CENTRE FOR HEALTH PROGRAM EVALUATION

The Transferable Permit Market: A Solution to Antibiotic Resistance?

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ABSTRACT

In a previous paper the authors argued that antibiotic resistance will be best controlled by a system of tradeable permits. It was argued that use of charges or regulation to achieve a reduction, or control, of resistance would not be efficient. Regulation will not account for different marginal costs of reducing antibiotic prescription among GPs, but charges, although based on sound economic concepts, are based on an unrealistic amount of required information.

The regulatory problem is to constrain prescription to achieve a desired reduction in antibiotic resistance. However, given informational uncertainties and variance in resistance, as well as other areas important in this system, such regulation or charges will not be efficient. It was argued, therefore, that permits, by combining the targets of regulation and the market flexibility of charges, would achieve the government's objectives more efficiently than simple regulation and be more practical than simple charges. The attraction of permits is to put an effective limit on the use of antibiotics but in a flexible manner.

In this paper the authors progress this proposed policy by considering various important issues which arise in attempting to design such a tradeable permit system for antibiotics. Peculiarities of such a permit system, coupled with the peculiarities of healthcare, make this a tricky market to develop. The paper is therefore not an exhaustive plan enabling a blueprint for such a market to be designed, but a proposal from which certain issues are raised, and which can be used as platform for further development of such an initiative to deal with resistance.

Given the degree of uncertainty surrounding resistance patterns, however, achieving a global limit will necessarily be pretty arbitrary, but it is better than no global limit at all!

1   Introduction

Antibiotic resistance occurs when a microorganism which has been exposed to an antibiotic develops resistance to its effects (Cannon 1995). Such resistance is an important problem for society as it means that drugs to which bacteria have become resistant are no longer effective in treating infection. This creates the potential for increased morbidity, mortality and health care costs associated with infections which have, until now, been simply and cheaply treated. Such resistant bacteria are being isolated with increasing frequency and there is concern that the world is entering an era in which antibiotics will no longer be effective treatment for a wide range of common bacterial infections (Murray 1994; Tomasz 1994; Neu 1992; American Society for Microbiology 1995; Kubin 1993; Levy 1990; Williams 1986).

Since the use of any antibiotic can have, as an unwanted and indirect effect, an impact on the development of resistance, resistance may therefore be considered an "externality", associated with the use of antibiotics in treating infections. The effects of antibiotic use are unlikely to be felt directly by either the consumer or the supplier of that treatment, but will impact on the overall welfare of the community, by reducing the ability to treat infections in the future. Whether such an externality could be accounted for in the economic evaluation of new antibiotics has already been considered by the authors (Coast et al 1996), whose conclusion was that, for a variety of reasons, it could not (for a brief summary of this paper see Appendix A).

In the absence of economic evaluation as a suitable policy instrument, the authors subsequently considered alternative economic responses: principally use of regulation, charges and permits (Coast et al 1997) (for a brief summary of this paper see Appendix B). Overall, the authors tentatively concluded that permits, in a tradeable market, were potentially the most efficient way to address the problem of resistance. This paper explores further the concept of a tradeable market in permits for antibiotics, considering some of the conceptual and practical issues which would need to be addressed before such a system could be operationalised.

This review of issues is by no means complete or exhaustive. As the paper is not aimed specifically at any one healthcare system, but is a general review, it is not possible to develop any firm recommendations for implementation. Rather, the aim is to highlight several of the most critical features of such a system which would require further exploration if such a system were to be operationalised. However, the paper does conclude with a brief proposal for addressing the issues raised, which may be generally applicable across health care systems.

Following this introduction, the paper will discuss the rudiments of such a 'market', outlining why permits are desirable. Sections 3 then considers the objective we may wish to pursue with such a market, section 4 considers the fundamental considerations which need to be addressed to establish such a market and section 5 discusses issues in the use of permits differentiated on the basis of location, type of antibiotic and time. Section 6 provides a brief examination of how the market may be enforced and section 7 concludes with a tentative recommendation for such a market based on the analysis of issues presented in the paper.

2 The Case for Permits Revisited

To begin, it is worth reiterating briefly why permits may be considered to be a desirable policy for addressing antibiotic resistance. In essence, resistance is a form of negative externality. That is, it is an external cost associated with consumption of antibiotics which is placed on society. This external cost is in the form of greater healthcare costs in treating infection (as the degree of resistance increases, a greater number of antibiotics, or more expensive therapy, is required to successfully treat an infection), and greater morbidity and mortality for those individuals who are infected with resistant microorganisms. Such a negative externality is analogous to forms of pollution, such as gaseous emissions, where the presence of such externalities results in the failure of the market to equate marginal costs and benefits. The market will fail as the full opportunity costs associated with the production and consumption of the good (in this case antibiotics) are not internalised. In a previous paper the authors also illustrate how such an externality will not generally be accounted for in the economic evaluation of antibiotics (Coast et al 1996) (for a summary of this paper see Appendix A).

Often the response to such an externality is political in the setting of standards or limits to 'pollution'. Such simple regulation of antibiotics[1] would involve a specification of the quantity of antibiotics which may be prescribed by each provider[2]. Any prescription above this would then be in violation of this set standard and the provider appropriately sanctioned. However, the main problem with centralised regulation is that different "polluters" are required to conform to the same standard of pollution, irrespective of their individual cost of reducing such 'pollution'. For antibiotic resistance, as with pollution, the marginal abatement costs will vary widely between different polluters[3] (Coast et al 1997). The primary problem with this approach is therefore that there is no guarantee that the particular allocation of prescriptions chosen as standard by the regulatory body will achieve the resistance goals at anything approaching minimum cost.

The efficiency of abatement would therefore be improved if there was *flexibility* in the reduction of pollution that allowed some polluters to reduce pollution more than others. The obvious response for economists to this problem is therefore to try to create a market type response to ensure such external costs are taken into account in the productive/consumptive decisions. Such a response will be based on the concept of charges - polluter pays or Pigovian taxes. The idea behind this is that, when faced with a choice between paying a tax on production or bearing the costs of reducing production, the provider will limit production (eg prescribing of antibiotics) to the level at which the marginal costs of reducing pollution equals the charge (assuming perfect agency; for a discussion of this important issue see Section 7). Thus, the *marginal* cost of polluting will be equalised among all polluters leading to a minimum *total* cost of abatement.

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[1] Note that due to difficulties in collecting data on resistance levels, and thus regulating with respect to these, this paper is considering regulation based on the number and type of antibiotics prescribed as a proxy measure for the amount of resistance produced (as the level of prescriptions is simple to assess and control).

[2] In this paper the term "provider" is used to refer to the **GP prescribing the antibiotic**. It should be noted that clinical specialists may also prescribe, but our concern here is with community acquired infection, for which the predominant prescriber will be the GP.

[3] Briefly, the abatement cost refers to the cost of a possible increase in infections through reduced prescribing (although reduced prescribing will not necessarily lead to increased infection if current inappropriate prescribing is cut first). These costs will manifest themselves in two forms. First, the costs to the individual from reduced access to antibiotics. This will include possible increases in morbidity and mortality, and the indirect costs associated with this, such as time off work. Second, there will be medical costs to the health service, including the GP, of treating patients who may experience other treatment needs from reduced use of antibiotics. It will therefore be the GP's responsibility to balance the increase in these costs against the cost to them of purchasing and using permits in prescribing antibiotics (the permits themselves will, on a social level, simply redistribute income between those GPs who prescribe more than their allowance, who will have to purchase more permits, to those who prescribe under their allowance, who sell their permits). This creates a number of issues, which are dealt with in Section 7 of this paper.

As the authors have argued (Coast et al 1997), setting such charges would be an extremely arduous, if not impossible, task (to establish a particular quantity reduction in 'pollution' one needs to know at what level to set the charge - this requires a high degree of information sophistication). However, these deficiencies may be addressed, the authors would argue, by establishing a tradeable permit market, with few restrictions on transferability. Instead of setting a charge on 'pollution', the regulatory body decides on a *quantity* of 'pollution' which is acceptable, and issues corresponding permits. The trade of these in a market (given some initial allocation) will eventually set a price which will perform the same function as a charge - whereby those providers facing very steep control costs[4] can purchase permits from providers having lower costs, thereby subsidising the more intensive control of prescriptions by these low cost providers. Indeed, under competitive conditions the reallocation of permits which takes place by making them transferable could potentially reduce substantially the amount of resources committed to prescription control while meeting the resistance standards.

The important distinction between these two methods, from a conceptual point of view, is that, for charges, the regulatory body sets the *price,* and the market adjusts the quantity, but with permits the regulatory body sets the *quantity,* and the price adjusts in the market[5]. Thus, the government can take steps to ensure that a maximum amount of 'pollution' is not breached, but the least cost means of achieving this level is left to the market to decide. Not only would those who have lower marginal abatement costs achieve more reduction than those with high abatement costs, but those with the high abatement costs would have some incentive to reduce these costs or levels of 'pollution' - for instance by seeking substitutes.

The discussion in the remainder of this paper concerns issues arising in the development of such a transferable permit market.

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[4] The costs referred to are only partly concerned with what may be considered "traditional" costs of production. In the main we are referring here to "costs" such as the potential increase in morbidity associated with those individuals who may be refused antibiotic treatment. In addition, there may be costs associated with surveillance of prescriptions and resistance, and other "transactions" or "frictional" costs. These costs of implementing policy will have to weighed against the future costs averted from widespread antibiotic resistance.

[5] As already mentioned, the disadvantage of charges is that to establish a particular quantity reduction in 'pollution' one needs to know at what level to set the charge - this requires a high degree of information sophistication. The advantage of permits is thus that this quantity reduction may be achieved will far less information requirements.

3   Specifying the Objective

The first step in designing a permits market is to specify the objective. In this case, it will be assumed that the primary goal is one of efficiency in the use of antibiotics. It may be that other considerations, such as equity of access to antibiotics (ie the distributional impact of any reduction in use of antibiotics), may also be important factors which need to be considered. However, there is insufficient space to do these arguments justice here and so the paper will focus on achieving efficiency in the use of antibiotics.

The efficient[6] allocation will occur where the marginal external cost from the uncontrolled prescription of antibiotics is balanced with the costs incurred by avoiding such external costs. ie the extent of resource use, morbidity and mortality from *unrestricted* use compared to the resource costs, morbidity and mortality related to *restricted* use. In essence the ideal allocation would be the one which minimises the *sum* of these costs.

However, from a policy perspective this goal may be difficult, if not impossible, to achieve. The regulatory body would require information on the control and external costs associated with each provider, which will be (virtually) impossible to attain, if not also prohibitively expensive. For this reason we may approach the second best efficiency criterion and look to assess cost-effectiveness. This criterion is based on a dichotomisation of the control problem - that is, the specification of the policy target reduction and the costs of establishing a system to ensure this target is met. Cost effectiveness is thus only concerned with the least cost means to meet a target, and leaves the *appropriate* reduction to policy makers. There is no guidance as to what the target goal should be, but only in selecting the most 'efficient' means of achieving this goal[7].

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6   Here we are referring to both technical **and** allocative efficiency.

7   In terms of target reduction, the rate of discount of future costs and benefits is relevant also. It may be more efficient to reduce the level of antibiotics now to such a level that both inappropriate **and appropriate** prescriptions are reduced and thus increase morbidity and mortality. However, this will most likely be seen as politically unacceptable, and as such the only viable option may be to consider the most cost-effective means to reduce inappropriate prescribing (this therefore being the default "target").

4 Tradeable Permits: Fundamental Considerations

Once our objective is established, there are two issues which require immediate consideration to establish the fundamentals for a working market in tradeable antibiotic prescribing permits. The market proposed relies on the GP trading with other GPs in permits for antibiotic prescription rights. For such trade they will obviously require a means of (i) funding such trade and (ii) an initial endowment of permits from which to begin trade. These two issues are dealt with below.

4.1 Enabling Trade: Requirement for Drug Budgets

It is clear that trade in anything requires not only the desire but also the means to purchase. That is, demand is a function of a willingness and **ability** to pay for the permits. Trade will only, therefore, be facilitated by some kind of drug budget. The alternatives for this are a budget related *specifically* to antibiotics, a wider budget related to *all* prescriptions or, further, a *total* practice budget for all patient expense. Logically there could also be a combination of these, with compartmentalised budgets, but it is simpler to consider each separately.

Both a budget specifically related to antibiotics and one related to all drug prescriptions would require the GP to pay for permits, or to invest sums from the sale of permits, into this "account". The GP would therefore be required to balance the cost of prescribing an antibiotic with not prescribing another antibiotic (in case of an antibiotic drug budget), or with not prescribing any other sort of drug (as with a general drug budget). Either such system would be relatively simple to implement, with little disruption to whatever financing arrangements otherwise exist for GP services. However, the main disadvantage is that its relationship with these other financial arrangements would need to be clarified. For instance, if such a budget was not "ring-fenced", profits from the sale of permits could be used in other budgets (and, conversely, the GP may be able to use funds from other areas to fund permit acquisition), although the system of operation of budgets may prevent this. For instance one may envisage a separate central computerised account within a permit "bank" controlled by the regulatory agency through which no "non-permit" monies are allowed to flow.

In contrast, a budget which was allocated to cover all patient costs (under some set agreements), such as with GP Fundholding in the UK, would overcome this problem. Being given a fixed budget for all patient care the GP would no longer be simply estimating the marginal cost of prescribing antibiotic A with antibiotic B, or even with drug B (which may or may not be an antibiotic), but with any aspect of patient care. Although this system would not be as simple to implement as the straight antibiotic, or general drug, budget, it may allow a more accurate balance of marginal costs of reducing antibiotic prescribing versus reduction in other types of care to be established.

Another advantage may be in reducing the incentive for the GP to **cost shift**[8]. Depending upon the range of services expected to be covered by the budget, the GP has the incentive to prescribe optimally from the view of balancing the cost of antibiotic prescribing with the subsequent potential costs of not prescribing (ie additional treatment). This, for example, is similar to the UK GP Fundholding system, where certain elements of patient care come from the GP's budget. This provides the GP with the both the profit **and** loss incentive of the market in their decision-making concerning prescription.

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[8] This is covered in more detail in Section 7. Briefly, the cost of abatement will fall predominantly on to the patient and other areas of the health sector (such as by increasing hospitalisations). The incentive, in the absence of perfect agency, could be for the GP to "under-prescribe" - resulting in them receiving a profit from sales of permits, but with the cost of this "under-prescribing" falling on other areas of the health service.

4.2 Initial Allocation of Permits

The initial allocation (or distribution) of permits, as distinct from the final or subsequent distribution once trading has commenced, is a critical area for concern. This is because the regulatory body can control the initial allocation most closely or directly, having only indirect control once market trading has begun in terms of issuing new permits and/or 'buying back' permits.

It is worth reiterating that the permit market should be designed so as to lead to that ultimate allocation of permits which will yield cost-effective reductions in prescribing (and hence resistance) - this will be regardless of their initial allocation, *so long as the market is perfectly competitive* (Montgomery 1972). This intuitively follows from the transfer rights embodied in the system. Providers who can control prescribing most easily, and cheaply, have the incentive to sell to those providers who have higher costs of abatement. However, it is important to see that this initial allocation is not altogether unimportant, since it affects the initial cost faced by both regulator and GP, as well as having equity implications (ie those who are allocated more permits may both prescribe more or make more profit from sales than those allocated less).

Who bears the cost of the initial distribution depends upon the property rights that are deemed to exist for prescribing. These can be conceptualised as being either: (i) wholly residing with the regulatory body itself, who issues them to providers upon receipt of payment for them; or (ii) the prescribing entitlement (in effect the permits) could be deemed to reside with the providers and the regulatory body would have to provide compensation to the provider for yielding their right to prescribe[9]. That is, if the entitlement to prescribe is currently held by the provider, then in order to reduce prescribing the regulatory body would have to "buy back" some of this right, where this amount fully compensated the provider for reducing prescription[10]. However, the burden of reduced prescribing would fall upon the general public in terms of the direct and indirect costs of increased morbidity and mortality (providing of course that permits resulted in reductions in appropriate as well as inappropriate prescriptions. If just the latter are reduced there will be a net benefit to society). In contrast, if the entitlement is considered to be vested in the state, we are concerned with a traditional "polluter pays" principle - that is, GPs must purchase permits from the state regulatory body. In this case the cost falls on the provider (and ultimately those individuals denied antibiotics).

However, in reality perhaps the obvious means of distribution is to take a middle road, whereby the regulatory body distributes the permits at no cost to the provider to cover an initial allocation. That is, the regulatory body determines the overall level of prescription which is acceptable and then issues individual permits, the total quantity of which add up to this overall global target level. The extent to which costs to provider or regulatory body are then incurred is simply in the trade in the market (providers trade between each other and the regulatory body may trade by issuing or buying back permits for particular drugs - analogous to control of the money supply). However, this path obviously requires the regulatory body to define the basis for the initial allocation. Under "polluter pays" the initial allocation is determined by the market, and in the alternative "government pays" option the allocation is determined historically. However, when permits are distributed "free", then some basis for allocation has to be formally determined (which will have equity implications).

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[9] This also raises the issue of how the permits will be allocated (or payment made) to GPs in practice. For example, will this be on the basis of a permit per X,000 scripts per GP, per GP equivalent, per full-time GP equivalent or some allowance per service rendered ?

[10] Such compensation would be difficult to establish given that the costs to the provider directly may vary according to whether they will have to pay for subsequent morbidity. The bulk of the costs may potentially accrue to the patient and to other areas of the health service.

The initial allocation of permits will depend partly upon whether one wishes to reduce current levels of prescribing, or to only influence future levels[11]. Given concern over current prescribing behaviour it would seem that current levels ought to be targeted for reduction (Gonzales & Sande 1995) (Harvey 1988). However, this may not be politically expedient, in which case we may wish to allocate according to the status quo initially and use the permit market to prevent increases in prescribing in the future (subject to increases in future prescription, population or providers[12]). If permits are *initially* allocated to providers so as to allow each to prescribe as much as previously allowed, then any *subsequent* transfers among providers are voluntary, resulting in mutual gains for those trading. This system will guarantee that no provider faces higher initial costs than otherwise it would[13]. In addition it would cause the minimum disruption from moving from a non-market to market system, and side-step any equity concerns. Perfect foresight on the part of the provider and a perfectly competitive market would mean that the regulatory body would not be concerned with the intertemporal allocation of permits. All providers would foresee the future demands for the permits, as well as their effect on prices, and choose to control their allocation investment (decisions to buy and sell) accordingly. For a discussion of temporal issues see section 5.3.

However, the lack of a perfect market (and of course perfect foresight) will create problems, although the extent of these may be controlled. For instance, allocation on the basis of status quo could result in windfall profits to those providers who are currently over prescribing and can cut their prescribing easily and painlessly. A more equitable approach may be to allocate according to illness categories and some weighted average national use in that category. A further problem is that lack of perfect foresight by providers could cause the provider to underinvest in prescription reduction to be used in the future if they underestimate potential demand and future prices (and consequently over-restrict current prescription if they overestimate future demand/prices). This is because the permits can be sold for a profit. However, this may only apply if permits are allocated on an annual basis. One could avoid this concern by, for example, linking the permit allocation to the weekly flow of consultations, with the provider topping up their weekly allocation from the spot market using the previous weeks income.

In addition to the allocation of permits, and subsequent participation in trade, the government could also provide an additional incentive to reduce antibiotic prescription. The system proposed would be one where the permit market consists of a penalty for exceeding prescription levels permitted (as outlined), but also *a subsidy for unused permits*. This subsidy creates an additional incentive for the provider to reduce prescribing. This may be achieved by a greater search for substitutes for antibiotics for instance. This subsidy will be another incentive to those with low abatement costs to keep prescription low compared to those where such abatement is high. However, the undesirable feature is that it again involves more expense for the regulatory body.

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[11] This of course relies on future demand for antibiotics being expected to rise and will not tackle the current problems of resistance. This is a potentially dangerous assumption if there is currently a great deal of over-prescribing which is causing resistance (and of course future use may not rise anyway). ie we may not be tackling the problem if we just limit out policies to preventing future increases in prescribing.

[12] Arguably any future increase may be largely dependent upon increase in the population. However, there may also be a case for increase due to an increase in providers in areas where there was previously a great deal of unmet need for antibiotics (such as remote rural areas), or the development of new antibiotics which will tackle new infections, or better treat existing ones, for which it may be desirable to independently raise the total permit allocation (number of prescriptions) even if it may increase the overall level of resistance slightly.

[13] Of course this only applies to existing providers. New providers entering the system would be faced with higher start up costs of purchasing permits which may cause a significant barrier to entry and therefore increase or create oligopoly or monopoly characteristics. However regulatory power may be used to circumvent this issue.

5 Permit Differentiation

Another central aspect of the permit market is whether the permits are to be differentiated by certain characteristics. Important amongst these characteristics will be whether permits will be tradeable across certain geographical locations, across different 'types', or brands, of antibiotic and how the impact of time will be incorporated into the market.

5.1 Geographical Differentiation

The key to the cost-effective reduction of resistance, or achieving the most the cost-effective attainment of resistance targets, is the relationship between 'global' and 'local' resistance. Ideally we are looking for the establishment of some legal ceiling on prescriptions and then allocating responsibility to meet this among the providers, with incentives such that it requires the minimum amount of resources devoted by the controlling agency. This makes it easy to monitor and administer. The simplest form of permit, administratively, would therefore be an *undifferentiated* permit, which would convey the same entitlement to prescribe to every prescriber in every location. Transfers amongst providers would then take place on a free basis and total prescriptions remain unaffected by the trade.

However, this has the disadvantage that it is not uniquely related to the level of resistance caused at the *local* level. That is, such a system as proposed will tend to limit the *global* (eg national) spread of resistance, but not necessarily local levels (eg by state) since the amount of resistance will vary by locality according to the amount prescribed, which is a function of the density of providers. For example, one may expect urban areas to have higher than "national" levels of resistance, but rural areas lower levels. To differentiate across location, there are two forms of *differentiated* permits which are often explored in the environmental literature (Tietenberg 1974), and which may apply in the market for resistance.

The first such permit allows for differentiation across location, which may be desirable as resistance differs across location (Collignon et al 1992) (Vickery et al 1993) - principally across states and between urban and rural areas. For instance a separate allocation of permits may exist for metropolitan and non-metropolitan areas within Australia. The trade *within* each of these markets would take place on a dollar-for-dollar basis, but the trade *across* markets could be on another basis. That is, there would be an 'exchange rate' for intermarket trade, such that those wishing to purchase permits from within a market may do so at the posted price, but those wishing to purchase from outside this market would be required to pay at a level of, say, 50c per dollar - in this case effectively paying twice the price.

For example, suppose there are two markets (metropolitan area A and non-metropolitan area B), and two antibiotics, X and Y. Further assume that the resistance patterns for the two antibiotics differ across markets, such that the resistance levels to X are twice as high in market A as they are in B, and vice-versa for drug Y. Relative values of permits for each drug could be set such that to purchase drugs from another market, the purchaser must provide two of their permits for each drug purchased. Thus, if a GP in market A wishes to purchase drug X they must provide two permits for purchase of that drug to the seller in market B. Conversely, a purchaser in market B may buy 2 permits for X with every one they have. The reverse would be the case for drug Y. Any purchase of drug X or Y from within each market would take place on a one-for-one basis. This exchange rate system across markets will therefore encourage trade only where resistance in one market will be reduced for each increase in the other market, thus keeping the overall global level of resistance equal. However, if such trade did take place, resistance levels would require monitoring and such exchange rates revising. It is possible that, depending upon the degree of such trade, resistance will more or less equalise across markets resulting in a cross-market exchange rate of one.

This sort of exchange rate system is essential to ensure that regardless of which providers prescribe, the overall level of resistance will be at (or below) the aggregate target.[14] By ensuring penalties for those prescribing above the desirable limit per geographical region, the level of resistance in that region will not climb higher than is considered optimal, which may be the case with unrestricted flow of antibiotics across boundaries. However, as is obvious, a separate permit system for each market, with exchange rates between them, is more administratively cumbersome than a single permit market.

The second major form of differentiated permits attempts to overcome this problem by establishing a fixed number of permits to be allocated to each market, transferable on a free basis, but with no trade between markets allowed (Rose-Ackerman 1977) (Montgomery 1972). This is relatively simple, but may not yield the optimal distribution of permits, since 'free' trade is not possible. That is, allowing no trade whatsoever between markets is likely to be sub-optimal compared to a degree of trade with appropriate exchange rates attached.

Although differentiation may overcome some of the concerns of a globally tradeable permit, such a differentiated system, especially initially, would be administratively more complex and costly. In particular, there is limited epidemiological data at present concerning the geographical spread, and isolation, of resistance making development of a differentiated market difficult (Coast et al 1996) (Coast et al 1997). However, in Australia for example, evidence concerning resistance to different antibiotics on a state by state basis has been established (Collignon et al 1992) (Vickery et al 1993) and could be used to provide the initial differentiation if required, although this will likely be most useful in differentiating between type of antibiotic, as illustrated in Section 5.2.

In addition, there is concern over placing too much reliance on such geographical data since the link between the spread of resistance and domestic and international travel is a potential confounder. For example, one recent study found that the best predictor of clinically important resistance was a history of international travel (Tauxe et al 1990). Antibiotic resistance is a global issue. Travel, whether within the country of interest, or from overseas, *may* compromise the beneficial impact of differentiated permits, although the precise nature of the relationship between travel and the spread of resistance has yet to be established. The likely impact of such a relationship, if it were significant, may differ across counties. For example, in Europe there is such free flow of people encouraged that such partitioning may well be arbitrary and possibly unworkable. However, in some countries, such as Australia, it is possible to have country segregation, and even segregation to a certain degree for some states (eg Western Australia), although there are problems if local partitioning is not undertaken. For example, consider the situation where prescription targets are defined on a national level for Australia. Permits are then issued to providers and trading begins. Since there are no geographic constraints it is quite possible that a disproportionate share of permits could result in urban areas, such as Sydney or Melbourne (where there are most providers and greater density of population), with consequently less impact on resistance (especially as we would expect resistance to increase at a greater rate in urban areas). Resistance is, by its nature, often defined in term of locality specific rates (Collignon et al 1992) (Vickery et al 1993). The issue therefore becomes the number of such locality specific targets necessary to ensure such concentrates of resistance do not occur (to such an extent as is feasible).

Assessing the impact of travel is of some importance, since if we cannot guarantee that the policy will not be negated by imported resistance, then there may be little incentive to adopt such a unilateral stance. A major consideration is also that resistance can be transported long distance, since it is

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[14] In the case of antibiotics it may be unlikely that each provider would operate, or trade, in more than one market, so this may not be a significant issue. However, it would have to be monitored closely as one cannot predict whether or not such intermarket trade would be established (for instance the rural-urban trade may be a significant form of intermarket trade).

'carried' by people![15] Consequently the initial sources of resistance may be far removed from the area they colonise and spread. This may raise issues concerning "free riding". However, since resistance *is* carried by people, it is not impossible to prevent its spread by restricting entry by screening for resistant strains, although the feasibility of this is unclear.

However, as well as being potentially simpler and less costly, under competitive conditions the undifferentiated permit system can fulfil our requirements for efficiency (Baumol & Oates 1975) (Hamlen 1977). The transferability of permits ensures they will be reallocated by the market until the marginal costs of that control are equalised across providers. This also means that the responsibility for achieving target prescriptions is shared amongst providers and requires minimum input from the regulatory body, implying cost effectiveness in achieving target reductions in resistance (there is of course the issue of transactions costs in such trade, which need to be explored further).

With respect to the extent of coverage, a related issue is the extent of the providers to be covered. It could be argued that the costs of establishing and maintaining the market (largely consisting of transactions and surveillance costs) may result in it being only cost effective to require those prescribing more than a certain number of antibiotics to be regulated, thus perhaps removing rural GPs from the system and focusing on the urban areas. However, although it may be more cost-effective it leads to possible equity problems. For instance, does this system require that urban providers have an increased level of funding to enable them to trade in permits, whereas rural providers do not? Or do rural providers not have a drug budget, like those in urban areas, which means they possibly will lose out on making any "profits" from the system compared to urban providers? It is also difficult to have such an open-ended section of the market as there could be trade between the sectors. For instance rural GPs may "sell" scripts to urban GPs at a price lower than additional permits. Again this is an area which could be explored further.

5.2   Range Of Antibiotics Covered ("Brand" Differentiation)

It is clear that different antibiotics have different levels of associated resistance (Collignon et al 1992) (McCraig & Hughes 1995) (Kayser et al 1990)[16]. It is therefore important to consider which antibiotics to cover with such a permit system, and whether these antibiotics are to be treated equally in permit endowment, or to be subject to differential permit restrictions. Clearly differential permit restrictions would be most desirable given the wide differences in resistance between antibiotics. However this raises the issue of whether multiple markets (one for each antibiotic or class of antibiotics) or a single market, with 'weighted' permits, would be constructed.

Administratively it may be desirable that all types of antibiotics are handled within the context of a single market, which would be possible if the aggregate prescription target is defined in terms of equivalence's between antibiotics. This would involve some system of weighting, with weights chosen on the basis of data concerning their contribution to overall resistance. However, if these weights are temporally fixed then the system will not be cost-effective since the weights (reflecting resistance patterns) would necessarily change over time. In practice the weights would therefore have to be changed over time, although there are issues of practicality in achieving such revision. There would also be a requirement for surveillance and it may be difficult to know what the weights should be, although by default a system of not *explicitly* weighting will attach an *implicit* unitary weight to all.

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[15]   And of course by animals. The consideration in this paper is, however, limited to human use of antibiotics and transmission of resistance. It may be that it is more cost-effective to initially target use of antibiotics in animals, but this is beyond the scope of the current discussion. In addition there is considerable uncertainty about the impact of animals on resistance levels (U.S. Congress, Office of Technology Assessment 1995).

[16]   Note that there may be a distinction to be made also between broad-spectrum and specific antibiotics, although it is unclear what this should be as the relationship between these in terms of resistance is unclear.

However, given the level of epidemiological evidence to date some estimate would be feasible and would be preferable to an equal weighting system.

As information systems improve it may be feasible to move to a system of separate markets for each antibiotic (or class of antibiotic). This may be desirable in the long term to allow a greater degree of control over the precise amount of antibiotic use of any one type allowed, rather than use the indirect method of weighting. In practice, a system whereby, for example, drug X has a permit "cost" of 1, and drug Y a permit "cost" of 2, which is deducted from the GP's prescribing entitlement, would be no more difficult to undertake than a system where all are equally weighted (ie drug X and Y both have a permit "cost" of 1). Such a 'manual' of weights would also likely be easier to produce and understand than current drug manuals or CMBS, and would require production far less frequently.

An issue of significance concerning such differentiation or weighting at present is the limited epidemiological evidence to establish the level of resistance from any one class or brand of antibiotic, the effect of this resistance on the resistance to other antibiotics (ie will the markets be able to be sufficiently "independent", or is there too great an overlap?), and the level of change of resistance over time (ie whether some antibiotics develop resistance quicker than others). Establishing the link between any particular antibiotic and resistance is vital for differentiating permits along the lines suggested here. There is some evidence concerning the level of resistance by antibiotic at present (Collignon et al 1992) (McCraig & Hughes 1995) (Kayser et al 1990), and, although limited, could be used to establish an initial weighting system, although more up-to-date information is required and regular surveillance would need to be established.

5.3   The Temporal Dimension (Time Differentiation)

Both the quantity of an antibiotic prescribed over time, and exogenous factors, can impact on the level of resistance attributable to any one antibiotic. Several options exist for the integration of time into the permit system. At the extreme ends of the scale of possible options are daily change and monitoring and infrequent monitoring and change. For the former, "exchange rates" between antibiotics (and areas) would be changed daily in accordance with resistance patterns. The time and cost of this system to the public sector in monitoring, and the providers in changing, prescribing patterns would be prohibitive. The alternative extreme, in contrast, would be to have a system of controls which varies little over time. Although this may be easier to implement, administer and enforce, it may not account for changing patterns of resistance[17].

The permit system could be designed to entitle the provider to prescribe a specified amount of an antibiotic indefinitely, or for some finite time. In theory either option would be practical since transferability would ensure that they were reallocated in response to exogenous factors. A persuasive argument for a limited term permit system (for examples in other areas see: (David 1980) and (Tietenberg 1974)) is the likelihood of greater administrative flexibility in changing the allowed level of prescription. However, even with infinite entitlements the regulatory body can affect this by entering the market to issue or buy permits. In essence it is likely that permits may be issued with different terms, perhaps related to the length of time that resistance is thought to remain high/low for that particular antibiotic.

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[17] Since resistance is affected by factors other than just use of antibiotics (although arguably this is the major contributor to resistance) resistance patterns will change. At present it is unclear how quickly such resistance can develop, spread and change over time, and most information is, at best, based on annual data. It is therefore likely that such changes to permit entitlements will occur, at the most frequent, annually (at least initially).

As mentioned, there are limited data concerning the epidemiology of resistance. Of importance here is that there is limited information concerning how resistance patterns change over time. However, a compromise solution may be the monitoring of resistance to each antibiotic annually and control coinciding with the reissue of permits for the following year - ie allocation of permits on a yearly basis on the basis of historical resistance patterns for the preceding year.

6 Enforcing the System

There is little point in designing a tradeable permit market to reduce the degree of antibiotic resistance if that market is not enforceable. That is, the restrictions placed on the GPs ability to prescribe antibiotics must be enforceable or they will be ignored, and hence will be ineffective. Such enforcement will depend on the ability to detect violations, and the legal consequences of such violation once detected. Ability to monitor resistance is inadequate at present, and so the use of antibiotic prescriptions as a proxy will be most expedient for the detection of violations since scripts are easy to track and, in many cases, are currently monitored by a government agency. If not currently monitored, it would be relatively simple to establish a system whereby each time a prescription is submitted a provider number is required and the prescription deducted from the providers "allocation" on central computer: those with no provider number, or a provider who has prescribed over their allocation, would have the prescription denied. This is pivotal to the success of the system since if providers do not have to worry about being caught overprescribing then the incentive properties of the permit system are lost. There should be sufficient penalties for those who violate the system to discourage prescribing over the permit entitlement.

The type of sanction to be employed is important. There are three common forms of sanction for dealing with noncompliance: cease and desist orders, financial penalties, and closure (Downing & Watson 1973). The first of these typically has no palpable effect since it provides no penalty for past infringement and as such provides no incentive to reduce future infringement. The third is clearly to be seen as so harsh as to never be implemented, and as such may not be seen as a credible approach. Thus, it is often the case that some form of financial penalty system is required. These may take various forms, such as charge per unit prescribed over the permit entitlement, imposed continuously or in a lump sum form at the end of the financial year for instance. Spence and Weitzman (1978) recommend a unit charge which is predetermined and fixed at approximately the level of cost that the additional unit would be expected to incur in terms of the value of the 'pollution' to society. The provider, therefore, is aware of the cost of overprescribing prior to its noncompliance. This has the benefit of relating to *optimal noncompliance* rather than complete noncompliance. By relating the charge for overprescribing to the level of 'pollution' caused, when compliance costs are higher than the charge imposed then noncompliance is the expected (and desirable) outcome[18].

However, in the case of limiting antibiotic prescribing, there is a fourth option not considered in the environmental literature. As alluded to above, if there was a central "bank" of permits based on a central computer then there could be a sanction whereby the providers prescription is not valid unless they have sufficient "credit" in their "account" (of antibiotic permits) to cover it. If they did not the prescription would simply be denied. This has several advantages. First, it is simple to operate, thus making enforcement comprehensive and hard to evade. Second, it makes use of systems which are frequently in place for current monitoring of prescriptions. Third, it would also avoid the possible political undesirability of court cases against GPs for prescribing antibiotics over their allocation. However, it does imply that the pharmacist will have on-line access to the permit bank to check eligibility. An alternative would be for retrospective checking for eligibility and where prescriptions were ineligible (i) GP's be required to immediately purchase permits to cover their deficit, and if they fail to do so (ii) to impose a fine or other penalty. In addition, patients could also be informed when their prescription was ineligible, and that they should discuss this with their GP. This will encourage patient involvement in ensuring GP's prescribe within their entitlement, particularly for those who require lengthy or repeat prescriptions.

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[18] Also need to ensure that the financial penalties are greater than the cost of the permits in the market place otherwise the incentive would be to violate the restrictions rather than purchase additional permits, leading to a breakdown in the market.

7   Discussion

The use of a transferable permit market would appear to offer real potential for achieving a reduction in resistance to antibiotics at reasonable cost. It is clear that, given the degree of uncertainty surrounding resistance, the first clear objective should be to reduce *inappropriate* prescription. This will involve little opportunity cost (in terms of increased mortality, morbidity and health service cost), and will yield a net benefit (subject to the cost of the permit system). The second stage, following an improvement in epidemiological evidence, would then be to consider the optimal reduction in antibiotic prescription which would involve a trade off between current and future costs of resistance.

However, whatever objective is pursued, the practicalities of implementing such a tradeable permit market are by no means complete. The purpose of this paper was to illustrate some of the issues in the key areas required for establishing such a system. A summary of the features proposed are outlined in Table 1 (overleaf), and although not definitive give an indication of the potential features required for a basic system to function. The next stages would be to develop country-specific proposals, to then conduct simulations of the effects of variations in the parameters discussed, and finally to pilot such a system

In addition to the issues presented in this paper, several additional issues of importance were raised, but not dealt with in the main body of the text. These are discussed briefly here as areas for future consideration, although they are likely to differ significantly across country.

First, in this paper abatement cost has been assumed (as defined in footnote 3) to refer to the cost of a possible increase in infections through reduced prescribing. That is, in costs to the individual from reduced access to antibiotics (including possible morbidity, mortality and associated financial costs), and medical costs to the health service (including, of course, the GP). The GP's responsibility (as the patients agent) is to therefore balance the increase in these costs (largely to the patient) against the direct cost to themselves of purchasing and using permits in prescribing antibiotics. It is clear that in assessing this balance, the cost of reduced prescription by GPs who currently prescribe high numbers of antibiotics to those with self-limiting conditions (such as a sore throat) would be less than those to providers who prescribe for more serious conditions. Efficient abatement would therefore have to recognise this, which is simple under the assumption of *perfect agency*. However, in the presence of imperfect agency, the incentives to the GP to equalise such marginal costs becomes a complex issue. Simply, the main *cost* of abatement is borne by the individual patient, but the permit system is designed such that the *reward* for reducing the cost associated with resistance goes to the GP.

Table 1:
Summary of Proposed Transferable Permit Market

Area of Interest	Proposal
Objective	Cost-effective achievement of a "goal" (specified level of resistance or prescription in the short run - likely to be reduction of inappropriate prescribing initially). As data improves, move towards "efficient" use of antibiotics
Initial allocation of permits	Free distribution on a historical basis. Government "buying and selling" to indirectly control the market, with subsidies for permits unused at end of period
Geographical differentiation	Undifferentiated. Global limits to begin with, with a move to local limits in the long run as data collection is improved. May wish to consider differentiation by location with no cross-boundary trade, or fixed exchange rates initially. For example, permits only applicable to metropolitan areas initially, with a move to state and then country markets
"Brand" differentiation	Single market with a system of weighting. This can account for different resistance levels but only requires one market - transactions costs would be lower than separate markets. Move to separate permits for each class of antibiotic, and then each specific antibiotic in the long run
The temporal dimension	Allocation annually to begin with, but maybe a move toward quarterly as data improves
Enforcing the system	Refusal of authorisation for prescription if invalid "account". Perhaps revoking prescriber number or unit charge for each prescription over the permit entitlement

Arguably, there are some GPs who are more perfect agents than others, and GPs are by no means homogenous. It is likely that (given any form of permit market) there will be some who will wish to reduce prescribing below what may be considered the optimum in order to sell off their permits for a profit (especially if they can shift the consequences in terms of treatment costs for infection onto other areas, such as the hospital sector). On the other hand there will be GPs who will cling tenaciously to their established practice pattern and resist the market system. Ultimately, the system relies on GPs pursuing the best interests of their patients in the absence of the consequences of prescribing falling upon themselves, but falling on their patients. This assumption, or requirement, may be questionable, although the financial incentives could be changed to account for this. For example, by making GPs accountable for subsequent costs (as with UK GP Fundholders) and by making sure they wish to attract patients (ie the form of financing GP services) and the sanctions for overprescribing as discussed. There could also be an effort by the regulator to pursue a policy of patient education. This may be in the form of brochures regarding use of antibiotics (such as what ailments are viral and therefore not appropriately treated by antibiotics), or perhaps, as mentioned in section 6, the use of letters informing patients when their GP has prescribed without necessary permit entitlement.

Second, there will likely be substantial transactions costs associated with such a system. Not only may the system require a significant resource input to function, in terms of administration and surveillance for example, but the GPs themselves may be faced with substantial costs associated with trading in permits. This of course would depend upon the complexity of the market system established. For instance, if permits were allocated on an annual basis, and trade was via a central "computer" market, search costs to the GP may be low (although infra-structure costs to government may be high in developing this computerised system), compared to a system of allocation daily, or infinitely valid permits with trade via a "stock exchange system". However, costs to the state are likely to be incurred already through inappropriate prescription, and will be incurred in the future through the spread of resistance, so establishing the trade off against investment now or an increase in cost in the future is essential.

Third, there is an issue concerning comparability in market structure between general practice and hospital prescription of antibiotics. Would there be a coordinated market with general practice for permits, or would a separate market, or regulatory structure, exist for the hospital sector, and what relationship would these two sectors have with each other? This is an important consideration for further research in the development of a permit market.

Fourth, following on from the point made above, there is the potential for the GP to cost-shift to the hospital sector. That is, the market must ensure there is not an incentive for the GP to simply not prescribe, and therefore sell their permits at a profit, and to let the hospital sector bear the cost of treating the patient when their condition worsens sufficiently through non-prescription of antibiotics. In addition, there must be some system in place to prevent the GP avoiding prescribing by referring the patient to a specialist for a prescription (although this could be countered by any specialist prescriptions being debited against the permit account of the referring GP). It is clear that the incentive structure must be such that such behaviour is not encouraged. This may take the form, as discussed, of GPs bearing more of the costs of subsequent care, some regulatory mechanism such as clinical audit, or combined with the role of patient education as already referred to above.

Fifth, as the authors have previously discussed (Coast et al 1997), there is the complicating factor of the pharmaceutical industry. Any incentive structure to reduce the use of current antibiotics may reduce the incentive for the industry to develop new antibiotics, although the implication of policy on pharmaceutical research and development is unclear. Many antibiotics are used as replacement for current agents, in which case the effect on overall resistance may be favourable. However, some are additions to current agents in which case the value may be unclear. The benefits of reducing consumption (prescription) of antibiotics now depends on changes in future technology (both drug and non-drug therapies). Thus if new drugs are not being developed then the benefits of restricting use now will be greater than if they are to be developed. Hence any estimate of the potential benefits must be based on some degree of assumption about future technological development.

Sixth, there is also the issue of whether patients would be able to get antibiotics over-the-counter (OTC) from pharmacies (with the potential for the GP to cost shift to the patient rather than prescribing). The authors have already considered this issue, concluding that "moving [antibiotics] to OTC status may generate short term benefits for the government (in a reduced drugs bill) and pharmaceutical industry (in wind-fall profits), but will result in considerably increased health service costs in the long term" (Smith et al 1996, p1032).

Finally, there is the issue of discounting of future costs and benefits. With an even moderate positive rate of discount, the present value of future resistance may well be low. However, the authors have considered the issue of discounting at some length previously, where it was concluded that, because antibiotic resistance may be both long term and irreversible, "such discounting should be based on the use of a *social* discount rate [where that social discount rate] should reflect collective value

judgements and moral issues, rather than just the preference that individuals have for their ***own*** consumption over time" [emphasis added] (Coast et al, 1996, p221).

Although there may appear to be many uncertainties in the development of such a system, the whole area of antibiotic resistance is currently filled with uncertainty. It is primarily due to this that permits ***are*** being explored as they offer the most flexible means to tackle the issue of resistance. The attraction of permits is to put an effective limit on the use of antibiotics but in a flexible manner. Achieving a global limit will necessarily be pretty arbitrary, but it is better than no global limit at all.

REFERENCES

American Society for Microbiology 1995, 'Report of the ASM task force on antibiotic resistance', *Antimicrobial Agents and Chemotherapy*, Supplement:1-23.

Baumol WJ, Oates WA 1975, *The Theory of Environmental Policy*, Englewood Cliffs, NJ: Prentice Hall Inc.

Cannon G 1995, *Superbug: Natures Revenge*, Virgin Publishing, London.

Coast J, Smith RD, Millar M 1997, 'An economic perspective on policy to reduce antimicrobial resistance', *Social Science and Medicine* (In press) .

Coast J, Smith RD, Millar M 1996, 'Superbugs: Should antimicrobial resistance be included as a cost in economic evaluation?', *Health Economics*, vol 5, pp 217-226.

Collignon PJ, Bell JM, MacInnes SJ, Gilbert GL, Toohey M, and the Australian Group for Antimicrobial Resistance (AGAR) 1992, 'A national collaborative study of resistance to antimicrobial agents in *Haemophilus influenzae* in Australian hospitals', *Journal of Antimicrobial Chemotherapy*, vol 30, pp 153-163.

David MH 1980, 'Marketable permits for the control of phosphorous effluent into Lake Michigan', *Water Resources Research*, vol 16, pp 263-270.

Downing PB, Watson WD (1973). *Enforcement Economics in Air Pollution Control.*: US Environmental Agency, EPA 600/5-73-014.

Gonzales R, Sande M 1995, 'What will it take to stop physicians from prescribing antibiotics in acute bronchitis?', *Lancet*, pp 345:665.

Gruneberg R (1995). 'The Alexander project - the first two years', *Canadian Journal of Infectious Diseases* , vol 6, C226.

Hahn RW 1989, 'Economic prescriptions for environmental problems: How the patient followed the doctor's orders', *Journal of Economic Perspectives*, vol 3, pp 95-114.

Hahn RW, Noll R 1982, 'Designing a market for tradeable emissions permits', in *Reform of Environmental Regulations*, (ed.) W Magat, Ballinger, Cambridge MA, pp 119-146.

Hamlen W 1977, 'The quasi-optimal price of undepletable externalities', *The Bell Journal of Economics*, vol 8, pp 324-334.

Harvey K 1988, 'Antibiotic use in Australia', *Australian Prescriber*, vol 11, pp 74-77.

Kayser FH, Morenzoni G, Santanam P 1990, 'The second European collaborative study on the frequency of antimicrobial resistance in *Haemophilus influenzae*', *European Journal of Microbiology and Infectious Diseases*, vol 9, pp 810-817.

Kubin CM 1993, 'Resistance to antimicrobial drugs - a worldwide calamity', *Annals of Internal Medicine*, vol 118, pp 557-561.

Levy J 1990, 'Antibiotic resistance in Europe and the current use of antibiotics in severe paediatric infections', *Scandinavian Journal of Infectious Diseases*, vol 73, pp 23-29.

McCraig LF, Hughes JM 1995, 'Trends in antimicrobial drug prescribing among office-based physicians in the United States', *Journal of the American Medical Association.* vol 273, pp 214-219.

Montgomery D 1972, 'Markets in licenses and efficient pollution control programs', *Journal of Economic Theory*, vol 5, pp 395-418.

Murray BE 1994, 'Can antibiotic resistance be controlled?', *New England Journal of Medicine*, vol 330, pp 1229-1230.

Neu HC 1992, 'The crisis in antibiotic resistance', *Science*, vol 257, pp 1064-1073.

Rose-Ackerman S 1977, 'Market models for water pollution control: Their strengths and weaknesses', *Public Policy*, vol 25, pp 283-406.

Smith RD, Coast J, Millar M 1996, 'Over-the-counter antimicrobials: the hidden costs of resistance', *Journal of Antimicrobial Chemotherapy*, vol 37, pp 1031-1032.

Spence AM, Wietzman ML 1978, 'Regulatory strategies for pollution control', in *Approaches to Controlling Air Pollution*, (ed.) A Friedlander, The MIT Press, Cambridge, Mass.

Tauxe RV, Puhr ND, Wells JG, Hargett-Bean N, Blake PA 1990, 'Antimicrobial resistance of *Shingella* isolates in the USA: the importance of international travellers', *The Journal of Infectious Diseases*, vol 162, pp 1107-1111.

Tietenberg T 1974, 'Design of property rights for air pollution control', *Public Policy*, vol 22, pp 275-292.

Tomasz A 1994, 'Multiple-antibiotic resistant pathogenic bacteria. A report on the Rockefeller University workshop', *New England Journal of Medicine*, vol 330, pp 1247-1251.

U.S. Congress, Office of Technology Assessment 1995, *Impacts of Antibiotic-Resistant Bacteria*, U.S. Government Printing Office, Washington DC.

Vickery AM, and the Australian Group for Antimicrobial Resistance (AGAR) 1993, 'Strains of methicillin-resistant *Staphylococcus aureus* isolated in Australian hospitals from 1986 to 1990', *Journal of Hospital Infection*, vol 24, pp 139-151.

Williams JD 1986, 'Antibiotic policy', *Scandinavian Journal of Infectious Diseases*, vol 49, pp 175-181.

Why Economic Evaluation Will Fail to Deal with Antibiotic Resistance

Although economic evaluation should theoretically be able to incorporate the costs of this externality, it is clear that in practice this has not been the case. Three main reasons are postulated to explain this (Coast et al 1996).

First, it is naive to expect individual investigators to take up this daunting challenge as part of each, relatively simple, drug evaluation when, by ignoring the externality, it is possible for each analysis to effectively 'free ride' on the current level of antibiotic resistance. The marginal costs of antibiotic resistance are difficult to estimate (for instance due to uncertainties concerning the probability of new antibiotics being developed and the mechanisms by which bacteria become resistant). Without more detailed medical knowledge and adequate epidemiological models of resistance, attributing the costs of an increase in antibiotic resistance to any one treatment intervention will be difficult; maybe impossible (although attempts are being made to provide surveillance and documentation mechanisms which could potentially provide a framework for epidemiological models (American Society for Microbiology 1995) (Gruneberg 1995). Given constraints on funding and time it is unlikely that any one analyst will incur these costs for what will inevitably be a side issue in the context of each single evaluation.

Second, it may be wrong to expect economic evaluation to provide an effective policy response to the problem of an externality which is, by it's very nature, relatively diffuse. Given that each analysis is partial, and that many interventions are not subject to economic evaluation, it is unlikely that the sum of all these appraisals could add up to an adequate policy response.

Third, individual decision makers with alternative viewpoints (the health service or individual patients for example) may not choose to base their practice on the results of such societal evaluations. In the majority of other evaluations where externalities are involved, such as chemical pollution from the development of a waste disposal site, the single policy decision is taken by the group commissioning the research. In contrast, decisions about whether to prescribe will be taken over and over again by many thousands of decision makers. Further, the "decision maker" in this case may not be just the doctor providing care, but instead a combination of the doctor and patient together. This "decision maker" is unlikely to choose a societal perspective, or probably even a health service perspective.

Due to this multitude of decision makers, and the diffuse nature of the externality, the use of economic evaluation is not likely to be sufficient to procure an efficient outcome. Economic evaluation alone will not ensure that the costs of antibiotic resistance are incorporated into the decision making process and, alone, is inadequate as a policy response by economists to this problem.

Alternative Policies for Dealing with Antibiotic Resistance

If economic evaluation is unlikely to provide a sufficient policy response to antibiotic resistance, then what are the alternatives? The authors have previously identified three such alternative policy options (Coast et al 1997).

1. Regulation
Regulation is perhaps the most obvious means of reducing pollution. Although it is usually considered to be relatively easy to introduce and administer, it is less efficient than polices relying on economic incentives because the variation in marginal abatement costs is not generally accounted for by regulation - and, if it were to be, the costs for the regulatory agency of obtaining information about the most cost effective form of abatement for each location would be huge.

Attempting to regulate the amount of resistance produced in a location requires limiting the use of antibiotics. Such enforced limitation would necessarily have to be conducted via the GP as the *chief* supplier to the consumer (although specialists can also prescribe). There are two main ways of implementing such regulation: (1) via restriction of what patients/conditions it is appropriate to treat and with what antibiotic; (2) via a global limitation on the amount of antibiotics available to each GP over a period, to be dispensed as they see clinically fit, set on the basis of some sort of formula.

There are a number of potential difficulties in dealing with antibiotic resistance via regulation. First there is the heterogeneity of patients (to what extent would regulation account for patients with slightly different illnesses in slightly different circumstances?). Second, it would be difficult to ensure that clinicians were following the explicit rules about who should, and who should not, receive antibiotic treatment (also requiring development of "policing" methods to ensure clinicians were following these rules). Third, strong regulation is likely to conflict with clinical freedom and may meet with extensive opposition, but the alternative of weaker regulation (eg clinical guidelines) would be easier to ignore and violate, and it is questionable whether guidelines in this area would make any impact.

The second form of regulation described, in which clinicians have a global limit to prescribing, may have greater potential by creating an incentive to reduce current over-prescribing, whilst leaving the choice of which patient to treat with the clinician. The number of antibiotics available to each GP could, perhaps, be based on a formula which might take account of such factors as list size, deprivation etc (which obviously requires detailed work).

However, the "damage" caused by antibiotic use is likely to vary from place to place, as is the likely cost (in terms of patient suffering) that would result from regulation to abate antibiotic use. This suggests that this type of uniform abatement policy could be less cost-effective than policies which rely on economic incentives, to which we now turn.

2. Charges

On the basis of economic theory, taxes on pollution should provide an efficient means of abating pollution since the polluter will have to take account not only of their private costs but also the external costs placed on society (ie bear the full cost of production). This is achieved by imposing a tax equal to the marginal external cost.

For various reasons, such a tax would have to be levied on the consumption of antibiotics as a proxy for the generation of resistance. These products are easily identifiable, application of a charge for each antibiotic simple, revenue raised could subsidise research into new antibiotics and it would be possible to alter the charge for each antibiotic depending on changing resistance patterns.

The most expedient form of charging would apply where clinicians operate within a defined drugs budget (eg GP Fundholders in the UK), where the charge impacts on this drug budget. This would give the GP the incentive to reduce prescription of antibiotics in relation to prescription of other drugs, by reducing prescriptions for minor self-limiting conditions or substituting alternative therapies. However, estimating the actual charge for each antibiotic, tracking resistance patterns and changing such charges could be administratively complex. In addition there is a potential problem if the charge can be passed on to the patient (the attraction of permits, below, is that this global limit is enforced).

3. Permits

Permits may combine the best of both the above policies. Each "provider" (in this case the GP) is provided with permits to prescribe up to a certain level. Beyond this level prescription is not allowed - much as with strict regulation - *unless extra permits are obtained to cover the excess*. This system would work with drug budgets, which would enable GPs to purchase antibiotic permits from other clinicians (expecting that they would only do this once the benefit associated with further antibiotic prescriptions was greater than the benefit associated with prescriptions to other patients - as with charges). This enables those with lower abatement costs to carry out more of the pollution reduction and sell their permits (for a profit) to those with higher abatement costs. For the latter group, a smaller reduction in pollution is therefore necessary to comply with the law. Permits therefore have the advantage over regulation of increasing the flexibility by which an overall standard may be met. As with charges, there is the advantage that pollution can be reduced as cost-effectively as possible, without regulators requiring information about the shape of abatement cost functions. The major concern with permits is that increased transactions costs (given the potentially large number of participants in the market) could potentially outweigh any savings, compared with a more simple regulative policy as outlined.