

Key characteristics of successful quality improvement curricula in physician education: a realist review

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► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bmjqs-2014-002846>).

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Received 15 January 2014

Revised 20 August 2014

Accepted 30 August 2014

Published Online First

30 September 2014



CrossMark

To cite: Jones AC, Shipman SA, Ogrinc G. *BMJ Qual Saf* 2015;**24**:77–88.

ABSTRACT

Purpose Quality improvement (QI) is a common competency that must be taught in all physician training programmes, yet, there is no clear best approach to teach this content in clinical settings. We conducted a realist systematic review of the existing literature in QI curricula within the clinical setting, highlighting examples of trainees learning QI by doing QI.

Method Candidate theories describing successful QI curricula were articulated *a priori*. We searched MEDLINE (1 January 2000 to 12 March 2013), the Cochrane Library (2013) and Web of Science (15 March 2013) and reviewed references of prior systematic reviews. Inclusion criteria included study design, setting, population, interventions, clinical and educational outcomes. The data abstraction tool included categories for setting, population, intervention, outcomes and qualitative comments. Themes were iteratively developed and synthesised using realist review methodology. A methodological quality tool assessed the biases, confounders, secular trends, reporting and study quality.

Results Among 39 studies, most were before–after design with resident physicians as the primary population. Twenty-one described clinical interventions and 18 described educational interventions with a mean intervention length of 6.58 (SD=9.16) months. Twenty-eight reported successful clinical improvements; no studies reported clinical outcomes that worsened. Characteristics of successful clinical QI curricula include attention to the interface of educational and clinical systems, careful choice of QI work for the trainees and appropriately trained local faculty.

Conclusions This realist review identified success characteristics to guide training programmes, medical schools, faculty, trainees, accrediting organisations and funders to further develop educational and improvement resources in QI educational programmes.

BACKGROUND

Stemming from the Institute of Medicine's reports, *To Err Is Human* in 2000 and *Crossing the Quality Chasm* in 2001, improvement in patient outcomes and reduction in medical errors are foci for healthcare institutions around the world.¹ In 2003, the Accreditation Council for Graduate Medical Education (ACGME) and American Osteopathic Association responded by integrating systems-based practice (SBP) and practice-based learning and improvement (PBLI) as two of the six core competencies of medical education.² Quality improvement (QI) teaching encompasses content of both SPB and PBLI. However, uncertainty remains about which methods are the most effective, and in what circumstances, for improving educational and clinical outcomes.^{3–5}

Reviews of QI teaching in undergraduate and graduate medical education have found some improvement in educational outcomes but little effect on patient outcomes.^{6–8} Wong *et al*^{9 10} identified three categories of QI education, most of which fall into the first category: (1) formal curricula that teach concepts or methods intended to facilitate trainees' participation in QI activities; (2) educational activities that impart specific related skills and (3) QI initiatives that involve trainees as active or passive participants. Many others worldwide have developed clinical teaching of QI, aiming to engage physician trainees to improve the care of the patients they serve and the function of the system in which they practice.¹⁰

Although helpful in summarising the novel approaches to QI education, prior systematic reviews have been limited. They appropriately sought to answer the

question of whether or not QI educational interventions had an impact on physician trainees' ability to gain knowledge and sought to identify themes associated with successful QI curricula, but did not assess the specific mechanistic and contextual factors that predicted success, especially for improvement of patient care and system performance outcomes. The realist review approach offers one approach to deconstruct such complex interventions to assess key success characteristics and develop recommendations.^{11 12}

In this study, we define key characteristics of successful QI curricula in medical education. This realist review determines how the teaching of QI in the clinical setting enhances patient care and system performance while increasing trainee knowledge and skills.

METHODS

Review framework

A realist review is based on the premise that complex interventions are successful when certain characteristics facilitate the optimal functioning of a system to produce a particular outcome when a complex intervention is applied.¹¹ In a realist review, an iterative approach is used to identify the characteristics of complex interventions in the following categories: 'what works,' 'for whom,' 'under what circumstances' and 'to achieve what outcomes'.¹¹ The realist review begins with the articulation of candidate theories that may explain the characteristics required for interventions to be successful.¹¹ Next, identification and selection of studies is achieved through standard systematic review approach.¹¹ Once relevant studies are chosen for inclusion, data are systematically abstracted from the studies and the studies are read and reread to identify themes.¹¹ An iterative approach is used to identify data, quotations, tables and figures that either support or refute the candidate theories articulated at the outset. Theories are refined as more data are gathered from the articles.¹¹

We began by searching the literature for existing theories which explained teaching of QI in the clinical setting. We evaluated the prior systematic reviews on the topic of QI medical education,^{7-9 13} spoken with experts in the field,^{7 9} and prepared a candidate conceptual framework (see online supplement 1) and accompanying theory for review.^{7 14} Our candidate theory hypothesised that the process of educating physicians begins with a curriculum and is impacted by characteristics of the learner, teacher, community and others, all encompassed within the educational context. From within the educational context emerges engaged learners and teachers, who produce improved educational and clinical outcomes. The combination of these successes produces physicians who are capable of and believe that it is their job to do their work and improve their work.

The second step of the realist review is development of inclusion criteria, search strategies, a data

abstraction tool and methodological quality assessment for review of the literature and analysis of included studies. Throughout the above process, the candidate theories were tested and refined and new theories added. As the studies were evaluated, themes emerged that were based on the predetermined theories. Each theme was assigned a code and linked to a quotation in the study. As a new theme emerged it was assigned a new code; we then searched for this theme in all the included studies in the review. New and revised candidate theories were synthesised into the set of candidate theories to test in our realist review.

Study eligibility criteria

Included studies had the following criteria:

- ▶ Study design—original journal articles (no commentaries, letters to the editor, editorials or position pieces).
- ▶ Setting—medical schools, residency and fellowship programmes worldwide.
- ▶ Population—physician trainees (medical students, residents and/or fellows).
- ▶ Interventions—whether clinical or educational—that engage trainees in QI work, where they are involved in changes to the delivery of care to patients within the clinical setting.
- ▶ Reporting of clinical outcomes (patient care outcomes and system performance improvements) as the primary outcome measure.

Search methods

In collaboration with a professional librarian, one reviewer (ACJ) developed search strategies for the following databases: MEDLINE (2000 to 12 March 2013), Cochrane Library (2013) and Web of Science (15 March 2013). To locate potentially relevant studies in MEDLINE, we used exploded Medical Subject Headings terms and key words to generate sets for the themes of *QI* and *medical education*. We then used the Boolean term 'AND' to find their intersection. This basic approach was modified as necessary to search each electronic database. No language restriction was applied. Time limit was applied to obtain articles published after 2000, which corresponded with the publication of the *Institute of Medicine* reports *To Err Is Human* and *Crossing the Quality Chasm*. We excluded commentaries, editorials and letters. The full search strategy is available upon request. Reference reviews of the four earlier systematic reviews^{7-9 13} were performed by obtaining all references cited and searching forward using Web of Science to find all papers which cited these reviews and including them in title and abstract review.

Study selection

One reviewer (ACJ) independently screened each title and abstract for eligibility. Then, two non-blinded reviewers (ACJ and GO) independently assessed the

eligibility of each full text record. Discrepancies were resolved by consensus between both reviewers after full text review.

Data collection

One reviewer (ACJ) abstracted data from the full text articles. A standardised data collection tool was used to capture identifying information, intervention summaries, details of study protocol, all primary and secondary outcome data and a section to extract quotations from the articles for the realist review (see online supplement 2).

Analysis

Analysis of interventions and outcomes

Anticipating that the QI interventions and outcomes would be complex and different depending on the training programme, we used an iterative approach to categorise the different types of interventions and outcomes described in each study. We focused on any qualitative or quantitative reports of change in clinical outcomes. If outcomes were reported quantitatively, we determined whether statistical analysis was performed, either in the form of enumerative statistics or analytical statistics using statistical process control, a method of time-ordered analysis for QI.¹⁵ For the secondary outcome, we noted the findings of the educational outcomes such as knowledge, skills and attitudes.

Assessment of methodological quality

The Medical Education Research Quality Instrument¹⁶ is a validated instrument for methodological quality assessment of the medical education literature, but does not allow assessment of the methodological quality of the QI education literature specifically. Thus, we developed a set of criteria based upon the Cochrane Risk of Bias Tool and the Standards for Quality Improvement Reporting Excellence publication guidelines.^{17 18} Criteria were based on attention to quality factors in three major categories: the population, intervention and outcome reporting (see online supplements 3 and 4). Each study was assessed on all the criteria for quality, taking into account bias, confounding and study quality.

A final methodological quality score was given to each study, based on a scale ranging from 'fair,' if almost none of the criteria were met, to 'good,' when minor flaws were found, to 'very good,' when high-quality reporting was achieved in at least one criterion each for population, intervention and outcome reporting, and 'excellent,' when high quality was achieved for all criteria (see online supplement 5).

The realist review

After completing the methodology of a systematic review, we used the realist review methodology to rigorously test the conceptual framework. We

iteratively identified relevant themes, and through continuous data collection and rereading the articles, we tested the conceptual framework. Specifically, we looked for examples of when the curriculum was developed at the outset of the intervention to support the educational context of the candidate theory. We also looked for examples of successful completion of QI curricula and examples of physicians who are capable of and believe that it is their job to do their work and improve it.

RESULTS

Results of search

We included 39 studies for our final review (figure 1; excluded studies after full text review is available upon request), most of which were before–after studies or case reports in internal medicine or family medicine residency programmes (table 1). Less common were controlled trials, studies with medical students or reports from subspecialty resident programmes. Of the 29 studies that reported a sample size, the mean sample size was 5.6 trainees (SD=102), the median sample size was 24 trainees and the range was from 3 to 510 trainees.

Among the interventions, 21 were primarily clinical interventions in which the goal was clearly to improve patient care or system performance in the clinical setting with education of the trainee not the primary focus of the intervention; 18 studies primarily had educational interventions, in which the goal was to deliver a curriculum to trainees focused on learning about improvement of which a component was to improve patient care and system performance in the clinical setting. The mean intervention length was 6.6 months (SD=9.2).

Twenty studies reported system performance outcomes (e.g., improved documentation) while three reported only patient care outcomes (e.g., haemoglobin a1c, blood pressure) and 16 reported both patient care and system performance outcomes. Among the clinical outcomes, 28 studies reported successful improvements, two of which were not sustained. Ten studies demonstrated improvement in some measures and two clinical outcome reports were equivocal. No studies reported clinical outcomes that worsened.

Nineteen studies reported educational outcomes, using various measures of knowledge, skills and attitudes such as the Quality Improvement Knowledge Application Tool (QIKAT),¹⁹ satisfaction surveys or objective structured clinical examinations.

Description of studies

The most common types of interventions were team projects and involvement in an existing clinical QI team (table 2). Among the team project interventions, trainees worked together to make improvements in the clinical setting; these studies had varied methodological quality scores. Seven of these studies demonstrated significant

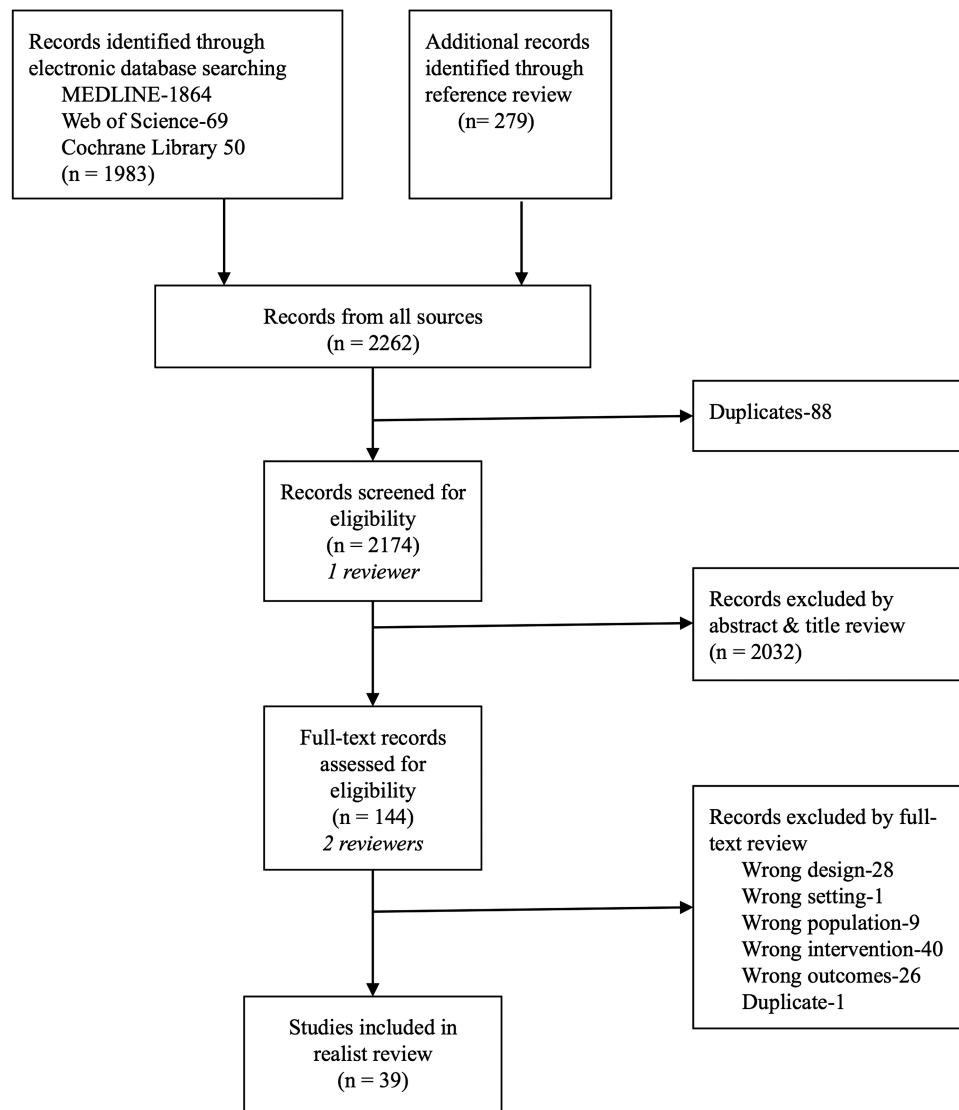


Figure 1 Study selection flow diagram.

improvement in documentation, critical care measures and medication adherence^{20–26}; six studies showed no significant clinical outcomes.^{4 27–31}

Of the interventions that involved trainees taking a role within an existing clinical interprofessional QI team, most were of ‘good’^{32–41} methodological quality. Most showed no significant clinical outcomes,^{33 35 37 40–43} but some showed statistically significant improvement in diabetes measures, vaccination rates, chronic care measures and critical care measures.^{32 34 36 38 39}

The third most common type of intervention used a chart audit. Most of these had ‘good’ methodological quality. About half these studies showed statistically significant outcomes, specifically in improved diabetes care, preventive care measures, documentation and critical care measures^{44–48}; and the other half did not show statistically significant outcomes.^{49–52}

The least common intervention used individual projects in which the trainee worked independently. Most

of these studies were rated ‘good’,^{53–56} and one received a ‘fair’.⁵⁷ Most of these studies showed no significant clinical outcomes,^{53 55–57} while one study showed significant improvement in care for heart failure patients.⁵⁴

Methodological quality

A majority of studies (30) had ‘good’ methodological quality. Six were ‘fair’ studies and 3 were ‘very good’. There were no ‘excellent’ studies.

Among the included studies, all but three studies described the intervention in sufficient detail so that it could be replicated. Although all the studies had, by our inclusion criteria, trainees participating in QI work within the clinical setting, only 14 studies articulated educational objectives for trainees. There were five studies which described a clinical intervention rather than an educational intervention and reported no educational outcomes (table 2).

Table 1 Baseline characteristics of included studies

Characteristic	n
Study design	
Controlled trials	2
Before–after studies	18
Case reports	10
Time series	7
Interrupted time series	1
Qualitative	1
Population	
Residents only	27
Medical students only	3
Fellows only	3
Residents and fellows	3
Medical students and residents	2
Medical students, residents and fellows	1
Specialty	
Internal medicine	10
Family medicine	7
Psychiatry	4
Paediatrics	3
Critical care	2
Surgery	2
Neonatology	1
Preventive medicine	1
Radiology	1
Various specialties	5
Medical schools	3
Clinical setting	
Outpatient	
Primary care	15
Psychiatry	2
Paediatrics	1
Inpatient	
General medical unit	2
Adult intensive care unit	2
Neonatal intensive care unit	1
Paediatric emergency department	1
Radiology	1

It is notable that three studies took steps to minimise bias and confounding. Holmboe *et al*⁴⁵ matched each second year resident in the intervention track to a third year control. Dysinger and Pappas²¹ enrolled the entire fourth year medical school class in a required month-long clinical QI rotation over 3 years, resulting in 510 students completing the curriculum, and allowing for comparison over 3 years of data collection to observe and account for secular trends. Asao *et al*,⁴⁹ in addition to enrolling only second year residents in the chart audit curriculum intervention, completed a multivariate analysis to account for the trainee's experience as an auditor, the duration of exposure to the curriculum independent of training level and number of comorbidities in the resident's patient sample.

Synthesis of results and realist review

We identified several major themes through realist review. These themes are organised by 'what works,' 'for whom,' 'under what circumstances' and 'to achieve what outcomes' (table 3). After synthesising the range of interventions, clinical and educational outcomes, the methodological quality and realist review of the 39 studies, we tested the candidate theory and conceptual framework by iteratively analysing the major themes which emerged from the data. Specifically, we looked for evidence of a pre-terminated curriculum and educational context, as we hypothesised at the outset. However, we failed to find evidence of these mechanistic and contextual factors as important determinants in producing physicians who are lifelong learners and improvers. Thus, we revised the candidate theories and developed a conceptual framework (figure 2).

Many different types of curricula are described in the included studies, some of which are distinct educational interventions and some of which involve trainees in existing clinical QI in their practices. Among the included studies, these interventions fell into four categories, and we found examples of statistically significant improvements in clinical outcomes in each category. Those studies with 'fair' methodological quality scores did not report significant results or failed to report numerical results with statistical analysis. Therefore, the higher-quality studies suggest that, with certain contexts and mechanisms, significant improvement in clinical outcomes is achievable when trainees are exposed to QI within the clinical setting.

Several success characteristics were common to different contexts of clinical QI education (table 3; for illustrative quotes see online supplement 6). As noted by Sockalingham *et al*⁵⁶ 'residents identified workload as a major barrier to (doing QI work).' Successful QI teaching programmes were consistently clear about the time required for trainee work-hour rules, competing demands and for faculty involvement. Success of specific programmes will also depend on whether it makes more sense to train all faculty members in QI principles or to have a dedicated select faculty group in charge of the QI curriculum. The availability of data through information systems is also a facilitator to trainee satisfaction and engagement. The sustained improvement reported by Halverson *et al*³⁶ was achieved through the use of timely regular data feedback to all providers, including trainees, about the care of patients with diabetes in the practice. Two studies also highlighted the challenges that occur when trainees must abstract their own data, such as is the case in a practice which has not implemented an electronic medical record, or when data feedback is not timely enough for continuous QI.^{34 44} Choice of the project topic is also important for trainees. QI educators need to consider the needs of the clinical setting as well as level of trainee; however, no consensus emerged as to the best approach.

Table 2 Summary of interventions, outcomes and methodological quality

Author and year	Population (n)	Intervention description	Clinical setting	Clinical outcomes		Educational outcomes	Quality assessment†
				Finding	Statistically significant*		
Chart audit							
Gould <i>et al</i> 2002 ⁴⁴	2nd year medical students (77)	Learners audited random sample of diabetes charts using Qualidigm, before and after 'Project in a Box'	Outpatient primary care clinic	Improved rates of Hba1c, foot exam and eye exam documentation	Yes	Improved knowledge, skills, attitudes; poor learner satisfaction	Good
Paukert <i>et al</i> 2003 ⁴⁸	FM residents (36)	Self and peer audits done at several time points	Outpatient primary care clinic	Improved, but unsustained, composite 'preventive' score	Yes	NR	Good
Holmboe <i>et al</i> 2005 ⁴⁵	2nd year IM residents (26)	Learners audited sample of their own diabetes patients using Qualidigm	Outpatient primary care clinic	Improved patient care (Hba1c, LDL) and system performance (monofilament testing documentation)	Yes	Improved perceived value and motivation	Very good
Kaddan <i>et al</i> 2006 ⁴⁶	Residents and medical students (NR)	Structured session every 24 hrs of all X-ray and culture reports among ED patients	Paediatric emergency department	Decrease in chart requiring attending comment and change in treatment course	Yes	High learner satisfaction	Good
Krajewski <i>et al</i> 2007 ⁵¹	Residents (NR)	Performed audit on self-identified problem in radiology reporting; presented at M&M conference	Radiology department	Multiple system improvements implemented	No	NR	Fair
Asao <i>et al</i> 2009 ⁴⁹	2nd and 3rd IM year residents (80)	Peer audit performed; feedback and motivational plan proposed by learner	Outpatient primary care clinic	Improved composite measures for COPD, CHD, DM, HTN, LVF	No	NR	Very good
Carek <i>et al</i> 2009 ⁵⁰	FM residents (20)	Chart audit before and after educational session	Outpatient primary care clinic	Improvement in oral and mental health, care of underserved populations, antibiotic use, elderly care, preventive services	No	NR	Good
Kirschenbaum <i>et al</i> 2010 ⁴⁷	CC fellows and residents (NR)	Team audit and analysis of all transfers from GMU to MICU	MICU	Improvement in number of cardiac arrests and deaths, number of times MET called	Yes	NR	Good
Smith <i>et al</i> 2012 ⁵²	IM residents (20)	Peer RCA on near-miss cases, presented at M&M conference	Various departments	Multiple system improvements implemented, some successful	No	High learner satisfaction	Fair
Participant on clinical QI team							
Coleman <i>et al</i> 2003 ³⁴	FM residents (NR)	Participation at training site QI team; learner chose projects and improvement approaches	Outpatient primary care clinic	Improved microalbuminuria screening, medication list completion, data summary sheets	Yes	NR	Good
Mohr <i>et al</i> 2003 ³⁸	Peds residents (8)	Resident team chose project for interprofessional practice team improvement	Outpatient paediatric clinic	Improved vaccination rates for the practice	Yes	NR	Good
Landis <i>et al</i> 2006 ³⁷	FM residents (126)	Residents involved in statewide learning collaborative to improve diabetes care	Outpatient primary care clinic	Improved ACIC scores	NR	NR	Good

Continued

Table 2 Continued

Author and year	Population (n)	Intervention description	Clinical setting	Clinical outcomes		Educational outcomes	Quality assessment†
				Finding	Statistically significant*		
Halverson <i>et al</i> 2007 ³⁶	FM residents (NR)	Resident served on committee to improve diabetes care	Outpatient primary care clinic	Improved percentage of patients at goal for Hba1c, LDL, BP	Yes	NR	Good
Stapleton <i>et al</i> 2009 ⁴²	Peds senior residents (NR)	RPIW on improving senior resident rotation	Paediatric inpatient service	Improved system performance measures	NR	NR	Fair
Buckley <i>et al</i> 2010 ³²	CC fellows and residents (NR)	Mandatory participation on MICU improvement team	MICU	Improved iatrogenic pneumothorax rates, sepsis-specific mortality, sepsis bundle compliance	Yes	NR	Good
Fischman <i>et al</i> 2010 ³⁵	IM residents (4)	Controlled trial with involvement on clinical QI team	Outpatient primary care clinic	Improvement in no-show, continuity measures, doctor-patient relationships	NR	NR	Good
Stevens <i>et al</i> 2010 ³⁹	IM, FM, peds residents (NR)	Involvement in statewide collaborative for diabetes care	Outpatient primary care clinic	Improved ACIC scores	Yes	High learner participation	Good
Yu <i>et al</i> 2010 ⁴¹	FM residents (6)	Resident participation in statewide collaborative to improve diabetes care	Outpatient primary care clinic	Improved ACIC scores	NR	Improved % of residents reviewing performance reports, demonstrating improved behaviours	Good
Vidarthi <i>et al</i> 2011 ⁴³	Fellows and residents (NR)	Financial incentive (US\$1200 per trainee) for involvement in improvement work at medical centre	Various departments	Several system performance measures improved	NR	NR	Fair
Stueven <i>et al</i> 2012 ⁴⁰	Residents and medical students (249)	Residents surveyed for relevant patient safety and QI improvement issues, attended retreats	Various departments	Several system performance measures improved	NR	NR	Good
Carey <i>et al</i> 2013 ³³	Neonatology fellows (3)	Fellows participate on Q and S committee, chair working group when issues arise	NICU	Improvement in broncho-pulmonary disease, catheter-associated bloodstream infections	NR	Learner self-reflections about QI, presentations at conferences	Good
Team project							
Varkey <i>et al</i> 2006 ³¹	Fellows, residents, medical students (7)	Multidisciplinary trainee teams in training hospital	Various departments	Improvement in documentation of medication reconciliation	NR	Improved QIKAT scores	Good
Oyler <i>et al</i> 2008 ²³	2nd year IM residents (34)	Mandatory project while on ambulatory rotation	Outpatient primary care clinic	Improvement in documentation of height, weights, BMI	Yes	NR	Good
Varkey <i>et al</i> 2008 ³⁰	Preventive medicine, endocrinology fellows (9)	QI project taught jointly by medicine and engineering faculty	Various departments	Improvement in patient understanding on treatment	NR	Improved QIKAT scores, learner satisfaction	Fair

Continued

Table 2 Continued

Author and year	Population (n)	Intervention description	Clinical setting	Clinical outcomes		Educational outcomes	Quality assessment†
				Finding	Statistically significant*		
Tomolo <i>et al</i> 2009 ²⁹	IM residents (42)	QI project while rotating on inpatient medicine service	Various departments	Multiple sustained system performance measures improved (i.e., missing lab values)	NR	High learner satisfaction	Good
Varkey <i>et al</i> 2009 ²⁶	Preventive medicine fellows (19)	Fellows develop and implement projects over 4-week rotation	Various departments	Multiple system performance and patient care measures improved	Yes	Improved QIKAT scores, OSCE performance, learner satisfaction	Good
Diaz <i>et al</i> 2010 ²⁰	2nd and 3rd year FM residents (61)	Clinical scholars curriculum delivered over 1 year of residency	Outpatient primary care clinic	Multiple system performance and patient care measures improved	Yes	Increase in number of publications and presentations	Good
Shiner <i>et al</i> 2010 ²⁵	Psychiatry residents (12)	Aiming to improve care for major depressive disorder	Outpatient psychiatry clinic	Improved percentage of patients seen within 6 weeks of starting MDD treatment	Yes	NR	Good
Clark <i>et al</i> 2011 ²⁸	General surgery residents (33)	Team completed needs assessment and improvement in signout process by template	Inpatient surgery service	Improvement in signout processes	NR	NR	Good
Dysinger <i>et al</i> 2011 ²¹	4th year medical students (510)	Required rotation, putting students into practices focused on improvement	Various departments	Improved documentation	Yes	Some improved learner satisfaction	Very good
Laiteerapong <i>et al</i> 2011 ²²	IM residents (10)	Team project to improve documentation	Outpatient primary care clinic	Improvement in height, weight, BMI documentation	Yes	Improved learner satisfaction	Good
Ogrinc <i>et al</i> 2011 ⁴	2nd year medical students (22)	Health Leadership Practicum Elective brings student teams into clinical settings in need of improvement	Various departments	Multiple reported improvements (i.e., urine samples screened in pregnant women)	NR	NR	Good
Oyler 2011 ²⁴	IM residents (64)	Required rotation encouraging teams to develop projects	Outpatient primary care clinic	Improvement in ASA use, documentation on BMI and smoking history	Yes	NR	Good
Arbuckle <i>et al</i> 2013 ²⁷	3rd year psychiatry residents (12)	Longitudinal QI curriculum over 37 weeks, including longitudinal project	Outpatient psychiatry clinic	Improvement in monitoring of depression symptoms, screening	NR	Improved QIKAT scores	Good
Individual project							
Weingart <i>et al</i> 2004 ⁵⁷	2nd and 3rd year IM residents (26)	RCA/QI project on voluntary elective	Various departments	Improvement in system performance and patient care measures	NR	Improved learner satisfaction	Fair
Canal <i>et al</i> 2007 ⁵³	3rd year general surgery residents (15)	Mandatory QI project on research time	Various departments	Improvement in several system performance measures	NR	Improved QI curriculum pre/post test	Good

Continued

Table 2 Continued

Author and year	Population (n)	Intervention description	Clinical setting	Clinical outcomes			Quality assessment†
				Finding	Statistically significant*	Educational outcomes	
Sockalingham <i>et al</i> 2010 ⁵⁶	2nd and 3rd year psychiatry residents (40)	Mandatory QI project while on rotation	Various psychiatry departments	Improvement in consult/referral services	NR	Information by focus group and questionnaire	Good
Oujiri <i>et al</i> 2011 ⁵⁴	3rd year IM residents	Learners chose QI project as part of elective rotation	Outpatient primary care clinic	Improvement in several patient care and system performance measures for heart failure patients	Yes	NR	Good
Reardon <i>et al</i> 2011 ⁵⁵	Psychiatry residents (16)	Learner assigned to unit and completed mandatory project	Various departments	Improvement in consult processes	NR	Improved QIKAT scores	Good

*If 'Yes' the majority of findings in the results of the study had to be shown to be statistically significant, either by p value or statistical process control (SPC) analysis.

†We modified methodological quality assessment of these studies to take into account the important factors of educational literature: clear accounting for systematic bias, clear description of the intervention, learning objectives articulated for educational interventions, minimisation of other exposures which could have impact on the outcome, minimisation of bias and confounding. QI, quality improvement; ACIC, assessment of chronic illness care; ASA, aspirin; BMI, Body Mass Index; BP, blood pressure; CC, critical care; CHD, chronic obstructive pulmonary disease; DM, diabetes mellitus; ED, emergency department; FM, family medicine; GIMU, general medical unit; Hba1c, haemoglobin a1c; HTN, hypertension; IM, internal medicine; LDL, low density lipoprotein; LVF, left ventricular failure; M&M, morbidity and mortality; MET, medical emergency team; MICU, medical intensive care unit; N, no; NICU, neonatal intensive care unit; NR, not reported; QIKAT, quality improvement knowledge assessment test; OSCE, objective structured clinical examination; RCA, root cause analysis; RPIW, rapid process improvement workshop; Y, yes.

DISCUSSION

How can our findings inform a comprehensive model of teaching, learning and doing QI in medical education? Our realist analysis and conceptual framework (figure 2) suggest that clinical education, whether providing care to an individual patient or doing QI work, does not begin with the curriculum. It begins with the trainee and patient at the centre of a healthcare system that encompasses many institutional levels. The trainee exists within two overlapping worlds: educational and clinical. The educational world is comprised of teaching faculty and together they exist within the training programme. The clinical world is made up of the patient and family at the centre of an interprofessional care team, of which the trainee is one part. The outcome of the educational world is improved trainee knowledge, skills and attitudes. The outcome of the clinical world is improved patient care and system performance. While these are often seen as separate, QI is one key area that exposes the inter-related complexities of the educational and care-delivery systems. In order to produce physicians who are capable of and believe that their duty is to do their work and improve their work, we should rethink the conventional wisdom

Table 3 Relevant themes from realist review

What works	Accurately account for the time it takes to deliver QI education in the clinical setting due to competing demands, existing work load of trainees, and work-hour rules Identifying educational and clinically relevant project topics is challenging Consider having trainees choose their own project Choose topics of clinical importance Use near misses as a way to identify system errors
For whom	Medical students can, and should be expected, to contribute to quality of care in the clinical setting Residents are front-line providers and have deep insights into the clinical processes and the knowledge for improvement within the system
Under what circumstances	Successful QI teaching in the clinical setting requires support from both educational and care delivery leaders and the work of the trainees Data are critical. The availability of data, especially through health information technologies, has a direct positive impact on learner satisfaction and engagement Opportunities for interprofessional engagement and education can be found in teaching about QI within the clinical setting Programs can be successful by either engaging all faculty around QI or by having dedicated QI faculty for teaching QI within the clinical setting
To achieve what outcomes	There is lack of clarity around whether educational and clinical outcomes are of equal or relative hierarchical importance Sustainability is important for the clinical setting and the trainee. Sustainable projects can impact the culture of the clinical setting, but unsustainable projects may leave the trainee and other participants disheartened about improvement work

QI, quality improvement.

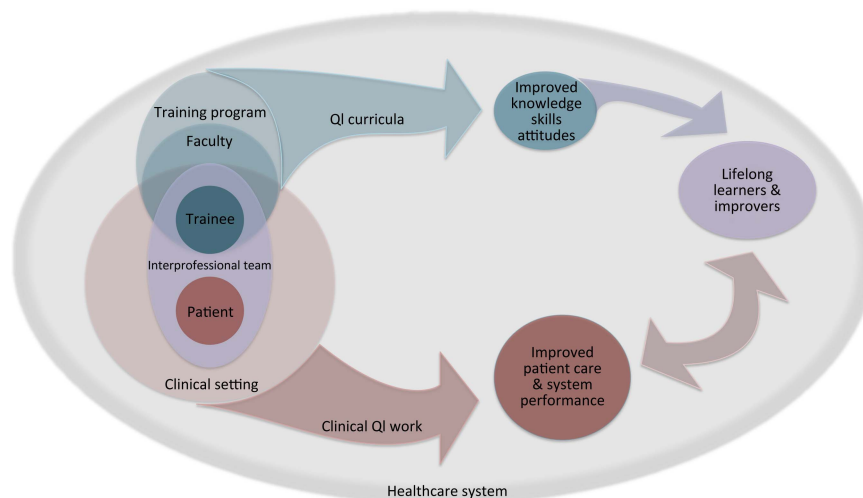


Figure 2 A conceptual framework describing the relationships between the contexts, mechanisms and outcomes for quality improvement (QI) in medical education.

around education and acquisition of improvement knowledge and skills. As Batalden and Davidoff⁵⁸ wrote, ‘Learning how to do quality improvement and actually carrying out quality improvement are essentially one and the same; both are special forms of experiential learning.’ In fact, medical education is currently embracing this culture in teaching clinical skills using Adult Learning Theory, which reminds us that professionals learn best when they see a *need* to acquire the knowledge and skills for fulfilment of goals.⁵⁹ If trainees see that faculty are asking questions of the process and *needing* to learn more to improve the system, then they have the opportunity to engage with them.⁶⁰ Interestingly, Asch *et al*⁶¹ have demonstrated that within obstetrical residencies, it is possible and, perhaps beneficial, to rank obstetrical programmes based on overall performance on clinical rather than educational outcomes, representing yet another innovation for the future of the medical profession. The ACGME has acknowledged the importance of the clinical learning environment as an essential component of resident education and, accordingly, adopted the Clinical Learning Environment Review, ‘to generate national data on programme and institutional attributes that have a salutary effect on quality and safety in settings where residents learn and on the quality of care rendered after graduation.’⁶² Through the knowledge, skills and attitudes that trainees achieve during their educational programme while taking part in the improvement of the clinical care, we expect to nurture lifelong learners and improvers who will advance clinical improvements in patient care and system performance.

This realist review has limitations that begin with the known publication bias in this field. This bias was corroborated in our review, as none of the published studies described a clinical process that was *worsened*. Not sharing failed pilots and curriculum

limits the learning that can occur across programmes. Also, although our search strategy allowed us to analyse *any* circumstance of trainees being involved in QI in the clinical setting, this may have caused us to falsely criticise studies with primarily clinical interventions, because they did not aim to prove that involving trainees made a difference in their clinical outcomes. The realist review process, however, helps to differentiate these studies and their important qualitative information about ‘what works,’ ‘for whom,’ ‘under what circumstances’ and ‘to achieve what outcomes’.

Because a methodological quality tool does not exist for assessment of the QI education literature, we created a tool by combining elements of existing validated tools. Although we did not use a validated instrument, the tool we developed contains the specificity for the QI education literature and thus made the quality assessment more rigorous. We did not, however, identify any ‘excellent’ quality studies (see online supplement 5). Although we found that all the lowest-quality studies did not demonstrate significant results, there were no strong studies to show improvement in both clinical and educational outcomes. We identified many studies with minor weaknesses, and the realist review process helps to glean the notable characteristics from these data. More high-quality studies would take steps to minimise bias in the study population, clearly describe the intervention and educational objectives, minimise other exposures or secular trends that could have accounted for the results, analyse results with enumerative or analytic statistics, explain all biases and confounders and report funding sources. Among the studies in this review, many would have been improved by particular attention to minimising bias and confounding in the study population, and a clear articulation of educational objectives.

CONCLUSION

The studies in this review reported on many more clinical outcomes than had been described in previous reviews, in large part due to the development of clinically oriented QI programmes since the prior reviews. Using the realist approach allowed us the advantage of synthesising these data to not just update, but reconceptualise (figure 2) the current landscape of QI teaching. Advances in teaching and doing QI has made tremendous strides in the past decade, but further work is needed to determine the factors that reliably facilitate the development of physicians who will believe and are capable of doing their work and improving their work—ultimately, physicians who are lifelong learners and improvers.

Acknowledgements The authors thank Tom Mead, MLS, Reference Librarian, Biomedical Libraries, Dartmouth College, for assistance with development of the search strategy; Aurora Leute Matzkin, PhD and Martha Reagan-Smith, MD, EdD (Professor Emerita, Geisel School of Medicine) for their assistance in reading drafts of the work and preparing the conceptual framework.

Contributors The conception or design of the work and interpretation of data was performed by ACJ, SAS and GO. The acquisition and analysis of data was performed by ACJ and GO. The manuscript was drafted by ACJ, and revised critically for important intellectual content by ACJ, SAS and GO. All authors approved the final version of the manuscript. ACJ, SAS and GO agree to be accountable for all aspects of this work and will ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding This work was supported by the VA National Quality Scholars Fellowship Program, the VA Office of Academic Affiliations, and the Geisel School of Medicine at Dartmouth Office of Health Systems and Clinical Improvement with the use of facilities and materials from the White River Junction VA in White River Junction, VT.

Competing interests ACJ and SAS have no competing interests to report. GSO is an Associate Editor of *BMJ Quality and Safety* but otherwise has no competing interests to report.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement ACJ had full access to all the data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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