Summary

The Center on Continuous Instructional Improvement (CCII) founded at the Consortium for Policy Research in Education (CPRE) proposed to examine the literature in other fields such as medicine or nursing to gain insight into factors, policies, tools, or programs needed to support a culture of continuous improvement in which individuals engage in collecting and analyzing data to inform decision-making within practice. We conducted such a literature review in medicine and found a number of strategies currently employed in the medical industry that support continuous improvement: Continuous Quality Improvement (CQI), guidelines, benchmarks, audit and feedback, information technology, and care pathways. Unfortunately, there are methodological weaknesses in much of the research, which limits conclusions of effects on practice; moreover, when more rigorous methods are employed, the effects are generally minimal. Thus, there is little strong evidence of impact of such strategies on practice. While some general practical insights are gleaned about how to implement or support such strategies, they often are not based on rigorous evaluative methodology. In final analysis, there is little solid research from medicine that can shed light on how best to support continuous improvement in education, and what insights are provided are not particularly new to education researchers. However, some trends in medicine do present educators with thought-provoking visions of support tools and programs for continuous improvement in education.
I. Background and Rationale for Literature Review

The Center on Continuous Instructional Improvement (CCII) is interested in promoting and supporting the development and adoption of policies, practices, tools, and programs that support a “cycle of continuous improvement” in American schools. The cycle of continuous improvement is a theory of action that depends on the use and interpretation of data to inform decisions in educational systems. **Basic elements of the CCII cycle include 1) collecting and gathering evidence of impact of an educational program or instructional intervention, 2) analyzing and evaluating the evidence and diagnosing the problem, and 3) searching for solutions and following through with a course of action**, which is then followed by subsequent iterative rounds of data collection and evaluation until intended goals or outcomes are met. This cycle can be envisioned occurring at different levels within the educational system. For example, at the classroom level, teachers would be involved in giving instruction to students, collecting evidence of student understanding (e.g., through a formative assessment), evaluating the evidence and diagnosing the level of student understanding or learning problem, searching for possible courses of action or solutions, and adapting instruction accordingly. A teacher would engage in continuous rounds of data collection and diagnosis. In a similar fashion, one could imagine a district implementing a new curriculum and collecting aggregate data on student performance, followed by evaluation and diagnosis of the progress of the student body within the district, followed by a search for possible courses of action and adapting district policies according to the aggregate student outcomes. A district also could engage in continuous rounds of such data collection and diagnosis of the whole student body in order to achieve districtwide goals.

Certainly education is not the only context in which continuous-improvement principles can be applied. In fact, sectors including health care, pharmacy, manufacturing, and air traffic control have adopted such strategies to meet the needs of their stakeholders (Deming, 1982; Chassin, 1998; Berwick, 1989). For teachers and schools engaged in continuous improvement, an analogy can be drawn with regard to the practices employed by physicians and hospitals/clinics. Just as a teacher collects data on a student’s learning outcomes (e.g., scores on end-of-unit assessments for an individual student), a physician collects data on an individual’s health progress (e.g., blood-pressure readings for a patient with hypertension or the amount of abnormal tissue for a patient with cancer). Just as teachers engage in cycles of data collection, data analysis, and informed decision-making, so do physicians seek to learn how their practices impact patient outcomes. And just as school administrators look at aggregate student data to learn how policies are affecting student outcomes, so do hospital administrators look at aggregate patient outcomes to learn how their practices, organizational structures, and policies are impacting patient outcomes. For example, hospital administrators might want to know how the use of new guidelines for treating patients with hypertension have impacted patient-health outcomes for this subpopulation. Hence, when considering how to implement and support continuous improvement, one can identify, at many different levels, a number of similarities between health care and education.

The Consortium for Policy Research in Education (CPRE) proposed to examine the literature in health care to understand what has been learned regarding the impact, development, implementation, and adoption of policies, practices, tools, and materials relating to continuous improvement. As stated above, we believe there are parallels between the education and health-care sectors that make especially relevant an examination of continuous improvement practices by physicians and hospitals/clinics. Moreover, there are contextual similarities between the two fields. For example, there have been as many calls for reform of health-care practices as there have been for reforming educational practices. Specifically, in the 1980s there were calls to improve the quality of health care and to reduce those practices that diverged from best practices
Wennberg, 1996; Wennberg, 1987; Berwick, 1989). In addition, pressures for accountability from government, patients, and health-care management have resulted in a flourish of strategies to improve the quality of health care, many of which employ continuous-improvement processes (Lanier, et al., 2003). Clearly, pressures for greater accountability in education are evident from state to national levels as evidenced by the greater use of state standardized tests and the passage of federal legislation such as No Child Left Behind. Thus, both the procedural similarities and contextual similarities make this comparison of education and medicine more compelling and suggest that it might be possible to learn something from medicine that has implications for education.

The following is an update of our review of the literature in health care relating to the cycle of continuous improvement. We identify and discuss six strategies that are being used in the administration of health care to support continuous improvement that might have positive impacts on both professional practice and patient outcomes. These strategies comprise Continuous Quality Improvement (CQI), guidelines, benchmarks, audit and feedback, information technology, and care pathways. We also examined two other strategies—one, rounds and, two, the clinical informationist. However, given their limited relevance to either education or CCII goals, these strategies are given less attention. While not all of the strategies addressed in this review are used widely or have solid evidence of effectiveness, they do reflect recent and current efforts to meet the needs of health-care providers and improve the quality of health care.

For most of the strategies outlined below, we provide the following information: A description of the strategy, a description of the type of research available in the field, an example to illustrate the strategy, and our synopsis of the findings from the literature. In addition, a description of the methods used to identify and evaluate papers for our review is presented in an appendix (see Appendix A). We also present a summary section that includes a chart of the research literature available for all eight strategies discussed and presents side-by-side profiles of the types of literature available for each strategy (e.g., quantitative studies, qualitative studies, mixed studies, etc.). We refer to this as the topology of literature on continuous improvement in health care. Finally, we provide an overall assessment of the research literature in medicine around the implementation and support of continuous improvement strategies and what insights the literature holds for educational researchers.

II. Strategies Used in Health Care Relevant to the Cycle of Continuous Improvement and That Aim to Improve the Quality of Health Care.

1. Continuous Quality Improvement

Description

Continuous Quality Improvement (CQI), also referred to as Total Quality Management (TQM), is described as “a philosophy of continual improvement of the processes associate with providing a good or service that meets or exceeds customer expectations” (Shortell & Bennett, 1998, p.594) and is a strategy that has been adopted by the health-care industry from the manufacturing industry (Deming, 1993; Juran, 1988; Shortell, et al., 1998). Salient features of CQI are its emphasis on iterative cycles of collecting data, analyzing data, problem-solving with staff involvement, and use of measurement to monitor progress towards defined outcomes (Rogers, 2001; Berwick, 1996). This strategy differs from other quality-improvement programs in its emphasis on both outcomes and processes, whereas other quality-improvement programs tend to focus solely on outcomes (Shortell, et al., 1998). CQI programs try to “understand and improve underlying work processes and systems in order to add value rather than on correction of individuals’ mistakes after the fact” (Shortell, et al., 1998). CQI programs are becoming more
commonplace in health-care facilities. Even as early as 1993, 69% of U.S. hospitals were implementing CQI programs (Barsness, et al., 1993). In CQI programs in the health-care setting, there is a strong emphasis on preventing inadequacies in health-care delivery or making processes more efficient—in some cases to improve patient outcomes and in other cases to improve operations of health-care facilities. CQI programs have been reviewed (Shortell, et al., 1998) and found to focus on a variety of hospital needs as demonstrated by the following examples:

- reducing appointment no-shows in mental-health clinics (Pellegrin, et al., 1995)
- improving patient satisfaction with visits at clinics (Piccirillo, 1996)
- improving the quality of Pap smears (Pachciarz, et al., 1992)
- increasing the number of clinical preventative services (Leshan, et al., 1997)
- improving delivery of in-hospital medications and other procedures for treating heart-attack patients (Caputo, et al., 1997)
- establishing better standards of pain management (Caswell, et al., 1996)
- lowering the rates of cesarean sections (Myers & Gleicher, 1988)
- reducing in-hospital complications by reducing catheter infections (Civetta, et al., 1996)
- improving coordination of in-hospital care by improving communication among interdisciplinary staff (Shindollar, et al., 1995)

An example of a CQI intervention is the Plan-Do-Study-Act (PDSA) program of improvement, a commonly used strategy in health care (Stalker, 2003) that involves cycles of collecting data, evaluating data, and acting on evaluation of data to improve outcomes—professional performance and/or patient outcomes. An example of a PDSA program to improve compliance with clinical guidelines is reported by Van Tiel and colleagues (2006), who implemented a PDSA program in a Dutch hospital to increase compliance with infection-control measures after cardiothoracic surgery. This group trained nurses and medical staff in the use of PDSA cycles, provided feedback on results of base-line measurements, used posters near the operating room, and appointed a quality-improvement team for the operating room. Staff were trained to engage in the following steps:

1. **Planning:** Identify potentially modifiable risk factors for wound infections in patients after cardiothoracic surgery and develop a pragmatic strategy to modify or prevent the occurrence of those risk factors.
2. **Do:** Collect base-line data, e.g., rates of compliance regarding the chosen indices of correct procedure (base-line measurement); carry out the planned intervention strategy; and collect basic data regarding the chosen indices of correct procedure (follow-up measurement).
3. **Study:** Analyze data; summarize the results; identify problems in the implementation of the designed intervention.
4. **Act:** Determine the overall success or failure of the intervention; identify potential modifications to improve the intervention strategy; update the intervention with solutions for the identified problems; prepare for the next cycle.

The authors reported increased compliance with recommended aseptic procedures following postoperative care of intravascular catheters and surgical wounds after one year of participation in a PDSA. A PDSA-cycle approach also has been advocated by some in the medical field to inform treatment of patients (Berwick, 1998). It also has been suggested that physicians be trained in the basic skills of data collection, presentation, and analysis so they can continually monitor progress of patient health in response to changes in treatment and use data to inform changes in treatments (Stalker, 2003; Berwick & Nolan, 1998).
Cycle of Improvement
The CQI strategy as applied to health care covers all relevant basic elements in the CCII cycle of improvement, since the core features of CQI are 1) collecting data on effectiveness, 2) analyzing and evaluating the data, and 3) assessing options and making decision based on that data—and and the subsequent repeat of all these steps until the group approaches the standards it aspires to achieve. Moreover, because CQI can be used to by individual doctors or entire hospitals, the strategy can be employed by participants at different levels within the system (this is also consistent with the theory of action for continuous improvement in education where teachers, schools, and/or districts can engage in the process).

Types of Papers
There are both qualitative and quantitative studies of CQI and a few systematic reviews of CQI. The following chart outlines the existing research and reviews on CQI resulting from searches in PubMed1 (combined in the tables are search hits for CQI, TQM, PDSA).

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<th>Type of articles</th>
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<td><strong>Total</strong></td>
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<td><strong>Total of all papers found</strong></td>
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Lessons From the Literature on CQI/TQM2
A scan of the papers on CQI/TQM suggests that there are relatively few controlled clinical trials testing the impact of CQI/TQM, and that the majority of the quantitative papers are simple clinical trials looking for effects, often without controls or comparison groups. This conclusion is supported by reviews on CQI /TQM (Shortell, et al., 1998). Thus, there are few rigorous quantitative studies to determine the impact of CQI/TQM. Moreover, a number of interventions have focused more on administrative processes and to a lesser extent on clinical services and patient outcomes. The impact on patients—a more relevant analogy to our education interests in continuous improvement—is even less clear (see section on relevance to education below).

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1 See Appendix A for details on the PubMed database.
2 Key points or points that may be of particular interest to members of CCII are in boldface.
However, of the studies on CQI that are available, systematic reviews suggest this strategy can yield positive effects on patient outcomes or health-care practices. However, the reviewers reported that higher quality studies using randomized controlled designs showed small to nonsignificant effects, and they were cautious in making claims about the effects of CQI on performance or outcomes (Shortell, et al., 1998; Wensing, et al., 2006). These reviewers also found that most studies were done at a single site, as opposed to multiple sites, and focused on narrowly defined practices in a single medical field (e.g., surgical care of prostate patients or compliance with hypertension guidelines for diabetics), rather than multiple fields. Thus, the generalizability of such studies is greatly limited. Moreover, the vast majority of studies in the reviews reported positive effects, which some suggest represents a bias towards publishing only positive results and therefore masks the true impact of the interventions. Scans of a number of clinical trials suggest that results within a single study often were mixed on measures of patient outcomes and/or health-care practice (Ferguson, 2003; Engles, et al., 2003; Solberg, et al., 2000; Laurila, et al., 2001; Goldberg, et al., 2002). For example, Ferguson and colleagues (2006) reported that only one of two process/care measures targeted for improvement in the treatment of coronary-artery-bypass graft surgery was positively correlated to the CQI intervention. Likewise, Rubenstein and colleagues (2006) reported that while the CQI intervention in primary clinics appeared to improve adherence to recommended practices for treating depression, there were no significant improvements in depression symptoms.

Regarding factors that can facilitate TQM/CQI implementation, there are few papers with solid methods, quantitative or qualitative, that identify critical factors influencing the implementation and maintenance of CQI programs in health-care settings. For example, often points raised were based on opinion of project leaders and not based on empirical data, often the specific interview or the surveys used were not discussed, and potential for bias existed for the investigator and/or the sample. However, we did find a few quantitative and qualitative papers with a moderate level of quality. By this we mean conclusions were based on empirical data; authors used a systematic or theoretical based approach grounded in thoughtful deliberation; the authors attempted to avoid bias; and conclusions were based on larger samples (or in some cases survey of all available literature). These papers identified positive and negative factors influencing CQI implementation (Huq & Martin, 2000; Lin, et al., 2005; Sila & Ebrahimpour, 2003; Maguerez, et al., 2001; La Brasseur, et al., 2002; Manley, 2000). Below are some of the key finding from these papers.

Huq and Martin (2000) found that eight cultural dimensions were helpful in distinguishing successful from unsuccessful CQI efforts: familiarity with TQM; measures of cost of quality; employee empowerment; performance appraisal; commitment to a continual-improvement, problem-solving approach; activities to remove barriers for reaching consensus; and education and training. Key points developed from the study were 1) “barriers to physician involvement and leadership may be the single most important issue choking successful implementation” and 2) “hospitals must establish clear job expectations and better understanding of the system, components and their interactions”.

Lin and colleagues (2003) found that “a dominant developmental culture, emphasizing readiness to meet new challenges, or a dominant group culture, emphasizing high cohesiveness and morale in the organization, is related to higher motivation”. However, it is important to point out that high motivation is not the same as highly successful implementation, so this conclusion is indirect. But given that other papers have cited low motivation as a major factor to successful implementation, this finding may have some relevance.

Maguerez, et al. (2001), examined 60 French hospitals that had implemented CQI programs in an attempt to characterize the programs and identify the factors that facilitated successful
implementation. They used qualitative methods and identified nine factors, which supported CQI literature from other fields:

- coherent overall management
- simple rigorous method
- voluntary participation
- good communication between the hospital and the project participants
- leadership qualities of people running the programs
- opinion leaders
- backing of hospital management
- up-front resources
- required support services

La Brasseur, et al. (2002), also tried to identify factors that influence CQI. They used surveys to measure CQI implementation and conducted a regression analysis to identify key factors. They found eight factors that explained over 50% of the variation of their dependent variable measuring CQI implementation:

- team skills and momentum
- clinical focus of projects
- structured relationship with suppliers
- vision/strategy and CQI linkages
- resources for and implementation of training programs
- teamwork and employee participation
- communication of new expectations by senior management
- involvement of medical professionals and physicians

Sila and Ebrahimpour (2003) examined studies on CQI across many fields and 23 countries and found that four factors can be commonly extracted from the papers (i.e., they found these factors in 65-85% of the papers examined and in 70-100% of the countries studied):

- top management commitment and leadership
- customer focus (i.e. internal and external customers)
- information and analysis
- training

The authors’ citing “top management commitment and leadership” speaks to the importance of leadership, commitment, and vision in implementing TQM, while “customer focus” speaks to an emphasis on analyzing and satisfying customers—who might be people using the products or services, or employees helping to provide or produce the services.

Manley (2000) engaged in an ethnography of a TQM program in a hospital and noted one common theme that appeared to be a barrier to implementation of TQM: tension between administration and staff on the issue of autonomy. Manley noted that “physicians perceived TQM as another effort to limit autonomy and tighten management control.” The author also noted that some administrators had a non-TQM orientation, passing blame on individuals, as opposed to the expected TQM orientation, focusing on teamwork and avoiding identifying individuals. Thus, the beliefs and attitudes of staff and administration clashed. Manley made the summary point that “the leaders of professional organizations have as much difficulty empowering professionals to solve the organization’s problems as professionals have relinquishing autonomy to organizational leaders.”
In addition to these few papers, there are a large number of case studies and reviews that discuss CQI/TQM programs and make comments as to what is critical or problematic to the success of a CQI/TQM program. These comments are for the most part based on opinion and not on rigorous methods with tested surveys or interviews. However, a number of factors facilitating the implementation of CQI repeatedly show up in the literature, suggesting there may be some legitimacy to some of these points. These facilitating factors include

- **the need to allocate and commit resources (financial, human, physical, time)** (Revere, et al., 2004; Benedetto, 2003; Christianson, et al., 2005; Maguerez, et al., 2001; LaBrasseur, et al., 2002);
- **the participation and buy-in or ownership of key staff (e.g., physicians)** (Christianson, et al., 2005; Loree, et al., 2003; Maquerez, et al., 2001; LaBrasseur, et al., 2002; Stagnaro-Green, et al., 1999; Chow-Chua & Goh, 2000);
- **the participation and understanding of the process by senior management** (Benedetto, 2003; Christianson, et al., 2005; Revere, et al., 2004);
- **having experts on the CQI/TQM as part of the project teams** (Revere, et al., 2004; Benedetto, 2003; Goldberg & Horowitz, 1999);
- **having accessible current data** (Sila & Ebrahimpour, 2003; Benedetto, 2003; Christianson, et al., 2005; Chow-Chua & Goh, 2000; Goldberg & Horowitz, 1999);
- **shared vision of mission and purpose—requiring good communication between administrators and staff** (Birleson, 1998; LeBrasseur, et al., 2002; Maguerez, et al., 2001);
- **management for change** (Benedetto, 2003; Chow-Chua & Goh, 2000).

Finally, we found only one research paper that systematically addressed the impact of policies on implementation of CQI programs. Wagner, et al. (2006), compared TQM systems in three European countries and were interested in whether government legislation or financial reimbursement could determine the successful or unsuccessful implementation of TQM (Wagner, et al., 2006). However, no such correlation could be found.

**Relevance to Education**

As mentioned above, CQI is a strategy to improve health care by collecting and analyzing data continuously to improve services; however, most people developing CQI strategies have targeted mostly administrative processes for improvement. For example, efforts have focused on improving the processing of records, reducing wait time for patients, cutting costs of health care, improving the distribution of educational materials to patients, and reducing unnecessary tests (Shortell, et al., 1998). The analogy in education would be processing student records, increasing communication with parents, and reducing costs. These services may be less relevant to the goal of CCII, which is to improve instruction through the collection and analysis of data continuously.

Nevertheless, CQI has been used to improve adherence to protocols to improve some patient outcomes such as infection rates after surgery, and there has also been much interest in using CQI strategies to track the outcome of individual patients after treatment (Staker, 2003; Berwick & Nolan, 1998). These latter examples are more in line with CCII’s vision of school improvement, which is to improve the academic achievement of students by making adjustments to instruction based on data gathered from student assessments. Unfortunately, the insights into CQI implementation used in this way are rather limited.

Even though some of the insights from papers on CQI in health care may be less relevant to the educational objectives of CCII, the general use of data to inform decisions compels one to take a hard look at this strategy to inform the CCII project. There are a number of similarities worthy of
consideration. For instance, continuous improvement in instruction requires the development of a learning organization where teams have to work together, where data has to be collected, where continuous monitoring has to be maintained, and where decisions have to be made based on data. Below are insights gleaned from the health-care literature relating to these points that CCII may want to consider in developing its model for the implementation of continuous improvement in instruction:

- Continuous improvement programs based on collecting data and making decisions in teams based on that data are time-intensive and cost-intensive, requiring a major commitment (in time and money) to engage in this type of activity.
- New skills will have to be developed (e.g., analyzing data, or using technology to accomplish data entry and analysis), and thus much attention has to be devoted to training and developing these skills.
- Experts in the process will have to be developed or maintained, requiring allocation of sufficient resources.
- Technology systems will have to be developed to support real-time data collection; therefore, resources have to be allocated and attention devoted to identifying appropriate systems as well as systems that are functionally compatible.
- Change leadership will be critical and may require attention to developing and training leaders to support change.
- Participation and buy-in by teachers and senior administrators will be necessary, and therefore incentives and strategies to inform and include administrators and key staff will be critical to consider.

2. Guidelines

**Description**
Guidelines—a term often used synonymously with clinical pathways—are “systematically developed statements to assist practitioner decisions about appropriate health care for specific clinical circumstances” (Field & Lohr, 1990). Initially developed by professional associations in the United States in the mid-1980s, guidelines are developed to guide clinical decision-making and can be used as tools in assessment of performance (Lanier, et al., 2003). Guidelines have been developed for a vast range of medical disciplines, including primary care, secondary care, and social care and in priority areas such as heart disease, diabetes, and mental health (Lanier, et al., 2003). The goal of guidelines is to develop a consensus, based on evidence, on how best to treat patients with specific conditions (McQueen, 2001), and they are seen as an avenue for bringing evidence-based medicine into practice and for promoting consistency in care among health-care providers.

Hundreds if not thousands of guidelines have been developed across North America and Europe. A case in point is the set of guidelines developed by the National Kidney Foundation (NKF) (http://www.kidney.org/professionals/kdoqi/guidelines.cfm). NKF has developed guidelines for diagnosing kidney disease based on specific measures of kidney function, monitoring patients with different diagnoses, and evaluating laboratory measurements for assessment of kidney disease. For dialysis alone, the National Kidney Foundation has developed as many as 114 guidelines (Kliger & Haley, 1999).

**Cycle of Improvement**
Guidelines provide standards for which to compare data and practice against, and thus help individual doctors or entire hospitals to analyze and interpret data. In addition, in some cases, guidelines also provide directives on how to treat patients and thus serve to help practitioners
make clinical decisions. Thus guidelines align with two basic elements of the CCII cycle of improvement: 1) analyzing and evaluating evidence, and 2) making decisions on how to proceed.

To illustrate these points, consider the National Kidney Foundation’s guidelines for patients with kidney disease. There are some guidelines that explicitly state how often physicians should check for coronary artery disease (CAD) in patients with kidney disease since CAD is common in patients with kidney disease. Such guidelines can serve as a standard by which to measure practice in the clinic if the clinic collects data on how often they check all their kidney disease patients for CAD. Physicians might also use these guidelines to compare their own current monitoring practices of CAD to what is recommended in the guidelines and thus evaluate their own practice (e.g., if the guidelines suggest checking for CAD every 12 months, but this is happening every 24 months in their practice, then physicians can determine how far off they are from best practices). Finally, guidelines can provide appropriate routes for improving practice. For example, if a patient’s kidney function is measured and determined to be at a dangerously low level, the National Kidney Foundation’s guidelines can be used to determine the course of action that should be taken with that specific patient.

Types of Papers
There are reviews on the use of guidelines, some of which are systematic reviews providing quantitative or qualitative descriptions, and there are research studies, both qualitative and quantitative, looking at everything from impact on clinical practice to impact on health outcomes. The following table outlines the papers relating to guidelines and quality improvement found on Pub-Med.

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Lessons From the Literature on Guidelines
A scan of a number of papers (Table 2) suggests there is much written about guidelines because many guidelines have been developed over the last few decades for a range of practices—from generalist to specialist. A survey of the literature suggests that the majority of clinical studies examining the effects of guidelines on practice and outcomes showed positive effects of
guidelines—in fact in some reports as many as 86% of the studies have revealed a positive effect of guidelines on practice (Ferris, et al., 2001; Grimshaw, et al., 2006). However, a review of guidelines in nursing failed to show significant findings in some interventions (Thomas, et al., 1999). One study noted that guidelines alone have no effect on the performance of physicians (Palmer, et al., 1996), but that guidelines combined with feedback does have an effect. Thus, it is not the case that all studies have revealed positive impacts, but rather a mixed record is apparent in the literature on the effectiveness of guidelines. Moreover, the impacts of guidelines generally are modest.

A review of a sampling of interventions to improve quality finds that many studies have included guidelines as part of a multimode strategy (e.g., with feedback, as part of information technology, or as part of a CQI intervention). However, two major limitations of guidelines have been pointed out: 1) guidelines are only as good as the evidence they are based on—poorly designed studies of effectiveness may lead to the development of inappropriate or ineffective guidelines—and 2) blindly following guidelines can sometimes do more harm than good (Woolf, et al., 2006). In addition, while guidelines in theory are to be based on evidence-based medicine, in practice the development of guidelines is influenced by opinion, clinical experience, and the makeup of the guideline development group (Woolf, et al., 2006), any of which can jeopardize their validity.

In the United States, dissemination of guidelines is decentralized. However, in European countries such as Britain, guidelines are disseminated uniformly by clinical governing structures so that all doctors receive them (Lanier, et al., 2003). Dissemination strategies for guidelines have not been well studied quantitatively (Thomas, et al., 1999); however, it has been noted that the Netherlands studied this question and found that 70% of family doctors in that country voluntarily use guidelines (higher than most family doctors for other countries) (Lanier, et al., 2003). This level of adoption may be due to “intensive procedures for development, authorization, and disseminations of standard formats easily applied in hard copy or office computer systems” (Lanier, et al., 2003). Thus it is possible that policy supports that target development and dissemination may be necessary to promote the uptake of guidelines.

Some content reviews have indicated that guidelines should first be evaluated and then adapted to local environments (Graham & Harrison, 2006). Similarly, some have commented that guidelines should be an integral part of a CQI programs and that guidelines should be locally adapted and changed based on collected pilot data (Klinger & Haley, 1999; Conroy & Shannon, 1995). Thus a few groups have developed strategies for developing and evaluating guidelines (Calderon, et al., 2006; Baker, et al., 2003; AGREE collaboration, 2003). These strategies focus on evaluating the evidence backing recommendations, costs and benefits analysis, and analysis of the clarity of recommendations. One group developed a strategy aimed at developing local guidelines through a prioritized review and feedback process and attempted to evaluate its impact on guideline use; however, this strategy failed to show significant changes in use of guideline in randomized controlled trials (Baker, et al., 2002).

Implementation strategies for guidelines have been systematically reviewed (Conroy & Shannon, 1995; Grimshaw, et al., 2004). Simply providing information is not viewed as a successful strategy to change clinical practice and improve adherence to guidelines; instead, strategies that employ feedback and individualized educational packages are viewed as more effective strategies. Grimshaw, et al. (2004), have further identified ineffective and effective strategies for implementing guidelines and have found that printed educational materials and didactic education sessions are ineffective, whereas reminders and/or prompts at time of consultation and educational outreach (known as academic detailing) have the most promising impacts on changing practice. Academic detailing is a one-on-one strategy similar to those used
in the pharmaceutical industry and involves educational visits, information transfer, and a marketing strategy. Some key elements of this strategy involve understanding baseline knowledge and motivation for current clinical practices, defining clear educational and behavioral objectives, establishing credibility, and providing unbiased source of information, stimulating physician participation in the process, using concise educational materials that highlight and repeat key messages, and providing positive reinforcement (Conroy & Shannon, 1995; Soumerai, 1990). However, it is worth noting that the authors of reviews on strategies for implementing guidelines comment that the evidence base is thin and most studies are not well designed and point out that this limits the strength of these recommendations at this time (Grimshaw, et al., 2004).

In addition to the thin research base and poor research design, the research on guideline implementation is mixed and one can find research that shows both no impact and positive impact for the same strategy of guideline implementation. For example, some studies suggest multifaceted approaches to implementing guidelines (meaning more than one strategy used to implement the guideline) are more effective than single interventions (Wensing, et al., 1998), and yet some studies suggest that multifaceted interventions are not necessarily more effective than single interventions (Grimshaw, et al., 2006).

Regarding perceptions of guidelines by practicing physicians, Tunis, et al. (1995), conducted a survey of general internists on their perceptions of guidelines and found that 20% of the surveyed physicians felt that guidelines were a threat to their autonomy suggesting that a significant fraction of physicians feel uncomfortable relying on guidelines. These surveys also revealed significant variation in the familiarity with guidelines ranging from as low as 11% to as high as 60% for specific guidelines. This suggests that many physicians may simply be too unaware or unfamiliar with guidelines to follow them.

Some studies based on surveys of physicians or systematic reviews of other studies on guidelines have identified a number of attributes that promote guideline use by physicians (Burgers, et al., 2003; Grol, et al., 1998). The following features of guidelines facilitate guideline use:

• compatible with existing norms and values
• not too controversial
• easy to follow
• not requiring substantial changes to fixed routines
• precisely stated
• based on scientific evidence

Some have also suggested that locally developed guidelines promote a sense of ownership and participation in guidelines (Conroy & Williams, 1995). In addition, a number of factors that deter guideline use have been identified (Burgers, et al., 2003; Grol, et al., 1998). The following features of guidelines correlate with less compliance:

• too complex
• requiring new knowledge or skills
• too vague

Regarding reasons why physicians fail to follow guidelines, several factors have been identified (Cabana, et al., 1999):

• lack of awareness, familiarity and experience with guidelines
• lack of agreement on recommendations
• lack of self-efficacy (believing that he/she can actually carry out the recommendation)
- **lack of outcome expectancy (believing that the recommendation will lead to improved outcomes)**

Some key factors that best predict a physician’s use of guidelines relate to how immediate and important the guidelines are viewed by physicians—specifically, a patient’s own request, perceptions for the possibility for malpractice ramifications, and perceived cost-effectiveness (Goldfarb, 1999).

Barriers unrelated to either guidelines format and content or physician attitudes also have been identified, such as patient-related barriers (e.g., the inability of patients to follow recommendations) or external barriers (e.g., the need for new resources, technologies, or specialized employees to carry out specific recommendations) (Cabana, et al., 1999).

Finally, qualitative studies have been carried out that examine the development of guidelines, and one in particular characterized the interactions between participants and in the guideline development process and through analysis of transcriptions, and identified some core themes regarding the process. **Participants were found to use a diversity of forms of knowledge when considering guidelines, and these knowledge forms can best be characterized as scientific, practical, political, and process oriented.** Scientific knowledge is concerned with robustness of the evidence; practical knowledge is concerned with the practical usability of the recommendations by physicians; political knowledge is concerned with the acceptability of the recommendations by other stakeholders; and process-oriented knowledge is concerned with adequacy of progress being made in carrying out the task charged to the guideline development group (Moreira, 2005). This study reveals a complex picture of guideline development that suggests multiple factors are at play when guidelines are developed.

In summary, a number of papers have commented on the impact of guidelines on clinical performance and patient outcomes as well as the barriers and facilitators to implementing guidelines in health care (Conroy & Shannon, 1995; Grol, et al., 1998; Cabana, et al., 1999; Freeman & Sweeney, 2001; Burgers, et al., 2003; Eccles & Grimshaw, 2004; Grimshaw, et al., 2004; Grimshaw, et al., 2006). These papers vary in methodology and quality from opinion, to survey of physicians, to systematic review of the literature on guideline implementation, and thus the validity of the conclusions from some of these studies is weakened. However, a number of common themes about guideline implementation emerge from these papers:

- format and clarity of guidelines can influence uptake;
- complexity of guidelines can influence uptake;
- familiarity with, awareness of, and experience with guidelines can influence uptake;
- organizational barriers can pose a threat to uptake;
- physician perceptions (either of patients or of guidelines) can influence uptake; and
- requirements for change in existing routines, norms, or values can pose challenges to uptake.

**Relevance to Education**

Guidelines in medicine can be relevant to education in at least two different ways. First, guidelines in education could be developed that outline how to diagnose and adapt instruction according to different populations of students identified through diagnostic assessments. Second, guidelines could be developed that outline how best to implement a continuous improvement program in schools and districts. In the former case, more insights can be gained from guidelines in medicine. Guidelines would be a very useful resource in helping teachers diagnose and adapt instruction according to the learning difficulties identified since little is currently available to aid teachers in this area. Formative assessment experts contend that a key aspect of formative
assessment is the use of data to inform and adjust instruction (Black & William, 1998). If a teacher does not take action, the assessment ceases to be formative; therefore, having guidelines would provide needed assistance on how to adjust instruction. However, it is not clear that high-quality guidelines can be developed in education. As discussed in the medical literature, guidelines are only as good as the evidence on which they are based on and unfortunately in many areas, there is a lack of rigorous evidence to support specific actions that teachers should take in a particular circumstance. Medicine has one advantage over education: In medicine, there are more randomized controlled studies that provide rigorous quantitative evidence to support specific courses of action. However, even in medicine there are fewer quality controlled studies than would be hoped for; thus, even in medicine guideline quality varies. Thus, in education, guidelines would have to be limited to areas where researchers have the greatest depth of understanding. If such guidelines were developed, then a few lessons from studies of medical guidelines would be relevant:

- It will be necessary to gain buy-in by practitioners (teachers).
- Guidelines would need to be specific, clear, and backed by evidence (local evidence may be especially helpful to promote uptake).
- Following guidelines should not require major changes in values or norms.
- It may be helpful to adapt guidelines to local needs, and this may require the participation of practitioners and administrators.
- Technology with guidelines linked to feedback and reminder systems may promote use of guidelines.

3. Benchmarks

Description
Benchmarking traces back to the quality-improvement approach implemented by industry (Ellis, 2006; Camp, 1989). Essentially, a benchmark is a point of comparison against which individuals in a system can be compared (Ellis, 2006; Codling, 1992). A benchmark is intended to reflect best practice and allow others to compare their performance against that standard (Ellis, 2006). According to the Department of Trade and Industry, a benchmark “quantifies the improvement required and qualifies the type of information necessary” (p. 10). The health-care industry began discussing the use of benchmarks in the mid-1990s (Phillips, 1995). In health care, benchmarks provide both a measurement by which to compare health-care practices and a goal that practitioners should strive to achieve (Ellis, 2006).

Different types of benchmarks have been used in health care including 1) competitive benchmarks, in which performance measures are used to compare how well or badly a person or organization is performing against competitors; 2) comparative benchmarks, in which the focus is on how similar functional activities are handled in different organizations; 3) collaborative benchmarks, in which the focus is on sharing knowledge about a particular activity; and 4) clinical benchmarks, in which the focus is on the structured comparison and sharing of best practices of clinical care (Ellis, 2004). Moreover, benchmarks have been used to measure performance, practice, and patient experience (Ellis, 2004). Benchmarking can thus support a CQI program and can be used to examine either patient outcomes or practice (Ellis, 2006). In fact, some view benchmarks as an “integral part of total quality management” (Ellis, 2006; Hertz, et al., 1994).

Currently, many quality-improvement programs provide health-care providers with benchmarks and averages to aid in the transition from “measurement of performance to performance improvement” (Weissman, et al., 1999). The rationale for this strategy is that knowledge of one’s
own performance relative to an average will motivate one to improve (Weissman, et al., 1999). An example is the “Achievable Benchmark of Care” (ABC Benchmark), which provides summaries of the performance of the top-ranked providers caring for 10% of the patient pool (Weissman, et al., 1999). ABC benchmarks have been developed for mammography and give the fraction of women actually getting mammograms by the best providers out of the number of women who should be getting mammograms based on best practices. For example, an ABC of 36% in Alabama suggests that among top providers in Alabama, only 36% of the women who should be getting mammograms are actually getting them (Weissman, 1999). In some cases, this information is sent to clinics and physicians so they can evaluate their own practice (Kief, et al., 2001).

**Cycle of Improvement**

In CCII’s model of continuous improvement, benchmarks would align with the basic element of analyzing and interpreting data. Benchmarks provide concrete quantitative and in some cases qualitative measures of clinical performance or provider process. They allow one to interpret performance and understand what progress has been made towards achieving desired standards of care.

**Types of Literature Found**

There are relatively few qualitative and quantitative studies that focus exclusively on benchmarks and no systematic reviews were found. The following chart outlines the existing research and reviews on benchmarks resulting from searches in PubMed when searched with *quality improvement* as a limiting key phrase.

<table>
<thead>
<tr>
<th>Table 3. Summary of research publications on Benchmarks</th>
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<tbody>
<tr>
<td><strong>Type of articles</strong></td>
</tr>
<tr>
<td>Reviews</td>
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<td></td>
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<tr>
<td>Research studies-qualitative</td>
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<tr>
<td>Research Studies-quantitative</td>
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<td><strong>Total of all papers found</strong></td>
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</table>

**Lessons Learned From the Literature on Benchmarks**

There are a limited number of studies analyzing the effects and usefulness of benchmarks for *quality improvement in health care* (see Table 3); thus, there is very little to say about the effectiveness of benchmarks. However, a review of the literature reveals several criteria for successfully incorporating benchmarks into the cycle of improvement. These criteria were deduced from qualitative studies that interviewed or surveyed physicians and hospital management that implemented benchmarks in an effort to improve the quality of care in their hospital. We caution that the quality of these papers is suspect given the potential for bias in their methods; nevertheless, we report on what has been found.
Studies emphasize the importance of deriving benchmarks from quantitative data instead of relying upon expert opinions (Weissman, et al., 1999; Bissell, 1999). Data provide a concrete measure to determine if the hospital is reaching its desired goals. Additionally, quantitative data enable benchmarks to be created in a reproducible, predetermined manner (Ellis, et al., 2000). However, benchmarks need to be continually updated to reflect the most recent data available to ensure their accuracy and maintain attainability (Bissell, 1999; Mehrotra, 2003).

One study found that benchmarks can be used to help structure feedback to physicians by providing a standard comparison or norm (Mehrotra, et al., 2003). Physicians were able to gain a better understanding of their performance by comparing their results to the benchmarks without being directly contrasted to their peers. However, benchmarks proved more successful as a tool of comparison if practitioners were part of the process to gauge their work within their own organization (Ellis, et al., 2000; Mehrotra, et al., 2003).

Relevance to Education
Benchmarks in medicine have been used to measure the use of best practices—for example, looking at the frequency of mammograms being given to women at risk for breast cancer by specific doctors or at specific clinics compared with established best practice (Weissman, et al., 1999). An analogous scenario in education might be a look at the number of teachers in a district applying formative assessment in their classrooms and modifying instruction based on results from those assessments. However, education currently has few such benchmarks and emphasis is placed instead on measuring student performance. We suggest benchmarks could be used to continually assess quality improvement at all levels of the education system (students, classrooms, schools, etc). Much like physicians, teachers operate independently from one another and might have a difficult time perceiving their performance relative to their peers. Benchmarks would provide a vehicle for teachers to examine their productivity and compare it with that of other teachers in their school, district, state, or country.

Selecting the proper outcome measure and collecting current data on that outcome become critical for implementing benchmarks in education. Medical literature suggests that practitioners need current data that gets updated regularly in order to chart patient progress. This stipulation, when applied to education, would require constant assessment that most likely would take the form of testing and more likely would focus on students and to a lesser degree on teachers. To implement benchmarks, the education field would have to develop measures not only for students but for teachers. Another lesson from medicine would suggest that teachers should be part of the process of benchmark development.

4. Audit and Feedback

Description
Audit has been defined as “any summary of clinical health care performance over a specified period of time given in written, verbal, or electronic form … [t]he summary may include data on process of care (e.g., number of diagnostic tests ordered), clinical endpoints (e.g., blood pressure readings), and clinical practice recommendations (e.g., proportion of patients managed in line with a recommendation)” (Jamtvedt, et al., 2004). Studies of audit and feedback date back to the early and mid-1980s (Linn, 1980; Martin, et al., 1980; Cohen, et al., 1982; Marton, et al., 1985; Chassin & McCue, 1986; Jamtvedt, et al., 2006) and have been relatively extensively reviewed (Buntinx, 1993; Balas, 1996; Thomas-O'Brian, 2000; Stone, et al., 2002; Jamtvedt, 2003; Grimson, 2004; Foy, et al., 2005; Jamtvedt, et al., 2006). The National Institute of Clinical Excellence in Britain extends this definition to include audit as a central component of any quality-improvement strategy and defines audit as
…a quality improvement process that seeks to improve patient care and outcomes through systematic review of care against explicit criteria and the implementation of change. Aspects of the structure, processes, and outcomes of care are selected and evaluated against explicit criteria. Where indicated, changes are implemented at an individual, team, or service level and further monitoring is used to confirm improvement in health care industry (Field & Lohr, 2002).

Studies of audit and feedback in health-care settings have ranged from single-mode intervention, where audit and feedback is the only strategy to improve practice, to multimodal interventions, where feedback and audit is part of a set of several strategies to improve practice (Jamtvedt, et al., 2006). Some interventions have incorporated intensive, active forms of audit and feedback, where feedback is provided at an individual level in a verbal format from a supervisor or senior colleague, to nonintensive, passive forms of feedback, where feedback is provided in a written format in a group effort, not from a supervisor (Jamtvedt, et al., 2006).

An example of an audit-and-feedback intervention is illustrated by Mitchell and colleagues (2005), who developed a program that targets patients with hypertension. In this intervention, physicians from general-practitioner clinics received feedback in an electronic format annually for three years. The audit involved collecting patient information such as blood pressure, presence of risk factors (e.g., smoking, diabetes, and stroke), diagnosis for hypertension (e.g., has hypertension or does not have hypertension), and state of treatment for hypertension (e.g., not being treated or is being treated). This information was collected, compiled, and computed to obtain information for each provider regarding percentage of patients in a given blood-pressure range, percentage of patients who have been diagnosed (or undiagnosed) with hypertension, and percentage of patients being treated (or not treated) for hypertension. In addition, patients deemed at high risk of death due to stroke in the next 10 years were ranked and highlighted. Finally, physicians could see their patient data relative to those of other providers in the area. All this information was sent to the physicians in the hope that its receipt would lead to action by physicians and increase the identification of patients at risk for hypertension (Mitchell, et al., 2005).

Cycle of Improvement
In the CCII model of continuous improvement, audit-and-feedback systems would align with collecting data since these systems often involve the collection, consolidation and distribution of data to health-care providers. However, audit and feedback also aligns with analyzing and interpreting data, and in some cases even making decisions. For example, comparison data on the number of mammographies administered can help practitioners understand how they are performing and meeting the needs of their patients relative to other doctors. In addition, when coupled with feedback systems that provide clinical reminders, physicians can get help in making clinical decisions, such as when to administer a mammography for a particular patient.

Types of Papers
There are both reviews on audit and feedback, some of which are systematic reviews providing quantitative or qualitative descriptions, and research studies, both qualitative and quantitative, looking at everything from impact on clinical practice to impact on health outcomes. The following chart outlines the existing research and reviews on audit and feedback resulting from searches in PubMed (note, audit and feedback were searched separately, and there may be some overlap in the hits).
Lessons From Literature on Audit and Feedback

We read a number of systematic reviews and several clinical studies that have examined the effect of audit and feedback on physician performance and patient outcomes. A scan of the literature reveals that a number of interventions in medicine to improve quality of care have used audit and feedback as part of a multimodal quality improvement plan. A recent comprehensive systematic review of 118 clinical studies involving audit and feedback by Jamtvedt, et al. (2006), indicates audit and feedback can be effective at improving health-provider practice. However, they noted that effects were “generally small to moderate” and that the effects were greater when base-line adherence to recommended practice was low and feedback was more intensively delivered (i.e., actively received by a supervisor in verbal form). The reviewers also found no significant difference between audit and feedback alone versus audit and feedback in conjunction with other interventions such as educational meetings or other multifaceted approaches.

Table 4. Summary of research publications on Feedback

<table>
<thead>
<tr>
<th>Type of articles</th>
<th>Subcategory</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviews</td>
<td>Meta-analysis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Consensus reviews</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
</tr>
<tr>
<td>Research studies-qualitative</td>
<td>Interviews</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Focus group</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Content analysis</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
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</tr>
<tr>
<td>Research studies-quantitative</td>
<td>Clinical trials</td>
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<tr>
<td></td>
<td>Controlled clinical studies (nonrandomized)</td>
<td>8</td>
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<tr>
<td></td>
<td>Randomized clinical trials</td>
<td>11</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>135</strong></td>
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<tr>
<td>Research studies-mixed methods</td>
<td>Randomized clinical trials</td>
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</tr>
<tr>
<td></td>
<td>Clinical studies</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
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<tr>
<td><strong>Total of all papers found</strong></td>
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<td><strong>169</strong></td>
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Table 5. Summary of research publications on Audit

<table>
<thead>
<tr>
<th>Type of articles</th>
<th>Subcategory</th>
<th>Number</th>
</tr>
</thead>
<tbody>
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<td>Surveys</td>
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<tr>
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<td><strong>Total</strong></td>
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<td>Research studies-quantitative</td>
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<td>Controlled clinical trials (nonrandomized)</td>
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<td>Randomized clinical trials</td>
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<td></td>
<td><strong>Total</strong></td>
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<td>Research studies-mixed methods</td>
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<td>Clinical studies</td>
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</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
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</tr>
<tr>
<td><strong>Total of all papers found</strong></td>
<td></td>
<td><strong>112</strong></td>
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</table>

Lessons From Literature on Audit and Feedback

We read a number of systematic reviews and several clinical studies that have examined the effect of audit and feedback on physician performance and patient outcomes. A scan of the literature reveals that a number of interventions in medicine to improve quality of care have used audit and feedback as part of a multimodal quality improvement plan. A recent comprehensive systematic review of 118 clinical studies involving audit and feedback by Jamtvedt, et al. (2006), indicates audit and feedback can be effective at improving health-provider practice. However, they noted that effects were “generally small to moderate” and that the effects were greater when base-line adherence to recommended practice was low and feedback was more intensively delivered (i.e., actively received by a supervisor in verbal form). The reviewers also found no significant difference between audit and feedback alone versus audit and feedback in conjunction with other interventions such as educational meetings or other multifaceted approaches.
interventions. These authors noted several limitations including small sample size, poor experimental design, potential sample biases, and lack of clearly defined methods for randomization, concealment, and efforts to avoid contamination. In addition, some studies lacked follow-up and base-line data, and many studies did not have a controlled randomization design to maximize strength of conclusions. We note, through a scan of the literature, that many studies are not generalized to other areas of medicine because the studies tend to focus on one site, or on a single field of medicine, or on a limited set of interventions. Others have cited these methodological problems as plaguing many of the studies targeting other quality-improvement strategies (Thomas, et al., 1999; Foy, et al., 2005).

Foy, et al. (2005), examined clinical studies of audit and feedback to determine if there is empirical evidence to support use of audit and feedback to improve quality of care. They found that while the evidence supports the general conclusion that there is a mild effect of audit and feedback on changing health-care professional practice, there is little evidence to inform how audit and feedback should be prepared, delivered, encouraged, or enforced, or how intense it should be because the evidence is quite heterogeneous and lacks consistent comparable groups and interventions.

The qualitative literature, mostly comprising interviews and focus groups, highlights several factors that contribute to the success of an audit and feedback intervention (although we caution that conclusions from this research are weakened by poor qualitative evaluative methodology). This research suggests that physicians’ perceptions of the auditors and assessment tools impact the success of the audit and feedback. Doctors’ views about the quality of the auditors highly influenced their likelihood of listening to and following the feedback (Sargaent, et al., 2005; Walshe, et al., 2001). This contributed to a diminished effect from the audit and feedback because physicians’ belief about the auditor’s bias contributed to their lack of following feedback (Jamtvedt, et al., 2006). Additionally, it appears important that physicians understand the tools used to assess them during the audit (Sargaent, et al., 2005; Stevenson, et al., 2001; Walshe, et al., 2001). It was also found that audit and feedback has a greater effect when physicians are involved in designing the assessment tools and have an understanding of the assessment process (Stevenson, et al., 2001).

Besides physician involvement in the audit, clear and understandable feedback was also found to be crucial to the success of the intervention. Researchers found that vague feedback was commonly ignored, while practitioners were more likely to follow specific feedback. (Sargaent, et al., 2005; Walshe, 2001). Research also found that positive attitudes were not associated with a successful audit or compliance to the feedback (Stevenson, et al., 2001). When asked about their views on the process, physicians and administrators complained that the audit and feedback intervention required too much valuable time (Walshe, et al., 2001) and did not provide new ideas or prove useful (Walshe, et al., 2001; Stevenson, et al., 2001).

Relevance to Education
There needs to be a measurable outcome to assess in order to conduct an audit and provide feedback. The education field has developed many tools for assessing students, but it does not have an agreed-upon measure for teacher quality (a theme similar that that mentioned for benchmarking); thus the analogous strategy to audit and feedback in medicine would be challenging to implement in educational settings. However, we can look at the traits of a successful audit and feedback program in the medical field to predict the potential problems of designing one for education. We have learned from medicine that physicians and administrators should be involved in designing the assessment tool used for auditing so that they become part of the process and understand how they are evaluated, and that the feedback should be specific. The
analogy to education would be to have teachers and their administrators involved in the design of the assessment tools for auditing and feedback. In addition, feedback on instruction or student progress should be specific and not vague.

5. Information Technology

Description
The PubMed database shows a number of terms relating to information technology (IT) in the service of quality improvement, including electronic medical record systems, clinical decision support systems/computerized decision support systems, and evidence-based databases. Numerous computer-based systems have been developed to assist health-care providers in improving quality or efficiency of care. Chaudhry and colleagues (2006) have categorized the various health-care management functions of computer-based systems into the following groups:

- electronic health records
- computerized provider order entries
- clinical decision support
- electronic results reporting
- consumer health information/patient-decision support
- mobile computing
- telemedicine (data-interchange based)
- electronic health communication
- administration
- data-exchange networks
- knowledge retrieval systems

The functional capabilities of these systems have further been categorized by Chaudhry and colleagues (2006) in the following dimensions:

- clinical documentation (health information/data)
- results management
- order-entry management
- decision support
- electronic communications and connectivity
- patient support
- administrative processes
- reporting and population health

Some systems carry out a single function, while many others carry out multiple functions and integrate patient records, clinical guidelines, reminders, and feedback (Bennett & Glaszious, 2003; Chaudry, et al., 2006; Sim, et al., 2001; McDonald, 1997). A majority of studies evaluating the impact of computer-based systems has focused on clinical-decision support; fewer but still significant numbers of studies have focused on electronic-record systems and computerized provider-order entry systems (Chaudry, et al., 2006). Reasons put forth for encouraging the use of computer-based systems focus on their potential to reduce medical errors (Bates, et al., 2001), facilitate the transfer of evidence-based medicine into practice and adherence to guidelines (Sim, et al., 2001), and provide “essential infrastructure for quality assessment and improvement ... ” (Henry, 1995).

An example of an IT system that can be used to support continuous improvement is the ATHENA decision-support system used in Veterans Administration centers in Northern California and North Carolina (Goldstein, et al., 2004). This system was developed to facilitate the transfer of
evidence-based research on hypertension into primary care in clinics and to guide patient-specific clinical decisions. It contains electronic medical records, with information such as blood pressure, pulse, height, and weight, all with corresponding dates; types and dosages of medications; and scheduled office visits for each patient. This system combines patient information with guidelines (along with interpretations of those guidelines) and advisories regarding the treatment of patients with hypertension. A graphical interface facilitates ease of use by attending physicians and enables attending physicians to provide feedback. In addition, the system allows for computer-generated evaluation by capturing patient data, recommendations for patient care, feedback from physicians, and the level of clinical usage of the system (the system keeps track of the number of screen clicks indicative of system usage).

Other examples of IT to support continuous improvement are found in evidence-based databases like FIRSTConsult, InfoRetriever, and UptoDate (Burkiewicz, et al., 2005), all of which are meant to be used by practicing physicians. FIRSTConsult is a database of evidence-based summaries based on other sources of research reviews such as Cochrane Database of Systematic Reviews and the National Guidelines Clearinghouse. InfoRetriever also provides summaries of evidence, but the emphasis is on studies that evaluate patient outcomes such as mortality or quality of life (Burkiewicz, et al., 2005). These summaries include clinical questions and short, bottom-line answers. InfoRetriever also allows a physician to search other databases such as Cochrane Systematic Reviews as well as abstracts of guidelines, clinical decision rules, and diagnostic test calculations. UptoDate includes topic reviews written by experts and reviewed by physician editors and peer reviewers. UptoDate also includes pharmaceutical information for medical specialties (Burkiewicz, et al., 2005). All three can be used with personal data assistants (PDAs). These databases have topic menus that enable physicians to identify topics of interest. Thus, all three of these tools allow providers an opportunity to quickly determine what the research says regarding specific diagnoses so they can rapidly assess their options for treating patients.

**Cycle of Improvement**

Regarding the cycle of continuous instructional improvement described by CCII, information systems (depending on the type of system) can support a number of elements in the cycle, including

1) collecting data through data and record-management systems;
2) analyzing data through data and record-management systems;
3) searching for options helping make decisions through searchable evidence-based databases, systems that provide clinical options, links to guidelines, or summaries of current evidence-based practice;
4) making decisions by providing reminders; and
5) monitoring progress through management systems that store old records and provide representations of progress.

**Types of Papers**

There are both reviews of information technology, some of which are systematic reviews, and research studies, both qualitative and quantitative, looking at everything from impact on clinical practice to impact on health outcomes. The following chart outlines the existing research and reviews on information technology resulting from searches in PubMed (this chart represents hits for clinical decision support systems, electronic records management, and computerized decision support).
Table 6. Summary of research publications on Information Technology Support Systems

<table>
<thead>
<tr>
<th>Type of articles</th>
<th>Subcategory</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviews</td>
<td>Meta-analysis</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Research studies-qualitative</td>
<td>Interviews</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Focus groups</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Content analysis</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Research studies-quantitative</td>
<td>Clinical trials</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Controlled clinical trials (nonrandomized)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Randomized controlled trials</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>87</td>
</tr>
<tr>
<td>Research studies-mixed methods</td>
<td>Randomized controlled trials</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Clinical studies</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Total of all papers found</strong></td>
<td></td>
<td>133</td>
</tr>
</tbody>
</table>

Lessons From the Literature on Information Technology (IT)

We have read a number of reviews and several clinical studies describing or examining the effects of IT on professional practice and patient outcomes. A systematic review of information technology on health-care quality, efficiency, and costs indicates there is not enough solid quantitative research to judge the effect of information technology (Chaudrhy, et al., 2006). However, they cite four institutions that have produced a large portfolio of studies on information technology: Regenstrief Institute, Brigham and Women’s Hospital, Department of Veteran Affairs, and LDS Hospital. The reviewers state that the major effect of IT systems on quality of care is in increasing adherence to guidelines (such as increased delivery of pneumococcal vaccinations as advised in primary-care guidelines) or protocol-based care, and note that clinical-decision support, usually in the form of reminders, is a major component of studies looking at adherence (Chaudrhy, et al., 2006). The reviewers also suggest that information technology can improve the monitoring of clinical cases and can reduce medication errors. However, others suggest that while there are some studies that support this viewpoint, few are randomized controlled trials and therefore should be viewed with caution (Walton, et al., 2001).

Another systematic review of clinical-decision support systems suggests that these systems can improve physician performance on drug dosage and preventative care, but not confidently on diagnosis (Hunt, et al., 1998). Finally, another systematic review suggests that clinical-support systems can improve practice through feedback and reminders (Bennett & Glasziou, 2003). Reviewers have cited the lack of good-quality, randomized, controlled studies as a problem with assessing the impact of information technology (Tan, et al., 2006; Walton, et al., 2001).

Findings from qualitative research on the use of information technology for quality improvement fall into one of two categories: 1) problems with IT programs and 2) characteristics of successful IT programs (although we caution again that many of these studies suffer from weak methodology and design). With regard to problems with IT, overall, it has been reported that there is a generally negative attitude toward IT programs among physicians and administrators. Clinicians are skeptical of recommendations from computer systems (Miller,
They lack trust in information provided by the “anonymous” IT source and fear that patients will lack confidence in their doctor if the doctor consults a computer (Short, 2004). Regardless of physician and patient perceptions, there are some tangible problems with IT use for quality improvement in medicine. Clinicians and managers complained that they do not have enough time to consult, input, or interpret data from an IT system. Many said that the IT systems consume more of their time and do not help them reduce time per consultation (Short, 2004; Kleinke, 1998; Tierney, 1995). Physicians said that they average 10 to 15 minutes with a patient and that they look for ways to be more efficient. They claimed that IT quality improvement systems add another task they need to complete during their limited time. Managers also complained about limited time and a need for efficiency. There are large up-front costs installing and implementing an IT system with unknown benefits; thus, managers are skeptical about cost efficiency of IT systems (Miller, 2004; Kleinke, 1998; Mathews, et al., 1996).

There are several factors contributing to administrators’ views that IT systems are not cost-effective:

- There are many electronic medical records systems that advertise different features.
- Managers have a difficult time negotiating the many options available and determining which best fits their needs.
- Departments within a hospital or across hospitals use different systems, many of which are incompatible with each other. This lack of consistency causes problems transferring data and communicating between staff.
- Technology is changing too fast for hospitals to keep up with the latest system requirements.

The result is that IT systems are perceived as too costly (Kleinke, 1998; Mathews, et al., 1996).

Although there is an overall negative view of IT systems, the literature in medicine identifies several necessary factors for the successful implementation of an IT system. Knowledge of and skills using technology and the implemented system prove critical. Physicians with familiarity and knowledge of computers had much more success utilizing IT support systems and EMRs (Colombet, et al., 2003; Frankel, 2005; Miller, 2004; Short, 2004; Kleinke, 1998; Tierney, 1995). Additionally, clinicians felt it was very important to receive extensive training for any new system being implemented (Miller, 2004). Many complained that their minimal training fell short of meeting their needs (Colombet, et al., 2003).

Besides having the capacity to use the system, physicians found that data analysis and interpretation skills also proved necessary. Clinicians and managers indicated that they lacked the knowledge to interpret the data and understand the statistics presented in the software programs. Additionally, even if the clinicians could understand the data, they said they struggled to interpret the information in a manner understandable to the patients (Colombet, et al., 2003; Short, 2004; Mathews, et al., 1996; Kleinke, 1998).

According to a veteran in IT for three decades, continual roadblocks to implementation and successful spread of IT include a lack of standardized electronic interfaces and a lack of a system to efficiently capture physician information (McDonald, 1997).

**Relevance to Education**

IT is viewed as a key means of supporting the successful implementation of CQI, audit and feedback, benchmarking and guidelines in medicine. In educational settings it is not difficult to consider the analogies. In fact, IT systems already are in place in many schools and districts. Some school and districts have systems that allow teachers to enter and analyze student
performance data. It is also likely that IT in educational setting could support many different applications and serve many different functions as they have in medicine—including systems that collate and analyze student performance; systems that provide guidelines, research summaries, and other guidance to teachers; systems that provide instructional feedback and reminders to teachers; systems that relate relative performance of teachers, etc. The similarities in implementing IT in medicine most likely carry over into education as well. As with physicians, teachers and administrators do not have significant amounts of time for inputting, analyzing, and interpreting data. Many teachers do not currently utilize computers in their work; thus, it is possible that they do not possess the knowledge and skills necessary to implement a successful IT quality improvement program. Teachers would require professional development not only for learning to use the system, but also for reading and interpreting the data output from the computer. Moreover, there are in fact many applications developed for schools, and it is unclear whether many would be compatible or carry out all the functions desired by teachers and administrators. Thus, major challenges for compatibility and interface will pose challenges to the successful implementation of IT systems in education that support continuous instructional improvement.

The large up-front costs with unknown benefits are another challenge for implementing an IT system in education. IT systems require a large investment in hardware as well as training and support costs. It could be difficult to persuade a district to incur these large initial costs without a measurable and provable return to their investment.

6. Care pathways
A care pathway (also referred to as a clinical pathways, critical pathways, care maps, and disease management) is defined as

… locally agreed, multidisciplinary practice based on guidelines and evidence where available, for a specific patient/client group. It forms all or part of the clinical record, documents the care given and facilitates the evaluation of outcomes for continuous quality improvement (Riley, 1998).

Others have defined care pathways as

… complex interventions made up of a number of components… a plan of care that aims to promote organized and efficient multidisciplinary patient care that is based on the best available evidence and guidelines (Kwan, 2006).

Thus, care pathways are locally developed, research-based plans of action targeting specific patient subgroups, and are meant to help health-care professionals achieve pre-specified patient goals (Kwan, 2006).

Examples of care pathways can be found in efforts to improve the treatment of breast cancer patients. There are some care pathways that focus on standardized methods and procedures for improving services such as the time delay at different stages of care during diagnosis or improving standardized procedures for reporting diagnostic results (de Luc, 2000). In addition, there are care pathways that focus on reducing morbidity and mortality rates in breast cancer treatment. For instance, Andtbacka and colleagues (2006) reported on a care pathway aimed at reducing venous thromboembolism, a frequently occurring complication of breast cancer surgery involving the formation of blood clots that can travel to other locations and block blood flow. This pathway spelled out the timing and use of ambulation and compression devices worn on legs to reduce venous thromboembolism. All of these care pathway examples involved multi-disciplinary teams that relied on craft wisdom and/or evidence-based research to develop their care pathways in an effort to minimize variation in practice.
Cycle of Improvement
In terms of the cycle of continuous improvement described by CCII, care pathways would be used to help decide how to proceed by providing specified steps to be taken for specific patients. However, care pathways also can be used to help analyze and interpret data, since they can provide a measure of performance within a system (they can serve to standardize care and thus all variations in care to be viewed as another source of data) (de Luc, 2000).

Type of Papers
There are reviews of care pathways, some of which are systematic reviews providing quantitative or qualitative descriptions, and there are research studies, both qualitative and quantitative, looking at everything from impact on clinical practice to impact on health outcomes. The following chart outlines the existing research and reviews on information technology resulting from searches in PubMed (this chart represents hits for care pathways, care maps, clinical pathways, disease management, and quality improvement).

<table>
<thead>
<tr>
<th>Type of articles</th>
<th>Subcategory</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviews</td>
<td>Meta-analysis</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
</tr>
<tr>
<td>Research studies-qualitative</td>
<td>Descriptive</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Ethnography</td>
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</tr>
<tr>
<td></td>
<td>Case study</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
</tr>
<tr>
<td>Research studies-quantitative</td>
<td>Clinical trials</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Controlled clinical trials</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(nonrandomized)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Randomized clinical trials</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
</tr>
<tr>
<td>Mixed methods</td>
<td><strong>Total</strong></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total of all papers</strong></td>
<td><strong>89</strong></td>
</tr>
</tbody>
</table>

Lesson From the Literature on Care Pathways and Relevance to Education
A systematic review by Kwan (2006) suggests that it is unclear whether care pathways have a positive or a negative effect regarding stroke care because of a lack of good, solid, randomized, controlled studies examining this area of medicine. However, there are some studies that suggest some benefit in improving physician practice and patient outcomes, e.g., length of hospital stay, costs, complications, and improvement in disease (Lanska, et al., 1998). In many ways, care pathways are similar to guidelines; however, they more specifically outline care and provide more step-by-step directions to physicians for the care of particular subgroups. This is perhaps even farther into the future in terms of relevance to educational settings given our limited understanding of how individual groups of student populations learn; thus, we limit our comment on this strategy. It is interesting nonetheless to consider what care pathways for individual student populations might look like and how they could support continuous improvement programs.
7. Clinical Informationists

Description
A *clinical informationist* is defined as “anyone who is cross trained in medicine, computer science, and information science” (Shearer, et al., 2002) and can be described as a person within a health-care setting who is designated to provide support to clinical staff by providing necessary information on the best available research evidence. Informationists integrate librarian services with clinical services, and as such they help identify areas where information is needed, and they collect, synthesize, and summarize available evidence from the literature (Giuse, et al., 2005). This person formerly was referred to as a clinical librarian (Wolf, et al., 2002) and was primarily bound to the confines of medical libraries, but the newer model expands this person’s role to one in which he or she becomes a member of the clinical team. Clinical informationists are expected to have expertise and knowledge of clinical content, computer literacy, research practice, statistical analysis, and data collection (which involves the knowledge of medical databases and other resources for finding evidence-based research) (Guise, et al., 2005). With the requisite knowledge and skill, informationists can contribute to the identification of potential diagnoses, possible treatments, and recommended practices (Guise, et al., 2005; Veenstra, 1992). At Vanderbilt University Medical Center, a location where clinical informationists are used extensively, these people present their insights at medical rounds and are seen as a way to increase adherence to guidelines and bring evidence-based medicine into practice (Giuse, et al., 2005).

Cycle of Improvement
Clinical informationists are relevant to the following CCII elements: determining problems, assessing options, and making decisions on courses of action.

Types of Papers Found.
A search on PubMed for *clinical informationist* in health care only turned up 9 hits, which highlights the paucity of information on this human resource to be gleaned from medical literature.

<table>
<thead>
<tr>
<th>Table 8. Summary of research publications on Clinical Informationist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of articles</strong></td>
</tr>
<tr>
<td>Reviews</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Research studies-qualitative/mixed</td>
</tr>
<tr>
<td>Research studies-quantitative</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

Lessons From the Literature on Clinical Informationists
Use of a clinical informationist is a relatively new trend so relatively little is available on their impact on health care outcomes or physician practice (Sladek, et al., 2004). However, a review of the field suggests that these programs are costly and time intensive and that sustaining support for them is difficult (Wolf, et al., 2002). It has been estimated that 20% of cases and case-related
learning behavior changed as a result of a clinical informationists (Scura & Davidoff, 1981). It also appears that a significant number of physicians appear be receptive to informationists and have found their services useful (Sladek, et al., 2004; Wagner, et al., 2004, Guise, et al., 2005). Finally, there is little research that can shed light on how to best to implement and sustain clinical informationists in medical settings.

Relevance to Education
Currently there is no analogy in education to a clinical informationist. However, if such a person were to exist, the analogy would be of someone who would be a designated member of a district or school whose main job would be to provide support to professional communities of teachers, helping to diagnose student problems and bringing research in education to bear on understanding student problems, and helping to identify options for next steps. However, given that we know little about the effectiveness of this resource in medicine, not much can be said about how best to implement the position of informationalist or what to expect in terms of impact on student performance. Given that there is some reported impact of this staff position on decisions made by physicians, one might expect some impact on teachers’ decisions. However, as a cautionary note, there may be difference in how teachers and physicians value the usefulness of evidence-based research; teachers may not value research-based evidence as much as physicians and that may influence the impact of such information.

8. Rounds

Description and Lessons From Literature on Rounds
Grand rounds in hospitals serve as regular professional-development activities for physicians. In the past, rounds took on an educational focus where medical students or residents would be presented with a particular medical case, senior physicians would probe the trainees on their thoughts on the case, and eventually a diagnosis would be presented (Altman, 2006). However, grand rounds today typically resemble a university lecture with physicians assembled in an auditorium or classroom listening to a presentation on a case, technique, or drug (Altman, 2006). While most rounds take on a didactic lecture format, there is large variation in intention and purpose, making it difficult to specify a common outcome measure to evaluate their effects. This problem might explain the dearth of controlled trial studies on grand rounds. A PubMed search on Grand Rounds limited to clinical trials, randomized controlled trials, and reviews found 30 hits with only one relevant article based on a convenience sample survey of 99 departments in 2004 (Mueller, et al., 2006). The study found that the objectives of grand rounds differed significantly between surveys conducted in 1988 and 2004. The authors conclude from this reported change that there is a lack in consistency about the purpose or intentions of grand rounds. Only 44 of the departments answering the survey utilized an educational-needs assessment to determine the subject of their lecture and less than 13 assessed the knowledge gained by attendees. Similarly, the presenter received little feedback from attendees.

Cycle of Improvement
Given the primarily educational focus of rounds in medicine today, rounds would not fit well into the current model of instructional improvement since the cycle of improvement is not focused on training new teachers. However, one could argue that if rounds were used as they once were by teams of physicians, then they would help in diagnosing patients’ problems, assessing options, and making decisions on courses of action.
Types of Papers
Below is a quick summary of the numbers of papers from a PubMed search. We could find only a limited number of papers on rounds with any kind of focus on improving patient care, which would be analogous to improving student performance.

<table>
<thead>
<tr>
<th>Type of articles</th>
<th>Subcategory</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td></td>
<td>Case reports</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>Research studies-qualitative</td>
<td><strong>Total</strong></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td>Research studies-quantitative</td>
<td>Clinical trials</td>
<td>1</td>
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<tr>
<td></td>
<td>Controlled clinical trials</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(nonrandomized)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Randomized clinical trials</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total of all papers found</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Relevance to Education
Many medical rounds today have changed in format and purpose and they take on more of a lecture format where training or in-service professionals learn about advances in the field. Teachers do attend professional development seminars where there are lectures on current trends in education. As mentioned above, this type of training is not the focus of the CII and therefore is less relevant to this discussion here. Medical rounds in the past did take on more of a role in bringing young training professionals together to diagnose problems and come up with treatment plans. There currently are few analogies to this in education since most teachers work in isolation. However, there is more of an effort to develop professional learning communities in some school districts where teachers get together to discuss the progress of students on district assessments. This might be somewhat analogous to medical rounds of the past. However, currently school-based learning communities tend to emphasize what students are getting wrong as opposed to why they are getting the wrong answers, so proper diagnosis of student learning difficulties is not occurring in these professional learning communities focused on data (Olah, et al., 2007; personal communication with El Paso science teachers). This type of practice in schools would be analogous to physicians in rounds of the past limiting their efforts only to identifying the obvious symptoms of patients and not trying to understand the underlying cause of the symptoms. Unfortunately, given the changing nature of medical rounds today and the sparse research on medical rounds in general, there is not much that can be suggested from the medical literature on this topic that could provide insight into how best to support groups of professionals working together to diagnose problems and come up with solutions.

III. Topology of Literature on Continuous Quality Improvement
Presented below is a summary of the literature on strategies that can support a cycle of continuous improvement in health care. Guidelines have been written about and studied the most. In contrast, benchmarks relating to quality improvement and a cycle of improvement have been written about and studied the least. While there is a large number of quantitative studies published, on average only 20% of the quantitative papers are randomized clinical trials; the rest are either nonrandomized controlled studies or clinical trials (pre/post or before/after studies). There are many more quantitative papers than qualitative papers, and there are a large number of reviews to examine. However, only a small fraction of the reviews are systematic and quantitative.
Table 10. Topology of literature with import on continuous quality improvement in health care

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Reviews</th>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Mixed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>22</td>
<td>91</td>
<td>5</td>
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<tr>
<td>Guidelines</td>
<td>264</td>
<td>18</td>
<td>331</td>
<td>14</td>
<td>627</td>
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<tr>
<td>Benchmarks</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Audit/feedback</td>
<td>11</td>
<td>15</td>
<td>135</td>
<td>8</td>
<td>169</td>
</tr>
<tr>
<td>Information technology</td>
<td>22</td>
<td>19</td>
<td>87</td>
<td>5</td>
<td>133</td>
</tr>
<tr>
<td>Care pathways</td>
<td>27</td>
<td>27</td>
<td>34</td>
<td>1</td>
<td>89</td>
</tr>
<tr>
<td>Rounds</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Informationists</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>402</td>
<td>104</td>
<td>685</td>
<td>35</td>
<td>1226</td>
</tr>
</tbody>
</table>

Having searched the MEDLINE database, we are comfortable that we have adequately described the types of papers out there relating to strategies that can support quality improvement. This does not mean, however, that this review is exhaustive, because the method of searching for key words could constrain the type of hits obtained. We also acknowledge that using quality improvement to narrow large topics like guidelines and benchmarks may be limiting. We also note that these are not the only strategies found in the medical literature that can support a cycle of continuous improvement. For instance, a number of strategies have been described in clinical studies relating to quality improvement and have been identified in reviews of quality improvement such as the use of educational meetings, continuing medical education, and collaborative working groups (Ferris, et al., 2001; Wensing, et al., 2006; Lanier, et al., 2003). We believe such strategies also could support a cycle of continuous improvement; however, our impression is that literature on these strategies will be less relevant to the goals of CCII (since many have a strong training focus) or will provide little insight in general due to a lack of research on the topic or a lack of studies with strong methods.

IV. Final Thoughts

Our overall evaluation of the field is that there are a number of strategies employed by the health care field to improve quality of care via methods that align with continuous improvement elements—some such as CQI that completely align with the CCII model of continuous improvement, and some such as information technology that support many elements. However, we note that there are relatively few well controlled randomized trials to adequately assess impact of such interventions on practice and many of the meta analyses cite methodological weaknesses that limit the strength and generality of conclusions from quantitative studies. Even when we consider the most widely studied strategy in health care—guidelines—only 25% of the studies were randomized controlled studies, and of those randomized studies, only a fraction were of high quality where all criteria for rigorous methodology were met such as use of unbiased samples, use of proper precautions to ensure concealment, use of large sample, and inclusion of detailed and explicit methodology. Positive outcomes often were reported by many of the quantitative studies; however, when more rigorous methods and designs were employed, effects on practice or outcomes were generally minimal to none. In addition, qualitative studies often were not very explicit in methodology, were plagued by observer bias, and failed to be explicit and thorough in description of methods. In general, qualitative studies failed to shed much light on social or
organizational factors necessary to implement the strategies. Often thoughts about program challenges or successes were expressed more as opinion based on reflection on experience with the strategy or program and less on rigorous evaluative methodology. Occasionally, insights are to be gained when collaborators from business or psychology help provide more reliable measures of assessment, but it is clear that one cannot look towards medicine to provide clarity on how to implement such programs. On the other hand, one can gain some practical insights into potential pitfalls and challenges of implementing such strategies. For example, buy-in and participation from practitioners and administrators will most likely be necessary, involvement of experts and striving towards a common vision are most likely helpful, and investment in infrastructure and alignment of the interface among information technology systems will be needed. Finally, attention to attitudes and beliefs may be necessary to change practice. However, none of these points are particularly new to educators. Thus, in final analysis of the research, there is little solid evidence of the impact of these strategies on practice and little quality evidence to highlight the best ways to support or implement such strategies.

One strategy that might deserve some attention is CQI from medicine, as this strategy aligns so well with the elements of the cycle of continuous improvement. However, more research is needed on this topic in medicine before one can make strong recommendations to education on how to implement. Thus, we recommend keeping an eye on this literature, but at present think that only limited insight is possible.

What might be of more value from this review is a vision for the development of new tools or programs taken from cues in medicine. For example, medicine has developed research-based guidelines and benchmarks for many areas of medicine and these have spread quickly. While the effect of such guidelines or benchmarks on medical practice may be minimal, they do seem an interesting tool to aid practitioners in education. While the research base is thin in many areas of educational research, there may be areas where research is deep enough to develop guidelines for teachers, districts, or schools to aid in the evaluation and decision stages of continuous improvement. For example, at the classroom level we know that students’ prior ideas often pose problems for them in learning new ideas (Bransford, 2000). Thus, it behooves teachers to identify these alternative understandings (or misconceptions, as some researchers refer to them) prior to starting a new lesson, and such advice could be introduced into guidelines on the application and use of formative assessments in classrooms. Another tool in medicine that might be interesting to consider for education is the use of information technology to support a range of activities from record keeping to tracking student performance. While there is little data from medicine to support the impact of such technology, the field is particularly optimistic about the possibility of using such supports. Education has begun to develop computer systems for record keeping and tracking student progress; however, education has not reached the level of integration that medicine has attained. In medicine, technology tools have been developed that integrate several lines of information (e.g., patient records, guidelines, feedback, reminders, and visual displays of patient progress all in one device). It would be thought-provoking to think about educational technology systems that could integrate student records, guidelines, educational options, and student progress indicators. In final analysis, we might not learn much from medicine about how to support continuous improvement by reviewing the literature in medicine, but the literature review nonetheless might stimulate new ideas for tool development in education.
References


Appendix A. Methods.

1. Literature searches.
To identify research papers and existing reviews, we searched the MEDLINE database using PubMed, an open-access database. MEDLINE is a comprehensive database containing over 16 million citations spanning medicine, nursing, dentistry, veterinary medicine, the health-care system, preclinical science, and biomedical and life sciences, dating back to the mid 1960s in the United States and 70 other countries. (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?DB=pubmed).

In addition to PubMed, we searched the Cochrane Database of Systematic Reviews to find quality systematic reviews of research in health care.

Various strategies were used to find relevant articles including key-word searches—the results of which are summarized tables presented in the narrative of this report. Examples of key words used in searches include the following:
- “quality improvement” and “health care”
- “continuous quality improvement” and “health care”
- “total quality management” and “health care”
- “audit and feedback” and “quality improvement”
- “information technology” and “quality improvement”
- “clinical decision system” and “health care” and “quality improvement”
- “guidelines” and “quality improvement” and “health care”
- “benchmarks” and “quality improvement” and “health care”
- “care pathways”

In addition, the key-word searches were crossed with other key words such as “case study” “qualitative study,” “ethnography,” and “case report,” or in some cases limited by using PubMed filter features to focus on reviews or clinical studies. Papers that, upon reading of the abstract, did not appear to be related to quality improvement or continuous improvement in health care were eliminated from the summaries of existing literature in this report.

2. Systematic review of articles.
We have developed a set of criteria when looking at and analyzing the literature in health care. We have criteria for three types of papers examined for our literature review: reviews, quantitative research papers, and qualitative research papers. Below are relevant aspects of the papers that we considered upon reading. During the review, we filled out a standardized form that prompted us to reflect on the criteria for evaluating paper.

1. Reviews
- Clarity of narrative (poor/adequate/excellent)
- Type of review (quantitative, e.g. meta-analysis; qualitative, or purely descriptive; or content review presenting an overview of the field)
- Use of systematic system to review literature (yes/no)
- Use of empirical evidence to base decisions (yes/no)
- Overall usefulness (not useful/somewhat useful/useful/very useful)

2. Quantitative research papers
- Type of quantitative study: randomized controlled clinical trial, controlled clinical trial (nonrandomized), clinical trial (includes pre/post tests or before/after studies)
• Methods (very problematic/somewhat problematic/adequate/excellent)
  o Thoroughness of description of methods
  o Selection bias present
  o Unfair comparisons
  o Sample size
  o Questionable analysis techniques
  o Inappropriate measure of impact
  o Questionable data collection
• Effects (poor/marginal/meaningful/dramatic)
• Claims warranted (no support/limited support/adequate support)
• Overall quality (poor/average/excellent)

3. Qualitative research papers
• Type of study: case study, interviews, survey, ethnography
• Methods (very problematic/somewhat problematic/adequate/excellent
  o Thoroughness of description of methods
  o Threats to valid descriptions (accuracy and completeness of data)
  o Threats to interpretation (imposing one’s own framework or meaning)
  o Threats to theoretical validity (e.g. paying attention to discrepant data; not considering alternative explanations)
• Informative (not informative/somewhat informative/informative/very informative)
• Overall quality (poor/average/excellent)