

# Medical malpractice as an epidemiological problem

Michelle M. Mello\*, David Hemenway

*Department of Health Policy and Management, Harvard School of Public Health, 667 Huntington Avenue, Boston, MA 02115, USA*

## Abstract

The notion that the tort liability system deters negligence in health care has been invoked to make the “business case for patient safety.” However, existing data on the relationship between hospital adverse events and malpractice claims typically are interpreted as evidence that the tort system does not deter negligence because of the poor fit between those who are negligently injured and those who sue. Using a familiar analogy from epidemiology—the problem of false positives in screening tests for rare diseases—and data from two large studies of medical injuries and malpractice claims in the United States, this paper presents an argument that the standard interpretation overlooks a complexity in the data. Although most malpractice claims do not actually involve a negligent injury, a patient who suffers a negligent injury is more than 20 times more likely, on average, to file a claim than a patient who does not. However, because malpractice claiming is a rare event with many false positives, for the average hospital or group practice, even substantial improvements in rates of negligent injury will not lead to a large reduction in claims rates. These findings suggest that the strength of the business case for patient safety depends on the perspective from which one views the data.

© 2003 Elsevier Ltd. All rights reserved.

*Keywords:* Malpractice; Patient safety; Litigation; Liability; Medical error; USA

## Introduction

One theoretical purpose of medical malpractice liability is to deter health care providers from rendering substandard care (Posner, 1972). The notion that the tort system deters negligence has been invoked to make the “business case for patient safety”—the argument that the costs associated with malpractice litigation create an economic incentive to reduce medical injuries (Mello & Brennan, 2002). However, the deterrent signal that the malpractice system sends to health care providers is thought to be relatively weak, due to a number of factors. One issue is that professional liability insurance premiums are not experience rated for individual physicians, which insulates physicians from the economic consequences of their mistakes (Sloan & Hassan, 1990). But more troubling is that patterns of

suing appear to bear little relation to whether the patient was actually the victim of negligent care.

Data from two major studies of hospital adverse events and malpractice claims in the American states of New York, Utah, and Colorado are commonly cited as supporting evidence for the latter point. In the Harvard Medical Practice Study (“New York study”) (Brennan et al., 1991; Leape et al., 1991; Localio et al., 1991) and Utah/Colorado Medical Practice Study (“Utah/Colorado study”) (Studdert et al., 2000; Thomas et al., 1999, 2000), records from thousands of hospital discharges and malpractice claims in three states were reviewed for the purpose of determining the incidence of hospital adverse events and the extent to which negligent adverse events were represented in malpractice claims filed. Although the two studies were conducted a decade apart in states that differed in several respects, their findings were remarkably consistent:

- (1) *Negligent injury occurs in about 1% of hospitalizations.* In the New York study, 280 negligent injuries occurred in 30,121 hospitalizations (0.9%). In the

\*Corresponding author. Tel.: +1-617-432-0217; fax: +1-617-432-4494.

E-mail address: mmello@hsph.harvard.edu (M.M. Mello).

Utah/Colorado study, 161 negligent injuries occurred in 14,700 hospitalizations (1.1%).

- (2) *Patients file malpractice claims in a very low percentage of cases.* In the New York study, only 47 claims arose out of the 30,121 hospitalizations (0.16%). Similarly, in the Utah/Colorado study, 18 claims arose out of the 14,700 hospitalizations (0.12%). Only 2.9% and 2.5%, respectively, of the patients who were injured due to negligence filed a claim.
- (3) *Only a small fraction of the patients who do file claims have actually suffered a negligent injury.* In the New York study, 8 out of 47 claims filed (17%) involved a negligent injury as determined by a physician chart review. In the Utah/Colorado study, 4 out of 18 claims (22%) involved a negligent injury. The rest of the claims lacked either a perceptible injury, evidence of negligence, or both.

The conclusion most have drawn from these results is that the tort system does not work as a mechanism for deterring negligence in health care because the fit between those who are negligently injured and those who sue is too poor (Localio et al., 1991; Mello & Brennan, 2002). As Paul Weiler put it, the tort system is like a traffic cop who “regularly [gives] out more tickets to drivers who go through green lights than to those who go through red lights” (Weiler et al., 1993). In this article, we show that in fact, these data have two faces. Contrary to their usual interpretation, when viewed from a particular perspective the data suggest that malpractice claiming is not as haphazard as physicians tend to believe. We use a familiar analogy from epidemiology—the false-positive problem in screening tests for rare diseases—to show why.

Before proceeding, it is helpful to clarify some terminology. We use the terms “negligence”, “negligent injury”, “negligent adverse event”, and “malpractice” interchangeably to refer to substandard care that results in an injury, even though not all instances of negligent care in fact lead to injury. We avoid the term “medical error”, though the rates of negligent adverse events from the New York and Utah/Colorado studies are often referred to as error rates, because not all errors involve negligence. Finally, we use the term “claim” instead of “lawsuit” because the New York and Utah/Colorado study statistics are claims rates, including all demands for payment whether they become lawsuits or not.

### Is suing haphazard?

Consider two questions that a physician or hospital might reasonably ask about their malpractice risk: in the context of an individual patient encounter, “How much more likely is it that this patient will file a claim if he is

negligently injured than if he is not negligently injured?” (Question 1). And, in the context of a group of patients under an institutional provider’s care, “How much less often will claims be filed if our organization reduces the overall rate of negligent injuries among our patients?” (Question 2). These questions turn out to have very different answers based on the data.

Question 1 asks how much a provider can reduce the risk of being claimed against by not treating a given patient negligently. The answer is, somewhat surprisingly, *a lot*. An unpublished but easily calculable result from the New York and Utah/Colorado studies is that although all patients are unlikely to sue, and although most claims do not actually involve a negligent injury, patients who suffer a negligent injury are *much* more likely to file a claim than those who do not. In the New York study, patients with negligent injuries filed claims at the rate of approximately 2.9%, while patients without negligent injuries filed claims at the rate of 0.13%. Similarly, in Utah/Colorado the rates were approximately 2.5% and 0.10%, respectively. These data show that on average, patients are 22 to 26 times more likely to file a claim if negligently injured than if not. This statistic is known as the positive likelihood ratio. In epidemiological terms, the positive likelihood ratio is the probability of testing positive on a screening test among people who have the disease in question (the sensitivity of the test) divided by the probability of testing positive among people who do not have the disease (1–the specificity) (Knottnerus, van Weel, & Muris, 2002).

This finding is striking when juxtaposed with providers’ general perception that, because there are so many frivolous claims, it is near random and largely out of their control whether any given patient will file a claim against them (Harvard Medical Practice Study Investigators, 1990; Hupert, Lawthers, Brennan, & Peterson, 1996). Providers’ often-expressed frustration is, “This patient might sue me no matter what I do!” That is true, but he is *much* more likely to file a claim if the provider negligently injures him.

The answer to Question 2, however, tells a different story about the incentives associated with tort risk. The answer here is that providers should not expect to cut their rate or overall number of claims very significantly by substantially reducing the rate of negligent injuries among their patients. The extent of the reduction depends to some extent on the provider’s baseline injury rate. Assume that we are speaking of an average institutional provider who causes negligent injury in 1% of cases, and assume for simplicity that patients who suffer a negligent injury are exactly 20 times more likely to sue than patients who do not (i.e., 2% vs. 0.1% likelihood of claiming). If the provider cuts its rate of negligent injury by half, from 1% to 0.5%, its claims rate will be expected to decrease by less than 9%, from

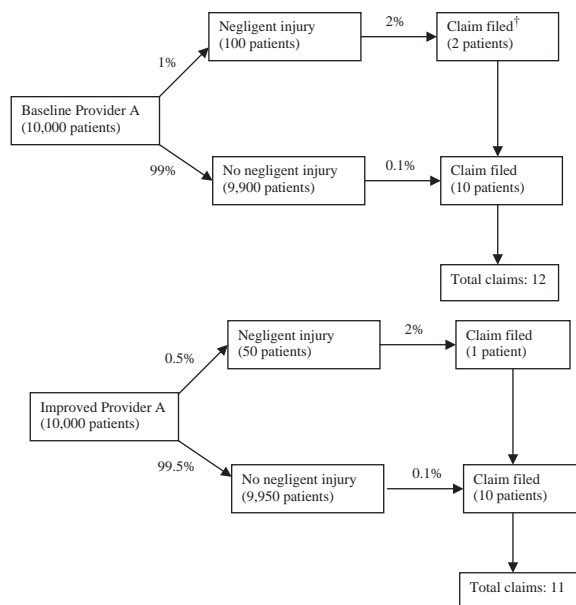


Fig. 1. An average provider cuts negligent injury in half. <sup>†</sup>All claims figures rounded to the nearest whole number.

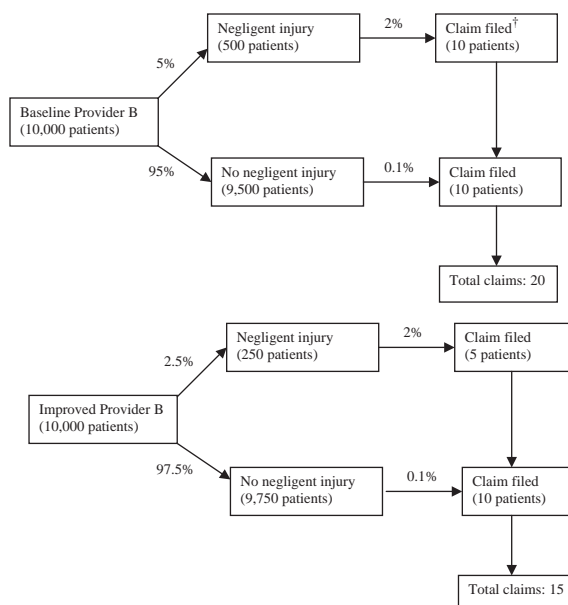


Fig. 2. A “Bad Apple” cuts negligent injury in half. <sup>†</sup>All claims figures rounded to the nearest whole number.

12 claims to 11 claims per 10,000 patients (Fig. 1). Based on these calculations, the tort system does not appear to be providing a strong incentive to reduce the negligent injury rate.

However, suppose the provider is one of the proverbial “bad apples” with a relatively high baseline negligent injury rate of 5%. If it cuts this rate in half, its expected claims rate will fall from roughly 20 claims per 10,000 patients to about 15 (Fig. 2), a reduction of about 26%. The tort signal is stronger here. Indeed, the worse the provider is to begin with, the bigger the claims improvement it can expect to see (Fig. 3, lower curve).

### The problem of false positives

Why are the answers to Questions 1 and 2 so different? An analogy to a familiar problem in epidemiology—the false-positive problem of screening tests for rare diseases (Hemenway, 1997)—provides an explanation. No screen is 100% accurate, and for rare diseases, there are many opportunities to incorrectly identify an individual as having the disease. Where the disease has a low prevalence, “no matter how specific the test, ... results that are positive will mostly be false positives” (Hennekens & Buring, 1987). False positives are the reason that the tort incentive to reduce negligent injuries is so weak at the group level.

Consider a patient’s bringing or not bringing a claim as the “screen”, and consider whether the patient was or

was not negligently injured as the “truth” (Table 1). Negligence is a rare “disease”, with about 1% prevalence. The sensitivity of the screen (the percentage of negligently injured patients who bring a claim) is very low (about 2%), but still much higher than the likelihood that a non-negligently injured patient will bring a claim (0.1%). Nonetheless, since for every negligently treated patient there are 99 who did not receive negligent treatment, most of those who bring claims will be “false positives”. The well-known outcome is that the positive predictive value of the malpractice system (the percentage of the screened positives that are true positives) is quite low: only about 20% of patients who file claims have actually suffered a negligent injury.

The principal reason for the different conclusions about deterrence for Questions 1 and 2 thus lies in the preponderance of false positives among claims. The underlying prevalence of negligent injury is one factor responsible for this circumstance. In most screening tests, a patient who really has the disease is much more likely to test positive than a patient who does not have the disease. But when the disease prevalence is very low, most positives are false positives, and a reduction in the true prevalence of the disease will not result in a large reduction in the number of positive screens. Similarly, a patient who has been injured by negligence is much more likely to file a claim than a patient who has not. But a hospital that cuts its rate of negligent adverse events cannot expect to see a large reduction in

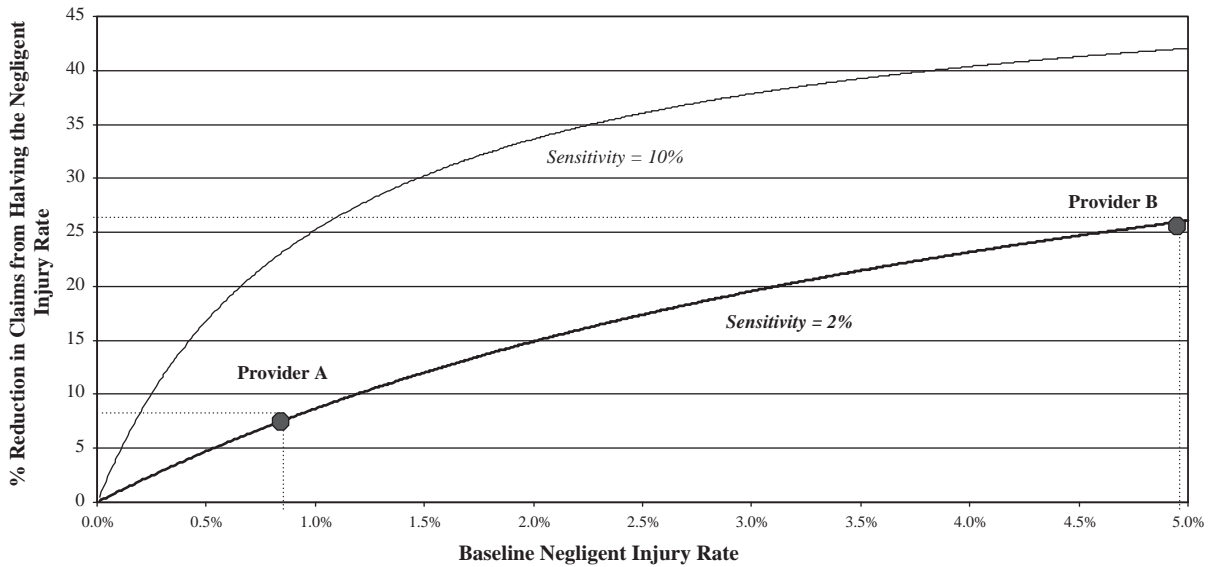


Fig. 3. Relationship between negligent injury rate and expected claims.

Table 1  
Malpractice claiming as screening test

Claiming behavior (“Screen”)	Injury status (“Truth”)	
	+	–
+	True positives: negligently injured patients who bring claims	False positives: patients who were not negligently injured but who bring claims
–	False negatives: negligently injured patients who do not bring claims	True negatives: patients who were not negligently injured and do not bring claims

*New York*<sup>a</sup>

	+	–	Total
+	8	39	47
–	272	29,802	30,074
Total	280	29,841	30,121

*Utah/Colorado*<sup>b</sup>

	+	–	Total
+	4	14	18
–	157	14,525	14,682
Total	161	14,539	14,700

<sup>a</sup>Sensitivity = 8/280 = 2.9%; specificity = 29802/29841 = 99.87%; positive predictive value = 8/47 = 17%; true incidence of negligence = 280/30121 = 0.9%.

<sup>b</sup>Sensitivity = 4/161 = 2.5%; specificity = 14525/14539 = 99.9%; positive predictive value = 4/18 = 22%; true incidence of negligence = 161/14700 = 1.1%.

malpractice claims because most claims are brought by patients who have not been negligently injured. A provider whose central interest is in loss prevention

may do better by focusing on improving relational factors that have been identified as prompting malpractice claims, such as poor communication and

devaluing a patient's views (Beckman, Markakis, Suchman, & Frankel, 1994; Cole, 1997; Levinson, Roter, Mullooly, Dull, & Frankel, 1997; Moore, Adler, & Robertson, 2000), rather than reducing rates of actual malpractice.

A second factor explaining the false-positive problem is the sensitivity and specificity of the malpractice system. In particular, the system has very low sensitivity (less than 3%). This fact makes our analogy to screening tests imprecise, because most screening tests have high sensitivity. However, our general point—that the deterrence problem arises from the high proportion of claims that are false positives—still stands. Both prevalence and sensitivity contribute to this high proportion. Improving the sensitivity of the malpractice system would substantially augment the incentives to reduce rates of negligent injury (Fig. 3, upper curve).

Our analysis suggests that Weiler's traffic-cop description of the malpractice system is somewhat misleading. While it is accurate to say that a greater absolute number of tickets are issued to motorists driving lawfully through green lights than to those running red lights, this is only because virtually everyone is driving through green lights. A motorist who runs a red light is more than 20 times more likely to get a ticket than one who drives through a green. The deterrent signal, in this sense, is not haphazard.

### The patient safety perspective

Patient safety advocates might take issue with this analysis because of its focus on negligence. Safety advocates assert that “systems failures” are a larger contributor to medical injuries than individual negligence (Leape, 1994) and that providers should direct their efforts toward reducing all avoidable injuries, not just the subset of avoidable injuries that is attributable to negligence (Layde et al., 2002). This approach suggests that the comparison of interest is not between negligently injured patients and all other patients, but rather between patients who suffer any injury and patients who do not have an injury. What incentives does the tort system provide to reduce *all* injuries?

The data show that on average, a patient who suffers an injury—whether due to negligence or not—is still 16 to 19 times more likely than an uninjured patient to file a claim (Table 2). A substantial portion of the excess risk has to do with being injured, rather than being the victim of negligence. Even among cases in which no negligence occurred, suffering an injury made a patient about 12 times more likely to file a claim. A patient who is injured by negligence is about 30 times more likely to claim than a patient with no injury, and about 2.5 times more likely to claim than a patient with an injury that is not attributable to negligence (Table 2).

Table 2  
Comparisons from the perspective of the patient safety movement

<i>Any injury</i>				
New York <sup>a</sup>	3.8% of patients ( <i>n</i> = 1,133), of whom		1.6% ( <i>n</i> = 18) filed claims	
Utah/Colorado <sup>b</sup>	4.0% of patients ( <i>n</i> = 587), of whom		1.4% ( <i>n</i> = 8) filed claims	
<i>Injury due to negligence</i>				
New York	0.9% of patients ( <i>n</i> = 280), of whom		2.9% ( <i>n</i> = 8) filed claims	
Utah/Colorado	1.1% of patients ( <i>n</i> = 161), of whom		2.5% ( <i>n</i> = 4) filed claims	
<i>Injury but no negligence</i>				
New York	2.8% of patients ( <i>n</i> = 853), of whom		1.2% ( <i>n</i> = 10) filed claims	
Utah/Colorado	2.9% of patients ( <i>n</i> = 426), of whom		0.9% ( <i>n</i> = 4) filed claims	
<i>No injury</i>				
New York	96.2% of patients ( <i>n</i> = 28,988), of whom		0.1% ( <i>n</i> = 29) filed claims	
Utah/Colorado	96.0% of patients ( <i>n</i> = 14,113), of whom		0.07% ( <i>n</i> = 10) filed claims	
Positive likelihood ratios for filing a claim <sup>c</sup>				
	<u>Any injury</u>	<u>Injury but no negligence</u>	<u>Injury due to negligence</u>	<u>Injury due to negligence</u>
	No injury	No injury	No injury	Injury but no negligence
New York	15.9	11.7	29.0	2.4
Utah/Colorado	19.2	13.2	35.7	2.7

<sup>a</sup> *n* = 30,121.

<sup>b</sup> *n* = 14,700.

<sup>c</sup>  $LR+ = \frac{\text{Pr}(\text{screen positive}|\text{positive})}{\text{Pr}(\text{screen positive}|\text{negative})} = \frac{\text{sensitivity}}{1 - \text{specificity}}$ .

It is interesting to consider these findings in light of survey reports about physicians' own perceptions of their malpractice risk. The New York study investigators surveyed 734 New York physicians in 1989 and found that on average, physicians believed that 60% percent of patients who suffered a temporary or permanent disability due to negligent medical management would file suit, and that 45% of patients with a disability due to non-negligent medical management would sue (Harvard Medical Practice Study Investigators, 1990; Lawthers et al., 1992). Thus, the physicians radically overestimated both the absolute risk of being sued and the absolute excess risk attributable to negligence.

The finding that injury itself is a highly influential driver of claiming may be a manifestation of patients' inability to distinguish between negligent and nonnegligent injuries. That is, patients may (mistakenly) believe that most medical injuries are attributable to negligence. Indeed, research suggests that even expert physicians, whose judgments are used as the basis for legal determinations of negligence, are unreliable in identifying negligence (Layde et al., 2002; Thomas, Studdert, & Brennan, 2002). If so, then the argument that providers should endeavor to reduce all injuries, rather than trying to target negligence, appears quite sensible from the perspective of lowering tort risk.

But even substantially reducing the patient injury rate may do little to reduce the overall number of malpractice claims a provider experiences, assuming no increase in the sensitivity of the system. The graph of the relationship between injury reduction and claims reduction (available upon request) looks very similar to Fig. 3. An average provider with a baseline injury rate of 3% would expect to experience about a 17% reduction in claims (from about 13 to about 11 claims per 10,000 patients) by halving its injury rate. A "bad apple" with a 6% baseline injury rate could expect a 25% reduction (from 17 to about 13 claims).

## Discussion

Viewing malpractice litigation patterns through an epidemiological lens provides an interesting perspective on the key data invoked in arguments that malpractice liability has no deterrent value in health care. Because of a situation analogous to the problem of false-positives in screens for rare diseases, a provider who reduces injury rates substantially can expect to see only a small decrease in the number of claims filed. But the data also show that patients who are negligently injured are more than 20 times more likely to sue than patients who are not. In this sense, claiming behavior is not as haphazard as physicians suppose.

The deterrent effect of malpractice litigation could be improved by implementing reforms to increase the sensitivity and specificity of the tort liability system. Sensitivity-enhancing reforms aim at increasing the percentage of negligently injured patients who file claims by making the claiming process simpler, more expeditious, and less adversarial. Administrative no-fault compensation schemes are a prime example (Studdert & Brennan, 2001; Weiler, 1991). Specificity-enhancing reforms, which aim at weeding out frivolous claims, include pretrial screening panels and medical expert precertification requirements. A discussion of the efficacy and feasibility of the various reform options is beyond the scope of this paper, but useful reviews are available elsewhere (Bovbjerg, 1989; Brennan & Rosenthal, 1995; Goldschmid, 1991; Kinney, 1995).

Our analysis should be viewed in light of some potential limitations. Although the New York and Utah/Colorado data constitute the best available estimates of medical injury rates in the United States, they may understate or overstate the true rates. The negligence data are based on the implicit judgments of physician reviewers, which have been found to have moderate to poor reliability (Hofer, Bernstein, DeMonner, & Hayward, 2000; Localio et al., 1996; Thomas et al., 2002). The quality and quantity of data available from medical chart reviews have other well-known limitations (Gibbs et al., 2001; Gilbert, Lowenstein, Koziol-McLain, Barta, & Steiner, 1996; Wu & Ashton, 1997). Consider one possibility, that some incidents of negligent care are not documented in the chart so the study data underestimate the true prevalence of negligent injury. This is unlikely to appreciably affect the findings of our analysis unless the missed cases are among the group that filed claims. In that event, negligently injured individuals would have an even higher likelihood of filing a claim, relative to non-negligently injured individuals, than we report, increasing the incentive to avoid negligent care.

It is also possible that claiming rates have changed since the New York and Utah/Colorado studies were conducted. The Institute of Medicine's (2000) report, *To Err Is Human*, has made the public much more conscious of the prevalence and severity of errors in the hospital (Davis et al., 2002; Kaiser Family Foundation, 2000). In such a charged environment, a greater percentage of patients who suffer a negligent injury, and perhaps also a greater percentage of patients who do not suffer a negligent injury, may now be filing malpractice claims (i.e., the sensitivity and specificity of the system may be changing). However, there is no particular reason to think that the ratio of the claims rates of these two groups has changed dramatically over the past few years. If the claims rates for both groups are rising over time, then the business case for safety becomes slightly stronger, because a higher absolute

number of claims can be avoided by reducing rates of negligent injury.

We focus on the risk of being claimed against as the primary mechanism of deterrence, but also relevant may be the amount of money providers expect to pay out for each suit filed (though typically this payout is covered by insurance with little or no resulting increase in premiums). Studies that have examined the relationship between negligence and damages in malpractice suits have produced mixed findings: The New York study found that severity of injury was the strongest driver of damages awards while negligence was not a significant predictor (Brennan, Sox, & Burstin, 1996), but others have found a statistical association between negligence and damages (Farber & White, 1991; Taragin, Willett, Wilczek, Trout, & Carson, 1992).

In a similar vein, our analysis assumes that all claims are equal in the eyes of the provider, but a reduction of one claim per 10,000 hospitalizations (the expected reduction for an average provider which halved its rate of negligent injury) could be quite important for the provider if that one claim is a multimillion-dollar suit that garners enormous publicity. For this reason, even a provider with an average or above-average safety record may be motivated to pursue error reduction for loss prevention purposes.

## Conclusion

We conclude with three key messages about incentivizing providers to reduce medical errors. First, deterrence is a complex phenomenon. Our intention in this paper is to make a limited point about the data upon which arguments about deterrence typically hang—not to present a comprehensive analysis of deterrence. We have elsewhere set forth a model for evaluating deterrence as a function of multiple factors, including the base rate of claiming (and physicians' misperceptions of it), the fit between negligent injury and suing, insurance pricing effects, cost-externalization dynamics, and psychological and reputational aspects of being sued (Mello & Brennan, 2002). A holistic evaluation of the deterrent effect of the malpractice system must take the full range of influential factors into consideration.

Second, even if the tort system provides relatively weak incentives to reduce medical injuries, there may be other sources of economic incentives. For example, adverse events in the hospital may lead to a prolonged hospital stay, increasing the overall cost of the patient's hospitalization (Thomas et al., 1999). If the hospital is paid on a diagnosis-related-group basis rather than a per-diem basis, the hospital may be unable to obtain reimbursement for these additional costs (Mello & Brennan, 2002). Physicians who are paid through global

capitation face a similar situation. Providers who reduce their injury rates can avoid these costs.

Finally, while much attention has been focused recently on making the business case for patient safety, this argument is clearly not the only means of motivating providers to pursue safety initiatives. Reducing rates of patient injury is an important societal and professional goal, even if it does not translate into dramatic reductions in malpractice risk. Physicians' affirmative obligation to work collaboratively with other professionals to reduce medical error is emphasized in the charter on 21st-century medical professionalism recently issued by the American Board of Internal Medicine and other physician organizations (Project of the ABIM Foundation, ACP-ASIM Foundation, & European Federation of Internal Medicine, 2002). Thus, while the business case for patient safety may be equivocal, the practitioner's ethical obligation of patient safety remains imperative.

## Acknowledgements

The authors thank Matthew Miller, David Studdert, and Troy Brennan for helpful comments on earlier versions of the manuscript.

## References

- Beckman, H. B., Markakis, K. M., Suchman, A. L., & Frankel, R. M. (1994). The doctor–patient relationship and malpractice: Lessons from plaintiff depositions. *Archives of Internal Medicine*, *154*(12), 1365–1370.
- Bovbjerg, R. R. (1989). Legislation on medical malpractice: Further developments and preliminary report card. *University of California-Davis Law Review*, *22*(2), 499–556.
- Brennan, T. A., & Rosenthal, M. (1995). Medical malpractice reform: The current proposals. *Journal of General Internal Medicine*, *10*(4), 211–218.
- Brennan, T. A., Leape, L. L., Laird, N. M., Hebert, L., Localio, A. R., & Lawthers, A. G., et al. (1991). Incidence of adverse events and negligence in hospitalized patients: Results of the Harvard medical practice study I. *New England Journal of Medicine*, *324*(6), 370–376.
- Brennan, T. A., Sox, C. M., & Burstin, H. R. (1996). Relation between negligent adverse events and the outcomes of medical-malpractice litigation. *New England Journal of Medicine*, *335*(26), 1963–1967.
- Cole, S. A. (1997). Reducing malpractice risk through more effective communication. *American Journal of Managed Care*, *3*(4), 649–653.
- Davis, K., Schoenbaum, S. C., Collins, K. S., Tenney, K., Hughes, D. L., Audet, A. J. (2002). *Room for improvement: Patient's report on the quality of their Health Care 2002*. Available at [www.cmwf.org/programs/quality/davis\\_improvement\\_534.pdf](http://www.cmwf.org/programs/quality/davis_improvement_534.pdf) (Accessed 30 April 2002).

- Farber, H. S., & White, M. J. (1991). Medical malpractice: An empirical investigation of the litigation process. *RAND Journal of Economics*, 22(2), 199–217.
- Gibbs, J., Clark, K., Khurir, S., Henderson, W., Hur, K., & Daley, J. (2001). Validating risk-adjusted surgical outcomes: Chart review of process of care. *International Journal for Quality in Health Care*, 13(3), 187–196.
- Gilbert, E. H., Lowenstein, S. R., Koziol-McLain, J., Barta, D. C., & Steiner, J. (1996). Chart reviews in emergency medicine research: Where are the methods? *Annals of Emergency Medicine*, 27(3), 305–308.
- Goldschmid, J. (1991). Where have all the panels gone? A history of the Arizona medical liability review panel. *Arizona State Law Journal*, 23, 1013–1109.
- Harvard Medical Practice Study Investigators. (1990). *Patients, doctors, and lawyers: Medical injury, malpractice litigation, and patient compensation in New York. The report of the Harvard Medical Practice Study to the State of New York*. Boston: Harvard Medical Practice Study Investigators.
- Hemenway, D. (1997). The myth of millions of annual self-defense gun uses: A case study of survey overestimates of rare events. *Chance*, 10(3), 6–10.
- Hennekens, C. H., & Buring, J. E. (1987). *Epidemiology in medicine*. Boston: Little, Brown.
- Hofer, T. P., Bernstein, S. J., DeMonner, S., & Hayward, R. A. (2000). Discussion between reviewers does not improve reliability of peer review of hospital quality. *Medical Care*, 38(2), 152–161.
- Hupert, N., Lawthers, A. G., Brennan, T. A., & Peterson, L. M. (1996). Processing the tort deterrent signal: A qualitative study. *Social Science & Medicine*, 43(1), 1–11.
- Institute of Medicine. (2000). *To err is human: Building a safer health system*. Washington: National Academy Press.
- Kaiser Family Foundation. (2000). *National Survey on Americans as Health Care Consumers: An update on the Role of Quality Information 2000*. Available at [www.kff.org/content/2000/3093/AHRQTOplines.pdf](http://www.kff.org/content/2000/3093/AHRQTOplines.pdf) (Accessed 30 April 2002).
- Kinney, E. D. (1995). Malpractice reform in the 1990s: Past disappointments, future success? *Journal of Health Politics, Policy & Law*, 20(1), 99–135.
- Knottnerus, J. A., van Weel, C., & Muris, J. W. M. (2002). Evaluation of diagnostic procedures. *BMJ*, 324(7335), 477–480.
- Lawthers, A. G., Localio, A. R., Laird, N. M., Lipsitz, S., Hebert, L., & Brennan, T. A. (1992). Physicians' perceptions of the risk of being sued. *Journal of Health Politics, Policy & Law*, 17(3), 463–482.
- Layde, P. M., Cortes, L. M., Teret, S. P., Brasel, K. J., Kuhn, E. M., & Mercy, J. A., et al. (2002). Patient safety efforts should focus on medical injuries. *New England Journal of Medicine*, 287(15), 1993–1997.
- Leape, L. L. (1994). Error in medicine. *JAMA*, 272(23), 1851–1857.
- Leape, L. L., Brennan, T. A., Laird, N., Lawthers, A. G., Localio, A. R., & Barnes, B. A., et al. (1991). The nature of adverse events in hospitalized patients. *New England Journal of Medicine*, 324(6), 377–384.
- Levinson, W., Roter, D. L., Mullooly, J. P., Dull, V. T., & Frankel, R. M. (1997). Physician-patient communication: The relationship with malpractice claims among primary care physicians and surgeons. *JAMA*, 277(7), 553–559.
- Localio, A. R., Lawthers, A. G., Brennan, T. A., Laird, N. M., Hebert, L. E., & Peterson, L. M., et al. (1991). Relation between malpractice claims and adverse events due to negligence: Results of the Harvard Medical Practice Study III. *New England Journal of Medicine*, 325(4), 245–251.
- Localio, A. R., Weaver, S. L., Landis, J. R., Lawthers, A. G., Brennan, T. A., & Hebert, L., et al. (1996). Identifying adverse events caused by medical care: Degree of physician agreement in a retrospective chart review. *Annals of Internal Medicine*, 125(6), 457–464.
- Mello, M. M., & Brennan, T. A. (2002). Deterrence of medical errors: Theory and evidence for malpractice reform. *Texas Law Review*, 80(7), 1595–1637.
- Moore, P. J., Adler, N. E., & Robertson, P. A. (2000). Medical malpractice: The effect of doctor-patient relations on medical patient perceptions and malpractice intentions. *Western Journal of Medicine*, 173(4), 244–250.
- Posner, R. A. (1972). A theory of negligence. *Journal of Legal Studies*, 1(1), 29–96.
- Project of the ABIM Foundation, ACP-ASIM Foundation, and European Federation of Internal Medicine. (2002). Medical professionalism in the new millennium: A physician charter. *Annals of Internal Medicine*, 136(3), 243–246.
- Sloan, F. A., & Hassan, M. (1990). Equity and accuracy in medical malpractice insurance pricing. *Journal of Health Economics*, 9(3), 289–319.
- Studdert, D. M., & Brennan, T. A. (2001). No-fault compensation for medical injuries: The prospect for error prevention. *JAMA*, 286(2), 217–223.
- Studdert, D. M., Thomas, E. J., Burstin, H. R., Zbar, B. I., Orav, J., & Brennan, T. A. (2000). Negligent care and malpractice claiming behavior in Utah and Colorado. *Medical Care*, 38(3), 250–260.
- Taragin, M. I., Willett, L. R., Wilczek, A. P., Trout, R., & Carson, J. L. (1992). The influence of standard of care and severity of injury on the resolution of malpractice claims. *Annals of Internal Medicine*, 117(9), 780–784.
- Thomas, E. J., Studdert, D. M., & Brennan, T. A. (2002). The reliability of medical record review for estimating adverse event rates. *Annals of Internal Medicine*, 136(11), 812–816.
- Thomas, E. J., Studdert, D. M., Burstin, H. R., Orav, E. J., Zeena, T., & Williams, E. J., et al. (2000). Incidence and types of adverse events and negligent care in Utah and Colorado. *Medical Care*, 38(3), 261–271.
- Thomas, E. J., Studdert, D. M., Newhouse, J. P., Zbar, B. I., Orav, E. J., & Brennan, T. A. (1999). Costs of medical injuries in Utah and Colorado. *Inquiry*, 36(3), 155–164.
- Weiler, P. C. (1991). *Medical malpractice on trial*. Cambridge: Harvard University Press.
- Weiler, P. C., Hiatt, H., Newhouse, J. P., Johnson, W. G., Brennan, T. A., & Leape, L. (1993). *A measure of malpractice: Medical injury, malpractice litigation and patient compensation*. Cambridge: Harvard University Press.
- Wu, L., & Ashton, C. M. (1997). Chart review: A need for reappraisal. *Evaluation and the Health Professions*, 20(2), 146–163.