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Getting the incentives right

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Medical errors:

Getting the incentives right*

by

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Abstract:
This work examines the role of penalties as providers of incentives to prevent medical errors and ensure that such incidents, once they occur, become common knowledge. It is shown that a scheme with two penalties (accountability and non-report) is able to induce the first-best solution. However, this scheme needs not imply a punitive environment, but may, under given circumstances, yield insignificant and even negative penalties. Alternative incentive systems, such as voluntary reporting and legal immunity, are found to have less desirable properties. An exception is the principle of confidentiality (anonymity) which turns out to be an optimal scheme. It is also shown that when a judicial upper limit is binding, for the non-report penalty, it becomes rationale to go "soft" on the accountability penalty.

JEL classification: D82, I18, K42
Key words: Iatrogenic injury, adverse events, reporting incentives, confidentiality

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1. Introduction

The focus on medical error prevention has increased the last few years most probably because of the publication *To err is human* by The Institute of Medicine of the National Academy of Sciences (see Kohn, Corrigan and Donaldson, 1999). The report received massive attention and the main conclusions were that health care is a risky business since iatrogenic injuries are common and that errors involve considerable costs.[1] As much as 100 000 Americans a year could be dying from preventable errors with many more incurring various injuries.[2] The total U.S. national costs for adverse events are estimated to be between $37.6 and $50 billion while for preventable adverse events they are between $17 and $29. Brennan et al., (1991) reviewed the medical charts of more than 30 000 patients in USA, admitted to 51 different acute care hospitals, and found that injuries caused by medical management occurred in 3.7% of the admissions. The same data were also analysed by Leape et al., (1993) which concluded that 69% of the injuries were caused by errors. An Australian study of 28 hospitals reported that adverse events occurred in 16.6% of admissions resulting in permanent disability in 13.7% of patients and death in 4.9%, while 51% of the adverse events were considered to be preventable. Observational studies have identified even higher rates of error and injury from medical care (see for example the survey by Weingart et al., (2000) and the references therein).

Kohn, Corrigan and Donaldson (1999) define a medical error as an adverse event or near miss that is preventable with the current state of knowledge.[3] However the occurrences of such errors need not involve liability nor imply individual failures. Reason (2000) classifies medical failures into active and latent failures where active failures are unsafe acts committed by people who are in direct contact with the patient while latent conditions are error provoking conditions (system failures) such as time pressure, understaffing, inadequate equipment, fatigue and inexperience. So far control systems have focused mainly on responsible individuals, neglecting the fact that most serious faults involve multiple system failures and the involvement of many health care workers. Humans are fallible and errors are to be expected and the blaming of individuals and the isolation of unsafe acts from their system context should be replaced by the search for system failures and the targeting of institutions. Additionally, effective risk management depends crucially on establishing a reporting culture. Another conclusion from the literature is that errors or incidents appear to be significantly underreported (Kohn, Corrigan and Donaldson, 1999). Cullen et al., (1995) finds, for example, that errors are underreported by a factor of 10. Barach and Small (2000) refers to literature for which the underreporting of adverse events is estimated to range from 50%-96% annually.

[1] Other recent and important publications on this topic are DH (2000) and Runciman and Moller (2001).
[2] In the U.S. medical errors result in 44 000-98 000 unnecessary deaths each year and 1 000 000 excess injuries (Kohn, Corrigan and Donaldson, 1999).
[3] Near misses are events that could have resulted in an accident, injury or illness, but did not, while adverse events are injuries caused by medical management that results in measurable disability.

The literature on medical errors stresses the importance of learning from failure and that reporting is fundamental to the broader goal of error reduction. Underreporting represents costly information losses since regulatory bodies and health-care institutions themselves could systematically report, register, analyse and disseminate such data and translate them into useful information.[4] In the literature there has been a debate on the adequacy of punitive versus non-punitive incentive programs.[5] Punitive programs are believed to act as barriers because of legal risk and the fear of malpractice suits, patient anger, as well as being a negative signal on practitioners' incompetence (reputation damage).[6] Leape and Berwick (2000) find that responsible professionals, being involved in medical errors, feel the sense of guilt and remorse, and that a current culture of "blaming, naming and shaming" represents an obstacle to error reporting since it becomes unsafe to admit error and explore why errors occur. In a study by Rosenthal (1995), a strong norm of not criticising among medics is identified. The same study also reports of the existence of self-regulatory mechanisms believed to be quite ineffective in dealing with incompetent doctors. As a consequence, incentive programs being characterised as less punitive, such as voluntary reporting, confidentiality and immunity, have been suggested to replace present systems.

The demand for non-punitive environments to create incentives for reporting seems to contradict conclusions in the economic literature where compliance with a law is believed to increase with the penalty imposed upon conviction (see e.g. Becker, 1968). Maximum enforcement at lowest possible costs is achieved by tough penalties combined with an insignificant amount of resources to detect non-compliance. The intention of this paper is to provide some insights on the role of incentives in association with medical errors and discuss to what extent a punitive or non-punitive environment is the adequate one. Consequently, the paper is concerned with the design of optimal malpractice or liability systems.[7] In doing so an analytical model is presented which describes a relationship between a regulator and an institution (a team of health care workers or a responsible physician). The regulator is to design an optimal incentive structure for preventing medical errors while on the same time inducing physicians to report about errors once they occur. Two possible penalties are introduced into the model - one that concerns accountability (ex-ante) and one that concerns reporting incentives (ex-post). The physicians face a two step decision process where they first are to decide on preventive

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[4] One suggestion is to record all information in a computerised database parallel to what have been done in sectors with well-developed reporting systems like aviation and the nuclear industry. However, errors in the health care industry differ from those in these industries being less visible and dramatic and concerns one patient at a time while damages happen to a third party. Hence the optimal design of incentives must differ.

[5] See ISMP (1999) and articles published in an issue of the British Medical Journal (No. 7237, 18 March, 2000).

[6] In the literature the concepts of mandatory and voluntary reporting systems are frequently applied. Kohn, Corrigan and Donaldson (1999) define mandatory reporting as systems that hold providers accountable for performance where regulatory bodies have the authority to investigate specific cases and issue penalties or fines for wrong-doing. However, penalties for not reporting errors are not explicitly mentioned in this publication.

[7] The model set-up draws upon former works on environmental compliance such as Greenberg (1984), Harrington (1988) and Heyes (1996).

effort to reduce the risk of errors, and secondly, if a preventable error has occurred, to decide on whether to report the incident or not. The occurrence of an error is assumed to provide the physicians with private information which can influence their reporting decision. The model combines moral hazard with adverse selection and all agents are assumed to be risk-neutral.

The economic literature on medical errors is concerned with the impact liability has on pricing and income (Jensen et al., 1999 and Danzon et al., 1990), medical malpractice insurance (Thornton, 1999), and the optimal design of insurance schemes (Sloan, 1990). Danzon (2000) views these analyses as extensions of economic analysis on tort liability presented by Posner (1972), Brown (1973) and Shavell (1980), where the deterrence function of liability is discussed. In addition there is evidence on liability reforms to reduce medical expenses without important consequences on health outcomes [see e.g. Localio (1993), Dubay et al., (1999), Kessler and McClellan (1996)] - findings that suggest the practicing of defensive medicine.[8] To my knowledge, the health economic literature has not focused at reporting incentives. However, the topic is formerly treated in literature on tax compliance and the enforcement of pollution standards (see e.g. Andreoni et al., 1998 and Malik, 1993). This paper, however, differs from the above mentioned works since the reporting of decisions provides additional gains in terms of information that reduce the future problem. The paper is organised as follows. First, a punitive incentive model is presented and an optimal penalty scheme derived. Secondly, the model is modified in order to analyse the consequences from less punitive schemes such as voluntary reporting, the principle of confidentiality and legal immunity. Finally, the impact from the presence of institutional barriers on the optimal penalties is discussed

2. The optimal penalty scheme.

The model presented in this section analyses the incentives of health care workers that is exposed to the risk of committing medical errors.[9] The regulator is concerned both with the expected social costs that accrue from errors and informational gains. The physicians undertake a two-step decision process.[10] First, they decide on how much effort to invest in costly preventive activities to avoid the occurrences of preventable errors, where the effort level is unobservable for the regulator. After treatment of a patient, the physician privately observes whether an error has occurred or not, and if so, whether to report the incidence promptly to the regulator or not.

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[8] Kessler and McClellan (2002) define defensive medicine as "precautionary treatment with minimal expected medical benefit out of fear of legal liability".

[9] Throughout the paper, errors, preventable errors and medical errors are applied to describe adverse events and near misses being preventable with the current state of knowledge.

[10] The observed tendency to blame individuals rather than to place responsibility on institutions is challenged in several works (see Reason, 2000 and Reinertsen, 2000). This work is not concerned with what level to put the blame, however, in the text we use physicians as the responsible agent.

In the following p(e) denotes the probability of a preventable error to occur, where *e* is the effort invested in reducing this probability. *p(e)* is continuous, twice differentiable, negative, and a strictly decreasing function in effort; $p_e^{'} < 0, p_{ee}^{''} > 0$. Hence, preventive effort is here assumed to influence the probability of errors only, and not the distribution of outcomes. The value of *e* is unobservable (or not verifiable) for the regulator.

At the end of the first period, for a given *e*, physicians observe privately whether a preventable error has occurred or not. The actual occurrence of a preventable error is private information for physicians and such incidents also provide them with private information on what type of error which occurred. Four possible types of errors are assumed differing with respect to the probability of being held liable for a medical error if they become common knowledge. The types of errors are classified according to the degree of social costs inflicted and the physician's own perception of the quality of evidence. D_H and D_L are the two types of social costs that may follow from a preventable error where $D_H > D_L$.[11] These costs include patient injury and discomfort as well as costs following from treatment costs such as rehabilitation, increased hospital stay and additional medical expenses.[12] For each category of costs there are two possible outcomes w.r.t. the quality of evidence. In this way we end up with four types of errors where r_{HH} and r_{HL} denote the exogenous liability probabilities for high damage events, D_H, with a high quality and a low quality of evidence, respectively, where $r_{HH} > r_{HL}$. For low damage events, D_L, r_{LH} and r_{LL} now denote the same two liability probabilities, where $r_{LH} > r_{LL}$.[13] The occurrences of preventable errors need not imply judicial liability since errors can not always be attributed to carelessness or incompetence, because of inherent scientific and clinical uncertainties, and due to the inability to meet standard of proofs.

Given an incidence, physicians face two options - whether to report about the incidence to the regulator (self-report) or to lie low (non-report). It is assumed that both choices involve expected costs for the physicians beyond the penalties imposed by the regulator (see e.g. Wu, 2000). Given the decision to self-report, a cost, b, is experienced which is to reflect patient anger, the feeling of being singled out, exposed, and one's competence questioned (adverse publicity and reputation losses) in the following denoted as the shame-parameter.[14] For physicians who decide to keep silent about errors, a

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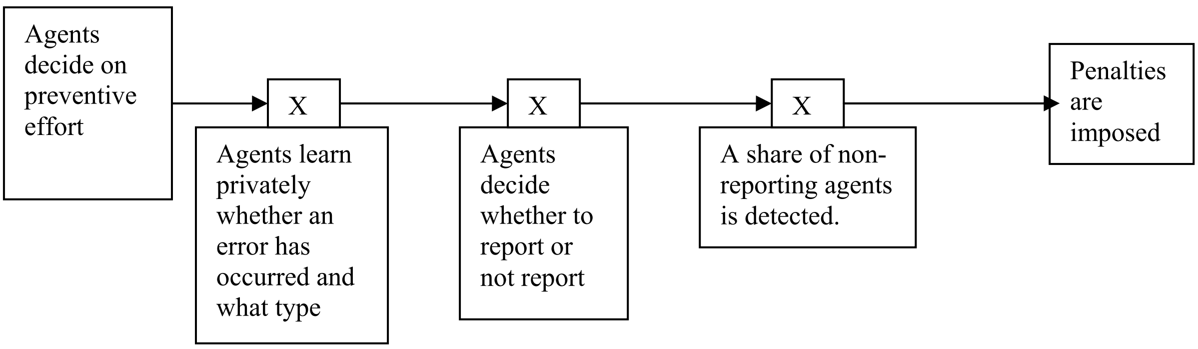
[11] If D_L is set equal to zero it can be interpreted as a medical near miss. DH (2000) considers near misses as free lessons.
[12] Costs from lost income and household production costs can also be included.
[13] The model could also be presented more simplistically by assuming two types of errors. It is here chosen to introduce four types to stress the heterogeneity which prevail as concerning medical errors. The number of possible equilibria in the model increases with the number of error types (see section 4).
[14] Sexton, Thomas and Helmreich (2000) report that more than half of the intensive care staff finds it difficult to discuss mistakes because of personal reputation and possible disciplinary actions.

parameter a is introduced (guilt-parameter) to reflect the fear of being discovered as well as moral costs that goes with the violation of the ethical responsibility to inform both patients and the regulator.[15]

In the case of non-reporting, any physician faces the possibility of being detected by the patient, the patient family, by colleagues, or by medical audits. A unique relationship is assumed between the level of damage, D_i, and the exogenous probability of detection, if choosing not to self-report, q_i ($q_H > q_L$). The rationale behind this assumption is the belief that preventable errors with outcomes that inflict much discomfort for the patient, is more difficult to hide from the regulator.

The regulator has two instruments (penalties) at her disposal to influence physician behaviour. First, a penalty, t, imposed if the physician is being held liable for a preventable error. This penalty, in the following denoted as the accountability penalty, is the same independent of how the incident was revealed to the regulator. Second, the regulator may impose a penalty, s (non-report penalty), for those who fail to report about an incidence and are being detected. Consequently, an individual choosing not to self-report, but is detected and held liable, is penalised by $t + s$, while an self-reporting individual being held liable faces the penalty t, only. The timing of the game is shown in figure 1where agents decide on effort before they privately know whether an error will occur and what type of error (ex-ante), while the reporting decision is made after receiving private information (ex-post).

Figure 1: The timing of the game



From the above assumptions it follows that physicians differ with respect to whether or not they experience a preventable error, and if they do, what type of error. The occurrence of errors and their true type is not observed by the regulator, but their probability distribution is common knowledge.

[15] The professional's feeling of guilt and remorse may include concerns for the patient experiencing errors. It seems reasonable to assume that such costs do not vary across modes of behaviour (reporting or non-reporting).

Social (patient) costs and the detection probabilities is assumed to take the values D_H, q_H and D_L, q_L with probabilities β and $1-\beta$, the liability probabilities for high damage errors takes the values r_{HH} and r_{HL} with probabilities γ and $1-\gamma$, while the liability probabilities for low damage errors takes the values r_{LH} and r_{LL} with probabilities μ and $1-\mu$. The parameters β, γ, μ, a and b are all common knowledge.[16] (A map of the decision process is presented in the Appendix).

In the following, the second stage decision is described (ex-post). Physicians, at this stage of the game, know whether a preventable error has occurred and which type they are confronted with. The expected pay-offs, given the occurrence of a preventable error of type *ij*, are;

$$SR_{ij} = b + r_{ij}t + (1-r_{ij})0 = b + r_{ij}t \qquad \text{where} \quad i = H,L \text{ and } j = H,L \qquad (1)$$

$$NR_{ij} = a + q_i[r_{ij}(t+s) + (1-r_{ij})s] = a + q_i(r_{ij}t + s) \qquad \text{where} \quad i = H,L \text{ and } j = H,L \qquad (2)$$

where SR_{ij} denotes the expected pay-off if the preventable error is reported to the regulator, while NR_{ij} is the expected pay-off if the physician fail to report the incident. It is observed from eq.(1) that the expected self-report pay-off is the sum of the shame parameter and the expected accountability penalty being the product of the actual probability of being held liable, r_{ij}, and the accountability penalty itself, t. The expected non-report pay-off (see eq. 2) is the sum of the parameter reflecting guilt, the expected non-report penalty if being detected, and the expected accountability penalty if being detected and held liable. It is observed that the self-report pay-off, SR_{ij}, depends on the accountability penalty, t, only, while the pay-off relevant for the other mode of behaviour, NR_{ij} is a function of both penalties (t and s).

The condition which ensures that physicians self-report, given the occurrence of an error of type *ij*, denoted the optimal self-report rule, is;

$$SR_{ij} \le NR_{ij} \Rightarrow b + r_{ij}t < a + q_i(s + r_{ij}t) \Rightarrow b - a < q_i s + r_{ij}t(q_i - 1) \quad i = H,L \text{ and } j = H,L \qquad (3)$$

It follows from eq. (3) that if the "shame" associated with self-reporting is significantly higher than the "guilt" that goes with lying low (a non-reporting culture; $m \equiv b - a > 0$), a high non-report penalty

[16] In this paper individuals differ w.r.t what errors they experience while the parameters a and b are assumed to be the same for all individuals and all types of errors. As follows from (3), the reporting decision does not depend on the absolute level of a and b but their relative size.

(s) and a low accountability penalty (t) are needed to induce health care workers to self-report. The conclusion as concerns s is self-evident while the role of t is explained by considering the following expressions;

$$\frac{\partial SR_{ij}}{\partial t} = r_{ij} > \frac{\partial NR_{ij}}{\partial t} = q_i r_{ij} \qquad \text{where} \quad i = H, L \text{ and } j = H, L \tag{4}$$

It is observed from (4) that the marginal increase in expected pay-offs from a higher accountability penalty is higher for self-reports than for non-reports, since non-reporters may evade a penalty. Hence, an increasing accountability penalty weakens the incentives for self-reporting. It follows from (3) that for a detection probability close to zero, self-reporting can only occur in guilt-dominated cultures (a reporting culture; $m \equiv b - a < 0$). Finally, it is observed that for given values of t and s, individuals may choose differently depending on the type of errors they experience.

The expected pay-off (penalty) function, for a physician, after observing a preventable error *ij* (ex-post), can now be written as;

$$R_{ij}(t,s) = \begin{Bmatrix} b + r_{ij}t & \text{if } b + r_{ij}t \leq a + q_i(r_{ij}t + s) \\ a + q_i(r_{ij}t + s) & \text{if } b + r_{ij}t > a + q_i(r_{ij}t + s) \end{Bmatrix} \qquad \text{where } i = H, L \text{ and } j = H, L \tag{5}$$

The expected penalty function, given the occurrence of an error, but before knowing what type of error has occurred (ex-ante) is;

$$R^a(t,s) = \beta\gamma \min\{b + r_{HH}t;\ a + [r_{HH}t + s]q_H\} + \beta(1-\gamma)\min\{b + r_{HL}t;\ a + [r_{HL}t + s]q_H\} + \tag{6}$$
$$(1-\beta)\mu \min\{b + r_{LH}t;\ a + [r_{LH}t + s]q_L\} + (1-\beta)(1-\mu)\min\{b + r_{LL}t;\ a + [r_{LL}t + s]q_L\}$$

The first period decision (ex-ante), where physicians are to decide on the amount of resources to invest in preventable activities, follows from;

$$\underset{e}{Min}\ C^p = e + p(e)R^a(t,s) \tag{7}$$

Physicians are assumed to minimise the sum of preventive costs, e, and the expected costs associated with preventable errors, being the product of the probability and the expected (ex-ante) penalty function, in the following denoted as the expected physician costs; C^p. It also follows that the outcome of not experiencing a preventable error with probability, $1-p(e)$, is assumed to equal zero.[17]

In order to derive the first-best penalties we need to define the optimal (social) level of preventive effort and make assumptions about the value of information following from self-reporting and non-reporting behaviour. The optimal preventive effort level is determined by the following expression;

$$e^* \equiv \arg\min_e \; C^r = e + p(e)\bar{D} \tag{8}$$

where $$\bar{D} = \beta D_H + (1-\beta) D_L \tag{9}$$

$\bar{D}$ is the expected patient (social) costs following from preventable errors, while C^r is the expected regulator (social) costs. Hence, the optimal preventive effort, e^*, is the level which equates the marginal increase in effort costs (the marginal deterrence cost) with the marginal decline in expected patient costs (marginal deterrence benefit). The quality of information from errors that become common knowledge is the same across all types of errors and the information quality (or quantity) does not depend on the way it becomes common knowledge – whether self-reported or detected. The quality of information is normalised to 1, which implies that the expected quality of information is 1 and q_i, for self-reported errors and non-reported errors, respectively.[18] Since the regulator is indifferent to the information source, she is always better off, given self-reporting behaviour. The above discussion makes evident why the first–best solution is one where all physicians are self-reporting and where each of them invest e^* into preventive effort. At this stage it is, for ethical reasons, chosen not to introduce a social welfare function e.g. defined in informational benefits (lower future probability of errors due to learning) and social costs (C^r). Such an approach could produce an optimal preventive effort level being less than e^*, since lower efforts increase the expected benefits that arise from information simply by increasing the expected number of errors.[19]

It is observed that moral costs (feelings of shame and guilt) are not included in the social cost function in (8) since it is not obvious that costs such as provider discomfort associated with non-compliance to law (non-reporting), patient anger, and the fear of being detected are to be considered as social ones.

[17] The model is not explicitly related to provider health insurance being a shield against financial claims and litigation expenses. However, the model may also be interpreted within such a context where *t* can represent non-financial liability costs e.g. time costs associated with legal processes.
[18] In this paper, the focus is not on how to analyse and use information in order to translate negative results into useful information. Here, the approach is quite simple, where the number of collected reports is assumed to increase the quantity of information, hence creating an increasing awareness and a reduction of the problem.
[19] The minimization problem in (8) rules out the possibility of such a trade-off is here ruled out (lexicographic preferences).

One the other hand, feelings of guilt and remorse and concern for the patient could well be included e.g. by introducing a parameter that reflects the fraction of moral costs considered as social costs (see also footnote 20 and Lewin and Trumbull (1990) for a discussion of the social value of offences).

The optimal penalty scheme is now straightforward to derive, since the regulator induces self-reporting by setting the non-report penalty, s, sufficiently high for any level of t. The setting of t, on the other hand, is guided by the objective to induce optimal preventive effort, e^*. Given the level of $s = s^*$, which ensures that all physicians are self-reporting independent of their type, the ex-ante expected penalty function becomes;

$$R_{SR}^a(t,s^*) = \beta\gamma[b + r_{HH}t] + \beta(1-\gamma)[b + r_{HL}t] + (1-\beta)\mu[b + r_{LH}t] + (1-\beta)(1-\mu)[b + r_{LL}t] \qquad (10)$$

The first-best accountability penalty is the one that makes the (ex-ante) expected penalty, given self-reporting behaviour, $R_{SR}^a(t,s^*)$, to equal the expected patient costs that follow from a preventable error, $\bar{D}$. Now, all societal costs are internalised by the decision-maker. The formal representation of this condition is;

$$\bar{D} = \beta D_H + (1-\beta)D_L = R_{SR}^a(t^*,s^*) \qquad (11)$$

Rearranging (11), using (10), yields the following expression;

$$t^* = \frac{\bar{D} - b}{r} = \frac{\beta D_H + (1-\beta)D_L - b}{[\beta\gamma r_{HH} + \beta(1-\gamma)r_{HL}] + [(1-\beta)\mu r_{LH} + (1-\beta)(1-\mu)r_{LL}]}, \qquad (12)$$

where r denotes the expected liability probability. It follows from (12) that t^* is to be positive if the expected social costs from a preventable error exceed the shame parameter. In this situation, the decision-maker is not internalising all social costs and a positive penalty is necessary to get the incentives right. If the opposite is the case, defensive medicine is expected, and t^* must be negative. It is also observed from (12) that t^* is to decrease with the expected liability probability, r.[20]

[20] The first-best accountability penalty changes if moral costs are included into the social cost function. Let ω be the fraction of moral costs that enters the social cost function where $0 < \omega < 1$. The first-best penalty now becomes; $t^* = \frac{\bar{D} - b(1-\omega)}{r}$, which implies a higher t^* for any $\bar{D}$, b and r compared to (12).

The next step for the regulator, given $t = t^*$, is to set the non-report penalty as to induce self-reporting from all decision-makers, irrespective of the types of errors experienced. To solve this problem I first define levels of s_{ij} that make the optimal self-report rule binding for each type of errors. This is done by using (3) which provides us with the following four critical levels;

$$s_{ij} = \frac{b - a + r_{ij} t^* (1 - q_i)}{q_i} \qquad \text{where } i = H, L \text{ and } j = H, L \tag{13}$$

where s_{ij} is the lowest possible value *s* can attain, for an error of type *ij*, and on the same time induce self-reporting behaviour. The first-best non-report penalty becomes;

$$s^* \geq \max\left\{S_{ij}\right\}. \tag{14}$$

The expression in (14) says that the optimal non-report penalty is to equal (or to be higher than) the highest critical value of *s* defined (13). We know by assumption that $s_{HH} > s_{HL}$ and $s_{LH} > s_{LL}$. Furthermore, we assume that $s_{LH} > s_{HH}$.[21] Hence, errors of type LH (near miss and high quality of evidence), characterised by a low probability of detection, and a high liability probability, become the relevant ones. The optimal non-report penalty is,

$$s^* \geq s^*_{LH} = \frac{m + r_{LH} t^* (1 - q_L)}{q_L} \tag{15}$$

The first-best penalty, s^*, described in (15), implies by definition that errors of type LH are self-reported. The same penalty also induces all other types of errors to be self-reported, since for any level of t and s, the incentives are least significant for such errors. If eq. (15) is binding, s^* increases with the shame parameter and the accountability penalty, but decreases with the guilt-parameter and the detection probability.

The optimal penalty scheme is summarised below;

$$t^* = \frac{\bar{D} - b}{r} \tag{16}$$

[21] This assumption is satisfied if; $\frac{m}{t^*}\left(q_L - q_H\right) < r_{LH}(1 - q_L)q_H - r_{HH}(1 - q_H)q_L$

$$s^* \geq \frac{m + r_{LH} t^*_{LH} (1-q_L)}{q_L} = \frac{b\left[1 - \frac{r_{LH}}{r}(1-q_L)\right] - a + \frac{r_{LH}}{r}\bar{D}(1-q_L)}{q_L} \tag{17}$$

In table 1 the optimal penalties are signed, given a particular ranking of the parameters a, b and expected patient costs, $\bar{D}$.[22] The sign of the accountability penalty is uniquely determined by the size of social costs relative to the shame parameter, while the sign of the non-report penalty depends both

Table 1: The signs of first-best penalties for different rankings of a, b, and D.

	$\bar{D}$ > b	$\bar{D}$ = b	$\bar{D}$ < b
***m*≡*a-b* > 0**	$t^* > 0$ $s^* > 0$	$t^* = 0$ $s^* > 0$	$t^* < 0$ $s^* \geq 0$
***m*≡*a-b*= 0**	$t^* > 0$ $s^* > 0$	$t^* = 0$ $s^* = 0$	$t^* < 0$ $s^* = 0$
***m*≡ *a-b*< 0**	$t^* > 0$ $s^* \geq 0$	$t^* = 0$ $s^* = 0$	$t^* < 0$ $s^* = 0$

on the sign of t^* and whether the medical culture is shame- or guilt dominated. A positive accountability penalty implies a positive non-report penalty. The non-report penalty is positive (or zero) independent of the sign of t^* in non-reporting cultures (*m>0*). This is because the costs of self-reporting are quite significant in shame-dominated cultures, so that s^* needs to be positive to ensure self-reporting. It also follows that the penalty scheme is most punitive for $\bar{D} > b > a$, while the opposite ranking yields a non-report penalty equal to zero and a negative accountability penalty.

Our model induces the first-best and the optimal penalty scheme needs not be a punitive one. Depending on the value of the parameters of guilt, shame and expected patient costs, penalties can be low, equal to zero and even negative. A non-punitive environment may, under some circumstances, be a necessary condition for getting the incentives right. Numerous recommendations in the literature on medical errors recommend a non-punitive environment (see the references in footnote 5), however, these suggestions are not conditioned upon specific conditions but appear as universal solutions.

Section 3: Voluntary reporting, confidentiality, and immunity.

Much literature on errors stresses the need for creating safe environments and suggests the application of less punitive measures such as voluntary reporting, immunity and confidentiality. In this section such reforms are discussed. However, a problem with this literature is the absence of a precise definition of the above concepts, consequently we present below our own interpretations. In the following four alternative systems are discussed and each system is defined by modifying the optimal self-report rule [see (3)]. The four alternatives are;[23]

Absent non-report penalty: $$b + r_{ij}t \leq \theta a + q_i r_{ij} t \qquad 0 < \theta < 1 \tag{18}$$

Immunity: $$b \leq a + q_i r_{ij} t + q_i s \tag{19}$$

Confidentiality: $$\lambda_1 b + q_i[\lambda_2 b + r_{ij}t] \leq a + q_i r_{ij} t + q_i s \qquad 0 < \lambda_1 < 1,\ 0 < \lambda_2 < 1 \tag{20}$$

Voluntary reporting: $$\lambda_1 b \leq \theta a \tag{21}$$

It follows from (18) – (21) that the shame and guilt parameters are adjusted by the parameters λ_i and θ, respectively, to reflect the possibility that the absence of penalties may have an impact on feelings of guilt and shame. If the following each of the above conditions will be compared to the optimal self-report rule presented in eq. (3).

An Absent non-report penalty causes two changes in (3). First, the non-report penalty, s, is not an option for the regulator anymore since the act of non-reporting is not associated with the threat of sanctions. Second, the guilt parameter, a, is deflated by introducing a parameter θ where $0<\theta<1$. The parameter θ reflects that guilt now is lower, compared to a system with strict liability, since the failure to report is not considered a law violation. The accountability property of the model, however, is kept due to the presence of *t* for both modes of behaviour. Their presence implies that ex-ante incentives can be adjusted so that optimal preventive effort follows. However, the absence of a non-report penalty, may represent a hindrance for reaching the first-best solution. To see this consider the sufficient condition for Absent non-report penalty to induce self-reporting for all types of errors;

$$t^* \leq \frac{\theta a - b}{r_{LH}(1 - q_L)}, \tag{22}$$

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[22] If the condition described in (17) is not binding for the optimal value of the accountability penalty, s^* is set equal to zero.

[23] It is here chosen to ignore the costs of implementing and running the various schemes.

where t* is defined in (12). If $t^* > 0$ and a non-reporting culture ($m > 0$), it follows that optimality is unattainable since errors of type LH will not be reported.

The principle of immunity (see 19), is here interpreted as if the probability of being held liable, conditional on self-reporting behaviour, is equal to zero ($r_{ij} = 0$ if self-reporting). Consequently, the risk of being held liable, given the occurrence of an error, is relevant only if failing to report. The first-best solution is now unattainable, since the regulator is left without any instruments to influence preventive behaviour. However, the regulator may still induce self-reporting behaviour, since being left with two instruments (t and s) to ensure this mode of behaviour. Only if $b = \bar{D}$, which implies that $e = e^*$, can the first-best solution be reached.

Confidentiality implies that the identity of self-reporting individuals is not revealed to others but the receivers of the actual information (protected from legal discovery).[24] It follows from (20) that three modifications are now undertaken to represent this principle. First, the shame parameter is deflated by the parameter, λ, to reflect a lower burden (shame) when information is given under confidentiality. Second, the expected penalty for being held liable is changed from $b + r_{ij}t$ to $q_i\lambda_2 b + q_i r_{ij} t$, to capture that the act of confidential self-reporting, needs not to trigger a judicial process.[25] However, confidential self-reporting does not imply immunity. An error may still be detected by others, as a consequence, the expected accountability penalty that matters for a confidential self-report coincides with the expected penalty for failing to report. Third, the detection of a confidentially reported error is also assumed to involve shame, but to a lower extent, represented by the parameter λ_2. The regulator now possesses two instruments, one for each objective, and the first–best solution is attainable. The only difference, as compared to the model in section 2, is that the accountability penalty does not any longer change the relative incentives between the two modes of behaviour. This observation, *ceteris paribus*, has two implications. First, the accountability penalty must now be higher, relative to the model of section 2, to induce optimal preventive effort, since confidential reporting lowers the expected penalty associated with self-reporting with the value q_i. Secondly, the non-report penalty can be lower, since higher values of t do not worsen the incentives for self-reporting, as was the case for the model presented in section 2.

[24] The intent of anonymous reporting is to ensure that the reporter cannot be identified from the report. Confidentiality differs from Anonymity in that analysts can not contact reporters for more information in the latter.

[25] A possible way of doing this is to let the report be handled by an independent bureau having an obligation to protect it's source.

The fourth case, denoted Voluntary reporting, is here assumed to be a completely non-punitive system, ($t = s = 0$). Now, the self-report rule becomes $\lambda_1 b \leq \theta a$, saying that self-reporting becomes optimal only in reporting cultures.[26] The absence of any formal penalty implies that no regulatory instruments are available, neither to induce self-reporting nor to induce optimal preventive effort. The first-best is realised only if $\overline{D} = \lambda_1 b \leq \theta a$.

Confidentiality has the same ability as the model presented in section 2 to induce the first-best solution. For Absent non-report penalties and Immunity, on the other hand, this is not the case. Absent non-report penalty is unable to create incentives to make physicians to self-report (ex-post incentives). The principle of Immunity represents an inability to influence preventive effort (ex-ante incentives). In a pure non-punitive system (Voluntary reporting), both above problems are present, which implies that even if professional ethics solves the problem of self-reporting, $\lambda_1 b \leq \theta a$, ex-ante incentives still remain incorrect.

The proponents of non-punitive systems stress the importance of creating reporting cultures and points to penalties as disincentives for self-reporting. The analysis undertaken in this paper confirms this view for t with the exception of the principle of confidentiality. However, the accountability penalty serves another and important function in providing ex-ante incentives, a role that seems to be ignored by the proponents of non-punitive systems. In addition, non-report penalties clearly represent incentives for self-reporting.[27] If we focus at the incentives for self-reporting only, and ignore ex-ante incentives, it is observed from eqs. (18-21) that the modifications undertaken worsen the incentives for self-reporting given an Absent non-report scheme, while the same incentive improves for Confidentiality and Immunity. For Voluntary reporting both a positive and negative effect is observed.[28] Confidentiality is the only system of the four that can ensure self-reporting for any parameter values, given that a sufficiently high non-report penalty is chosen. The above discussion makes clear that the non-report penalty shares similarities with penalties intended to ensure compliance with law, in that a higher value reduces the risk of law violation. The accountability penalty, on the other hand, has a different role. This penalty is to internalise the expected social

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[26] A non-punitive environment is believed to create thrust which strengthens the incentives for error reporting (see e.g. Cohen, 2000 and Reason, 2000). In our model this argument can be interpreted as if a non-punitive environment reduces the size of b , only. If so, the incentives for self-reporting may well be strengthened, but need not be fulfilled since λb may still exceed *a*. In addition, this argument ignores ex-ante incentives, which may be weakened due to a lower *b*.

[27] In some works non-punitive reporting programmes are believed to provide more useful information about errors than punitive programmes, since practitioners now can tell the complete story without fear of retribution (see e.g. Cohen, 2000).

[28] For Confidentiality this matters if λ_1 is sufficiently low.

(patient) damages that accrue from errors. Very high penalty levels may trigger undesirable social behaviour (defensive medicine).

4. Institutional barriers

Up to now, the regulator has been able to set the penalties at any desired level. However, this need not be possible since penalties in principle serve other purposes as well which may constitute obstacles in reaching first-best. The actual size of penalties face possible restrictions due to legitimacy, practical and political reasons, and notions of fairness (see e.g. Harrington, 1988). One example is the application of optimal negative penalties as suggested by the analysis in section 2, especially when the violation of a law involves recklessness or negligence. In the following, one particular institutional constraint is considered - the existence of binding upper limits. It is here chosen to focus at the case for which the non-report penalty can not be set according to the desired level, $s^* > \overline{s}$, where $\overline{s}$ is defined as a maximum limit. Consider for example the case of near misses, which in our model can be interpreted as if $D_L = 0$ and $q_L \simeq 0$. From (12) and (15), it now follows that t^* should be low, while s^* approaches infinity. This situation suggests an effective binding upper limit on the non-report penalty, consequently a second-best regime must be considered.

First we discuss the role of ex-ante incentives. It is self-evident that it will be optimal for the regulator to set $s = \overline{s}$. By introducing this property into (7), the following first-order condition is derived;

$$\frac{\partial P(e)}{\partial e} = -\frac{1}{R^a(t,\overline{s})}, \tag{23}$$

where the second order condition is fulfilled by our former assumption $\frac{\partial^2 p(e)}{\partial e \partial e} > 0.$

It follows from (6) that $R^a(t,\overline{s})$ is strictly increasing in t, which again yields;

$$\frac{\partial e(t,\overline{s})}{\partial t} = -\left[\frac{\frac{\partial P(e)}{\partial e}\frac{\partial R^a(t,\overline{s})}{\partial t}}{\frac{\partial^2 P(e)}{\partial e \partial e}R^a(t,\overline{s})}\right] > 0 \tag{24}$$

We already know from (4) that both pay-offs (expected penalties) increase with t, and that the marginal increase is most significant for the expected pay-off given self-reporting behaviour (see eq. 5). Consequently, a higher accountability penalty has a positive and a negative effect in welfare terms. First, an increase in preventive effort, due to a higher t, is positive in welfare terms if $e < e^*$.

Secondly, the same increase induces a potential negative effect in welfare terms since the incentives for self-reporting are weakened.

In order to define the exact relationship between changes in t and the incentives for self-reporting, four critical values of t are defined from the binding optimal self-report rule;

$$b + r_{ij}t_{ij} = a + q_i r_{ij} t_{ij} + q_i \overline{s} \qquad \text{where} \quad i = H, L \text{ and } j = H, L \tag{25}$$

which can be rewritten as;

$$t_{ij} = \frac{a - b + q_i \overline{s}}{r_{ij}(1 - q_i)} \qquad \text{where} \quad i = H, L \text{ and } j = H, L \tag{26}$$

t_{ij} is defined as the highest possible value t can attain while on the same time induce physicians experiencing an error of type *ij* to self-report. From earlier assumptions ($r_{HH} > r_{HL}$ and $r_{LH} > r_{LL}$) it follows that $t_{HL} > t_{HH}$ and $t_{LH} > t_{LL}$. By introducing the two following assumptions;

(I) $r_{HH} > r_{LH} > r_{HL} > r_{LL}$

(II) $r_{HH}(1 - q_H) < r_{LH}(1 - q_L)$,

the following ranking of the critical values matters; $t_{HL} > t_{HH} > t_{LH} > t_{LL}$. The critical value of t is highest for errors of type HL (adverse events and low quality of evidence). Such errors are associated with a high probability of being detected and a relatively low probability of being held liable. Both characteristics allow for t being relatively high without triggering a non-reporting decision. The types of errors being most exposed to non-reporting behaviour, and thus a low critical value of t, are errors of type LL (low social costs and low quality of evidence) for which both the detection probability and the liability probability are low. The definition and ranking of the critical values of t, now define regions for when physicians, experiencing particular types of error, will self-report. The results are summarised in table 2.

It follows from table 2 that we have two pooling equilibria (one with self-reporting and one without reporting) and three separating equilibria. For a sufficiently low t ($t \le t_{LL}$) and a sufficiently high t ($t > t_{HL}$), all types of errors are self-reported or not reported, respectively. For intermediate values of t, some type of errors is self-reported while others are not.

The next step is to derive the expected amount of information that relates to the same intervals of t. These results are available in table 2. It is now straightforward to show that $I_A > I_B > I_C > I_D > I_E$, saying that the expected quantity of information decreases stepwise with a higher accountability penalty.

Table 2: The relationships between the level of the liability penalty, self-reported error types, and the expected quantity of information.

Cases	**Intervals of** t	**Error types being self-reported**	**Expected quantity of information**
A	$t \le t_{LL} \Rightarrow$	LH, HH, HL and LL	$I_A = 1$
B	$t_{LL} < t \le t_{LH} \Rightarrow$	LH, HH, and HL	$I_B = \beta + (1-\beta)[\mu + (1-\mu)q_L]$
C	$t_{LH} < t \le t_{HH} \Rightarrow$	HH and HL	$I_C = \beta + (1-\beta)q_L$
D	$t_{HH} < t \le t_{HL}$	HL	$I_D = \beta(\gamma q_H + (1-\gamma)) + (1-\beta)q_L$
E	$t > t_{HL}$	None	$I_E = \beta q_H + (1-\beta)q_L \equiv \overline{q}$

The above discussion shows the presence of a regulator trade-off in *t*. In order to derive the second-best level of t we now introduce a social criteria function. The ethical problem, already commented upon in section 2 that arises from introducing social preferences is now less of a problem since the motive for inducing an effort level different from e^* is to increase the degree of self-reporting among physicians and not to increase the expected number of errors. Regulator preferences defined (additively) over expected information quantity, $B(t,\overline{s})$, and expected social accountability costs, $C^r(t,\overline{s})$, are as follows;[29]

$$W(t,\overline{s}) = B(t,\overline{s}) - C^r(t,\overline{s}) \tag{27}$$

To help identify the second best penalty a particular specification of the social costs function in (27) is chosen that relates these costs to a constant being equal to the minimum expected social costs; $C^r(e^*) = e^* + p(e^*)\overline{D}$. The social cost function is now, $\eta\left(C^r(e^*) - C^r(t,\overline{s})\right)^2$, where η is a weight parameter. Furthermore the benefit (information) function in (27) is assumed to equal $kI(t,\overline{s})$ where k denotes the marginal welfare from additional information.

[29] For ethical reasons it can be difficult to accept a reduction in preventive effort (lower than e^*) also when motivated by the need to increase self-reporting among physicians. Given that this is the case the second-best problem is reduced to setting of the level of *t* that induces e^*.

Figure 2: Information benefits and deviation in expected accountability costs as a function of t.

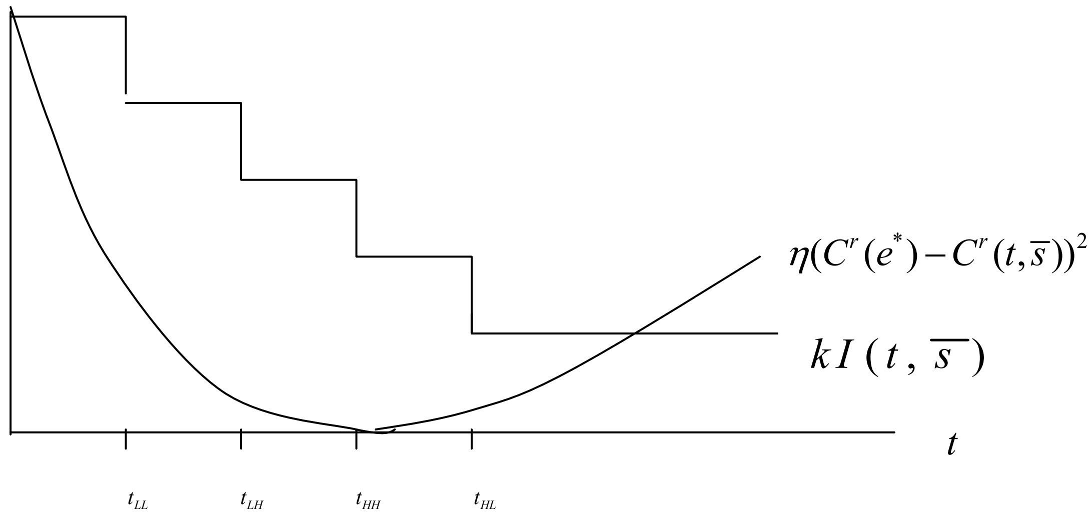
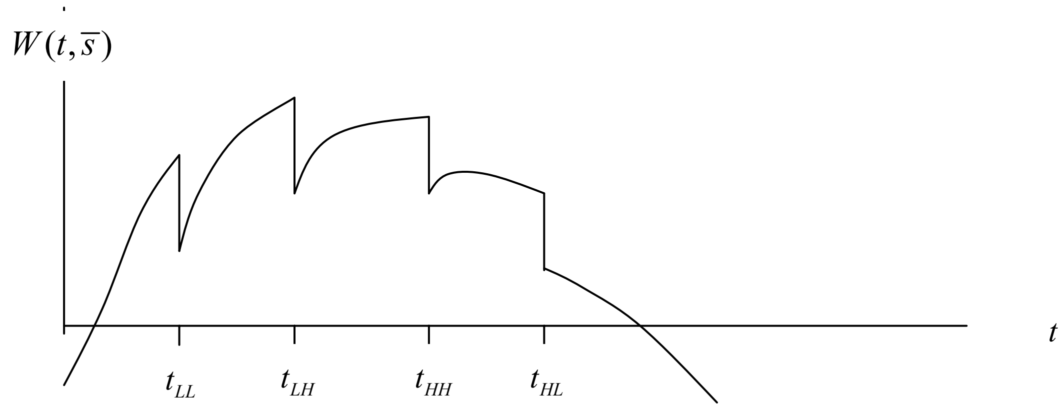


Figure 3: Social welfare as a function of t.



The present regulator trade-off is illustrated in figure 2 and 3. Figure 2 describes both the development in information benefits and the development in social accountability relative to $C^r(e^*)$, for increasing values of t. It is observed that $e = e^*$, corresponds to a value of t slightly higher than t_{HH}. For higher values of t, the expected accountability costs increase, due to defensive medicine. Information benefits, on the other hand, are declining stepwise for increasing values of t. Social welfare is described in figure 3. It is observed that the second-best penalty in this case is t_{LH}, which yields an under-investment of effort and a separating equilibria for which errors of type LH, HH and HL all are self-reported, while errors of type LL are not. The trade-off can also be illustrated by considering a lower value of t, e.g. $t = t_{LL}$. This particular value of t is sufficient low to make errors of type LL to be self-reported, however, as follows from figure 3, the gain in expected information is not sufficient to compensate for the increase in accountability costs that goes with less preventive effort.

In the following we will present a numerical solution for an additional example. Consider now the case where $t_{LH} \Rightarrow e_{LH} = e^*$ which implies that;

$$C^r(t_{LH}, \overline{s}) = C^r(e^*) \tag{28}$$

We know from (28) that a penalty higher than t_{LH} induces defensive medicine, while on the same time errors of type LH will not be reported. Both effects reduce welfare, hence the second-best accountability penalty in this case must be equal to or less than t_{LH} and the only relevant alternative to $t = t_{LH}$ is $t = t_{LL}$. However, the expected increase in quantity of information that follows from a lower value of *t* will come at the expense of a reduction in preventive effort. In this perspective, choosing between t_{LH} and t_{LL}, reflects a trade-off in expected information and accountability.

In the following it is assumed that $P(e) = \exp^{-re}$, which yields the following first-order conditions for each of the two candidates;

$$P(e_{LH}) = P(e^*) = \frac{1}{rR^a(t_{LH}, \overline{s})} = \frac{1}{r\overline{D}} \tag{29}$$

$$P(e_{LL}) = \frac{1}{rR^a(t_{LL}, \overline{s})} \tag{30}$$

Now an explicit expression for $W(t_{LL}, \overline{s})$ can be derived by using (30) and the expression for the expected quantity of information when $t = t_{LL}$ (see case A in table 2). This procedure yields the following expression;

$$W(t_{LL}, \overline{s}) = k - \eta \left[\frac{1}{r} \left[1 - \frac{\overline{D}}{R^a(t_{LL}, \overline{s})} \right] + (e^* - e_{LL}) \right]^2 \tag{31}$$

Following the same procedure for $t = t_{LH}$ yields social welfare equal to;

$$W(t_{LH}, \overline{s}) = k\left[\beta + (1-\beta)(\mu + (1-\mu)q_L\right] \tag{32}$$

The condition for the highest penalty (t_{LH}) being the preferable one, $W(t_{LH}, \overline{s}) > W(t_{LL}, \overline{s})$, now becomes as follows;

$$\frac{k}{\eta} > \frac{-\left\{\frac{1}{r}\left(1-\frac{D}{R^a(t_{LL},\bar{s})}\right)+(e^*-e_{LL})\right\}^2}{(1-\beta)(1-\mu)(q_L-1)} \qquad (33)$$

The numerator of (33) is always negative where the first term represents the difference in expected patient damages across the two cases (being negative since $\bar{D} > R^a(t_{LL},\bar{s})$), while the second term (being positive) reflects the savings in effort investments that follow from a lower *t*. The denominator of (33) is always negative and reflects differences in the expected quantity of information across the two penalty levels. It is observed that the probability of choosing the lowest penalty increases with the weight, η, and the lower the marginal increase in welfare from additional information, *k*, is.

The above examples show how an institutional barrier on the non-report penalty may lower the accountability penalty. The regulator is forced to solve two contradicting effects with one instrument, only, as a result we may end up with a less punitive penalty scheme. The regulator can be said to be forced to go "soft" on accountability in order to encourage self-reporting. If the model of Confidentiality had been applied to analyse the impact from upper binding limits, the conclusion would be different. The trade-off from a higher *t* between information and preventive effort is now absent since the accountability penalty does not change the relative incentives for self-reporting. Hence, the second-best solution is to set *t* so that $e = e^*$.

5. Conclusion

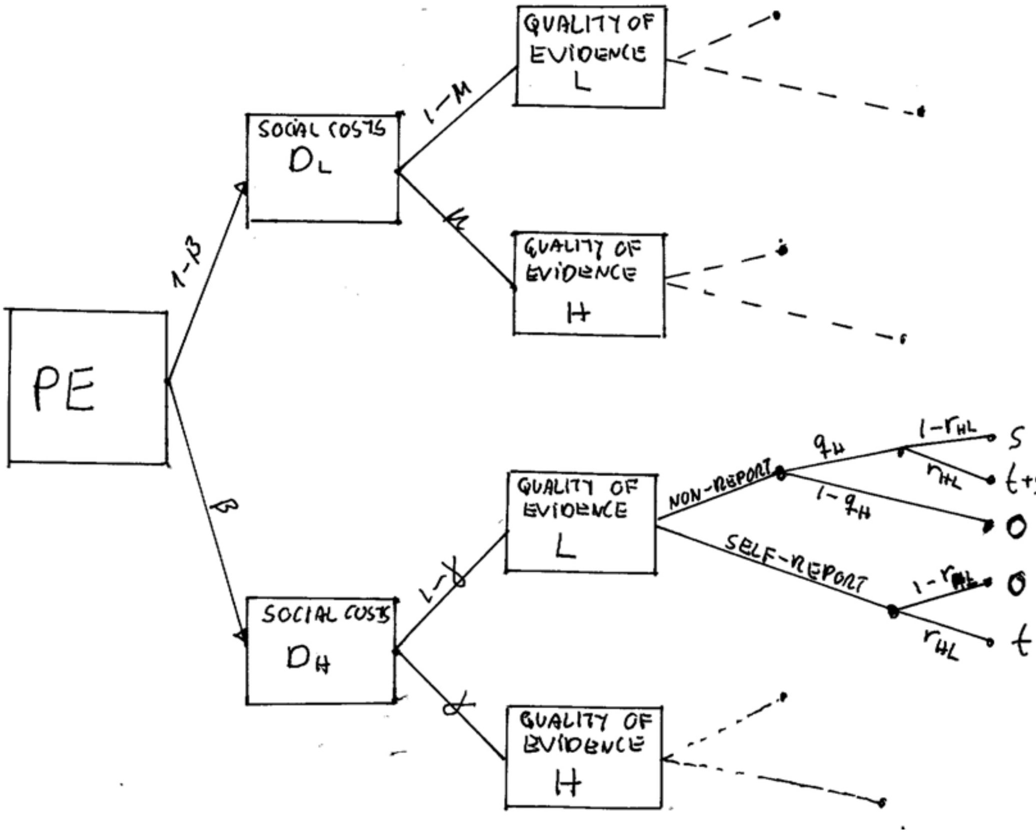
The question of optimal liability policy is an important health policy issue for many reasons among them the increased importance given at efforts to health cost containment in many countries and the rise of managed care in the US. Recent publications conclude that medical errors are frequent, at unacceptably high levels, and involve significant patient discomfort and treatment costs. In addition the underreporting of such incidents is believed to represent a hindrance for collecting and analysing data to develop strategies for reducing the future problem of errors. In order to encourage the reporting of such incidents non-punitive principles have been recommended. In this work a simple analytical model is presented to analyse the role of incentives and control in combination with medical errors.

It is shown that a scheme with two penalties, one addressing ex-ante incentives and one addressing ex-post incentives, is sufficient to reach the first-best solution. The optimal penalty scheme needs not be a punitive one, since the optimal penalty levels can be insignificant and even negative depending on parameter levels. Voluntary reporting, immunity and confidentiality are also analysed, however, only confidentiality is found to have the optimal properties. The conclusions arrived at suggest that advocates of non-punitive mechanisms ignore the vital and legitimate role accountability has in holding institutions responsible for their actions. Furthermore, it follows that non-punitive measures need not be effective in encouraging self-reporting behaviour.

The optimal penalty scheme identified in this paper may involve significant penalty levels if; i) medical cultures can be described as non-reporting cultures, and ii) if the expected social costs that accrue from medical errors exceed health care workers feelings of remorse and shame following from the occurrence of medical errors. Such levels need not be practically attainable, in particular for the non-report penalty, in this way representing an upper bond for this penalty. Introducing an institutional limitation of this type into the model is found to create a downward pressure on the level of the accountability penalty, while the non-report is to be set as high as the upper bond allows.

Our conclusions derive from a quite simple model, and several extensions are possible in future works. Examples here would be to analyse the role of risk preferences, to assume that preventive behaviour affects the probability distribution of patient costs from medical errors, and discuss what the implications are when informational gains depend both upon types of errors and how errors become common knowledge (self-reported or detected). This analysis shows that the continuing debate on tort reforms should go beyond the question of deterrence and address reporting incentives as well.

Appendix: A decision map of the model presented in section 2.



The above figure presents the possible outcomes (ex-ante) for a physician given the occurrence of a medical denoted by PE. A medical error can with probability $1-\beta$ be a near miss, D_L, and with probability β be an adverse event, D_H. A fraction of all adverse events, $1-\gamma$, is characterised by a low quality of evidence while a fraction γ is characterised by a high quality of evidence. After privately observing the type of error, each being associated with a particular probability, r_{ij}, of being held liable and penalised by t, the agent is to decide on whether to report or not report this particular incident to the health regulator. If not choosing to self-report the agent face the risk of being detected by probability q_i and penalised by s. The penalty outcomes, for each possible case, are presented at the end of the system of arrows.

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