of AIDS related behaviour which is clearly consistent with his hypothesis. Likewise, Mullahy (2000), demonstrates a high correlation between prevalence and the demand for influenza vaccine in the USA. In the most thorough study to date, Philipson (1996), examined the relationship between the prevalence of measles in the USA between 1984 and 1990 and the age of first measles vaccination. From this he infers an average prevalence elasticity of demand for measles vaccination of between 1.56 and 1.89 - a 10% increase in disease prevalence was associated with a 15.6% to 18.9% increase in the demand for vaccinations. The strength and stability of the relationship suggests that the predictions of “economic epidemiology” should be taken seriously.

¹ Complete disease eradication would only be desirable if immunity was complete and permanent, and the benefits to future patients and generations were not discounted by the rate of time preference.

Economic policy and bacterial resistance

There is a second, 'externality' in the treatment of infectious diseases. This arises from the overuse of antibiotics for particular individuals which, in aggregate, leads to the growth of antibiotic resistance. The harmful effects of this are not reflected in patient or doctor costs at the time of overuse. In a series of recent studies it has been suggested that a flexible solution to this problem could be the establishment of a market in tradeable permits for the use of antibiotics, in which the sum of the permits would be capped at a predetermined level which balanced the benefits and the longer term expected costs of using antibiotics (Coast et al 1996, 1998; Smith and Coast 1998). Economists have similarly argued for the creation of a market to buy and sell pollution permits where the sum of these would create the socially optimal level of pollution.

Initial permits for antibiotic use would be allocated freely each year to providers in proportion to the expected use of such providers generally. Permits could then be traded at a market determined rate in accordance with the form of practice adopted by the providers. The tendency for under use would be offset, in part, by professional motives and, in part, by the potential loss of patients who would be aware of provider incentives. In a capitated health service or where no additional fees were paid for repeat visits, under-use would, additionally, increase the likelihood of uncompensated repeat services.

Numerous issues need resolution before such a scheme could be adopted (and many of these have been discussed by the schemes' proponents). For example, rationing might be inequitable if doctors treated patients differently according to their assessment of the patient's likelihood of rejecting the doctor's authority and if—as is likely—this was associated with a patient's education and socio economic status. Despite this, the proposal has the potential to mitigate a to-date intractable problem. It represents an interesting application of economic theory to a serious systemic failure.

3 Micro level analysis and economic evaluation

The newly emerging field of "economic epidemiology", with its macro or systemic focus, represents only a tiny part of the economic analyses of infectious and other diseases. Most of these have a micro or single disease focus and are concerned with either the burden of disease (BoD) or the benefits and costs of particular interventions (economic evaluation). The BoD requires, first, an estimate of disease incidence and progression through time and, secondly, a method for evaluating and comparing the evolving health states. Economic evaluation requires, first, an estimate of the efficacy/efficiency of an intervention and secondly, a method for comparing the value of the health state improvement with the costs of the intervention. In both cases, the first task is epidemiological and the second requires health economics.

A further similarity is that both forms of analysis require the combination of the quantity and quality of life into a single unit of value. Unsurprisingly, very similar methodologies have been employed to do this in BoD and evaluation studies. In both cases, each year of life is weighted by an index of the QoL which has been derived (usually) from interviews of well-informed and "appropriate" groups of individuals. These are asked to trade off quantity and quality of life - either years of life for improved quality (the Time Trade Off -TTO - technique) or the number of people cured against the extent of the cure (the Person Trade Off - PTO - technique). The result of these procedures is the Quality Adjusted Life Year (QALY). Variations in the methodologies arise from the choice of "scaling instrument" (TTO etc); the perspective adopted in the scaling

interview (“imagine you are a patient/government decision maker”; from the time frame 1 year/full duration of the disease/lifetime), choice of group interviewed (public, patients, experts) etc. At least 20/30 variations of QALY like measures exist and, at present, there is no consensus over the most appropriate of these.

A recent publication by Tengs (2000) brings together 1,000 of the QoL scores obtained to date and classifies them by disease type. An extract of the study is reproduced in Table 1.

Table 1 ‘Utility’ scores for Health States associated with Infectious Disease

Health State	QoL Weight	SD	Scaling Instrument
HIV, asymptomatic	0.87	0.29	TTO
HIV, asymptomatic, CD4 count mean 459	0.804	0.215	SC
HIV, symptomatic CD4 count mean 398	0.822	0.224	SC
HIV, CDC classification 3	0.772	0.018	QWB
HIV, CDC classification 4a	0.623	0.032	QWB
HIV, CDC classification 4c1	0.653	0.024	QWB
HIV, CDC classification 4d	0.59	0.056	QWB
HIV, high (4 th quartile) β -2 microglobulin level	0.649	0.2	QWB
AIDS, CD4 count mean 90	0.744	0.218	RS
AIDS, CD4 count mean 90	0.796	0.247	SG
AIDS, CD4 count mean 166, placebo	0.634	0.0844	QWB
AIDS, CD4 count mean 188, azidothymidine (AZT)	0.6486	0.0735	QWB

Source: Tengs, 2000

Appendix A

Key: TTO = Time Trade off; SC = Standard Count, RS = Rating Scale; QWB = Quality of Wellbeing (a generic utility instrument)

The QoL score in column 2 is, in fact, more than a “weight”; it is, in effect, an exchange rate between the quantity and quality of life. Thus, the score of 0.87 for asymptomatic HIV, indicates that survey respondents were prepared to give up 13 per cent ($1.00-0.87 = 0.13$) of their life to avoid a health state with the typical physical and psychological characteristics of asymptomatic HIV. These and similar data are now the basis for much of the micro economic analyses of disease.

Burden of Disease

In 1996 the W.H.O. published estimates of the burden of diseases associated with every disease in every country. After a variety of methodological changes, these were used to produce more precise estimates for Australia and for Victoria (Mathers et al, 1999; Vos et al, 2000). All three studies define the BoD as the disease induced loss of “Disability Adjusted Life Years” (DALYs), where these are one of the family of QALY-like metrics defined by the use of the person trade off scaling technique and by the particular methods of elicitation used. Unlike the two Australian studies, the WHO also used “age-weights” to reflect the relative “social value” of DALYs at different stages of the life cycle. Extracts from the full Australian study are reproduced in Table 2.

Table 2 BoD: Disability Adjusted Life Years (DALYs)

Cause	DALYs			
	Numbers (000)		Percent of total DALY Loss	
	Male	Female	Male	Female
HIV/AIDS	13,885	ns	1.0	
Lower Respiratory Infections	9,844	10,673	0.7	0.9
Hepatitis	3,398	ns	0.3	ns
Total Infectious and Parasitic Disease	27,950	16,506	2.1	1.4

Notes: ns = not amongst leading 75 causes of DALY loss

Source: Mathers C, Vos, T and Stevenson, 1999, Tables 5.3, 5.5

As noted earlier, this mortality/morbidity based definition of the BoD represents a subset of the broader BoD concept which includes the costs of disease avoidance. Cost of illness studies may also include current resource outlays in the health sector associated with each disease.

BoD studies, and especially the WHO study, have been surprisingly controversial (Williams 1999; Mooney, et al 1997; Mathers and Vos 1999; Murray and Lopez 2000). Contention focusses upon the usefulness of BoD studies and their potential for misleading policy makers. Critics argue that there will be a powerful temptation to use such BoD studies as the basis for the allocation of resources. They correctly argue that the greatest or best C/B ratio may be obtained from interventions for diseases with very low total BoD's. It is also correctly argued that the reallocation of resources should be based upon incremental and achievable benefits (reductions in the BoD) and not upon the theoretical maximum benefit indicated by the total BoD. Defenders argue that the BoD per sé has a different purpose. First, global BoD studies represent a “stocktake” of the nation's health and, like the GDP, may be used to monitor overall national health performance. Secondly, the BoD does indicate the maximum achievable benefit within any disease category and is therefore a sensible basis for allocating funds for disease focussed research. Critics doubt that the BoD data will only be used for these limited purposes and believe that, as in the past, health officials decision making will be driven by readily available data, by the need for quick fix methods and solutions and by an intuitively plausible, but wrong, belief that there is a close nexus between total program benefits and the magnitude of the BoD.

A third defence of comprehensive BoD studies is that results may, in fact, be used to estimate the benefits from interventions once the efficacy of the intervention is known. If it is assumed that marginal and average benefits are the same then the QALY/DALY benefit of an intervention which cures x percent of patients will be x percent of the BoD. The assumption is not unreasonable and is commonly made in single intervention studies. Critics are concerned that this approach will result in 'bad currency driving out good': that the availability of quick, cheap and 'dirty' results will crowd out the more expensive but accurate intervention-specific studies. But this response shifts the focus of the debate. The initial criticism is that, even conceptually, BoD data cannot be useful in economic evaluation studies. The latter criticism is that BoD data will be unacceptably inaccurate. At present there is no objective basis for assessing the importance of this legitimate concern.

The immediate relevance of this debate is that the relatively small BoD associated with infectious diseases should not imply a correspondingly small priority for cost effective interventions which target infectious diseases. Exhortations to focus upon national priority areas, defined by the BoD, may be appropriate for the determination of research spending, but not for the determination of incremental program grants.

Economic Evaluation

The largest number of "micro economic" studies of health and health care, are concerned with the benefits and costs of particular health services. Because of the difficulty of assigning a dollar value to life, the predominant form of economic evaluation evolved from Cost Benefit Analysis (CBA), - defined by the reduction of all benefits and costs to dollars, - to Cost Effectiveness Analysis (CEA) which seeks to find the cost of health improvement where this is measured in natural units, and most commonly, by life years. Attempts to include the Quality of Life (QoL) led to the development of Cost Utility Analysis (CUA), which estimates the cost of obtaining additional QALYs, as discussed above. Recently, the introduction of additional social considerations into evaluation studies – age weights, severity, distributional considerations etc. – has led to a suggested new category, 'Cost Value Analysis' (Nord et al 1998, Nord 1999, Menzel et al 1999).

Within these broad categories methods and conventions remain unstandardised. Thus, for example, the authors of a world review of economic evaluations of hepatitis B concluded in 1994 that 'we found profound variability in the main parameters of the efficiency equation (disease incidence, costing methods, use of marginal theory, discounting and study time span, sensitivity analysis and reporting methods). We also found inconsistencies in definition and study design in thirty-eight percent of a subset studies ... there is an urgent need to standardise study methods and to define a common set of procedures (Jefferson and Demicheli 1994, p25).

The following year a USA team published such a set of standardised results (Tengs et al 1995)². These included only 30 interventions for infectious diseases. Six of these were for childhood immunisations (Pertussis, Diphtheria, Tetanus, Polio, Rubella and Measles). In each of these cases costs were negative – the direct cost of immunisation was less than the direct down stream cost savings from averted illnesses. Fifteen of the remaining results are reported in Table 3.

² The seven criteria for inclusion were that (i) estimates existed or could be made of the 'cost per life year saved'; (ii) cost and benefits incorporated a societal perspective; (iii) indirect costs such as forgone earnings should be excluded; (iv) costs and effectiveness should be net figures allowing for resource savings and mortality risks; (v) future values should be discounted at a rate of five percent per annum; (vi) cost effectiveness ratios should be incremental and compared with a well defined baseline alternative; and (vii) costs should be expressed in 1993 US dollars with adjustment to this year made with the consumer price index.

Table 3 Selected Cost-effectiveness Ratios

Intervention		Cost/Life Year (\$US1993)
HIV/AIDS	Prevention	
	Voluntary (vs limited) screening for HIV in female drug users and sex partners	<0
	Screen blood donors for HIV	\$14,000
	Screen donated blood for HIV with an additional FDA-licensed test	\$880,000
	Universal (vs category-specific) precautions to prevent HIV transmission)	\$890,000
HIV/AIDS	Treatment	
	Zidovudine for asymptomatic HIV + people	<\$0
	Oral dapsone for prophylaxis of PCP in HIV + people	\$16,000
	Aerosolized pentamidine for prophylaxis of PCP in HIV + people	\$20,000
	AZT for people with AIDS	\$26,000
	Prophylactic AZT following needle stick injury in health care workers	\$41,000
Pneumonia	vaccination	
	Pneumonia vaccination for people age 65+	\$1,800
	Pneumonia vaccination for people age 65+	\$2,000
	Pneumonia vaccination for people age 65+	\$2,200
	Pneumonia vaccination for high risk people age 25-44	\$14,000
	Pneumonia vaccination for children age 2-4	\$170,000
Tuberculosis	Treatment	
	Isoniazid chemotherapy for high risk White male tuberculin reactors age 20	<\$0
	Isoniazid chemotherapy for low risk White male tuberculin reactors age 55	\$17,000

Source: Tengs et al, 1995. Appendix A

Results illustrate the single most important conclusion to be drawn from economic analyses in the health sector. This is that the cost of health improvement, and in this case, lives saved, varies enormously. A direct implication is that with a limited budget the amount of health which might be obtained also varies enormously with the type of expenditure. Thus, from Table 2, for an average cost of \$US880,000 it was possible to gain an additional life year in 1993 in the USA by conducting an additional test on blood already screened for HIV. The same expenditure could have gained 52 life years if it had been spent on isoniazid chemotherapy for low risk white male tuberculin reactors aged above 55, or 489 life years if spent on pneumonia vaccinations for people over sixty-five³.

³ Despite standardisation with respect to certain study parameters, the results were not subject to exhausted validation and anomalies exist. Thus, for example, zidovudine treatment for symptomatic AIDS has a published cost per life year gained which is negative in one study for \$45,000 in another

Relative to the size of the task there has only been a miniscule number of economic evaluations carried out in Australia and, outside the context of the PBAC and MSAC (described below) there has been no attempt to impose standardised methodologies on existing Australian analyses or to adapt overseas studies to Australian standards and conditions. An internal document of the Commonwealth Department of Health and Aged Care reviews various Australian studies of the costs and benefits of published health interventions including vaccinations (Dadds, 1998). The overview does not purport to evaluate the quality or policy relevance of the various policy options. Subsequent studies, and particularly in the area of Hepatitis C, have identified highly cost effective strategies (Harris et al, 2000; Shiell and Law, 2000; Crowley et al, 2000). While of high standard, these studies are opportunistic in the sense that they arose from a particular interest and not as a response to a coordinated approach to the National provision of medical services or a comprehensive strategy for the cost effective reduction of infectious diseases.

In one respect Australia has led the World in the adoption of a coherent economic framework. It was the first country to require an economic evaluation as part of the process for selecting drugs for public subsidy through the pharmaceutical benefits scheme and it is currently pioneering a similar requirement for new medical services seeking listing on the medical benefits schedule for Medicare subsidised services. Criteria for use in these evaluations have also been carefully detailed and reviewed. The impact of these requirements is, however, unknown although the study by Harris and Mitchell (2000) indicates that drugs with high cost to benefit ratios have generally been excluded and those with a lower cost approved for public subsidy. In aggregate, however, the impact of these requirements must necessarily be very small. Only a handful of drugs and medical services have been reviewed the backlog of untested established drugs and procedures are vast and there is no plan for their progressive evaluation and rationalisation.

4 Conclusions

Economics has a potentially large role to play in the understanding of disease behaviour and in the adoption of policies which will maximise health from available resources. The full potential is undoubtedly unrealised. At the systemic level 'Economic Epidemiology' is a new and involving area. At the micro level, service evaluation methods are still evolving. This does not explain, however, the failure to use existing methodologies to help rationalise the delivery of existing services. Evidence reported here clearly indicates that significantly greater health improvements may be obtained from some expenditures than from others and such information must be available to those who are designing best practice guidelines, if these are to maximise health gains from a limited budget.

In the absence of an economic framework for analysis, ad hoc approaches to the prioritisation of health expenditures are likely to emerge. In particular, the priority given to interventions for diseases with a large burden of disease or for diseases on a list of national health priorities may result in an inappropriate low priority for other diseases, including infectious diseases, when their incremental benefit to cost ratio is high.

Inconsistencies in present economic studies are, in part, capable of a resolution through the adoption of methodological guidelines. In part, they reflect the inevitable shortcomings of individual studies and imply the need for a collaborative and well resourced approach to the evaluation of individual studies and possibly, the creation of an organisation such as the Cochrane Collaboration for the evaluation of clinical trials and for the dissemination of the

resulting information. Such a database is being developed in both the US and UK and a cross National collaboration may well emerge. With or without such a development there is a need for an Australian capacity to evaluate the relevance of such studies in the context of the Australian health system and Australian social values.

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