

A Narrative Review of the Development and Outcomes of ABMS Member Board Continuing Certification Programs, 2000–2024

Published by the American Board of Medical Specialties



**American Board
of Medical Specialties**

Higher standards. Better care.®

TABLE OF CONTENTS

Introduction	3
Certification and the Evolution of ABMS Recertification	3
Why is it Necessary to Revalidate Certification?	6
Stakeholder Attitudes Toward Maintenance of Certification	7
Continuing Certification, Patient Care, and Patient Outcomes	9
Longitudinal Assessment for Learning	12
Looking Forward	13
References	17

INTRODUCTION

This is a narrative review¹ of research related to the American Board of Medical Specialties (ABMS) program of recertification, which is now referred to as continuing certification.² The purpose of this review is to describe relevant research about the program: what it is, why it exists, how it evolved, how stakeholders feel about it, and its relationship to clinical practice and patient outcomes.

For context, the evolution of ABMS Member Board (Board) recertification programs is traced through three phases. Prior to 2000, recertification took the form of a single point-in-time examination of medical knowledge and clinical skills through a cognitive exam administered every 10 years. In response to changes in medical education and the growth of the quality movement in health care, the Boards adopted a new program in 2000 called Maintenance of Certification (MOC). Although still anchored by a single point-in-time exam, MOC incorporated other elements, including professional conduct and quality improvement (QI). Following a decade of testing new approaches to assessment, and a period of extensive consultation in close collaboration with professional specialty societies and other stakeholders, and drawing on a wide variety of research in the learning and testing sciences, new standards were adopted for a process of longitudinal continuing certification, which became effective in 2024. This review describes the research that informed each phase in the evolution of continuing certification, as well as available research on the relationship between MOC and patient care and outcomes.

Through the three eras of continuing certification programs the purpose has remained the same: to verify that the bearer of a certificate from a Board has demonstrated the knowledge, skills, and conduct required for safe and effective practice in a specialty.

CERTIFICATION AND THE EVOLUTION OF ABMS RECERTIFICATION

Certification is a process for identifying and verifying the knowledge, skills, and behaviors essential to capable performance in a specific job.³ Thus, in the case of specialty physician certification, the Boards develop standards for the knowledge, skills, and behaviors essential to safe and effective specialty practice and assess specialists to validate that these standards have been met. Certification is a public validation that physicians have demonstrated the specific clinical expertise defined by the Boards.⁴

In its origins at the beginning of the 20th century, certification was meant to distinguish physicians with specialty training from those without it. The first medical specialty certification program was developed in Ophthalmology in 1916. Three Boards followed during the next two decades (Dermatology, Obstetrics and Gynecology, and Otolaryngology). These four Boards formed the Advisory Board of Medical Specialties in 1933 (renamed the American Board of Medical Specialties in 1970), which subsequently approved 20 additional Boards, the most recent of which was the American Board of Medical Genetics and Genomics in 1991. The 24 Boards now certify nearly one million physicians in 40 primary specialties and 89 subspecialties.⁵ [Details about ABMS, the [Member Boards](#), and the [specialties and subspecialties certified](#) can be found at abms.org.]

Alongside the certification movement, the science of measurement and testing, known as psychometrics, evolved into a distinct scientific discipline in the social sciences. Today, there are methods for defining the knowledge, skills, behaviors, and competencies necessary to practice in a specialty.⁶ Additionally, there is strong consensus around standards for the development, content validation, administration, and scoring of exams to ensure that they are fair, valid, and reliable.⁷

Initially, physicians were certified at the termination of training and retained certification for their lifetime. In 1968, recertification was introduced by the American Board of Family Medicine, which issued time-limited certification at its founding. The Boards developed guidelines for recertification in 1973, and the American Board of Emergency Medicine required recertification at its founding in 1979. Between 1980 and 1995, all the Boards implemented plans for periodic revalidation of knowledge and clinical skills.

In 2000, the Boards adopted MOC in response to both the growing movement to reform graduate medical education (GME) around core competencies essential to good medical practice⁸ and the public demand to improve quality and safety in health care.⁹

The concept of a competency-based system of medical education emerged in the 1960s with an understanding that skills development is multi-dimensional, developmental, and idiosyncratic.¹⁰ That is, people develop skills at different paces, depending on their personal endowments, interests, and training. In the 1990s, a global effort to define competencies for medical training led to the development of multiple competency frameworks. In the United States, ABMS and the Accreditation Council for Graduate Medical Education (ACGME) agreed in 1999 to a framework of six core competencies that were to become the basis for both training and certification.¹¹ ACGME committed to incorporate the competencies into its accreditation standards for GME, and ABMS likewise committed to incorporate them into programs of specialty certification. Conceptually, MOC sought to reflect this competency framework in an integrated program of learning, assessment, and improvement through four assessment-based elements: professionalism or professional conduct; learning and self-assessment; knowledge and clinical skills; and QI. During the last two decades, ACGME has developed a system of developmental milestones based on these domains as the basis for determining whether programs are adequately preparing candidates for certification in all six competencies.¹²

At the same time, a growing body of research raised serious concerns about the quality and safety of health care in the U.S. Wenneberg demonstrated vast population-based differences in health care use that could not be explained.¹³ Many studies showed widespread overuse of services that were not clinically indicated or were of marginal benefit, and underuse of services that were clinically indicated and might have been helpful to the patient.^{14,15,16} The RAND Health Services Utilization Study showed inappropriate indications for commonly performed procedures. Errors in medicine were also found to be prevalent.¹⁷ Numerous studies demonstrated underuse of proven effective treatment for common conditions.¹⁸ By 1998, the Institute of Medicine had declared an “urgent need” to improve health care quality,¹⁹ placing quality of care squarely on the national policy agenda.²⁰ Quality had been defined by the Institute of Medicine as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.”²¹ Thus, maintaining current professional knowledge had become a

national policy priority. The Boards believed they could take a leading role in helping the nation reduce the quality gap through MOC.²²

MOC is a demonstration that the standards of knowledge, clinical skills, and conduct represented by certification continue to be met. At its core is a revalidation of the clinical expertise signified by certification, updated to reflect changes in medical science and stakeholder expectations, including the expectation that physicians participate in safety and QI and behave according to professional norms.

Notwithstanding the strengths of a traditional cognitive assessment of clinical expertise,²³ in 2014, the American Board of Anesthesiology began to pilot an alternative form of convenient, online testing as an alternative to the periodic, 10-year, exam.²⁴ That same year, the American Board of Pediatrics convened a technical workshop to assess alternative testing methods. During the next seven years all the Boards adopted alternatives to their point-in-time assessments, reducing time commitments and incidental costs, eliminating the need to take time away from practice to participate, allowing for more content customization, and providing direct feedback to support learning.

Ongoing physician concerns about the cost, burden, and value of MOC led ABMS, in association with the Council of Medical Specialty Societies, to form an independent body to assess and make recommendations to ABMS on a new direction for continuing certification. The Continuing Certification: Vision for the Future Commission (Vision Commission) organized in 2017 in collaboration with the professional specialty societies, collected testimony from a wide variety of stakeholders through 2018, and provided a report with recommendations to ABMS in early 2019.²⁵ Based on the findings, and endorsed by the ABMS Board of Directors, several task forces with engagement of public stakeholders, were created to develop new standards, reflecting the Vision Commission's call for alternative testing options that reduce time and cost burden, provide demonstrable learning value to participating physicians, and create opportunities for remediation. New standards for continuing certification were adopted in 2021 to be implemented by 2024.²⁶

Despite these changes, questions about the value and evidence associated with continuing certification continue to be raised. Some physician organizations have taken the position that individually self-directed continuing medical education (CME) should be sufficient for recertification and have questioned whether it is necessary to demonstrate on an ongoing basis that the specific body of knowledge and skills represented by the certificate have been maintained.²⁷ In 2014, the American Medical Association adopted a policy recommending that ABMS eliminate examinations and QI requirements, and permit physicians to recertify based on self-directed CME. According to industry standards, a program relying exclusively on self-directed CME does not qualify as certification. Certification warrants that specifically defined knowledge, skills, and behaviors have been objectively validated.²⁸ A certificate granted solely on participation in education is simply a "Certificate of Participation."²⁹

The research evidence suggests that self-directed learning through CME activities is insufficient to revalidate certification, and research in medical education and cognitive psychology explains why.

WHY IS IT NECESSARY TO REVALIDATE CERTIFICATION?

Several lines of research suggest the need for an ongoing objective assessment of current professional knowledge.

The Boards had initially judged recertification to be necessary because of the explosive growth in medical science along with evidence that physician knowledge and clinical skills decline over time resulting in some physicians not keeping fully abreast of advances in their specialty.³⁰ Since that time, the volume of research verifying the decline of physician medical knowledge and clinical skills with distance from formal training has grown considerably.^{31,32,33,34} Research on the science of learning and forgetting suggests that all knowledge is subject to decay without a memory challenge to reinforce retention.^{35,36} “Since skills naturally decline over time without actions to prevent decline, determinations about professional competency made years earlier have diminishing predictive association with evolving expectations for professional competency over time.”³⁷

Second, it is widely recognized that the accelerated pace of growth in medical science makes it difficult to keep up to date.^{38,39,40} Certifying bodies are expected to recertify, with a periodicity tied to the rate of changes in knowledge and skills.⁴¹ Moreover, given the pace of change in medicine, a process of targeting, filtering, and curating clinical evidence may help clinicians to direct their learning to the most important advances in their disciplines.

Third, as one medical researcher put it, “a large gap exists between what we know and what we practice.”⁴² Comparing records against guidelines, McGlynn and colleagues found that physicians provide recommended care a little more than half the time, based on a review of medical records.⁴³ Provision of recommended care ranged widely across 25 studied conditions, from a low of 10 percent to a high of 78.7 percent. Research suggests that it takes an average of 17 years for new evidence to move into practice.^{44,45}

Crucially, cognitive science tells us that individuals cannot assess their own skills accurately, and the least skilled among us are the least able to assess themselves accurately.⁴⁶ Since the Dunning-Kruger Effect was first described⁴⁷ this “illusion of competence” has been studied in many disciplines, including medicine. Studies have verified that there is low correlation between self-assessments and external assessments of expertise.^{48,49,50} All but the highest performers tend to overstate their performance and ability, and even the lowest performers perceive themselves to be above average in performance. If physicians do not “know what they don’t know,” the system of self-directed CME, which has traditionally been relied upon to keep physicians up to date, does not fill important knowledge and skill gaps that are unrecognized by physicians themselves.⁵¹ In 2023, Fraundorf et al.⁵² published an extensive review of the cognitive science related to strengths and weaknesses of self-assessment suggesting other cognitive biases that might affect what learners choose to learn. Learners enjoy a “stability bias” that leads them to underpredict how much they no longer know. A “fluency bias” makes learners believe that things that seem easy to learn are actually learned, and they tend to believe that they have internalized information they have accessed from other sources. All these cognitive biases affect the effectiveness of self-directed learning absent assessment and feedback.

Finally, when asked, patients repeatedly say that they prefer physicians who are certified and they expect certification to demonstrate that physicians are up to date on a regular basis.^{53,54} This is discussed more fully below.

STAKEHOLDER ATTITUDES TOWARD MOC

Published individual commentary about MOC during the last 15 years has been both positive⁵⁵ and negative.⁵⁶ The following are systematic studies about participant and patient attitudes toward MOC, and the use of MOC in hospital credentialing.

Physicians – Even as the Boards were implementing their MOC programs, concerns about the new approach to recertification began appearing in professional journals. In 2010, *New England Journal of Medicine* editors Jeffrey M. Drazen, MD, and Debra F. Weinstein, MD, challenged readers with a clinical decision scenario centering on whether physicians with non-time-limited certifications should participate in the new program of recertification.⁵⁷ Pro and con viewpoints were published alongside the editorial.⁵⁸ Since then, many testimonials have been published for and against MOC.⁵⁹ Concerns about MOC programs focused on time and financial cost, relevance to practice, the lack of personal learning benefit from the process, and the perceived lack of evidence that continuing certification is associated with differences in patient care and outcomes.

Cook et al.⁶⁰ conducted a series of focus groups in 2014 to mine the perceptions and attitudes of primary care physicians toward MOC. While generally supportive of its purpose, participants felt that the program needed to be more coherent, more integrated with clinical practice, more relevant to individual needs, and provide more useful feedback to support learning. Overall, respondents felt that MOC was “of little benefit to physicians, patients, or society.”

Freed et al.⁶¹ surveyed pediatricians with non-time-limited certification about their awareness and attitudes toward MOC. Only 28 percent of general pediatricians and 13 percent of subspecialists said that they would be willing to participate in general pediatrics MOC, although half of the subspecialists said they would participate in a subspecialty MOC. Three quarters of respondents thought MOC was necessary to keep up to date in pediatrics.

Using a different framing, Gallagher et al.⁶² conducted a survey of internists’ attitudes about assessing and maintaining clinical competence. Eighty percent of respondents said that it is important to get feedback on their knowledge, but only one quarter reported getting useful feedback most or all the time. While 75 percent agreed that it is important to participate in programs to assess their knowledge to stay up to date, and “58 percent believed that physicians should be required to demonstrate their knowledge via a secure examination every 9-10 years,” fewer than half of respondents said that they had participated in such programs in the previous three years.

In 2016, Cook et al.⁶³ reported on a national survey of more than 4,500 physicians across medical and surgical specialties that found pervasive dissatisfaction and low levels of support for MOC across almost all specialties, citing irrelevance, burden, and lack of support for professional development. Only 24 percent of respondents believed that MOC activities were relevant to their patients and 14 percent said it was worth their time and effort.

A 2018 national survey of physician attitudes by The Physicians Foundation asked whether physicians agreed that “Maintenance of Certification accurately assesses my clinical abilities.” Sixty-eight percent said that they disagreed with that statement.⁶⁴

Patients – When asked, patients consistently say that they expect physicians to demonstrate that they are up to date on a regular basis. Brennan et al.⁶⁵ reported on a survey of patient attitudes confirming that they believe certification to be important and would use it in deciding whom to turn to for treatment. A survey by Freed et al.⁶⁶ found that patients prefer board-certified pediatricians and expect them to participate in MOC. Importantly, respondents to this survey also expect pediatricians with non-time-limited certification to “demonstrate continued competence and mastery of clinical pediatrics by participating in activities included in MOC.”

A survey of 1,792 members of the general public was fielded by the National Opinion Research Center at the University of Chicago on behalf of ABMS in 2018.⁶⁷ Eighty-two percent of respondents said that board certification is important to their choice of physician; 98 percent said they expect their physicians to stay up to date with the latest advances in their field; 95 percent of respondents thought that physicians should be required to demonstrate that they are up to date; and 95 percent agreed that physicians should participate in assessment and education programs to assure that they are up to date.

More recently, in early 2023, the American Board of Emergency Medicine commissioned The Harris Poll to understand the public’s opinions about emergency physician board certification and the frequency of recertification.⁶⁸ The findings show strong support for both board certification and frequent, ongoing certification. Seventy-six percent of respondents said that certification was important; fewer than one percent said it was unimportant. Ninety-eight percent said that physicians should be retested, and more than half said that they should be retested annually.

Hospitals – Although most hospitals require certification as a condition for hospital privileges, about 30 percent do not.

Freed et al.⁶⁹ surveyed hospital credentialing practices for pediatricians to determine whether certification and recertification are required to obtain or maintain privileges. A telephone survey was conducted of 200 non-specialty hospitals. Seven hospitals were ineligible because they did not have any pediatricians on staff. One hundred and fifty-nine hospitals completed the interview for a response rate of 82 percent. At that time, only four percent of hospitals required certification of pediatricians to obtain hospital privileges. One-third did not require certification for privileges. Of 193 hospitals, 124 did not require certification for initial privileges but expected pediatricians to become certified at some point. Thirty-seven percent reported exceptions to their policies at the time of initial certification. Physicians with time-limited certifications were required to participate in MOC in 45 percent of hospitals.

A follow-up study by Freed et al.⁷⁰ examined changes in credentialing practices from 2005-2010. Overall, the percentage of hospitals requiring certification for initial privileges increased from four percent to 24 percent. In 2010, a greater proportion of hospitals reported board certification requirements for general pediatricians at the point of initial privileging (24% vs 4%). Board certification requirements increased for general pediatricians (from 67% to 80%) as

well as for pediatric subspecialists (71% to 86%). However, a greater proportion of hospitals reported exceptions to their board certification policies (99% vs 41%). Fewer than half of the responding hospitals required pediatricians with time-limited certification to enroll in MOC if their certifications expired.

In another study, Freed et al.⁷¹ examined the use of board certification and recertification in hospital privileges for general surgeons, surgical subspecialists, and nonsurgical subspecialists. One-third of responding hospitals did not require surgeons and non-surgical specialists to become board certified. Three-fourths had exception policies for surgeons and 77 percent had exception policies for nonsurgical subspecialists. Eighty-two percent of all hospitals and two-thirds of those requiring MOC participation permitted physicians to retain privileges even after their certifications expired. Few hospitals provided financial incentives for physicians to become or remain certified. In short, hospitals take a flexible approach to implementation of their certification requirements for credentialing.

In 2018, the National Association of Medical Staff Services, jointly with the American Hospital Association (AHA) and the Council of Medical Specialty Societies, surveyed hospital credentialers regarding their certification policies.⁷² Seventy-one percent of 850 respondents said that their hospital required certification; only 40 percent required participation in MOC. More than 40 percent reported that they permit exceptions to these policies, and more than 40 percent reported accepting certifications from boards other than ABMS Member Boards.

CONTINUING CERTIFICATION, PATIENT CARE, AND PATIENT OUTCOMES

The theoretical underpinning of continuing certification was examined in a special issue of the *Journal of Continuing Education in the Health Professions* in 2013,⁷³ including a review and summary of the evidence related to both initial board certification and MOC.⁷⁴ The evidence related to MOC is summarized below.

Most of this research addresses the relationship between cognitive expertise as measured by examination and performance on measures of clinical process or outcomes. MOC examinations do not simply assess medical knowledge. Items are presented in the form of clinical vignettes that test a wide range of patient care skills, including clinical reasoning, diagnostic skills, decision-making, patient management skills, and problem-solving skills.⁷⁵

Because MOC standards incorporated a QI element, some of the research also examines the impact of MOC-related QI activities.

The majority of studies on MOC have been conducted by the primary care Boards (Internal Medicine, Family Medicine, and Pediatrics) and Emergency Medicine, but a few studies have looked at surgical or procedural disciplines such as Anesthesiology, Dermatology, and Physical Medicine and Rehabilitation. Some of the research looks at MOC or exam status, but more recent research also looks at differential performance based on examination scores. A large variety of process measures have been examined, along with some outcome measures, including cost, hospitalizations, emergency department visits, emergency surgery, mortality, and disciplinary action by state medical boards for professional misconduct. The research is

heterogeneous, ranging from studies that find no association to some which clearly demonstrate high correlation of MOC programs with improved outcomes.

A few studies have shown no association between MOC and quality of care measures. For example, Hayes et al.⁷⁶ found no relationship between MOC and performance on 10 common process of care measures in primary care related to cancer screening, and management of diabetes, hypertension, and coronary disease. Khatana et al.⁷⁷ examined whether provider characteristics, including participation in MOC, were related to variation in 30-day mortality following a percutaneous coronary intervention. MOC was not found to have a differential impact on this specific clinical outcome.

Some studies have shown mixed results. One study looking at the association between MOC and ambulatory care-sensitive hospitalizations and health care costs showed no differences in the chosen quality measures, but a small and significant (approximately 2.5%) reduction in total cost of care for physicians participating in MOC mostly through more efficient testing and patient management, with no decrement in quality.⁷⁸ This difference represents an average savings of \$167 per Medicare patient per year compared with patients treated by physicians not participating in MOC, amounting to potentially billions of dollars in health care cost savings per year.

There is, however, growing literature that demonstrates a positive association between MOC and clinical performance.^{79,80} Participation in continuing certification is associated with a number of positive indices of clinical care including lower risk of discipline for professional misconduct; better adherence to clinical guidelines; safer care; more rapid uptake of new evidence; more efficient and accurate diagnosis; lower total cost of care; and improved patient outcomes.

Lower risk of disciplinary action for professional misconduct. Multiple studies in several disciplines have shown a strong inverse relationship between certification and the risk of disciplinary actions by state medical boards.^{81,82,83,84,85,86,87,88,89,90,91} Physicians participating in MOC are less likely to be subject to disciplinary actions by state medical licensing boards than those not participating in continuing certification. This finding has been confirmed in multiple studies across disciplines as diverse as Anesthesiology,^{81,82,83} Emergency Medicine,⁸⁴ Family Medicine,⁸⁵ Internal Medicine,⁸⁶ Ophthalmology,⁸⁷ Physical Medicine and Rehabilitation,⁸⁸ and Surgery.^{89,90} One of these studies in Internal Medicine, looked at the relationship of discipline for misconduct to exam scores. The risk of discipline, in terms of both seriousness and frequency, was found to be inverse to the level of performance on the cognitive exam. In other words, the higher the exam scores, the less likely a physician was to be disciplined, and if disciplined, the less serious the infraction was likely to be.⁹¹

Adherence to clinical guidelines and clinical outcomes. Studies have shown that participation in continuing certification is associated with better adherence to clinical guidelines and treatment protocols,^{92,93} better management of patients with diabetes⁹⁴ and asthma,⁹⁵ and better mammography screening,⁹⁶ as well as more efficient use of chest imaging in the emergency department.⁹⁷ Holmboe et al.⁹⁸ was one of the first studies to examine the association of quality with MOC examination scores, finding that higher performers on the exam – those with a higher degree of cognitive expertise – performed better on all but one of the performance measures, confirming a link between cognitive expertise and clinical

outcomes. A subsequent study by Gray et al.⁹⁹ showed a positive association of performance scores on the MOC exam with process measures capturing treatment for diabetes and coronary disease from the Healthcare Effectiveness Data and Information Set. Eddy et al.¹⁰⁰ projected the potential health impact of improving performance on these measures, which they found accounted substantially for the morbidity and mortality associated with these diseases. They estimated that “if all providers had delivered care consistently at the median level of performance in 2005, almost two million MIs would have been prevented. CHD, strokes, cases of ESRD, and cases of blindness would also have been reduced.”

Safer prescribing practices. In 2021, Vandergrift et al.¹⁰¹ reported on a study of the association between performance on the American Board of Internal Medicine (ABIM) MOC knowledge exam and prescribing of potentially inappropriate medications as identified by the American Geriatric Society. The study found lower rates of potentially inappropriate prescribing among top performers on the ABIM exam.

Accelerated uptake of new evidence. Also in 2021, Gray and colleagues¹⁰² reported on the association between performance on the ABIM MOC knowledge exam and opioid prescribing practices for new onset back pain during a period of change in guidelines for opioid prescribing. They found that “when the standard of care shifted away from routine opioid prescribing, physicians who performed well on an ABIM examination were less likely to prescribe opioids for back pain than physicians who performed less well on the examination.”

More efficient and more accurate diagnosis. Gray and colleagues¹⁰³ studied the association between diagnostic knowledge as measured on the ABIM MOC exam and patient outcomes following an outpatient visit for a condition at risk for diagnostic error. They found that higher knowledge scores on the exam were associated with lower risk of adverse outcomes, including a 35 percent lower risk of death and 30 percent lower risk of hospitalization or subsequent emergency visits, with a significant dose response across terciles. Wilson et al.¹⁰⁴ examined hospital and emergency department factors associated with missed diagnoses and costs associated with Medicare patients with acute myocardial infarction. This study found that certification by the American Board of Emergency Medicine was associated with significantly lower odds of a missed diagnosis.

Engagement in QI. One of the more controversial elements of MOC has been the requirement for demonstrating QI in medical practice.¹⁰⁵ The Boards implemented this component in various ways. Most of the surgical Boards encouraged participation in clinical registries developed by specialty societies. The American Board of Anesthesiology partnered with the American Society of Anesthesiologists to promote engagement in simulation activities that would improve communication, teamwork, and other patient care competencies. The primary care Boards developed structured measurement-based practice improvement activities that required data abstraction from medical records and used standard QI methodologies.¹⁰⁶ The primary care Boards initiated, and eventually ABMS made available to all the Boards, a program permitting diplomates to earn MOC credit for participating in their own hospital-based QI activities.¹⁰⁷ The Boards of Pediatrics and Family Medicine joined with their specialty societies on national and state-wide collaborations,^{108,109} encouraging diplomates to satisfy MOC requirements through participation. Pediatric collaborations resulted in

reduced mortality after heart surgery,¹¹⁰ increased remission rates for inflammatory bowel disease,¹¹¹ and reduced central-line-associated infections among intensive care unit patients.¹¹²

Physicians were engaged effectively in QI activities in Dermatology,¹¹³ Family Medicine,^{114,115,116} Internal Medicine¹¹⁷ Pediatrics,¹¹⁸ and Ophthalmology.¹¹⁹ Nichols¹²⁰ reviewed 25 QI studies in the primary care and Emergency Medicine disciplines where MOC credit was awarded to diplomates engaged in a formal process to improve care. One study showed a reduction in a composite measure of cardiovascular risk in children.¹²¹ Another showed an increase in asthma control and a decline in asthma exacerbations.¹²² Phillips et al.¹²³ tested the impact of an MOC performance in practice module (PPM), a Medicare payment incentive through the Physician Quality Reporting System (PQRS), and a combination of the two (PPM plus PQRS) with respect to 12 quality measures of diabetes and hypertension management from a quality registry. They found positive improvement in all three groups, with independent effects from the PPM and PQRS programs administered alone, suggesting a rationale for better alignment between the programs. Starr et al.¹²⁴ reported a QI project showing improved opioid prescribing in Ophthalmology following the introduction of new prescribing protocols.

LONGITUDINAL ASSESSMENT FOR LEARNING

The value of the single point-in-time examination continued to be contested by physicians and their professional organizations. They found that preparing for the event was not only time consuming and costly, but it interfered with their practice schedule. The exam itself was anxiety provoking. Participating physicians received little feedback on their performance, losing the opportunity to fill whatever knowledge and skill gaps had been identified through examination. Because physicians tend to focus their practices over time, they wanted an exam with content more customized to the patients and medical conditions that they serve currently instead of a one-size-fits-all format. To address these issues, between 2014 and 2021 the Boards developed new forms of “longitudinal assessment” that present test items on a regular basis (some quarterly, some annually) with immediate feedback to support learning. This new approach to recertification has been incorporated into a new program of what is now called “continuing certification.”

Two foundational areas of research informed the development of this new approach to assessment. The first was research in the medical education community about how best to understand, assess, and improve clinical competence.¹²⁵ For example, programmatic assessment holds that a portfolio of assessments, mixing low- and high-stakes formats, will provide a superior picture of clinical competence over time, and better support learning, than a single, intermittent, high stakes event.^{126,127,128,129,130,131}

The revisions were also based on a large body of research in learning science about the value of testing in learning and retention.¹³² Substantial psychological literature in cognitive psychology, educational psychology, and testing science demonstrates how testing can benefit learners and improve long-term retention.^{133,134,135} The beneficial effects of testing, compared with self-study, is well established in numerous disciplines, including medical education.¹³⁶ While the “binge-and-purge” approach to learning associated with point-in-time testing shows high initial learning but low retention, formats with frequent, low-stakes testing better embeds

learning.¹³⁷ Fraundorf et al.¹³⁸ reviewed the cognitive science about using testing physicians to enhance learning and retention.

The Boards have designed their continuing certification programs to take advantage of this science to improve their effectiveness. Challenges to memory improve retention; and specific techniques such as spaced repetition (repeating similar challenges over time) and interleaving (mixing different content areas over time rather than testing different topics in isolated blocks)¹³⁹ are more conducive to long-term learning.¹⁴⁰ Studies confirm the expectations that new forms of formative testing enhance learning in programs developed in Family Medicine,¹⁴¹ Anesthesiology,¹⁴² Pediatrics,¹⁴³ and Physical Medicine and Rehabilitation.¹⁴⁴

More customized assessments. In terms of tailoring the recertification processes more closely to an individual physician's practice, longitudinal assessment programs by several of the Boards permit participating physicians to customize the content of their assessments.^{145,146}

Physician experience. Early results have shown enthusiastic acceptance of the new models by physicians and medical specialists.^{147,148} In a survey of 4,016 pediatricians participating in longitudinal assessment, the vast majority (88%) noted reduced testing anxiety and 93 percent were satisfied with the new longitudinal testing format compared to point-in-time exams.¹⁴⁹ The new approaches appear to offer a less stressful way for physicians to demonstrate that they are keeping up with advances in their specialty while also supporting their practice-relevant learning needs.

Enhanced focus on diagnostic skill. Recent research from the Internal Medicine community showed a direct relationship between cognitive skills and the adoption of new evidence,¹⁵⁰ diagnostic ability and downstream clinical outcomes,¹⁵¹ cost savings due to diagnostic efficiency,¹⁵² and safer prescribing practices.¹⁵³ Because these studies looked at clinical outcomes related to performance on the exam, researchers were able to show incremental improvements (or harms) associated with different levels of clinical expertise. The formative and continuing nature of longitudinal assessment models makes it possible to view certification as an intervention targeted to specific content or practice skills. During the onset of the Zika virus, the American Board of Obstetrics and Gynecology was able to push information to their diplomates (physicians certified by the Board) through the longitudinal assessment program and assess whether they were able to demonstrate that knowledge on an exam. Many Boards did the same through the COVID-19 pandemic.

LOOKING FORWARD

In 2021, the Boards adopted new standards for continuing certification based on the recommendations made in the report from the Vision Commission with a plan for implementation by January 2024.¹⁵⁴ The new ABMS standards require the Boards to offer assessment alternatives to the point-in-time test; evaluate program effectiveness; be more intentional about their program goals; establish quality and safety objectives; and, perhaps most importantly, deliver enhanced perceived value to participating physicians.¹⁵⁵ All of these features of continuing certification suggest new opportunities to continue to research the effectiveness of these programs.

Collaboration with professional societies, academic medical centers, CME providers, and other stakeholders who provide learning and improvement products and services will be key to effectively supporting continuing professional development. Collaborative efforts will focus on building an infrastructure to support physician learning, increase engagement in practice improvement, and reduce redundant activities for diplomates.

Better integration of the systems of CME and continuing specialty certification should benefit learners and improve medical practice. Sharing information about the knowledge architecture underlying the assessment programs may help educators to prioritize their educational offerings. Collaboration between certifying bodies and specialty organizations to address quality and safety problems in the specialties may support learning and assessment to address them. Aggregate data from assessments may help educators and guideline developers to know how well their educational programs and guidelines are altering practice across the specialties.

Nearly all the extant evidence about ABMS recertification programs date from the MOC era, that is, before implementation of continuing certification. While the next phase of research may draw on prior research, it will focus primarily on the objectives of the new programs and the mechanisms built to achieve them.

Enhancing perceived value to participating physicians. The broader certification community is moving toward more flexible, yet still rigorous, recertification programs with continuous assessment that emphasizes formative feedback¹⁵⁶ with the goal of providing more direct value to participating certificants while retaining their value to public stakeholders.¹⁵⁷ However, extensive research is still needed in medical education about how physicians seek (or don't) feedback,¹⁵⁸ how they receive feedback, and use it (or don't) to inform their learning especially experienced physicians with advanced clinical expertise.^{159,160} Moreover, more research is needed to determine how physicians regulate their knowledge gaps in practice, especially as tools for researching clinical problems become ubiquitous and embedded in practice. Another area of the literature has explored the complexities of self-assessment and how physicians regulate their learning needs in practice.^{161,162,163} Here too, a great deal needs to be learned about how to resolve the central paradox that learners must both be autonomous and self-directed while requiring feedback to inform their learning.

Formal program evaluation. The Boards will be continuously evaluating their continuing certification programs. In 2024, the ABMS Research and Education Foundation began funding independent researchers, outside of the ABMS community, to conduct such studies.¹⁶⁴ Ongoing program evaluation will be facilitated by requirements for well-specified program goals and collaboratively developed quality and safety objectives. The Boards will continue to use a variety of evaluation methods to ensure that their programs optimize value to their diplomates, patients, and other stakeholders who rely on the certificate. The Boards will need to develop logic models that map program intent with expected results and draw on multiple methodologies, including evaluation science, implementation science, and health services research, to gain insight into continuing certification programs and inform continued improvement.

Focus on adoption of new evidence and diagnostic excellence. The new forms of longitudinal assessment offer an opportunity to leverage continuing certification as a mechanism for heightening awareness of new science and encouraging the adoption of new

practice guidelines developed by specialty societies. Most of the Boards have incorporated items related to new and emerging science as core features of their longitudinal assessment content. Future research may examine whether continuing certification accelerates the adoption of emerging science and new practice guidelines.

In addition, longitudinal assessment in continuing certification programs has been identified as one of the few available strategies for improving diagnostic accuracy and efficiency.¹⁶⁵ A report from the National Academy of Medicine on improving diagnosis in health care included among its recommendations leveraging board certification as a mechanism for assuring that physicians have and maintain the competencies they need for expert performance in the diagnostic process.¹⁶⁶ While most of the attention in diagnostic research has been on the primary care disciplines¹⁶⁷ and Emergency Medicine, diagnostic expertise is essential in all disciplines, including the surgical disciplines,^{168,169} and involves diverse cognitive competencies.¹⁷⁰ The Boards have hypothesized that a formative program of assessment that provides immediate and ongoing feedback to participating physicians can help them better calibrate what they know, direct their learning to areas of weakness, and perhaps increase their awareness of the limits of their clinical knowledge.^{171,172}

These two issues go hand in hand. For example, guidelines recommending against routine urinalysis testing appeared as early as 2002 and were subsequently updated during the next two decades by the Infectious Disease Society of America, U.S. Preventive Services Task Force, and American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. Twenty years later, Shenoy et al.^{173,174} found no change in the use of urinalysis. It may be possible for the Boards to work collaboratively with their specialty societies to accelerate the uptake of clinical recommendations regarding low-value care as in this example.

Continuing toward competency-based assessment. As previously mentioned, when MOC was adopted in 2000, the Boards incorporated a competency framework into their expectations for continuing certification.¹⁷⁵ However, in practice, lacking direct observation of practicing physicians, certification has leaned heavily on the asynchronous assessment of medical knowledge and patient care skills. Consensus does not yet exist around optimal methods for assessment of the other competencies¹⁷⁶ in/amongst practicing physicians.

Yet consensus does exist that these other competencies are essential to safe and effective practice in today's health system. At the request of ACGME, AHA led the hospital community in a review of the competency framework in 2012.¹⁷⁷ The AHA reported that the framework is still relevant, but that the system of training and certification needs to increase the attention paid to non-knowledge-based skills such as patient engagement, interprofessional communication, teamwork, improvement, and technology skills that the contemporary hospital environment demands. Assessment of all the competency domains is a priority for all stakeholders, including hospitals, physicians, and patients.¹⁷⁸

There is an urgent need to develop new assessment methods that have validity for physicians and address the expectations of other stakeholders for the evaluation of patient care skills and behaviors other than technical skills. For cognitive assessments, physicians have questioned whether the presentation of clinical vignettes in an exam format will fairly represent how they solve clinical problems in practice. It may be possible to create higher-fidelity case presentations that appear like the practice experience, for example by introducing audio and

video to testing platforms or by introducing virtual reality.¹⁷⁹ These technologies may enhance the ability of exams to transform the experience of participating in the program.

Also needed are assessments that capture other domains of clinical competence. A decade ago, Birkmeyer et al.¹⁸⁰ demonstrated the feasibility of using video of surgical procedures to assess surgeon technical skill. Analogously, Weiner and Schwartz¹⁸¹ demonstrated the feasibility of using audio of clinical interviews to assess how well physicians communicate with patients and identify social determinants of health that would affect patient management decisions; a program that has recently been evaluated, with positive results.¹⁸² These techniques are effective but resource intensive and have been felt not to be scalable. But advances in machine learning and generative artificial intelligence suggest that it may soon be possible to score videos and evaluate recordings on a large scale.¹⁸³ If the technical problems can be solved, surgeons may find value in receiving feedback on such video-based assessments for QI.¹⁸⁴ However, concerns have been expressed about the use of this technology to make judgments about clinician competence,¹⁸⁵ suggesting a need for research to explore how to deploy them in ways that will provide value to physicians.

Next Steps. This narrative review tells the story of the evolution of ABMS Member Board recertification programs from periodic reexamination and MOC to the newly implemented continuing certification programs and the research underlying them. The research demonstrates clear associations between the Boards' continuing certification programs and better clinical outcomes and system performance.

These programs will continue to evolve. Ongoing feedback from participating physicians, patients, and public stakeholders; growing research on competency assessment and its relationship to learning and improvement; and further research on the relationship between certification and clinical performance will inform the progress of the Boards' continuing certification programs. As new information becomes available, this document will be updated.

REFERENCES

- ¹ This is not a systematic review. This paper does not attempt to qualify the strength of the evidence. This work is akin to a scoping review that includes an exhaustive review of available literature, aims to be transparent, and presents data in a structured format. This paper will be updated as relevant new evidence becomes available and the programs evolve.
- ² “Recertification” is the industry term for validation of certification. See National Commission for Certifying Agencies. Standards for the Accreditation of Certification Programs. Washington, DC: Institute for Credentialing Excellence. 2021.
- ³ Jacobs, JA, Ed. Certification and Accreditation Law Handbook, 3rd Edition. ASAE: Washington, DC. 2016.
- ⁴ The demonstration of a specific body of expertise distinguishes certification from other types of certificate programs, including those that may be assessment-based. To clarify this distinction, see the report, Defining Features of Quality Based Certification and Assessment-based Certificate Programs. Institute for Credentialing Excellence: Washington DC, 2010.
- ⁵ Updated data and national statistics on certification and continuing certification can be found at <https://www.abms.org/abms-board-certification-report/> [Accessed 7.8.2024]
- ⁶ See, for example, Myers, T., Morral, E., & Sares, T. (2019). Job analysis. In J. Henderson (Ed.), *Certification: The ICE handbook* (3rd edition, pp. 253–273). Institute for Credentialing Excellence: Washington, DC. Becker et al. (2023); Job Analysis. Institute for Credentialing Excellence, 2023; and Raymond, M. Integrating competency modeling with traditional job and practice analysis. *CLEAR Exam Review* (2017/18) XVII(2)21-27.
- ⁷ American Educational Research Association, American Psychological Association, and National Council on Measurement in Education. Standards for Educational and Psychological Testing. Washington DC. American Psychological Association. 2014.
- ⁸ Holmboe, E; ten Cate, O; and Durning, SJ. Assessment in the Era of Outcomes-based Education. Chapter 1 in E. Holmboe and S. Durning, Eds, *Practical Guide to the Assessment of Clinical Competence*, 3rd Edition. Philadelphia, PA: Elsevier. 2024.
- ⁹ Advisory Commission on Health Consumer Protection and Quality in the Health Care Industry. *Quality First: Better Health Care for All Americans*. Washington DC: US Government Printing Office; 1998.
- ¹⁰ Ten Cate O. Competency-Based Postgraduate Medical Education: Past, Present and Future. *GMS J Med Educ*. 2017 Nov 15;34(5):Doc69. doi: 10.3205/zma001146. PMID: 29226237; PMCID: PMC5704607.
- ¹¹ The ABMS-ACGME competency framework is organized into six domains: Professionalism, Patient Care and Procedural Skills, Medical Knowledge, Interpersonal and Communication Skills, Practice-based learning and Improvement, and System-based Practice.
- ¹² Holmboe, E; ten Cate, O; and Durning, SJ. Assessment in the Era of Outcomes-based Education. Chapter 1 in E. Holmboe and S. Durning, Eds, *Practical Guide to the Assessment of Clinical Competence*, 3rd Edition. Philadelphia, PA: Elsevier. 2024.
- ¹³ Wennberg J, Gittelsohn. Small area variations in health care delivery. *Science*. 1973 Dec 14;182(4117):1102-8. doi: 10.1126/science.182.4117.1102. PMID: 4750608.
- ¹⁴ Chassin MR, Kosecoff J, Park RE, Winslow CM, Kahn KL, Merrick NJ, Keeseey J, Fink A, Solomon DH, Brook RH. Does inappropriate use explain geographic variations in the use of health care services? A study of three procedures. *JAMA*. 1987 Nov 13;258(18):2533-7. PMID: 3312655.
- ¹⁵ Schuster MA, McGlynn EA, Brook RH. How good is the quality of health care in the United States? *Milbank Q*. 1998;76(4):517-63, 509. doi: 10.1111/1468-0009.00105. PMID: 9879302; PMCID: PMC2751100.
- ¹⁶ Chassin MR, Galvin RW. The urgent need to improve health care quality. Institute of Medicine National Roundtable on Health Care Quality. *JAMA*. 1998 Sep 16;280(11):1000-5. doi: 10.1001/jama.280.11.1000. PMID: 9749483.
- ¹⁷ Leape LL. Error in medicine. *JAMA*. 1994 Dec 21;272(23):1851-7. PMID: 7503827.
- ¹⁸ Schuster MA, McGlynn EA, Brook RH. How good is the quality of health care in the United States? *Milbank Q*. 1998;76(4):517-63, 509. doi: 10.1111/1468-0009.00105. PMID: 9879302; PMCID: PMC2751100.

-
- ¹⁹ Chassin MR, Galvin RW. The urgent need to improve health care quality. Institute of Medicine National Roundtable on Health Care Quality. *JAMA*. 1998 Sep 16;280(11):1000-5. doi: 10.1001/jama.280.11.1000. PMID: 9749483.
- ²⁰ Advisory Commission on Health Consumer Protection and Quality in the Health Care Industry. *Quality First: Better Health Care for All Americans*. Washington DC: US Government Printing Office. 1998.
- ²¹ Institute of Medicine. 1990. *Medicare: A Strategy for Quality Assurance, Volume II: Sources and Methods*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/1548>.
- ²² Horowitz SD, Miller SH, Miles PV. Board certification and physician quality. *Med Educ*. 2004 Jan;38(1):10-1. doi: 10.1046/j.1365-2923.2004.01702.x. PMID: 14962019.
- ²³ Lipner RS, Lucey CR. Putting the secure examination to the test. *JAMA*. 2010 Sep 22;304(12):1379-80. doi: 10.1001/jama.2010.1378. PMID: 20858883.
- ²⁴ Hawkins RE, Irons MB, Welcher CM, Pouwels MV, Holmboe ES, Reisdorff EJ, Cohen JM, Dentzer S, Nichols DG, Lien CA, Horn TD, Noone RB, Lipner RS, Eva KW, Norcini JJ, Nora LM, Gold JP. The ABMS MOC Part III Examination: Value, Concerns, and Alternative Formats. *Acad Med*. 2016 Nov;91(11):1509-1515. doi: 10.1097/ACM.0000000000001291. PMID: 27355778.
- ²⁵ Colenda CC, Scanlon WJ, Hawkins RE. Vision for the Future of Continuing Board Certification. *JAMA*. 2019 Jun 18;321(23):2279-2280. doi: 10.1001/jama.2019.4815. PMID: 31099825.
- ²⁶ Hawkins RE, Ogrinc G, Ramin SM. American Board of Medical Specialties and New Standards for Continuing Certification. *JAMA*. 2022 May 3;327(17):1645-1646. doi: 10.1001/jama.2022.6053. PMID: 35426897.
- ²⁷ Self-directed education provides great learning benefit to clinicians, but on its face, it is not a substitute for certification, since certification requires that a specific body of knowledge be demonstrated through examination. Certification is, by definition, public facing.
- ²⁸ Jacobs, Jerrold A., Ed. *Certification and Accreditation Law Handbook*. Washington DC: ASAE – The Center for Association Leadership. 2016.
- ²⁹ Institute for Credentialing Excellence. *Defining features of Quality Certification and Assessment-based certificate programs*. Washington DC: Institute for Credentialing Excellence. 2010.
- ³⁰ Day SC, Norcini JJ, Webster GD, Viner ED, Chirico AM. The effect of changes in medical knowledge on examination performance at the time of recertification. *Res Med Educ*. 1988;27:139-44. PMID: 3218848.
- ³¹ Choudhry NK, Fletcher RH, Soumerai SB. Systematic review: the relationship between clinical experience and quality of health care. *Ann Intern Med*. 2005;142(4):260-273. doi:10.7326/0003-4819-142-4-200502150-00008.
- ³² Norcini JJ, Boulet JR, Opalek A, Dauphinee WD. Patients of doctors further from medical school graduation have poorer outcomes. *Med Educ*. 2017;51(5):480-489.
- ³³ Marco, CA; Wahl, RP; House, HR; Goyal, DG; Keim, SM; Ma, OJ; Joldersma, KB; Johnston, MM; Harvey, AL. Physician Age and Performance on the American Board of Emergency Medicine ConCert Examination. *Acad Emerg Med*. 2018 Apr 2. doi: 10.1111/acem.13420.
- ³⁴ Hawkins RE, Welcher CM, Stagg Elliott V, Pieters RS, Puscas L, Wick PH. Ensuring Competent Care by Senior Physicians. *J Contin Educ Health Prof*. 2016;36(3):226-231. doi:10.1097/CEH.0000000000000080
- ³⁵ Custers EJFM. Long-term retention of basic science knowledge: a review study. *Adv Health Sci Educ Theory Pract*. 2010;15(1):109-128. doi:10.1007/s10459-008-9101-y
- ³⁶ Subirana B, Bagiati A, and Sarma S. On the forgetting of college academics: At “Ebbinghaus Speed”? Memo No. 068. Center for Brains, Minds + Machines. Massachusetts Institute of Technology, Cambridge, MA.
- ³⁷ Lyness JM, McMahon GT. The Role of Specialty Certification in Career-Long Competence. *Acad Med*. 2023 Oct 1;98(10):1104-1106. doi: 10.1097/ACM.00000000000005314. Epub 2023 Jul 4. PMID: 37406286.
- ³⁸ Bastian H, Glasziou P, Chalmers I. Seventy-five trials and eleven systematic reviews a day: how will we ever keep up?. *PLoS Med*. 2010;7(9):e1000326. Published 2010 Sep 21. doi:10.1371/journal.pmed.1000326
- ³⁹ See, for example, the blog post “Staying current in medicine: Advice for new doctors” by Elizabeth Poorman, MD, on NEJM/Knowledge+. Accessed at <https://knowledgeplus.nejm.org/blog/staying-current-in-medicine-advice-for-new-doctors/>

-
- ⁴⁰ Lyness JM, McMahon GT. The Role of Specialty Certification in Career-Long Competence. *Acad Med*. 2023 Oct 1;98(10):1104-1106. doi: 10.1097/ACM.00000000000005314. Epub 2023 Jul 4. PMID: 37406286.
- ⁴¹ National Commission for Certifying Agencies. Standards for Accreditation of Certification Organizations. Washington, DC: Institute for Credentialing Excellence, 2014, revised 2021.
- ⁴² Davis D, Evans M, Jadad A, Perrier L, Rath D, Ryan D, Sibbald G, Straus S, Rappolt S, Wowk M, Zwarenstein M. The case for knowledge translation: shortening the journey from evidence to effect. *BMJ*. 2003 Jul 5;327(7405):33-5. doi: 10.1136/bmj.327.7405.33. PMID: 12842955; PMCID: PMC164240.
- ⁴³ McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, Kerr EA. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003 Jun 26;348(26):2635-45. doi: 10.1056/NEJMsa022615. PMID: 12826639.
- ⁴⁴ Westfall JM, Mold J, Fagnan L. Practice-based research--"Blue Highways" on the NIH roadmap. *JAMA*. 2007 Jan 24;297(4):403-6. doi: 10.1001/jama.297.4.403. PMID: 17244837.
- ⁴⁵ Morris ZS, Wooding S, Grant J. The answer is 17 years, what is the question: understanding time lags in translational research. *J R Soc Med*. 2011 Dec;104(12):510-20. doi: 10.1258/jrsm.2011.110180. PMID: 22179294; PMCID: PMC3241518.
- ⁴⁶ Lyness JM, McMahon GT. The Role of Specialty Certification in Career-Long Competence. *Acad Med*. 2023 Oct 1;98(10):1104-1106. doi: 10.1097/ACM.00000000000005314. Epub 2023 Jul 4. PMID: 37406286.
- ⁴⁷ Kruger J, Dunning D. Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. *J Pers Soc Psychol*. 1999;77(6):1121-1134. doi:10.1037//0022-3514.77.6.1121
- ⁴⁸ Dunning D, Heath C, Suls JM. Flawed Self-Assessment: Implications for Health, Education, and the Workplace. *Psychol Sci Public Interest*. 2004;5(3):69-106. doi:10.1111/j.1529-1006.2004.00018.x
- ⁴⁹ Davis DA, Mazmanian PE, Fordis M, Van Harrison R, Thorpe KE, Perrier L. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. *JAMA*. 2006;296(9):1094-1102. doi:10.1001/jama.296.9.1094
- ⁵⁰ Violato C, Lockyer J. Self and peer assessment of pediatricians, psychiatrists and medicine specialists: implications for self-directed learning. *Adv Health Sci Educ Theory Pract*. 2006 Aug;11(3):235-44. doi: 10.1007/s10459-005-5639-0. PMID: 16832707.
- ⁵¹ Other definitions of self-assessment have been proposed in the context of how physicians regulate knowledge in the context of clinical practice. This issue is discussed briefly in the final section on areas for future research.
- ⁵² Fraundorf SH, Caddick ZA, Nokes-Malach TJ, Rottman BM. Cognitive perspectives on maintaining physicians' medical expertise: III. Strengths and weaknesses of self-assessment. *Cogn Res Princ Implic*. 2023 Aug 30;8(1):58. doi: 10.1186/s41235-023-00511-z. PMID: 37646932; PMCID: PMC10469193.
- ⁵³ Brennan TA, Horwitz RI, Duffy FD, Cassel CK, Goode LD, Lipner RS. The role of physician specialty board certification status in the quality movement. *JAMA*. 2004;292(9):1038-1043. doi:10.1001/jama.292.9.1038
- ⁵⁴ Freed GL, Dunham KM, Clark SJ, Davis MM; Research Advisory Committee of the American Board of Pediatrics. Perspectives and preferences among the general public regarding physician selection and board certification. *J Pediatr*. 2010;156(5):841-845.e1. doi:10.1016/j.jpeds.2009.11.055
- ⁵⁵ Brennan TA. Recertification for internists--one "grandfather's" experience. *N Engl J Med*. 2005 Nov 10;353(19):1989-92. doi: 10.1056/NEJMp058223. PMID: 16282171.
- ⁵⁶ Teirstein PS. Boarded to death--why maintenance of certification is bad for doctors and patients. *N Engl J Med*. 2015 Jan 8;372(2):106-8. doi: 10.1056/NEJMp1407422. PMID: 25564895.
- ⁵⁷ Drazen JM, Weinstein DF. Considering recertification. *N Engl J Med*. 2010 Mar 11;362(10):946-7. doi: 10.1056/NEJMe1000174. PMID: 20220191.
- ⁵⁸ Drazen JM, Weinstein DF. Considering recertification. *N Engl J Med*. 2010 Mar 11;362(10):946-7. doi: 10.1056/NEJMe1000174. PMID: 20220191.
- ⁵⁹ Iglehart JK, Baron RB. Ensuring physicians' competence--is maintenance of certification the answer? *N Engl J Med*. 2012 Dec 27;367(26):2543-9. doi: 10.1056/NEJMp1211043. Erratum in: *N Engl J Med*. 2013 Feb 21;368(8):781. PMID: 23268670.

-
- ⁶⁰ Cook DA, Holmboe ES, Sorensen KJ, Berger RA, Wilkinson JM. Getting maintenance of certification to work: a grounded theory study of physicians' perceptions. *JAMA Intern Med.* 2015 Jan;175(1):35-42. doi: 10.1001/jamainternmed.2014.5437. PMID: 25365596.
- ⁶¹ Freed GL, Dunham KM, Lamarand KE; Research Advisory Committee of the American Board of Pediatrics. Permanent pediatric diplomate awareness of and perspectives on maintenance of certification. *J Pediatr.* 2009 Dec;155(6):919-923.e1. doi: 10.1016/j.jpeds.2009.09.046. Epub 2009 Oct 20. PMID: 19846113.
- ⁶² Gallagher TH, Prouty CD, Brock DM, Liao JM, Weissman A, Holmboe ES. Internists' attitudes about assessing and maintaining clinical competence. *J Gen Intern Med.* 2014 Apr;29(4):608-14. doi: 10.1007/s11606-013-2706-8. Epub 2013 Dec 3. PMID: 24297666; PMCID: PMC3965737.
- ⁶³ Cook DA, Blachman MJ, West CP, Wittich CM. Physician Attitudes About Maintenance of Certification: A Cross-Specialty National Survey. *Mayo Clin Proc.* 2016 Oct;91(10):1336-1345. doi: 10.1016/j.mayocp.2016.07.004. PMID: 27712632.
- ⁶⁴ America's Physicians: Practice Patterns & Perspectives. Survey conducted on behalf of The Physicians Foundation by Merritt Hawkins. The Physicians Foundation, 2018.
- ⁶⁵ Brennan TA, Horwitz RI, Duffy FD, Cassel CK, Goode LD, Lipner RS. The role of physician specialty board certification status in the quality movement. *JAMA.* 2004;292(9):1038-1043. doi:10.1001/jama.292.9.1038
- ⁶⁶ Freed GL, Dunham KM, Clark SJ, Davis MM; Research Advisory Committee of the American Board of Pediatrics. Perspectives and preferences among the general public regarding physician selection and board certification. *J Pediatr.* 2010;156(5):841-845.e1. doi:10.1016/j.jpeds.2009.11.055
- ⁶⁷ NORC at the University of Chicago conducted the survey from May 9, 2018 to June 11, 2018. The survey was fielded using NORC's probability-based AmeriSpeak Panel, which is designed to be representative of the U.S. population. Respondents were contacted by phone and online. In total, 1,792 adults were surveyed, representing a mix of genders, races and ethnicities, education levels, and ages. The results have a margin of error of 3.5% at a 95% confidence level.
- ⁶⁸ <https://www.abem.org/public/news-events/abem-news/2023/05/16/the-american-public-supports-board-certification-and-continuous-learning-for-emergency-physicians>
- ⁶⁹ Freed GL, Uren RL, Hudson EJ, Lakhani I, Wheeler JRC, Stockman JA 3rd; Research Advisory Committee of the American Board of Pediatrics. Policies and practices related to the role of board certification and recertification of pediatricians in hospital privileging. *JAMA.* 2006;295(8):905-12. doi: 10.1001/jama.295.8.905.
- ⁷⁰ Freed GL, Dunham KM, Gebremariam A. Changes in hospitals' credentialing requirements for board certification from 2005 to 2010. *J Hosp Med.* 2013 Jun;8(6):298-303. doi: 10.1002/jhm.2033.
- ⁷¹ Freed GL, Dunham KM, Singer D. Use of board certification and recertification in hospital privileging: policies for general surgeons, surgical specialists, and nonsurgical subspecialists. *Arch Surg.* 2009 Aug;144(8):746-52. doi: 10.1001/archsurg.2009.28. PMID: 19687379.
- ⁷² NAMSS-AHA-CMSS Survey of hospital Credentialing Practices. Unpublished results available upon request.
- ⁷³ Evolving health care systems and approaches to maintenance of certification. *J Contin Educ Health Prof.* 2013 Fall;33Suppl. 1
- ⁷⁴ Lipner RS, Hess BJ, Phillips RL Jr. Specialty board certification in the United States: issues and evidence. *J Contin Educ Health Prof.* 2013 Fall;33 Suppl 1:S20-35. doi: 10.1002/chp.21203. PMID: 24347150.
- ⁷⁵ Lipner RS, Lucey CR. Putting the secure examination to the test. *JAMA.* 2010 Sep 22;304(12):1379-80. doi: 10.1001/jama.2010.1378. PMID: 20858883.
- ⁷⁶ Hayes J, Jackson JL, McNutt GM, Hertz BJ, Ryan JJ, Pawlikowski SA. Association between physician time-unlimited vs time-limited internal medicine board certification and ambulatory patient care quality. *JAMA.* 2014;312(22):2358-2363. doi:10.1001/jama.2014.13992
- ⁷⁷ Khatana SAM, Fiorilli PN, Nathan AS, et al. Association Between 30-Day Mortality After Percutaneous Coronary Intervention and Education and Certification Variables for New York State Interventional Cardiologists. *Circ Cardiovasc Interv.* 2018;11(9):e006094. doi:10.1161/CIRCINTERVENTIONS.117.006094

-
- ⁷⁸ Gray BM, Vandergrift JL, Johnston MM, et al. Association between imposition of a Maintenance of Certification requirement and ambulatory care-sensitive hospitalizations and health care costs. *JAMA*. 2014;312(22):2348-2357. doi:10.1001/jama.2014.12716
- ⁷⁹ Hess BJ, Weng W, Holmboe ES, Lipner RS. The association between physicians' cognitive skills and quality of diabetes care. *Acad Med*. 2012;87(2):157-163. doi:10.1097/ACM.0b013e31823f3a57;
- ⁸⁰ Holmboe ES, Wang Y, Meehan TP, et al. Association between maintenance of certification examination scores and quality of care for Medicare beneficiaries. *Arch Intern Med*. 2008;168(13):1396-1403. doi:10.1001/archinte.168.13.1396
- ⁸¹ Sun H, Culley DJ, Lien CA, Kitchener DL, Harman AE, Warner DO. Predictors of performance on the Maintenance of Certification in Anesthesiology Program® (MOCA®) examination. *J Clin Anesth*. 2015;27(1):1-6. doi:10.1016/j.jclinane.2014.08.007
- ⁸² Zhou Y, Sun H, Macario A, et al. Association Between Participation and Performance in MOCA Minute and Actions Against the Medical Licenses of Anesthesiologists. *Anesth Analg*. 2019;129(5):1401-1407. doi:10.1213/ANE.0000000000004268
- ⁸³ Zhou Y, Sun H, Macario A, et al. Association between Performance in a Maintenance of Certification Program and Disciplinary Actions against the Medical Licenses of Anesthesiologists. *Anesthesiology*. 2018;129(4):812-820. doi:10.1097/ALN.0000000000002326
- ⁸⁴ Nelson LS, Duhigg LM, Arnold GK, Lipner RS, Harvey AL, Reisdorff EJ. The Association Between Maintaining American Board of Emergency Medicine Certification and State Medical Board Disciplinary Actions. *J Emerg Med*. 2019;57(6):772-779. doi:10.1016/j.jemermed.2019.08.028
- ⁸⁵ Peabody MR, Young A, Peterson LE, et al. The Relationship Between Board Certification and Disciplinary Actions Against Board-Eligible Family Physicians. *Acad Med*. 2019;94(6):847-852. doi:10.1097/ACM.0000000000002650
- ⁸⁶ McDonald FS, Duhigg LM, Arnold GK, Hafer RM, Lipner RS. The American Board of Internal Medicine Maintenance of Certification Examination and State Medical Board Disciplinary Actions: a Population Cohort Study. *J Gen Intern Med*. 2018;33(8):1292-1298. doi:10.1007/s11606-018-4376-z
- ⁸⁷ Sheth BP, Schnabel SD, Comber BA, Martin B, McGowan M, Bartley GB. Relationship Between the American Board of Ophthalmology Maintenance of Certification Program and Actions Against the Medical License. *Am J Ophthalmol*. 2022 Nov 9;247:1-8. doi: 10.1016/j.ajo.2022.11.001.
- ⁸⁸ Kinney CL, Raddatz MM, Sliwa JA, Driscoll SW, Robinson LR. Association of Participation in the American Board of Physical Medicine and Rehabilitation Maintenance of Certification Program and Physician Disciplinary Actions. *Am J Phys Med Rehabil*. 2020;99(4):325-329. doi:10.1097/PHM.0000000000001331
- ⁸⁹ Jones AT, Kopp JP, Malangoni MA. Recertification Exam Performance in General Surgery is Associated with Subsequent Loss of License Actions [published online ahead of print, 2019 Apr 23]. *Ann Surg*. 2019;10.1097/SLA.0000000000003330. doi:10.1097/SLA.0000000000003330
- ⁹⁰ Jones AT, Kopp JP, Malangoni MA. Association Between Maintaining Certification in General Surgery and Loss-of-License Actions. *JAMA*. 2018;320(11):1195-1196. doi:10.1001/jama.2018.9550
- ⁸⁶ McDonald FS, Duhigg LM, Arnold GK, Hafer RM, Lipner RS. The American Board of Internal Medicine Maintenance of Certification Examination and State Medical Board Disciplinary Actions: a Population Cohort Study. *J Gen Intern Med*. 2018;33(8):1292-1298. doi:10.1007/s11606-018-4376-z
- ⁹² Holmboe ES, Wang Y, Meehan TP, et al. Association between maintenance of certification examination scores and quality of care for Medicare beneficiaries. *Arch Intern Med*. 2008;168(13):1396-1403. doi:10.1001/archinte.168.13.1396
- ⁹³ Gray B, Vandergrift J, Landon B, Reschovsky J, Lipner R. Associations Between American Board of Internal Medicine Maintenance of Certification Status and Performance on a Set of Healthcare Effectiveness Data and Information Set (HEDIS) Process Measures. *Ann Intern Med*. 2018;169(2):97-105. doi:10.7326/M16-2643
- ⁹⁴ Phillips RL, Blackburn B, Peterson LE, Puffer JC. Maintenance of Certification, Medicare Quality Reporting, and Quality of Diabetes Care. *Am J Med Qual*. 2016;31(3):217-223. doi:10.1177/1062860615571662

-
- ⁹⁵ Vernacchio L, Francis ME, Epstein DM, et al. Effectiveness of an asthma quality improvement program designed for maintenance of certification. *Pediatrics*. 2014;134(1):e242-e248. doi:10.1542/peds.2013-2643
- ⁹⁶ Gray BM, Vandergrift JL, Lipner RS. Association between the American Board of Internal Medicine's General Internist's Maintenance of Certification Requirement and Mammography Screening for Medicare Beneficiaries. *Womens Health Issues*. 2018;28(1):35-41. doi:10.1016/j.whi.2017.10.003
- ⁹⁷ Venkatesh AK, Agha L, Abaluck J, Rothenberg C, Kabrhel C, Raja AS. Trends and Variation in the Utilization and Diagnostic Yield of Chest Imaging for Medicare Patients with Suspected Pulmonary Embolism in the Emergency Department. *AJR Am J Roentgenol*. 2018;210(3):572-577. doi:10.2214/AJR.17.18586
- ⁹⁸ Holmboe ES, Wang Y, Meehan TP, et al. Association between maintenance of certification examination scores and quality of care for Medicare beneficiaries. *Arch Intern Med*. 2008;168(13):1396-1403. doi:10.1001/archinte.168.13.1396
- ⁹⁹ Gray B, Vandergrift J, Landon B, Reschovsky J, Lipner R. Associations Between American Board of Internal Medicine Maintenance of Certification Status and Performance on a Set of Healthcare Effectiveness Data and Information Set (HEDIS) Process Measures. *Ann Intern Med*. 2018 Jul 17;169(2):97-105. doi: 10.7326/M16-2643. Epub 2018 Jun 12. PMID: 29893788.
- ¹⁰⁰ Eddy DM, Pawlson LG, Schaaf D, Peskin B, Shcheprov A, Dziuba J, Bowman J, Eng B. The potential effects of HEDIS performance measures on the quality of care. *Health Aff (Millwood)*. 2008 Sep-Oct;27(5):1429-41. doi: 10.1377/hlthaff.27.5.1429. PMID: 18780934.
- ¹⁰¹ Vandergrift JL, Weng W, Gray BM. The association between physician knowledge and inappropriate medications for older populations. *J Am Geriatr Soc*. 2021 Dec;69(12):3584-3594.
- ¹⁰² Gray BM, Vandergrift JL, Weng W, Lipner RS, Barnett ML. Clinical Knowledge and Trends in Physicians' Prescribing of Opioids for New Onset Back Pain, 2009-2017. *JAMA Network Open*. 2021 Jul 1;4(7)
- ¹⁰³ Gray BM, Vandergrift JL, McCoy RG, Lipner RS, Landon BE. Association between primary care physician diagnostic knowledge and death, hospitalisation and emergency department visits following an outpatient visit at risk for diagnostic error: a retrospective cohort study using Medicare claims. *BMJ Open*. 2021 Apr 1;11(4).
- ¹⁰⁴ Wilson M, Welch J, Schuur J, O'Laughlin K, Cutler D. Hospital and emergency department factors associated with variations in missed diagnosis and costs for patients age 65 years and older with acute myocardial infarction who present to emergency departments. *Acad Emerg Med*. 2014 Oct;21(10):1101-8. doi: 10.1111/acem.12486. PMID: 25308132; PMCID: PMC4285372.
- ¹⁰⁵ Teirstein PS. Boarded to death--why maintenance of certification is bad for doctors and patients. *N Engl J Med*. 2015;372(2):106-108. doi:10.1056/NEJMp1407422
- ¹⁰⁶ Holmboe ES, Meehan TP, Lynn L, Doyle P, Sherwin T, Duffy FD. Promoting physicians' self-assessment and quality improvement: the ABIM diabetes practice improvement module. *J Contin Educ Health Prof*. 2006 Spring;26(2):109-19. doi: 10.1002/chp.59. PMID: 16802312.
- ¹⁰⁷ Tieder JS, Prall SP, Beck J, Alberda E, Jensen D, Nair D, Carline JD. A Survey of Perceived Effectiveness of Part 4 Maintenance of Certification. *Hosp Pediatr*. 2017 Nov;7(11):642-648. doi: 10.1542/hpeds.2017-0117. PMID: 29046431. See also Tieder JS. *Seattle Children's Maintenance of Certification Annual Report*. Seattle, WA: Seattle Children's;2022
- ¹⁰⁸ Billett AL, Colletti RB, Mandel KE, Miller M, Muething SE, Sharek PJ, Lannon CM. Exemplar pediatric collaborative improvement networks: achieving results. *Pediatrics*. 2013 Jun;131 Suppl 4:S196-203. doi: 10.1542/peds.2012-3786F. PMID: 23729760.
- ¹⁰⁹ Margolis PA, DeWalt DA, Simon JE, Horowitz S, Scoville R, Kahn N, Perelman R, Bagley B, Miles P. Designing a large-scale multilevel improvement initiative: the improving performance in practice program. *J Contin Educ Health Prof*. 2010 Summer;30(3):187-96. doi: 10.1002/chp.20080. PMID: 20872774.
- ¹¹⁰ Anderson JB, Beekman RH 3rd, Kugler JD, Rosenthal GL, Jenkins KJ, Klitzner TS, Martin GR, Neish SR, Brown DW, Mangeot C, King E, Peterson LE, Provost L, Lannon C; National Pediatric Cardiology Quality Improvement Collaborative. Improvement in Interstage Survival in a National Pediatric Cardiology Learning Network. *Circ Cardiovasc Qual Outcomes*. 2015 Jul;8(4):428-36. doi: 10.1161/CIRCOUTCOMES.115.001956. Epub 2015 Jun 9. PMID: 26058717.

-
- ¹¹¹ Crandall WV, Margolis PA, Kappelman MD, King EC, Pratt JM, Boyle BM, Duffy LF, Grunow JE, Kim SC, Leibowitz I, Schoen BT, Colletti RB; ImproveCareNow Collaborative. Improved outcomes in a quality improvement collaborative for pediatric inflammatory bowel disease. *Pediatrics*. 2012 Apr;129(4):e1030-41. doi: 10.1542/peds.2011-1700. Epub 2012 Mar 12. PMID: 22412030; PMCID: PMC3313634.
- ¹¹² Miller MR, Niedner MF, Huskins WC, Colantuoni E, Yenokyan G, Moss M, Rice TB, Ridling D, Campbell D, Brill R; National Association of Children's Hospitals and Related Institutions Pediatric Intensive Care Unit Central Line-Associated Bloodstream Infection Quality Transformation Teams. Reducing PICU central line-associated bloodstream infections: 3-year results. *Pediatrics*. 2011 Nov;128(5):e1077-83. doi: 10.1542/peds.2010-3675. Epub 2011 Oct 24. PMID: 22025594.
- ¹¹³ Stratman EJ, Miller SJ. Assessment of the Focused Practice Improvement Module Pilot Program of the American Board of Dermatology for Meeting Requirements of Maintenance of Certification. *JAMA Dermatol*. 2017;153(7):715-716. doi:10.1001/jamadermatol.2017.0396
- ¹¹⁴ Peterson LE, Eden A, Cochrane A, Hagen M. Physician Satisfaction With and Practice Changes Resulting From American Board of Family Medicine Maintenance of Certification Performance in Practice Modules. *J Contin Educ Health Prof*. 2016 Winter;36(1):55-60. doi: 10.1097/CEH.0000000000000022. PMID: 26954246.
- ¹¹⁵ Peterson LE, Blackburn BE, Puffer JC, Phillips RL Jr. Family physicians' quality interventions and performance improvement through the ABFM diabetes performance in practice module. *Ann Fam Med*. 2014;12(1):17-20. doi:10.1370/afm.1592.
- ¹¹⁶ Peterson LE, Blackburn B, Phillips RL, Puffer JC. Improving quality of care for diabetes through a maintenance of certification activity: family physicians' use of the chronic care model. *J Contin Educ Health Prof*. 2014;34(1):47-55. doi:10.1002/chp.21216
- ¹¹⁷ Holmboe ES, Meehan TP, Lynn L, Doyle P, Sherwin T, Duffy FD. Promoting physicians' self-assessment and quality improvement: the ABIM diabetes practice improvement module. *J Contin Educ Health Prof*. 2006;26(2):109-119. doi:10.1002/chp.59
- ¹¹⁸ Shaw KN, Tanzer L, Keren R, Taylor A, DeRusso PA, St Geme JW 3rd. Maintenance of Certification Part 4: From Trial to Tribute. *J Pediatr*. 2017;185:4-5.e1. doi:10.1016/j.jpeds.2017.03.016
- ¹¹⁹ Wiggins RE Jr, Etz R. Assessment of the American Board of Ophthalmology's Maintenance of Certification Part 4 (Improvement in Medical Practice). *JAMA Ophthalmol*. 2016;134(9):967-974. doi:10.1001/jamaophthalmol.2016.1848
- ¹²⁰ Nichols DG. Maintenance of Certification and the Challenge of Professionalism. *Pediatrics*. 2017;139(5):e20164371. doi:10.1542/peds.2016-4371
- ¹²¹ LaBresh KA, Ariza AJ, Lazorick S, Furberg RD, Whetstone L, Hobbs C, de Jesus J, Salinas IG, Bender RH, Binns HJ. Adoption of cardiovascular risk reduction guidelines: a cluster-randomized trial. *Pediatrics*. 2014 Sep;134(3):e732-8. doi: 10.1542/peds.2014-0876. PMID: 25157013; PMCID: PMC4144001.
- ¹²² Vernacchio L, Francis ME, Epstein DM, Santangelo J, Trudell EK, Reynolds ME, Risko W. Effectiveness of an asthma quality improvement program designed for maintenance of certification. *Pediatrics*. 2014 Jul;134(1):e242-8. doi: 10.1542/peds.2013-2643. Epub 2014 Jun 16. PMID: 24935994.
- ¹²³ Phillips RL, Blackburn B, Peterson LE, Puffer JC. Maintenance of Certification, Medicare Quality Reporting, and Quality of Diabetes Care. *Am J Med Qual*. 2016 May;31(3):217-23. doi: 10.1177/1062860615571662. Epub 2015 Mar 2. PMID: 25732376.
- ¹²⁴ Starr MR, Patel SV, Bartley GB, Bothun ED. Impact of Standardized Prescribing Guidelines on Postoperative Opioid Prescriptions after Ophthalmic Surgery. *Ophthalmology*. 2020 Nov;127(11):1454-1459. doi: 10.1016/j.ophtha.2020.04.015. Epub 2020 Apr 18. PMID: 32654758.
- ¹²⁵ See, for example, Hodges, BD, and Lingard, L, Eds. *The Question of Competence*. Ithaca, NY: Cornell University Press. 2012; and Holmboe, ES and Durning, SJ, Eds.; *Practical Guide to the Assessment of Clinical Competence*, 3rd Edition. Philadelphia, PA: Elsevier. 2024.
- ¹²⁶ Schuwirth LW, Van der Vleuten CP. Programmatic assessment: From assessment of learning to assessment for learning. *Med Teach*. 2011;33(6):478-485. doi:10.3109/0142159X.2011.565828

-
- ¹²⁷ Vander Vleuten CP. The assessment of professional competence: Developments, research and practical implications. *Adv Health Sci Educ Theory Pract.* 1996;1(1):41-67. doi:10.1007/BF00596229
- ¹²⁸ Van der Vleuten CP, Schuwirth LW. Assessing professional competence: from methods to programmes. *Med Educ.* 2005;39(3):309-317. doi:10.1111/j.1365-2929.2005.02094.x
- ¹²⁹ Van der Vleuten CP, Schuwirth LW, Scheele F, Driessen EW, Hodges B. The assessment of professional competence: building blocks for theory development. *Best Pract Res Clin Obstet Gynaecol.* 2010;24(6):703-719. doi:10.1016/j.bpobgyn.2010.04.001
- ¹³⁰ Van Der Vleuten CPM, Schuwirth LWT, Driessen EW, Govaerts MJB, Heeneman S. Twelve Tips for programmatic assessment. *Med Teach.* 2015;37(7):641-646. doi:10.3109/0142159X.2014.973388
- ¹³¹ Van der Vleuten CP. Revisiting 'Assessing professional competence: from methods to programmes'. *Med Educ.* 2016;50(9):885-888. doi:10.1111/medu.12632
- ¹³² Larsen DP, Butler AC, Roediger HL 3rd. Test-enhanced learning in medical education. *Med Educ.* 2008 Oct;42(10):959-66. doi: 10.1111/j.1365-2923.2008.03124.x. PMID: 18823514.
- ¹³³ Roediger HL 3rd, Butler AC. The critical role of retrieval practice in long-term retention. *Trends Cogn Sci.* 2011;15(1):20-27. doi:10.1016/j.tics.2010.09.003
- ¹³⁴ Rohrer, D, and Paschler, H. Recent research in human learning challenges conventional educational strategies. *Educational Researcher*, Vol. 39, No. 5, pp. 406–412. DOI: 10.3102/0013189X10374770
- ¹³⁵ Roediger HL, Karpicke JD. Test-enhanced learning: taking memory tests improves long-term retention. *Psychol Sci.* 2006;17(3):249-255. doi:10.1111/j.1467-9280.2006.01693.x
- ¹³⁶ Rowland CA. The effect of testing versus restudy on retention: a meta-analytic review of the testing effect. *Psychological bulletin.* 2014 Nov;140(6):1432. Karpicke JD, Aue WR. The testing effect is alive and well with complex materials. *Educational Psychology Review.* 2015 Jun;27:317-26.
- ¹³⁷ Brown, P. C., Roediger, H. L. III, & McDaniel, M. A. (2014). *Make it stick: The science of successful learning.* Belknap Press of Harvard University Press.
- ¹³⁸ Fraundorf SH, Caddick ZA, Nokes-Malach TJ, Rottman BM. Cognitive perspectives on maintaining physicians' medical expertise: IV. Best practices and open questions in using testing to enhance learning and retention. *Cogn Res Princ Implic.* 2023 Aug 8;8(1):53. doi: 10.1186/s41235-023-00508-8. PMID: 37552437; PMCID: PMC10409703.
- ¹³⁹ Price DW, Wang T, O'Neill TR, Newton WP. Spaced Repetition in a Cohort of Practicing Physicians: Methods and Preliminary Results. *Acad Med.* 2022 Nov 1;97(11S):S141.
- ¹⁴⁰ Brown, P. C., Roediger, H. L. III, & McDaniel, M. A. (2014). *Make it stick: The science of successful learning.* Belknap Press of Harvard University Press.
- ¹⁴¹ Price DW, Wang T, O'Neill TR, Newton WP. Spaced Repetition in a Cohort of Practicing Physicians: Methods and Preliminary Results. *Acad Med.* 2022 Nov 1;97(11S):S141.
- ¹⁴² Sun H, Zhou Y, Culley DJ, Lien CA, Harman AE, Warner DO. Association between Participation in an Intensive Longitudinal Assessment Program and Performance on a Cognitive Examination in the Maintenance of Certification in Anesthesiology Program®. *Anesthesiology.* 2016;125(5):1046-1055. doi:10.1097/ALN.0000000000001301
- ¹⁴³ Turner AL, Olmsted M, Smith AC, et al. Pediatrician Perspectives on Learning and Practice Change in the MOCA-Peds 2017 Pilot. *Pediatrics.* 2019;144(6):e20192305. doi:10.1542/peds.2019-2305
- ¹⁴⁴ Robinson LR, Raddatz MM, Kinney CL. Evaluation of Longitudinal Assessment for Use in Maintenance of Certification. *Am J Phys Med Rehabil.* 2020;99(5):420-423. doi:10.1097/PHM.0000000000001359
- ¹⁴⁵ Dwyer AC, Althouse LA. Validity Evidence for the General Pediatrics Board Certification Examinations: A Practice Analysis. *J Pediatr.* 2018;203:4-6.e3. doi:10.1016/j.jpeds.2018.09.039
- ¹⁴⁶ Leslie LK, Olmsted MG, Turner A, Carraccio C, Dwyer A, Althouse L. MOCA-Peds: Development of a New Assessment of Medical Knowledge for Continuing Certification. *Pediatrics.* 2018;142(6):e20181428. doi:10.1542/peds.2018-1428

-
- ¹⁴⁷ Leslie LK, Turner AL, Smith AC, Dounoucos V, Olmsted MG, Althouse L. Pediatrician Perspectives on Feasibility and Acceptability of the MOCA-Peds 2017 Pilot. *Pediatrics*. 2019;144(6):e20192303. doi:10.1542/peds.2019-2303
- ¹⁴⁸ Price DW, Wang T, O'Neill TR, Newton WP. Spaced Repetition in a Cohort of Practicing Physicians: Methods and Preliminary Results. *Acad Med*. 2022 Nov 1;97(11S):S141.
- ¹⁴⁹ Leslie LK, Turner AL, Smith AC, Dounoucos V, Olmsted MG, Althouse L. Pediatrician Perspectives on Feasibility and Acceptability of the MOCA-Peds 2017 Pilot. *Pediatrics*. 2019;144(6):e20192303. doi:10.1542/peds.2019-2303
- ¹⁵⁰ Gray BM, Vandergrift JL, Weng W, Lipner RS, Barnett ML. Clinical Knowledge and Trends in Physicians' Prescribing of Opioids for New Onset Back Pain, 2009-2017. *JAMA Netw Open*. 2021 Jul 1;4(7):e2115328. doi: 10.1001/jamanetworkopen.2021.15328. PMID: 34196714; PMCID: PMC8251502.
- ¹⁵¹ Gray BM, Vandergrift JL, McCoy RG, Lipner RS, Landon BE. Association between primary care physician diagnostic knowledge and death, hospitalisation and emergency department visits following an outpatient visit at risk for diagnostic error: a retrospective cohort study using medicare claims. *BMJ Open*. 2021 Apr 1;11(4):e041817. doi: 10.1136/bmjopen-2020-041817. PMID: 33795293; PMCID: PMC8021735.
- ¹⁵² Gray BM, Vandergrift JL, Johnston MM, Reschovsky JD, Lynn LA, Holmboe ES, McCullough JS, Lipner RS. Association between imposition of a Maintenance of Certification requirement and ambulatory care-sensitive hospitalizations and health care costs. *JAMA*. 2014 Dec 10;312(22):2348-57. doi: 10.1001/jama.2014.12716. PMID: 25490325.
- ¹⁵³ Vandergrift JL, Weng W, Gray BM. The association between physician knowledge and inappropriate medications for older populations. *J Am Geriatr Soc*. 2021 Dec;69(12):3584-3594. doi: 10.1111/jgs.17413. Epub 2021 Aug 30. PMID: 34459494.
- ¹⁵⁴ <https://www.abms.org/board-certification/board-certification-standards/standards-for-continuing-certification/> Accessed 05-01-2024.
- ¹⁵⁵ Hawkins RE, Ogrinc G, Ramin SM. American Board of Medical Specialties and New Standards for Continuing Certification. *JAMA*. 2022 May 3;327(17):1645-1646. doi: 10.1001/jama.2022.6053. PMID: 35426897.
- ¹⁵⁶ National Commission for Certifying Agencies. Standards for Accreditation of Certification Organizations. Washington, DC: Institute for Credentialing Excellence, 2014, revised 2021.
- ¹⁵⁷ Robinson, J, and Granatir, T. Reframing certification for continuing competence. In Henderson, J, The ICE Certification Handbook, 3rd Edition. Washington DC: Institute for Credentialing Excellence. 2019.
- ¹⁵⁸ Gallagher TH, Prouty CD, Brock DM, Liao JM, Weissman A, Holmboe ES. Internists' attitudes about assessing and maintaining clinical competence. *J Gen Intern Med*. 2014 Apr;29(4):608-14. doi: 10.1007/s11606-013-2706-8. Epub 2013 Dec 3. PMID: 24297666; PMCID: PMC3965737.
- ¹⁵⁹ Mann K, van der Vleuten C, Eva K, Armson H, Chesluk B, Dornan T, Holmboe E, Lockyer J, Loney E, Sargeant J. Tensions in informed self-assessment: how the desire for feedback and reticence to collect and use it can conflict. *Acad Med*. 2011 Sep;86(9):1120-7. doi: 10.1097/ACM.0b013e318226abdd. PMID: 21785309.
- ¹⁶⁰ Sargeant J. Future Research in Feedback: How to Use Feedback and Coaching Conversations in a Way That Supports Development of the Individual as a Self-Directed Learner and Resilient Professional. *Acad Med*. 2019 Nov;94(11S Association of American Medical Colleges Learn Serve Lead: Proceedings of the 58th Annual Research in Medical Education Sessions):S9-S10. doi: 10.1097/ACM.0000000000002911. PMID: 31365395.
- ¹⁶¹ Eva KW, Regehr G. Self-assessment in the health professions: a reformulation and research agenda. *Acad Med*. 2005 Oct;80(10 Suppl):S46-54. doi: 10.1097/00001888-200510001-00015. PMID: 16199457.
- ¹⁶² Eva KW, Regehr G. Knowing when to look it up: a new conception of self-assessment ability. *Acad Med*. 2007 Oct;82(10 Suppl):S81-4. doi: 10.1097/ACM.0b013e31813e6755. PMID: 17895699.
- ¹⁶³ Sargeant J, Armson H, Chesluk B, Dornan T, Eva K, Holmboe E, Lockyer J, Loney E, Mann K, van der Vleuten C. The processes and dimensions of informed self-assessment: a conceptual model. *Acad Med*. 2010 Jul;85(7):1212-20. doi: 10.1097/ACM.0b013e3181d85a4e. PMID: 20375832.
- ¹⁶⁴ [Grant Opportunities | American Board of Medical Specialties \(abms.org\)](https://www.abms.org/grant-opportunities/)

-
- ¹⁶⁵ Wachter RM. Why diagnostic errors don't get any respect--and what can be done about them. *Health Aff (Millwood)*. 2010 Sep;29(9):1605-10. doi: 10.1377/hlthaff.2009.0513. PMID: 20820015.
- ¹⁶⁶ National Academies of Sciences, Engineering, and Medicine. 2015. Improving diagnosis in health care. Washington, DC: The National Academies Press.
- ¹⁶⁷ Singh H, Schiff GD, Graber ML, Onakpoya I, Thompson MJ. The global burden of diagnostic errors in primary care. *BMJ Qual Saf*. 2017 Jun;26(6):484-494. doi: 10.1136/bmjqs-2016-005401. Epub 2016 Aug 16. PMID: 27530239; PMCID: PMC5502242.
- ¹⁶⁸ Müskens JLM, Kool RB, van Dulmen SA, Westert GP. Overuse of diagnostic testing in healthcare: a systematic review. *BMJ Qual Saf*. 2022 Jan;31(1):54-63. doi: 10.1136/bmjqs-2020-012576. Epub 2021 May 10. PMID: 33972387; PMCID: PMC8685650.
- ¹⁶⁹ Kwan JL, Calder LA, Bowman CL, MacIntyre A, Mimeault R, Honey L, Dunn C, Garber G, Singh H. Characteristics and contributing factors of diagnostic error in surgery: analysis of closed medico-legal cases and complaints in Canada. *Can J Surg*. 2024 Feb 6;67(1):E58-E65. doi: 10.1503/cjs.003523. PMID: 38320779; PMCID: PMC10852193.
- ¹⁷⁰ Olson A, Rencic J, Cosby K, Ruz D, Papa F, Croskerry P, Zierler B, Harkless G, Giuliano MA, Schoenbaum S, Colford C, Cahill M, Gerstner L, Grice GR, Graber ML. Competencies for improving diagnosis: an interprofessional framework for education and training in health care. *Diagnosis (Berl)*. 2019 Nov 26;6(4):335-341. doi: 10.1515/dx-2018-0107. PMID: 31271549.
- ¹⁷¹ Cifu AS. Diagnostic Errors and Diagnostic Calibration. *JAMA*. 2017 Sep 12;318(10):905-906. doi: 10.1001/jama.2017.11030. PMID: 28828468.
- ¹⁷² Dhaliwal G. Premature closure? Not so fast. *BMJ Qual Saf*. 2017 Feb;26(2):87-89. doi: 10.1136/bmjqs-2016-005267. Epub 2016 Mar 15. PMID: 26980778.
- ¹⁷³ Shenoy ES, Giuriato MA, Song Z. Prevalence, Costs, and Consequences of Low-Value Preprocedural Urinalyses in the US. *JAMA Intern Med*. 2021 Nov 1;181(11):1533-1535. doi: 10.1001/jamainternmed.2021.4075. PMID: 34338720; PMCID: PMC8329792.
- ¹⁷⁴ Latifi N, Grady D. Moving Beyond Guidelines--Use of Value-Based Preoperative Testing. *JAMA Intern Med*. 2021 Nov 1;181(11):1431-1432. doi: 10.1001/jamainternmed.2021.4081. PMID: 34338740.
- ¹⁷⁵ Hawkins RE, Lipner RS, Ham HP, Wagner R, Holmboe ES. American Board of Medical Specialties Maintenance of Certification: theory and evidence regarding the current framework. *J Contin Educ Health Prof*. 2013 Fall;33 Suppl 1:S7-19. doi: 10.1002/chp.21201. PMID: 24347156.
- ¹⁷⁶ Professionalism, Interpersonal Communication Skills, Practice Based Learning and Improvement, and System-Based Practice
- ¹⁷⁷ Combes J.R. and Arespacochaga E., Lifelong Learning Physician Competency Development. American Hospital Association's Physician Leadership Forum, Chicago, IL. June 2012.
- ¹⁷⁸ Hirpa M, Woreta T, Addis H, Kebede S. What matters to patients? A timely question for value-based care. *PLoS One*. 2020 Jul 9;15(7):e0227845. doi: 10.1371/journal.pone.0227845. PMID: 32644993; PMCID: PMC7347201.
- ¹⁷⁹ McGrath JL, Taekman JM, Dev P, Danforth DR, Mohan D, Kman N, Crichlow A, Bond WF, Riker S, Lemheney AJ, Talbot TB. Using virtual reality simulation environments to assess competence for emergency medicine learners. *Acad Emerg Med*. 2018 Feb;25(2):186-95.
- ¹⁸⁰ Birkmeyer JD, Finks JF, O'Reilly A, Oerline M, Carlin AM, Nunn AR, Dimick J, Banerjee M, Birkmeyer NJ; Michigan Bariatric Surgery Collaborative. Surgical skill and complication rates after bariatric surgery. *N Engl J Med*. 2013 Oct 10;369(15):1434-42. doi: 10.1056/NEJMsal300625. PMID: 24106936.
- ¹⁸¹ Weiner, S, and Schwartz, A. Listening for What Matters: Avoiding Contextual Errors in Health Care. New York: Oxford University Press. 2016
- ¹⁸² Weiner S, Schwartz A, Altman L, Ball S, Bartle B, Binns-Calvey A, Chan C, Falck-Ytter C, Frenchman M, Gee B, Jackson JL, Jordan N, Kass B, Kelly B, Safdar N, Scholcoff C, Sharma G, Weaver F, Wopat M. Evaluation of a Patient-Collected Audio Audit and Feedback Quality Improvement Program on Clinician Attention to Patient

Life Context and Health Care Costs in the Veterans Affairs Health Care System. *JAMA Netw Open*. 2020 Jul 1;3(7):e209644. doi: 10.1001/jamanetworkopen.2020.9644. PMID: 32735338; PMCID: PMC7395234.

¹⁸³ Dias RD, Gupta A, Yule SJ. Using Machine Learning to Assess Physician Competence: A Systematic Review. *Acad Med*. 2019 Mar;94(3):427-439. doi: 10.1097/ACM.0000000000002414. PMID: 30113364.

¹⁸⁴ Pryor AD, Lendvay T, Jones A, Ibáñez B, Pugh C. An American Board of Surgery Pilot of Video Assessment of Surgeon Technical Performance in Surgery. *Ann Surg*. 2023 Apr 1;277(4):591-595. doi: 10.1097/SLA.0000000000005804. Epub 2023 Jan 16. PMID: 36645875.

¹⁸⁵ Reitz ACW, Massarweh NN. Video-Based Assessment of Surgical Quality-Will Video Kill the Radio Star? *JAMA Netw Open*. 2024 Apr 1;7(4):e246477. doi: 10.1001/jamanetworkopen.2024.6477. PMID: 38639941.