

The Role of Physician Specialty Board Certification Status in the Quality Movement

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QUALITY OF CARE CONTINUES to dominate the health policy agenda. Originally engendered by the now multiple reports of the Institute of Medicine (IOM) on quality of care,¹ in particular on patient safety,² and given new impetus by ongoing reports concerning the variable effectiveness of care provided by hospitals and physicians,^{3,4} the quality movement has expanding momentum. Perhaps most important, high-quality medical care has become a significant objective for US business, as motivated employers make the point that value purchasing should be as much a rule for medical care as it is for other areas of industry.⁵

In the wake of the IOM's advocacy, traditional regulators of quality have renewed their efforts, and they have been joined by a series of new initiatives that are intended to hold hospitals publicly accountable for quality. For example, the Joint Commission on Accreditation of Healthcare Organizations and the Centers for Medicare & Medicaid Services quality improvement organizations have retooled over the last 5 years, now more explicitly expecting demonstra-

The Institute of Medicine's reports and discussions on quality of medical care have focused on a systems-based approach to quality improvement. Our objective is to summarize evidence and theory about the role of a physician's current board certification status in quality improvement. The first body of evidence includes the validity of board certification demonstrated by the testing process, the relationship of examination scores with other measures of physician competence, and the relationship between certification status and clinical outcomes. The second body of evidence involves the adaptation of error prevention theory to medical care. Patient safety is enhanced when problem-solving uses readily accessed habits of behavior, the same behavior necessary to achieve board certification. The third body of evidence, obtained through a Gallup poll, demonstrates that certification and maintenance of certification are highly valued by the public. The majority of respondents thought it important for physicians to be reevaluated on their qualifications every few years and that physicians should do more to demonstrate ongoing competence than is currently required by the profession. We conclude that a physician's current certification status should be among the evidence-based measures used in the quality movement.

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tion of effective and safe health care and insisting that regulated entities use data about outcomes to improve the care provided. The Leapfrog Group, an influential collaborative of large employers who have prepared specific criteria to ensure better quality of the care they purchase, and the National Quality Forum, a private/public coalition that aims to sanction certain measures of quality, are both examples of quality promotion that did not exist 5 years ago.⁶ All regulating entities are insisting on improved measurement and implementation of mechanisms to improve quality.

Remarkably quiet in this quality movement is the physician. Indeed, many architects of the new initiatives consider physicians to be impediments to systematic efforts to improve quality. The IOM reports were intended to go directly to the public, for fear that an appeal to professionals

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would fail to overcome physician inertia on the question of quality improvement.⁷

Perhaps more to the point, the traditional physician approach to quality, eg, certification, has received minimal notice within the new quality movement. While physician certification is reported by many health plans and is a component of the National Committee for Quality Assurance Health Plan Employer Data and Information Set (HEDIS) formula, maintenance of certification is not routinely considered or reported. Current certification status appears to be overlooked or assumed in the catalogs of measures compiled by the Leapfrog Group, the National Quality Forum, the Joint Commission on Accreditation of Healthcare Organizations, or the Agency for Healthcare Research and Quality initiative on evidence-based quality measures.

A possible part of the reason that certification status has been overlooked or assumed is based on the accurate perception that the majority of physicians in the United States are certified. In 2002, more than 85% of licensed physicians held a valid certificate.⁸ However, this does not address the lack of attention to renewing or maintaining certification on the part of regulators, health plans, and others.

We discuss the role of the individual physician in the overall quality framework and argue that the minimal attention to the role of the individual physician is a missed opportunity and review data that suggest patients agree with us. We also outline the prominent role that current and evolving versions of physician certification and maintenance of certification can play in advancing quality and accountability.

WHERE ARE THE PHYSICIANS?

There are 2 reasons that physicians, and the quality of individual physician care, have played a secondary role in the quality movement. The first reason arises from the original impetus for the current quality movement, eg, the ini-

tial IOM report, *To Err Is Human*.² The subject of this report was in part the epidemic of medical errors and the injuries such errors cause. A notable and frequently repeated headline from *To Err Is Human* reported that 44 000 to 98 000 persons die each year in US hospitals as a result of preventable iatrogenic injury. The press reaction was intense and created momentum that still sustains the movement.

The follow-up IOM reports deepened discussions and understanding about strategies for enhancing the quality of patient care. A major contribution was the classification of 6 central components of quality: patient-centeredness, safety, effectiveness, efficiency, timeliness, and equity. Most evidence-based measures of quality relate to the categories of patient-centeredness and effectiveness,⁶ but safety enhancements remained the critical motivation of much of the renewed interest in quality. For example, the number of lives that could be saved by reducing errors was the initial justification for 3 early Leapfrog Group measures: computerized provider order entry, full-time intensivists in intensive care units, and concentration of procedures in high-volume centers.⁵

To Err Is Human not only focused on safety, but also called for continuous quality improvement through change in systems of medical care. Modern industrial quality improvement principles eschew assigning individual blame as a method for improving quality.⁹ This principle gained greater significance in light of the IOM's strategic recognition that the key regulatory approach to medical injury has traditionally been malpractice litigation. Malpractice is founded on individual blame and is routinely criticized as a method of improving care or preventing injuries by physicians.¹⁰ To avoid the conundrum of malpractice and blame and because significant data from outside the medical profession support the efficacy of a systems-based approach to quality improvement, the IOM report focused on systems. An un-

intended result evolved—the nearly solitary focus on systems overshadowed the important and complementary role of individual physician accountability.

The second reason for the minimal inclusion of physician competence in the quality movement is the perception that limited reliable approaches exist to support measuring individual physician quality. For years, the great hope for evidence-based quality measures, especially related to effectiveness, was that clinical outcome measures could be used to judge the quality of, and perhaps to rank, individual physicians. Under this approach, the quality of care provided by physicians would be judged by how effectively their patients' diseases were managed (eg, the rate of glycosylated hemoglobin levels at goal for diabetes or rate of cholesterol levels at goal for coronary disease).

Methodologists have long had concerns about technical obstacles (eg, sample size limitations) that exist when evaluating the performance of individual physicians in their clinical practices.^{11,12} There is general agreement that, although a worthwhile goal, reliable and valid clinical performance assessment of individual physicians will require considerable research and development.

In the interim, to overcome the technical problems associated with small numbers, the quality regulators adopted approaches that aggregate physicians or providers at the group, health plan, or hospital levels. In addition, improvement experts have focused on evaluations of structural elements in systems that are related to improved outcomes, such as report cards indicating whether a hospital has a computerized order entry system and processes of care. These initiatives are welcome and hold promise for improved care, but the unfortunate corollary is that the traditional measure of individual physician quality, certification status, has been taken for granted in the quality movement. This is especially unfortunate given new policies promulgated by the American Board of Medical Specialties (ABMS) and indi-

vidual certifying boards to expand the requirements for maintaining certification and put a time limit on certificates.

EVOLUTION OF CERTIFICATION AND MAINTENANCE OF CERTIFICATION

The evolving requirements for certification and maintenance of certification are spurred by many leaders in the profession agreeing that physicians must do more to demonstrate to the public that they are skilled and knowledgeable. This momentum predates the IOM quality reports but is now given further impetus by the general activism surrounding quality.

Historically, board certification has depended on performance on a proctored examination of knowledge. Growing from a perceived need to demonstrate quality and differentiate among specialties, the first specialty board, ophthalmology, was founded in 1917. Other specialties followed, and in 1933 they organized as a federation called the Advisory Board of Medical Specialists (renamed the American Board of Medical Specialties [or ABMS] in 1970).¹³ Today the ABMS consists of 24 boards. To achieve initial certification, each board requires between 3 and 6 years of training in an accredited training program and a passing score on a rigorous cognitive examination. In addition, to assess clinical competence, some boards require satisfactory program director evaluations on 6 competencies (patient care, medical knowledge, practice-based learning and improvement, interpersonal and communications skills, professionalism, and systems-based practice), while others require oral examinations, audits of medical records, review of case logs, or observed performance on real or standardized patients.¹⁴

The changing scope of medical information, the increased concern of the public for the need to recredential physicians, and some evidence that knowledge and skills of practicing physicians decay over time motivated specialty boards to develop recertification programs and to limit the dura-

tion of certificates.^{15,16} Realizing that satisfactory performance on a single examination does not guarantee that physicians remain competent through their careers, the ABMS has taken on the challenge to insist that all member boards' maintenance of certification programs include the 6 certification competencies, organized into a 4-part framework, now referred to as "maintenance of certification."⁸ The ABMS maintenance of certification initiative calls for evidence of the following: (1) professional standing, (2) lifelong learning and periodic self-assessment, (3) cognitive expertise as demonstrated by a secure examination, and (4) performance in practice. Each ABMS member board has agreed to design methods to meet these requirements by instituting maintenance of certification programs that will be continuous in nature and include periodic cognitive examinations, as well as components focused on clinical practice assessment and quality improvement. Although each board can design its own methods for compliance with this mandate, an ABMS Oversight and Monitoring Committee has been established to ensure adherence to the principles.¹⁷

Most boards believe that there is more to be done before the ambitious agenda set forth by the ABMS has been met. Nonetheless, all 24 boards have accepted the challenge, indicating the medical profession's commitment to the highest quality care, and specifically to the principle that the certified physician is continuously striving to better serve patients. Given this expanding commitment, it is ironic that the notion of individual physician quality has been overlooked. Review of the evidence and theory surrounding credentialing and quality suggests that the ambitious agenda of the ABMS should be embraced by the quality movement.

BOARD CERTIFICATION AS A MEASURE OF INDIVIDUAL PHYSICIAN QUALITY

Over the last 30 years, the ABMS boards and other colleagues have evaluated the effectiveness of certification focusing

primarily, until recently, on initial certification. The published evidence on the value of certification and maintenance of certification takes 3 forms: the internal validity of the testing process itself, the correlation of examination scores with other measures of physician quality, and the correlation of certification status with practice outcomes. We review each of these and suggest how the evidence of the value of certification is complemented by theories of error prevention.

The first body of evidence concerns the validity of the testing process. Typically, cognitive examinations are composed of questions developed by experts in the discipline and selected to fulfill a blueprint for the overall examination based on importance and frequency with which problems are faced in practice. Most examinations use pre-testing to assure their accuracy and, in some instances, certified practitioners who are not associated with the board rate the relevance of each question to clinical practice.¹⁸ All ABMS boards set standards for passing the secure examinations using widely accepted, credible standard-setting methods.^{19,20} Continuous monitoring of the standards set by the expert question-developers show them to be credible, valid, and reproducible over time, and different sets of experts arrive at comparable judgments.²¹⁻²³

The second body of evidence for the effectiveness of physician certification as a measure of quality concerns the relationship of examination scores with other measures of physician competence. A valid measure must be able to demonstrate relationships with other criterion measures to be believable; groups that should do well on the examination in fact do so. Certification examination results are correlated with the type of medical school training (as a group, US medical school graduates perform better than foreign medical school graduates)²⁴; the amount of formal training (those with more training perform better on subspecialty examinations than those with less training)²⁵; and supervisor assessment of clinical skills (phy-

sicians rated independently by their training program directors as excellent trainees perform better on the certification examinations than those less highly rated).^{26,27}

Physicians specializing in an area (eg, geriatrics or critical care medicine) perform better on those portions of a recertifying examination compared with those who do not have such interests.¹⁶ Also, a positive relationship exists between recertification examination performance and patient volume as well as complexity of patient problems reportedly seen in practice.²⁸ Performance on an open-book, take-home self-assessment examination used in the American Board of Internal Medicine (ABIM) maintenance of certification program shows that the scores are as reproducible as a 60-item licensing or certifying examination and having small but significant positive correlations with length of training, initial certification examination scores, and the composition of the clinical practice.²⁹ Likewise, the patient and peer self-assessment measure is as reproducible as other survey measures of its kind and has small but significant positive correlations with the internal medicine program director ratings of overall clinical performance and communication skills rendered nearly 10 years previously.³⁰

The third body of evidence regarding certification as a measure of physician quality attests to the relationship between certification status and various clinical outcomes; conclusions in this area are mixed. In a systematic review of the literature on studies published between 1966 and 1999,³¹ only 5% of the studies used research methods that were appropriate for assessing the research question and, among these, more than half support a positive relationship between board certification status and clinical outcomes.³¹ Of the studies that did not demonstrate a positive association, the majority showed no association between certification and clinical outcome measures. Examples from this review include the work by Ramsey and

colleagues,³² which found provision of preventive care services and a few outcomes (eg, lower mean glycosylated hemoglobin levels for diabetic patients) favoring board-certified physicians. In addition, board-certified surgeons had lower peptic ulcer surgical mortality rates, but rates did not differ from non-certified surgeons for stomach cancer surgery or abdominal aneurysm.³³ In a study of physicians disciplined by the state of California, Morrison and Wickershaw³⁴ found that disciplinary action was negatively associated with specialty board certification.

Literature published after 1999 also shows mixed findings. In a series of studies in Pennsylvania, certified cardiologists were shown to have lower in-hospital mortality rates independent of volume of patients.³⁵⁻³⁷ A retrospective study of patients in northern Illinois revealed that board certification in surgery was associated with reduced mortality for colon resection, but subspecialty certification in colorectal surgery was not related to outcomes.³⁸ Silber³⁹ studied patients who underwent surgical procedures in Pennsylvania and found that the lack of board certification was related to higher mortality rates; however, type of hospital was not controlled in the study. A study of family physicians in Quebec showed a positive relationship, sustained over 4 to 7 years out in practice, between certification examination scores and mammography screening, consultation rate, but not continuity of care.⁴⁰ A recent study of physicians disciplined by the Medical Board of California showed that lack of board certification was related to a greater risk of disciplinary action (practice suspension, public reprimand, probation, and license revocation).⁴¹

Although the evidence on clinical outcomes is mixed, it is nonetheless promising that better outcomes are associated with physician certification and maintenance of certification in many studies. Obviously, more research is needed to focus on the maintenance of certification process and to assess its value to the public and the profession as a measure in the quality movement.

CERTIFICATION AND GREATER PATIENT SAFETY?

The theory of error prevention suggests that certification may be more important for the safety domain of quality than the currently available empirical evidence suggests. The quality movement, especially the part focused on patient safety, has relied as much on cognitive psychology concepts, guided as much by theory and common sense, as by evidence of outcomes.⁴²

The safety domain of the quality movement owes a great deal to the importation by Leape et al⁴³ of basic error prevention theory into medical care proposed by Reason. Reason's most accessible work differentiates rule-based behavior (prone to lapses and slips) from knowledge-based behavior (prone to mistakes).⁴⁴ These insights are built on years of cognitive psychological research, which emphasize similar dichotomies, including the skill-, rule-, and knowledge-based levels of cognition of Rasmussen and Jensen⁴⁵; the symptomatic and topographic rules of Rouse⁴⁶; and Reason's own sophisticated differentiation between attentional and schematic modes of processing decisions.⁴⁴ While not all of the cognitive psychology literature supports this paradigm, the interpretation of Reason's theory by Leape et al has proven to be very intuitive to physicians and policy makers.

In each of these areas of psychological investigation, theorists recognize a complex interaction between problem-solving that relies on readily accessed habits of behavior and problem-solving that involves slower interrogation and processing of a knowledge base. Error prevention depends on recognizing that different behaviors are necessary to prevent mistakes or oversights arising from these respective types of problem-solving.

Certification and maintenance of certification evaluate a physician's evidence of possessing the requisite habits of practice (practice performance assessment) and robust knowledge base (cognitive examination) needed to prevent both types of errors. A physician

who performs well on a certification examination and who maintains certification by routine review of the medical literature presumably has demonstrated ability to access a base of clinical knowledge and uses this same skill and knowledge when faced with a patient problem. Common sense suggests that the physician with a broad and readily manipulated knowledge base will be more likely to arrive at the correct answer to a clinical question, although no empirical studies are available on this point.

The ABMS member boards' measures of performance in practice (part 4 of the ABMS maintenance of certification framework) are intended to demonstrate and improve the extent to which a physician practices within established national guidelines. For example, a person's habits of behavior can be judged by overall compliance with widely accepted guidelines: failure to prescribe β -blockers or aspirin after a patient suffers myocardial infarction may reflect poor habits of care, not a knowledge deficit. These deficits in executing known guidelines for care can be ameliorated by incorporating reminders in medical records. The ABIM, for example, provides practice improvement modules for use in the maintenance of certification program that stimulate awareness of intended practice and provides suggestions for improvement in office settings. In addition, peers and patients will likely have well-grounded observations about a physician's habits in practice. Physicians report that feedback received from peer and patient assessments is helpful.³⁰ Thus, the criteria on which certification or maintenance of certification are based will, at least in time, increase the likelihood that certified physicians provide recommended care, leading to improved quality.

CERTIFICATION IN THE PUBLIC'S EYE

Patients generally agree with these theoretical and common sense insights into certification. Research suggests that patients pay very little attention to the scorecards and measures that predominate

in the quality movement, often because of what and how information is presented.⁴⁷ The key question that patients ask with regard to quality is, "How do I find a good physician?"⁴⁸ The answer often involves certification status.

To test our hypothesis that measures of physician quality used in certification and maintenance of certification matter to patients, the ABIM commissioned the Gallup organization to poll the general public about their views on physician certification and maintenance of certification. Among the major findings, the survey revealed that certification and maintenance of certification are highly valued by the public, patients expect and would prefer that physicians demonstrate skills that are just beginning to be addressed by the ABMS requirements in their maintenance of certification programs, and that physicians should be evaluated more frequently than is currently required by any board (all require certificate renewal between 6 and 10 years). Perhaps most significant, respondents indicated that they would be likely to change their own behavior to ensure that they are treated by a certified physician. Most claimed they would change physicians if their current physician or specialist failed to maintain certification, and when given the choice between a board-certified physician or a noncertified physician recommended by a trusted friend or family member, the majority reported that they would choose the former (unpublished data, July 2003).

Based on evidence that consumers make limited use of quality measures,⁴⁸ it was not surprising to find that only a minority of respondents ever directly researched or inquired about a physician's credentials. Nonetheless, they intuitively and highly favor what the credential of certification represents and have strong and consistent views about the extent to which physicians should demonstrate ongoing competence. Is the public's confidence in certification misplaced? We believe it is not, and that several decades of empirical evidence, as well as modern theories of safety improve-

ment and recent changes in requirements by specialty boards, support certification as a measure of quality.

CONCLUSION

The ABMS continues to work on behalf of its ambitious agenda to improve physician quality through its maintenance of certification program. Reasonable empirical evidence suggests that certification and maintenance of certification programs will improve quality, and more research is under way. That evidence is supported by the theory of error prevention and even by common sense assumptions about medical practice. Our polling data suggest the public is convinced that there is a connection, no doubt swayed by common sense.

Maintenance of certification is essentially self-regulation by the profession. It is not intended to replace or supplant those efforts to improve quality that are generated outside the profession. There is every reason to believe that regulation by the profession and other organizations can be synergistic.

Therefore, the answer to the question, "where are the physicians?" should be that they are engaged in efforts to ensure professional quality using methods that comport with much of the rest of the quality movement and in conjunction with other organizations that are actively pursuing quality improvement. Indeed, our professional commitment to patients and each other demands nothing less.

REFERENCES

1. Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: Institute of Medicine; 2001.
2. Kohn KT, Corrigan JM, Donaldson, MS, eds. *To Err Is Human: Building a Safer Health System*. Washington, DC: Committee on Quality of Health Care in America, Institute of Medicine; 1999.
3. McGlynn EA, Asch SM, Adams J, et al. Quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348:2635-2645.
4. Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implication of regional variation in medicare spending, part 1: the content, quality, and accessibility of care. *Ann Intern Med*. 2003; 138:273-286.
5. Leapfrog Group for Patient Safety Web site. Available at: <http://www.leapfroggroup.org/purchase.htm>. Accessed March 7, 2004.

6. Mello MM, Brennan TA. Regulation of quality of care: the critical assessment. *J Health Polit Policy Law*. In press.
7. Lamb RM, Studdert DM, Bohmer RMJ, Berwick DM, Brennan TA. Hospital disclosure practices: results of a national survey. *Health Aff (Millwood)*. 2003;22:73-83.
8. Horowitz SD, Miller SH, Miles PV. Board certification and physician quality. *Med Educ*. 2004;38:10-11.
9. Brennan TA, Berwick DM. *New Rules: Regulation, Markets and the Quality of American Health Care*. San Francisco, Calif; Jossey-Bass: 1996.
10. Studdert DM, Mello MM, Brennan TA. Medical malpractice. *N Engl J Med*. 2004;350:283-292.
11. Hofer TP, Hayward RA, Greenfield S, Wagner EH, Kaplan SH, Manning WG. The unreliability of individual physician "report cards" for assessing the costs of quality of care of a chronic disease. *JAMA*. 1999;281:2098-2105.
12. Landon BE, Normand ST, Blumenthal D, Daley J. Physician clinical performance assessment: prospects and barriers. *JAMA*. 2003;290:1183-1189.
13. American Board of Medical Specialties. *2003 Annual Report and Reference Handbook*. Evanston, Ill: American Board of Medical Specialties; March 2003.
14. Lynch DC, Swing SR, Horowitz SD, Holt K, Messer JV. Assessing practice-based learning and improvement. *Teach Learn Med*. 2004;16:85-92.
15. Glascock RJ, Benson JA, Copeland RB, et al. Time-limited certification and recertification: the program of the American Board of Internal Medicine. *Ann Intern Med*. 1991;114:59-62.
16. Norcini JJ, Lipner RS, Benson Jr JA, Webster GD. An analysis of the knowledge base of practicing internists as measured by the 1980 recertification examination. *Ann Intern Med*. 1985;102:385-389.
17. American Board of Medical Specialties. *Annual Report and Reference Handbook*. Evanston, Ill: American Board of Medical Specialties; 2002.
18. Norcini JJ, Day SC, Popp RL, et al. The relevance to clinical practice of the certifying examination in internal medicine. *J Gen Intern Med*. 1993;8:82-85.
19. Cizek GJ. *Setting Performance Standards: Concepts, Methods, and Perspectives*. Newark, NJ: Lawrence Erlbaum Associates; 2001.
20. Kassirer JP. The new surrogates for board certification: what should the standards be? *N Engl J Med*. 1997;337:43-44.
21. Shea JA, Reshetar RA, Dawson BD, Norcini JJ. Sensitivity of the modified Angoff standard setting method to variations in item content. *Int J Teach Learn Med*. 1994;6:288-292.
22. Norcini JJ, Shea JA. The reproducibility of standards over groups and occasions. *Appl Meas Educ*. 1992;5:63-72.
23. Norcini JJ, Lipner RS, Langdon LO, Strecker CA. A comparison of three variations on a standard-setting method. *J Educ Meas*. 1987;24:56-64.
24. Norcini JJ, Shea JA, Benson JA. Changes in medical knowledge of candidates for certification in internal medicine. *Ann Intern Med*. 1991;114:33-35.
25. Norcini JJ, Shea JA, Langdon LO, Hudson LD. First American Board of Medicine critical care examination: process and results. *Crit Care Med*. 1989;17:695-698.
26. Norcini JJ, Grosso LJ, Shea JA, Webster GD. The relationship between features for residency training and ABIM certifying examination performance. *J Gen Intern Med*. 1987;2:330-336.
27. Norcini JJ, Maihoff NA, Day SC, Benson JA. Trends in medical knowledge is assessed by the certifying examination of internal medicine. *JAMA*. 1989;262:2402-2404.
28. Norcini JJ, Lipner RS. The relationship between the nature of practice and performance on a cognitive examination. *Acad Med*. 2000;75:S68-S70.
29. Norcini JJ, Lipner R, Downing SM. How meaningful are scores on a take-home recertification examination? *Acad Med*. 1996;71(10 suppl):S71-S73.
30. Lipner RS, Linda LB, Leas BF, Fortna GS. The value of patient and peer ratings in recertification. *Acad Med*. 2002;77:S64-S66.
31. Sharp LK, Bashook PG, Lipsky MS, Horowitz SD, Miller SH. Specialty board certification and clinical outcomes: the missing link. *Acad Med*. 2002;77:534-542.
32. Ramsey PG, Carline JD, Inui TS, Larson EB, Logerfo JP, Weinrich MD. Predictive validity of certification by the American Board of Internal Medicine. *Ann Intern Med*. 1989;110:719-726.
33. Kelly JV, Hellinger FJ. Physician and hospital factors associated with mortality of surgical patients. *Med Care*. 1986;24:785-800.
34. Morrison J, Wickersham MS. Physicians disciplined by a state medical board. *JAMA*. 1998;279:1889-1893.
35. Norcini JJ, Kimball HR, Lipner RS. Certification and specialization: do they matter in the outcome of acute myocardial infarction? *Acad Med*. 2000;75:1193-1198.
36. Norcini JJ, Lipner RS, Kimball HR. The certification status of generalist physicians and the mortality of their patients after acute myocardial infarction. *Acad Med*. 2001;76:S21-S23.
37. Norcini JJ, Lipner RS, Kimball HR. Certifying examination performance and patient outcomes following acute myocardial infarction. *Med Educ*. 2002;36:853-859.
38. Prystowsky JB. Patient outcomes for segmental colon resection according to surgeon's training, certification, and experience. *Surgery*. 2002;132:663-670.
39. Silber JH. Anesthesiologist board certification and patient outcomes. *Anesthesiology*. 2002;96:1044-1052.
40. Tamblyn R, Abrahamowicz M, Dauphinee WD, et al. Association between licensure examination scores and practice in primary care. *JAMA*. 2002;288:3019-3026.
41. Kohatsu ND, Gould D, Ross LK, Fox PJ. Characteristics associated with physician discipline. *Arch Intern Med*. 2004;164:653-658.
42. Leape LL, Berwick DF, Bates DW. What practices will most improve safety? evidence-based medicine meets patient safety. *JAMA*. 2002;288:501-507.
43. Leape LL, Lawthers AG, Brennan TA, Johnson WG. Preventing medical injury. *QRB Qual Rev Bull*. 1993;19:144-149.
44. Reason J. *Human Error*. Cambridge, England: Cambridge University Press; 1990.
45. Rasmussen J, Jensen A. Mental procedures in real-life tasks: a case study of electronic troubleshooting. *Ergonomics*. 1974;17:293-307.
46. Rouse WB. Models of human problem solving: detection, diagnosis, and compensation for system failure. *Automatica*. 1983;19:413-425.
47. Epstein AM. Rolling down the runway: the challenges ahead for quality report cards. *JAMA*. 1998;279:1691-1696.
48. Hibbard JH, Peters E, Slovic P, Finucane ML, Tversky M. Making healthcare easier to use. *Jt Comm J Qual Improv*. 2001;27:591-604.