

# A Framework for Teaching Medical Students and Residents about Practice-based Learning and Improvement, Synthesized from a Literature Review

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## ABSTRACT

**Purpose.** To create a framework for teaching the knowledge and skills of practice-based learning and improvement to medical students and residents based on proven, effective strategies.

**Method.** The authors conducted a Medline search of English-language articles published between 1996 and May 2001, using the term “quality improvement” (QI), and cross-matched it with “medical education” and “health professions education.” A thematic-synthesis method of review was used to compile the information from the articles. Based on the literature review, an expert panel recommended educational objectives for practice-based learning and improvement.

**Results.** Twenty-seven articles met the inclusion criteria. The majority of studies were conducted in academic medical centers and medical schools and 40% addressed experiential learning of QI. More than 75% were qualitative case reports capturing educational outcomes, and 7% included an experimental study

design. The expert panel integrated data from the literature review with the Dreyfus model of professional skill acquisition, the Institute for Healthcare Improvement’s (IHI) knowledge domains for improving health care, and the ACGME competencies and generated a framework of core educational objectives about teaching practice-based learning and improvement to medical students and residents.

**Conclusion.** Teaching the knowledge and skills of practice-based learning and improvement to medical students and residents is a necessary and important foundation for improving patient care. The authors present a framework of learning objectives—informed by the literature and synthesized by the expert panel—to assist educational leaders when integrating these objectives into a curriculum. This framework serves as a blueprint to bridge the gap between current knowledge and future practice needs.

*Acad. Med.* 2003;78:748–756.

Dr. Michaels notices a pile of mail as he returns from precepting residents. Be-

ing the program director has mostly been enjoyable over the past few

years, but keeping up with the rules and regulations can sometimes feel overwhelming. He opens correspondence from the Accreditation Council for Graduate Medical Education (ACGME). More changes in residency accreditation. . .bummer. He finally felt that he was getting ahead with his curriculum and now the rules are changing.

Two of these new “competencies” are particularly troublesome. He’s heard of quality improvement and

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medical systems, but now he's supposed to certify residents are competent in practice-based learning and improvement and systems-based practice? How in the world... He reaches to the bookshelf and grabs the curriculum folder. Perhaps these elements are already part of the residents' learning? Maybe the appropriate learning objectives are already being taught?

As he scans the index of the curriculum, he realizes that the traditional framework does not address practice-based learning and improvement. Looking through the curriculum at this point is like trying to fish without a pole or bait—he has no tools available to find what he needs. Questions overwhelm him. What are appropriate objectives? Are the residents ready for this learning? What have they learned about this in medical school? How can I understand practice-based learning and improvement for my own patients? Can I just add another lunchtime lecture or are there skills that must be practiced? So many questions, and no reliable way to get them answered.

This scenario illustrates one possible reaction to the ACGME's recent shift to competency-based accreditation. Significant concern seems to center on the practice-based learning and improvement and systems-based practice competencies. In this paper, we review the current literature for teaching practice-based learning and improvement to residents and medical students and make recommendations based on review.

Recent successes in clinical improvement highlight the importance of teaching medical students and residents about the improvement of health care. For example, using improvement knowledge combined with clinical knowledge, teams have improved mortality after coronary artery bypass graft surgery,<sup>1</sup> reduced infant mortality in a high-risk Native American population,<sup>2</sup> and decreased cost and increased

staff satisfaction on a general medicine inpatient unit.<sup>3</sup>

The ACGME's new approach to accreditation includes "practice-based learning and improvement" and "systems-based practice" as two of six core competencies that all residents must achieve.<sup>4</sup> In addition, the Association of American Medical Colleges' Medical Student Outcomes Project Quality of Care committee has called for experience-based learning in the improvement of health care during medical school.<sup>5</sup> These recommendations and changes in policy are on the heels of similar reports and recommendations from the Pew Health Professions Commission,<sup>6</sup> the Institute of Medicine,<sup>7,8</sup> and the Council on Graduate Medical Education.<sup>9</sup>

Against this backdrop of current successes in improvement work and recent policy changes, medical educators—at both undergraduate and residency levels—face significant challenges. What should we teach? How should we teach the improvement of health care? How will we measure success? To answer these questions, we reviewed the evidence in the literature and developed recommendations for teaching practice-based learning and improvement in medical school and residency.

## METHOD

We completed this project in two parts. Part 1 involved a literature search and structured summary. Part 2 consisted of synthesizing the results of the literature review and developing recommendations by an expert panel about teaching practice-based learning and improvement.

For Part 1, we searched Medline for English-language articles published between 1966 and May 2001, using the term "quality improvement" as a keyword and cross-matching it with the terms "medical education" and "health professions education." These are

terms a residency program director might use when searching for information on this topic. We limited our search to studies with human participants. Our search identified 55 articles. Two of us (GO and LAH) then reviewed the titles and abstracts for articles that focused on teaching practice-based learning and improvement to medical students or residents (13 articles). Also, since the search terms did not easily match to the Medline database, 14 documents such as organizational reports and book chapters that were familiar to us and pertinent to the topic were included for the systematic review (e.g., Collaborative Education to Ensure Patient Safety—Report to Secretary of U.S. Department of Health and Human Services<sup>10</sup>). Thus, we identified a total of 27 manuscripts for review.

We assembled an expert panel with members chosen for the following two sets of broad characteristics: (1) an understanding of the major issues facing health professions education today and in the future, and (2) a record of successful investigation into practice-based learning and improvement for medical students or residents. The final panel consisted of six individuals with experience as clinicians, educators, investigators, and administrators. The members of the panel summarized the articles using an adapted thematic-synthesis model of literature review.<sup>11</sup> This method uses a standardized summary sheet to quantify the content of the various articles.

In Part 2, the members of the expert panel synthesized and evaluated the data gathered in Part 1. Through monthly conference calls and one face-to-face meeting, the panel members reviewed the summary of the pertinent literature and reflected upon their own experience in the field. They considered several models to represent the progression of learning from beginning medical student through experienced resident, agreeing that Dreyfus's

model of skill acquisition was an appropriate base on which to build recommendations for practice-based learning and improvement (see Table 1).<sup>12</sup> Using the Dreyfus model allows for progression to the “competent” stage by the end of residency. “Competent” is consistent both with the current terminology used by the ACGME<sup>4</sup> and with a recent review on professional competence.<sup>13</sup>

We then cross-matched these stages of skill acquisition with the pertinent ACGME competencies (practice-based learning and improvement and systems-based practice) and seven of the eight domains of knowledge for the improvement of health care published by the Institute for Healthcare Improvement (IHI) (see List 1).<sup>14</sup> The IHI knowledge domains are well-recognized subdivisions of practice-based learning and improvement and systems-based practice on which to develop specific learning objectives for each stage of training. We omitted the knowledge domain “professional subject matter” because it is specific to a content area being studied (i.e., diabetes, cholecystectomy, pediatric vaccinations).

## List 1

### Institute for Healthcare Improvement’s (IHI’s) Eight Knowledge Domains for the Improvement of Health Care<sup>14</sup>

1. Customer/beneficiary knowledge  
Identifying person, persons, or groups for whom health care is provided and assessing their needs and preferences. This domain covers the relationship of the health care provided to those needs and preferences.
2. Health care as process/system  
The interdependent people (patients, families, eligible populations, and caregivers), procedures, activities, and technologies of health care-giving that come together to meet the need(s) of individuals and communities.
3. Variation and measurement  
Using measurement to understand the variation of performance in processes and systems of work and to improve the design and redesign of health care.
4. Leading, following and making changes in health care  
The methods and skills for making change in complex organizations, the general and strategic management of people and the health care work they do (financing, information technology, and daily health care-giving).
5. Collaboration  
The knowledge, methods, and skills needed to work effectively in groups, and understand and value the perspectives and responsibilities of others. This domain includes the capacity to foster collaboration in others.
6. Developing new, locally useful knowledge  
Recognizing the need for new knowledge in personal daily health professional practice. This domain includes the skill to develop new knowledge through empiric testing.
7. Social context and accountability  
An understanding of the social contexts (local, regional, national, and global) of health care, including health care financing.
8. Professional subject matter  
The health professional knowledge appropriate for a specific discipline and the ability to apply and connect domains 1–7. This domain includes core competencies published by professional boards, accrediting organizations, and other certifying entities.

**Table 1**

Dreyfus Levels of Professional Development of Knowledge and Performance <sup>12</sup>	
Learner Level	Behavior
Novice	Identifies and uses rules of thumb
Advanced beginner	Connects rules to the common aspects of the plan
Competent	Is able to plan an approach and execute the plan
Proficient	Regularly uses evidence-based work and takes waste out of that work
Expert	Can use intuition where empirical knowledge does not yet exist

Finally, the panel members agreed upon a model of practice-based learning and improvement that mirrored Dreyfus’s learning stages, integrated the IHI knowledge domains and two of the ACGME competencies, and progressed from beginning medical student through advanced medical student, then to beginning and advanced resident.

## RESULTS

### Part 1: Literature Review

We summarize the 27 articles in Table 2. Many articles contained more than one criterion in each category, such as

multiple foci, several different types of subjects, or multiple settings. The majority of studies focused on quality improvement (QI) learning<sup>15–39</sup> and QI teaching.<sup>15–19,21–23,25,26,28–37,39</sup> More than 40% involved experiential learning,<sup>17–19,22,24–26,33–36,39</sup> while about 30% focused on formal lecture-based instructions.<sup>17,18,25,33–35,37</sup> About 40% addressed specific curriculum design.<sup>16–18,20,25,28,30,32,34,35,37</sup> Over three fourths of the studies included qualitative case reports from one or multiple institutions,<sup>15–23,25–30,32–35,37–39</sup> nearly 20% contained a significant review of other literature,<sup>4,10,31,34,38</sup> and only 7% included an experimental design such as a before-and-after study.<sup>24,36</sup> No study used

**Table 2**

Summary of a Structured Review of the Current Literature for Teaching Quality Improvement (QI) to Residents and Medical Students*	
Category	No. (%) of Studies† (n = 27)
Topics explicitly discussed in the paper	
QI learning	25 (93)
QI teaching	21 (78)
Experimental learning	12 (44)
Curriculum design	11 (41)
Lecture-based learning	7 (26)
Design	
Case report	22 (81)
Review	5 (19)
Research	2 (7)
Participants	
Medical students	13 (48)
Faculty members	12 (44)
Residents	10 (37)
Setting	
Academic medical center	16 (59)
Medical school	13 (48)
Community health center	5 (19)
Health maintenance organization	1 (4)
Data source	
Observation	14 (52)
Chart review	5 (19)
Survey	5 (19)
Interviews	1 (4)

\*The authors searched Medline for English-language articles published between 1966 and May 2001.

†Some articles contained more than one criterion in each category.

a randomized design. Medical students in their preclinical and clinical years were the most frequent participants,<sup>19–21,26,27,29,30,32,33,37</sup> followed by faculty members<sup>16–19,21,22,25,29,32–35</sup> and residents.<sup>4,15,19,23,24,28,29,36,38,39</sup> Most studies were set in academic medical centers<sup>1,15–19,21,23–25,29,30,33,36,38,39</sup> or in medical schools,<sup>16,19–22,26–30,32,33,37</sup> with other settings that included community health centers<sup>16,21,29,32,33</sup> and a health maintenance organiza-

tion (HMO).<sup>21</sup> Data were gathered by observation and description,<sup>16–21,25,28,30,32,33,35,36,39</sup> chart review,<sup>24,26,27,36</sup> survey,<sup>22,23,27,30,32</sup> or interviews.<sup>36</sup>

Several studies reported successful teaching and learning opportunities. Working with first- and second-year medical students at Dartmouth, Weeks et al. described a course that combined didactic learning and small-group work to improve some aspect of care at a community practice site.<sup>37</sup> They identified four factors that contribute to successful improvement learning experiences for beginning medical students: (1) didactic teaching about improvement concepts and tools, (2) the availability of baseline patient data, (2) cohesive team characteristics and a sense of ownership in the process at the clinical site, and (4) access to additional information and resources needed to carry out the improvement effort (e.g., access to literature, databases, e-mail, and money for postage and copying).<sup>37</sup>

Others also found that didactic and experiential learning was a successful combination.<sup>29</sup> These include several reports from Case Western Reserve University, in Cleveland, Ohio, with interdisciplinary improvement projects for motivated first- and second-year medical students<sup>30</sup> and exercises to evaluate variation and suggest improvement in asthma care as part of a fourth-year primary care clerkship.<sup>26,27</sup>

Several studies demonstrated that with appropriate training, even beginning medical students could contribute to clinical improvement efforts.<sup>19,30,32</sup> Medical students in their clinical years have the opportunity to begin linking their clinical knowledge to improving patient care. To accomplish this, some have placed students into interdisciplinary improvement teams,<sup>19</sup> while others have used community-based opportunities<sup>33</sup> or rural settings.<sup>20</sup> A joint report from The George Washington University in Washington, D.C., and George Mason University

in Fairfax, Virginia, demonstrated that students who receive adequate training can be important contributors to improvement teams that can result in positive patient perceptions.<sup>32</sup>

Factors that may contribute to successful improvement experiences for students include using health data to set project priorities, having a clear definition of a target community, selecting projects that can be completed in short periods of time that coincide with the structure of an academic year, and emphasizing interdisciplinary teamwork.<sup>33</sup> However, there are no data to demonstrate the effectiveness of specific teaching methods or learning outcomes.

Efforts to teach improvement to residents have ranged from including residents on hospital QI committees,<sup>15</sup> special resident improvement teams to improve the residency itself,<sup>23</sup> and multiple projects without formal QI instruction.<sup>39</sup> These case reports and case series have demonstrated various degrees of success. Perhaps the most compelling evidence is from two before-and-after studies. Family practice residents researched current diabetic care guidelines, then improved baseline indicators by 40–70% over a one-year period.<sup>24</sup> Internal medicine residents successfully decreased unnecessary intravenous catheter use from 43% to 27%.<sup>36</sup> The exact QI methods, as well as educational outcomes, are not specified in either of these studies, but each combined teaching QI theory (e.g., systems thinking<sup>24</sup> and interdisciplinary collaboration<sup>36</sup>) with a practice-based project. This formula echoes years of success in residency training, whether involving patient interviewing, operative techniques, or practice-based learning and improvement.

## Part 2: Expert Panel Recommendations

Given the variations in the literature and limited published evidence for how

to teach practice-based learning and improvement, we decided to combine the literature review with expert opinion from our panel into a set of recommendations (see Table 3). These recommendations present a continuum of acquiring and applying knowledge and skill in practice-based learning and improvement from entering medical school to completing residency. Each recommendation is a combination of the overall conclusions from the literature review and the knowledge and experience of the expert panel. The core educational goals are based on the IHI knowledge domains (see List 1).<sup>14</sup> The depth of knowledge and application of the skills increase with each level and are matched to the Dreyfus model of professional skill acquisition (see Table 1).<sup>12</sup>

This model of skill acquisition is akin to learning the auscultation of heart sounds. A beginning medical student progresses from knowing anatomy and physiology of the heart to learning about normal heart sounds and various murmurs (Dreyfus level Novice). Then, as an advanced medical student, he or she will experience these sounds and pathologies in patient care during clinical clerkships (Dreyfus level Advanced Beginner). In early residency, the learner has experience with a greater number of patients and understands the interaction of heart sounds and clinical presentation (further development of Dreyfus level Advanced Beginner). As an advanced resident, the learner will be comfortable identifying heart sounds to make clinical decisions, implement therapies, and recognize variances (Dreyfus level Competent).

In the following, we briefly describe the recommendations for education in practice-based learning and improvement at each level of training. Table 3 contains educational objectives for each level of training and an example of how those objectives can be integrated into a curriculum at each level of training.

### **Beginning and Advanced Medical Students**

The expert panel members emphasized the need for beginning medical students to have didactic instruction in the principles of improvement science such as change theory, interdisciplinary approaches to health care, the structure of health systems, and the link of quality to cost. The panel also identified the need for well-defined, time-limited experiential activities that focus on the application of didactic knowledge. Given that beginning medical students typically have limited health care experiences, improvement concepts can be applied to a system that is perhaps more familiar and more important to students at this stage—their educational process. For example, students' improvement efforts might focus on applying an improvement cycle to the effectiveness of study groups for gross anatomy.

The expert panel members recommended that advanced medical students focus on a clinical improvement problem (see Table 3). Now that students have had considerable patient care experience, they can reflect upon health care from a patient's point of view, map a process of care, and decide upon appropriate measurements. By doing this, the students can add value to a local improvement effort, collaborate with others, and recommend changes to a process. The students receive experiential training to link their clinical knowledge to their improvement knowledge.

### **Beginning and Advanced Residents**

The expert panel members noted that residents have a unique opportunity that was not present in medical school. This opportunity is in the panel of patients a resident follows throughout his or her training, whether it is a continuity clinic, a cadre of surgical pathology specimens, or a surgical

panel of patients. A beginning resident has the opportunity to apply practice-based learning and improvement to his or her own patients. The initial focus should be an understanding of the panel ("who" and "what" questions). How many diabetic patients does the resident have? How are the past ten total knee-replacement patients functioning? What treatment are my patients with depression receiving? Residents could learn about methods to complete such exercises through large-group lectures, small-group activities, or one-on-one work with a faculty mentor.

As a resident progresses in training, the descriptive work completed early on is a foundation for small tests of change to the process of care. By provoking their own system of care, residents learn how to redesign the system ("why" and "how" questions). How can we most efficiently schedule postoperative follow-ups? How can the clinic better handle phone triage for uncomplicated urinary tract infections? Why do only 55% of our eligible patients receive a prescription for a beta-blocker upon discharge after a myocardial infarction? Improving the care for his or her own patients is the culmination of the foundation begun as a beginning medical student. More importantly, these skills can become embedded in the everyday work habits of the individual.

## **DISCUSSION**

Through our systematic and structured review of the literature, we identified that medical students and residents can develop skills to improve care through a combination of didactic and experiential learning, while also contributing to the improvement of patient care. For learners to achieve competence in practice-based learning and improvement by the completion of residency, we believe that the foundation must be laid during medical school.

**Table 3**

Educational Objectives Recommended by an Expert Panel for Each Training Level of Medical Students and Residents and the Corresponding Dreyfus Levels <sup>12</sup> and Examples of How to Integrate the Objectives into Curricula at Each Training Level							
Level of Training (Dreyfus Level)	Practice-based Learning and Improvement Competency*				Systems-based Practice Competency*		
	Customer Knowledge†	Measurement†	Making Change†	Developing New, Locally Useful Knowledge†	Health Care as a System†	Collaboration†	Social Context and Accountability†
Beginning medical student (Novice)	Demonstrate how improvement principles are useful, to both patients and medical students	Understand the variation inherent in health care systems Introductory assessment of health summary statistics for populations of patients	Understand basic change concepts in a personal or educational improvement process, identify where changes can be applied	Understand how the introductory concepts of improvement science are used to improve outcomes in own life or medical education Understand improvement science as synergistic with other scientific methods of building knowledge	Understand the basic components of a health care system Demonstrate how outcomes are dependent upon systems	Describe why an interdisciplinary approach is necessary for continuous improvement in health care	Describe the links between quality and costs in health care systems Describe approaches to assessing community health needs
<i>Example</i>	In large-group lecture format, students learn the basics of clinical improvement sciences, health care systems, and an introduction to population and improvement statistical methods. Through small-group sessions, students focus on medical education systems. Collaborating with other students, they will (1) develop an aim and an understanding of the process, (2) measure process or outcome variables, and (3) try a test of change (i.e., Plan-Do-Study-Act (PDSA) cycle) on a system that is important to them (e.g., gross anatomy study group). Projects are summarized and presented to the entire class.						
Advanced medical student (Advanced Beginner)	Be able to map the process of care from a patient's point of view for a clinical encounter	Identify outcome and process measures appropriate for a clinical problem	Be able to recommend changes in clinical processes for a group of patients	Apply the introductory concepts of improvement science to patient-focused outcomes	Describe the system and process of care for a group of patients in a defined setting	Display skill in communication and collaborative work with health professionals from other disciplines	Identify and understand the implications of health care resource allocation
<i>Example</i>	Students convene in small groups to focus on a clinical improvement project that is ongoing within an affiliated health care facility. With guidance from the clinical quality improvement team, students focus on a distinct patient group (i.e., sickle-cell disease, congestive heart failure, asthma). The group will (1) develop an aim; (2) describe how various disciplines work together to form the system of care for these patients; (3) identify, collect, and display appropriate measures of care, including cost; and (4) recommend changes to the clinical improvement team. Summarized reports are presented to the organization's clinical improvement leaders.						
Beginning resident (Advanced Beginner)	Demonstrate an appreciation of patients' needs and explore how these needs can be met	Begin to measure and describe the processes and outcomes of care for the resident's own patients	Identify places in the resident's own practice that can be changed to affect the processes and outcomes of care	Apply continuous improvement to one's own patient panel	Describe the system of care for a population of patients with which the resident interacts	Describe how an effective interdisciplinary team functions	Describe the business case for quality in health care Identify methods to improve care for populations in their practice

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**Table 3**

Continued							
Level of Training (Dreyfus Level)	Practice-based Learning and Improvement Competency*				Systems-based Practice Competency*		
	Customer Knowledge†	Measurement†	Making Change†	Developing New, Locally Useful Knowledge†	Health Care as a System†	Collaboration†	Social Context and Accountability†
<i>Example</i>	With mentoring from faculty members and advanced residents, the resident focuses on his or her own medical or surgical panel. After conducting an assessment of his or her patients' needs, an aim is specified to address those needs. Engaging other members of the health care team—ideally from various disciplines—the process of care is mapped and balanced measures are explored to follow the process. Small tests of change may be initiated to improve care.						
Advanced resident (Competent)	Identify needs within the resident's patient population (i.e., medical or surgical panel) and initiate changes to meet those needs	Be able to use balanced measures to show that changes have improved the care for the resident's patients	Demonstrate how to use several cycles of change to improve the care delivery system	Apply continuous improvement to a discrete population or have several efforts directed at different subpopulations	Understand and describe the reactions of a system when perturbed by change that is initiated by the resident	Contribute to an interdisciplinary team effort to improve care	Demonstrate the business case for quality in health care for specific quality improvement goals in their own practice Identify community resources to improve care for individuals within their practice
<i>Example</i>	Building on work initiated as a "beginning resident," the system of care is continually monitored to observe how it reacts to changes. As changes and improvements are ongoing, reassessment of patient needs may be necessary. The balanced instrument panel is modified as needed. Extending the improvement effort to other patient groups or other settings is encouraged, as is accessing community resources for the patients. "Advanced residents" also act to mentor the "beginning residents" through improvement efforts. The improvement efforts may form the basis for a senior resident grand rounds presentation and, in some residency programs, may be used to fulfill a research requirement.						

\*Accreditation Council for Graduate Medical Education (ACGME) core competency.

†Institute for Healthcare Improvement (IHI) Knowledge Domain.

Guidance from the literature is limited. No single study or report provided a perfect blueprint for teaching practice-based learning and improvement to medical students or residents. Instead, the few before-and-after studies<sup>24,36</sup> and the many case studies<sup>15–23,25–30,32–35,37–39</sup> provided guiding principles that inform the creation of learning opportunities about practice-based learning and improvement. The lack of a perfect blueprint in the literature perhaps indicates the inherent nature of im-

provement activities and underlying publication bias. Most improvement efforts, including those that incorporate learners, are locally funded and focused, so their generalizability may be limited. Therefore, we strongly encourage a broad sharing of experiences with teaching practice-based learning and improvement to medical students and residents through presentations and regular publications.

Infrastructure must be developed to teach practice-based learning and improvement. Although impressive suc-

cesses of improvement activities can be found in the literature,<sup>1–3</sup> many medical schools and residencies have significant concerns about adequate numbers of faculty members to teach these skills to the learners. Faculty development in these skills will be required for many organizations. As with education for medical students and residents, we recommend faculty development that focuses on the theoretical foundations combined with a practice-based improvement project. Several programs are actively training

faculty members who specialize in practice-based learning and improvement. The U.S. Department of Veterans Affairs National Quality Scholars Fellowship is in its fourth year of preparing physician educators and researchers of practice-based learning and improvement. Since 1999, Metro Health Medical Center, in Cleveland, Ohio, has trained a cadre of quality scholars, both physicians and non-physicians, among their faculty. These efforts should be expanded to build the critical mass of expertise needed to create clinical improvement, teach medical students and residents, and develop other faculty members.

We recognize that this review and the expert panel recommendations were limited by several factors. First, the search terms did not map well to Medline, so it was possible that other pertinent articles were not captured by our methods. We sought to use common terms that a residency program director might use to review the literature. Second, most knowledge on this topic is built locally and is not easily generalizable. This is compounded by the fact that funding for research in medical education is limited. We believe that this is why most studies were case reports or case series and no randomized designs were identified relative to the teaching of practice-based learning and improvement to medical students and residents. Third, it is a challenge to examine medical education as a continuum from matriculation into medical school through completing residency. We feel strongly that this integration is necessary to improve how medicine is practiced in the future.

In this review, we have created a framework for teaching practice-based learning and improvement to medical students and residents. We have clearly demonstrated that developing competence in practice-based learning and improvement is a skill-based activity with important theoret-

ical and methodologic foundations. These foundations must be laid in medical school to achieve competence reliably by the completion of residency. The framework we present is one attempt to identify concrete learning objectives with real-life examples for each stage of training. We hope that this framework—informed by the literature and synthesized by our expert panel—will be helpful to educational leaders as they create ways to include practice-based learning and improvement as a standard curricular element.

Dr. Ogrinc was a fellow in the VA National Quality Scholars Fellowship cohort that graduated in June 2002. This material is based on work supported by the Office of Academic Affiliations, U.S. Department of Veterans Affairs. The opinions and findings contained in this paper are those of the authors and do not necessarily represent the opinions or policies of the U.S. Department of Veterans Affairs or Dartmouth Medical School.

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