The Use of Three Strategies to Improve Quality of Care at a National Level

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Abstract

Background Improving the quality of care is essential and a priority for patients, surgeons, and healthcare providers. Strategies to improve quality have been proposed at the national level either through accreditation standards or through national payment schemes; however, their effectiveness in improving quality is controversial.

Questions/purposes The purpose of this review was to address three questions: (1) does pay-for-performance improve the quality of care; (2) do surgical safety checklists improve the quality of surgical care; and (3) do practice guidelines improve the quality of care? These three strategies were chosen because there has been some research assessing their effectiveness in improving quality, and implementation had been attempted on a large scale such as entire countries.

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Methods We performed a literature review from 1950 forward using Medline to identify Level I and II studies. We evaluated the three strategies and their effects on processes and outcomes of care. When possible, we examined strategy implementation, patients, and systems, including provider characteristics, which may affect the relationship between intervention and outcomes with a focus on factors that may have influenced effect size.

Results Pay-for-performance improved the process and to a lesser extent the outcome of care. Surgical checklists reduced morbidity and mortality. Explicit practice guidelines influenced the process and to a lesser extent the outcome of care. Although not definitively showed, clinician involvement during development of intervention and outcomes, with explicit strategies for communication and implementation, appears to increase the likelihood of positive results.

Conclusion Although the cost-effectiveness of these three strategies is unknown, quality of care could be enhanced by implementing pay-for-performance, surgical safety checklists, and explicit practice guidelines. However, this review identified that the effectiveness of these strategies is highly context-specific.

Introduction

Improvement in quality of care is of fundamental importance to every stakeholder in health care. Strategies to improve quality of care are needed not just at the clinician-patient interface, but also at the regional and national levels. In deciding where to focus attention, however, there are many issues. For example, as noted subsequently, there are multiple elements of quality [19]. In addition, each stakeholder brings their own particular perspective to the

critical elements of quality. Finally, for every element of quality, there are multiple possible strategies to enhance quality of care.

The Institute of Medicine definition of quality, used in this review, has six elements [19] characterized according to the acronym STEEP: Safe, Timely, Effective, Efficient, Equitable, and Patient-centered. As noted, the stakeholders in healthcare are multiple, but at minimum include patients, healthcare professionals (and their professional associations), hospitals, health agencies, third-party payors/insurers, and government. When the stakeholders are further broken down into their multiple layers such as different countries and levels of government, the number of stakeholders becomes even larger. If consideration is given to all elements of quality and all stakeholders with their multiple different perspectives, the scope of initiatives to improve quality becomes overwhelming.

Three initiatives, and the focus of this review, have the potential, either through government or professional associations, to improve quality of care: (1) pay-for-performance, the use of financial incentives to reward better quality of care [28]; (2) safety checklist, a communication tool that standardizes surgical processes to enhance safety [22]; and (3) practice guidelines, specific statements based on scientific evidence that aid clinical decision-making [47].

Search Strategies and Criteria

A literature review was performed using Medline from 1950 forward. The search strategy (Table 1) was designed to identify controlled studies (Levels I and II [77]) and systematic overviews. High-quality randomized controlled trials (RCTs) were considered Level I studies, and Level II evidence included prospective comparative studies and lesser quality RCTs [77]. The search was limited to English language articles. The MeSH search string for pay-for-performance was further restricted to health administration journals from 2000 onward to focus on the most relevant articles.

The search identified a total of 7161 records. After removing the duplicates, we screened 7041 abstracts and selected 278 for full text review. Studies that assessed effectiveness of pay-for-performance, surgical checklist, or practice guidelines for the improvement of care were considered for inclusion. Letters to the editor, editorials, commentaries, or review articles were excluded. Studies were also excluded if: (1) pay-for-performance, surgical checklist, or practice guideline was not the primary component of the intervention; (2) process or outcome of care measures were not reported; and/or (3) not a systematic overview or Level I or II evidence [77].

Table 1. Database: Ovid MEDLINE 1950 to the present with daily update search strategy: quality of health care (rerun December 13, 2010)

1	exp national health programs/or exp regional health planning/(94028)
2	comparative study/(1534984)
3	1 and 2 (3790)
4	limit 3 to health administration journals (624)
5	collective bargaining/or employee incentive plans/or employee performance appraisal/or physician incentive plans/or exp “salaries and fringe benefits”/(32090)
6	1 and 5 (2319)
7	limit 6 to health administration journals (788)
8	limit 3 to yr = “2000-Current” (2098)
9	limit 8 to health administration journals (254)
10	exp Taxes/(8049)
11	1 and 10 (526)
12	limit 11 to health administration journals (211)
13	Fees, Medical/(5081)
14	exp quality assurance, health care/or quality indicators, health care/or exp “utilization review”/(216636)
15	3 and 14 (394)
16	Checklist/or checklist*.mp. (13344)
17	16 or medical errors/(22820)
18	exp surgical procedures, operative/or oral surgical procedures/(2002678)
19	exp intraoperative complications/or exp postoperative complications/(384920)
20	18 or 19 (2132560)
21	17 and 20 (2271)
22	Guideline Adherence/or Guideline/or Practice Guideline/(34355)
23	(“clinical trial, all” or clinical trial).pt. or clinical trials as topic/(552474)
24	clinical trial, phase i.pt. or clinical trials, phase i as topic/(14416)
25	clinical trial, phase ii.pt. or clinical trials, phase ii as topic/(22181)
26	clinical trial, phase iii.pt. or clinical trials, phase iii as topic/(10529)
27	clinical trial, phase iv.pt. or clinical trials, phase iv as topic/(750)
28	controlled clinical trial.pt. or controlled clinical trials as topic/(87858)
29	meta-analysis.pt. or meta-analysis as topic/(37865)
30	multicenter study.pt. or multicenter studies as topic/(140395)
31	randomized controlled trial.pt. or randomized controlled trials as topic/(374278)
32	or/23–31 (820786)
33	22 and 32 (2744)
34	(pay\$ adj2 perform\$).ti.ab. (1045)
35	4 or 7 or 9 or 12 or 15 or 21 or 33 or 34 (7899)
36	limit 35 to english language (7348)

Seventy-three studies met all the inclusion criteria and were included in the review (Table 1): 20 on pay-for-performance, five on surgical checklists, and 48 on practice guidelines. Because there were few randomized trials and the methods were so different among studies, formal meta-analyses were not possible. The specific studies identified are presented in Appendix Table A1.

Does Pay-for-Performance Improve Quality of Care?

The answer to the first question was, in most cases, a qualified yes; only three studies [34, 35, 65] did not report improvement. However, the overall effect was small and highly context-specific [16, 28, 49, 61, 66, 67, 72]. Three of four studies of physician-level financial incentives, one study of financial incentives directed toward health administrators, and four of five studies of provider-level financial incentives showed positive improvement in quality [3, 9, 12, 28, 33, 44, 48, 64]. All but one study of pay-for-performance was conducted in the United States [15]. Five systematic reviews [16, 49, 61, 67, 72] concluded that pay-for-performance can improve quality, but observed effects were small and nuanced, influenced by other factors including program design and characteristics of the incentive, patients, and clinicians. In one review, appraisal of the most rigorous studies found only a 2- to 4-percentage point improvement [49]. Most pay-for-performance focused on process indicators, which were presumably under direct control of providers and/or the health system [61, 72]. In contrast, various factors contributed to patient outcomes, and many, if not most, were not within clinicians' control [66]. Greater improvement was reported when rewarding process and clinical indicators as compared with patient and efficiency outcomes, respectively [64, 66, 72]. Stakeholder involvement in design and evaluation of measures, and strong dissemination, further enhanced improvement [16, 72]. Pay-for-performance had the greatest effect on low rather than high performers [3, 9, 16, 33, 44, 64, 72]. Approaches with purely positive incentives (versus winners and losers) [12, 16, 34, 35, 48] and paying clinicians rather than hospitals were more effective [16, 61]. Pay-for-performance focused on the individual provider found no relationship between frequency [17] and size of incentive on effect sizes [72]. No characteristics of the provider or patient affected the results [72]. National programs (ie, United Kingdom) [15] compared with a fragmented approach (ie, United States) [17, 28, 44, 49, 64, 65] also led to improved results. This was attributed to a comprehensive, consistent, and well-understood relationship between pay-for-performance and results more easily achieved by a single payor such as the National Health Service [65, 72].

A potential unintended consequence of pay-for-performance was the increase in health inequalities with an incentive to select healthier patients and avoiding reducing income by serving minority populations [16, 61]. However, at least in the United Kingdom, minimal reductions in chronic disease management were observed [2]. Sustainability of gains was another issue. Improvement may be sustained even after intervention [2, 48], but at least one study suggested not only reduction in continuity in care once targets were achieved, but decline in the rate of quality of care improvement with time [15].

Do Safety Checklists Improve Quality of Surgical Care?

Studies showed improved overall communication as a result of both increased communication [56] and reduced failures of communication [45]. The sign-in, time-out, and sign-out periods prompted by a surgical checklist introduced in a pediatric hospital facilitated communication among operating room staff and, subsequently, identification of "near miss" situations [56]. The implementation of a surgical checklist in general surgery reduced the mean number of communication failures per procedure from 3.95 to 1.31 as well as reduced the number of communication failures associated with visible negative consequences by 64% [45]. Checklists also enhanced processes of care such as appropriate use of prophylactic antibiotics to reduce surgical site infection [22]. Two studies showed substantial reduction in adverse events and mortality after introduction of surgical checklists for elective and urgent operations [31, 76]. Until recently, the primary application of checklists was in the operative period. However, a recent study implied broader, more sustained improvement after implementation of a comprehensive, multidisciplinary checklist [22]. A key issue in the implementation of checklists is education and the use of champions [70]. Compliance with more elements of the checklist was associated with greater improvements in quality of care, but even with partial completion, substantial benefits in morbidity and mortality were observed [22, 31].

Do Practice Guidelines Improve Quality of Care?

Like with pay-for-performance, the answer was a qualified yes. A number of studies reported substantial improvement in quality both in inpatient [1, 11, 14, 18, 21, 32, 50, 53, 57, 60, 62, 68, 78] and outpatient settings [13, 29, 37, 40, 42, 46]. Numerous studies, including six RCTs [4, 7, 38, 51, 63, 71], failed to show any positive effects on quality associated with practice guidelines [5, 10, 20, 25, 26, 36]. Results were mixed in 12 studies, in which practice

guidelines improved quality for certain outcomes or patient subgroups but not others [8, 23, 24, 41, 43, 52, 54, 55, 58, 59, 73, 74]. Finally, three systematic reviews reported that clinical practice guidelines could improve the efficacy, efficiency, and cost-effectiveness of care; however, the size of effect was variable and generally small [6, 27, 47]. Studies found greater effect with explicit guidelines [6, 13, 21, 23, 50, 55], defined as “systematically developed statements to assist practitioner decisions about appropriate health care for specific clinical circumstances” [27], although practice guidelines improved both processes and outcomes of care, including cost [14, 29, 53, 62], and the results were greater for performance compared with patient outcomes. Clinician involvement in all aspects of guideline development was vital [5, 46, 53, 73]. However, benefits of comprehensive dissemination and implementation need to be further clarified [36].

Discussion

Improving quality of care is of prime consideration for patients, clinicians, and healthcare providers. Although many approaches are available, few have been promoted at the healthcare system level. This review focused on pay-for-performance, surgical checklists, and practice guidelines as potential strategies to improve quality of care.

Although we concluded based on the review that these strategies may be effective, we also acknowledge that the review and the identified studies have some limitations. First, and most important, programs are highly dependent on context, which is evidenced by the substantial clinical heterogeneity and variable effectiveness seen in the literature. For example, although pay-for-performance can improve quality, the type, amount, and timeliness of the incentives all affected the magnitude of the behavioral change and the potential benefit of the strategy. Second, most studies have selectively focused on only certain aspects of quality such as safety [22, 31, 75, 76] and timeliness [12, 52]. A complete evaluation of quality would require examination of all the elements. Third, not all studies have considered the unintended consequences that in some circumstances may diminish quality. For example, in pay-for-performance, rewarding certain quality targets may inadvertently direct focus away from others, resulting in neglect and diminished quality in those areas. Fourth, although some evidence related to each of the interventions suggests an overall benefit, the effects of integrating these interventions are largely unknown. Although additive effects are possible, the combination may not be equal to the sum of the parts because the same processes of care are being targeted. For example, checklists, pay-for-performance, and practice guidelines can all be independently

directed toward the appropriate use of antibiotics to prevent surgical site infection, but the effect of a combination of strategies remains unexplored. Furthermore, although interventions could be combined, specifically, using pay-for-performance to enhance the use of either surgical checklists and/or practice guidelines, as noted, the additional benefit of combining interventions is not verified. Fifth, with regard to methodology, this review is not comprehensive in examining all potential strategies to enhance quality of care. However, we focused on three major initiatives that have the potential to be established at a regional or national level. Sixth, even given the narrow focus of the three questions, the literature search is almost certainly incomplete. For example, we limited the literature search on pay-for-performance to health administration journals. Although expanding the literature to other types of journals and databases would have identified more studies, we do not believe the conclusions that these three strategies probably improve quality of care would change. The issue as noted that likely has a much greater impact on the effectiveness of the strategies is the context in which they are implemented. Seventh, the magnitude of the effect of pay-for-performance, surgical checklists, and practice guidelines cannot be accurately determined given the enormous heterogeneity in design and outcomes of the interventions. However, although the results are likely robust only to a specific context, the interventions were generally effective at improving quality of care albeit with generally small gains.

Pay-for-performance programs have the potential to align payor and provider incentives. However, pay-for-performance, to be effective, needs to consider all aspects of quality of care, including reduction in disparities and improvement in access to care with a consideration of anticipated and potential unanticipated outcomes. Furthermore, the majority of programs have focused on process measures rather than patient outcomes. Although clinicians may argue that paying for outcomes is not appropriate because many factors out of clinicians' control affect outcome, incenting process measures may not improve potential outcomes if the link between the process measure and outcomes is not strongly related. Furthermore, an aspect of care not considered by all pay-per-performance programs is whether the treatment or surgery is appropriate or indicated. A theme in many studies is the benefit of including providers in all aspects of pay-for-performance design. More research and of higher quality is required to understand how to improve the effect of pay-for-performance on quality, including defining appropriate outcomes and ideal incentives.

Surgical checklists arose from the safety literature based on the premise that simple checklists could not only improve compliance with important steps in healthcare

delivery, but perhaps even more important, create a situation of improved communication [39]. Although this review focused on surgical checklists, in other areas of medicine, checklists reportedly enhance quality of care [39]. The theoretical downside of increased time and reduced efficiency of checklists seems not to have been realized and although not fully tested, checklists may actually reduce inefficiencies that are a result of miscommunication of essential information. Furthermore, at least one study demonstrated that even partial completion of all checklist elements can improve quality. As previously noted, successful implementation does require a concerted and sustained effort involving education and champions. Furthermore, recent research suggests the checklist should not be restricted to the operating room but should be expanded to consider all aspects of the perioperative process [22].

Practice guidelines have the longest history of these three strategies in improving quality of care. However, the challenge has always been to make high-quality evidence into a useable format, to change clinician behavior, and to determine whether with both of these steps in a broader context (than in the original study setting) can improve care. Although the numbers of studies showing the actual improvement in outcomes of care are few, the overall results show that explicit practice guidelines have the potential to improve quality of care. This finding bolsters

the efforts of the American Academy of Orthopaedic Surgeons (AAOS) to develop practice guidelines. Although the evidence is lacking for many aspects of orthopaedic care as evidenced by the lack of Level I evidence in many AAOS guidelines, the potential for guidelines to improve orthopaedic care seems promising. Furthermore, the amount of high-quality evidence in orthopaedics is increasing [30] and will likely inform subsequent revisions of practice guidelines. A key issue for future research is to focus not only on the development of rigorous guidelines, but also on the dissemination and implementation directed toward the important challenge of changing surgeons' behavior.

Our review suggests that although the results are mixed, pay-for-performance, surgical checklists, and explicit practice guidelines would improve the quality of care. Key issues include the involvement of clinicians at all stages of development with explicit and comprehensive plans for communication and implementation of the interventions. Most of the factors that contribute to better results are unknown and should be the focus of future study. Finally, economic analysis of these programs needs to be conducted to better understand which interventions are likely to be most cost-effective in improving quality.

Appendix 1

See Table A1.

Table A1. Characteristics of identified articles

Study	Design	Population	Intervention	Outcome	Level of evidence
Alshamsan et al. [2]	Systematic review of 22 studies	Primary practice	Mixed pay-for-performance programs	Chronic disease management	II
An et al. [3]	Randomized trial	Primary care	\$5000 for 50 tobacco quit-line referrals	Quit-line referrals	I
Beaulieu and Horrigan [9]	Cohort	21 primary care physicians	Bonus up to 12% of income	Composite score of process and outcome measures for diabetes	II
Boland et al. [12]	Cohort	Radiology department	\$2500 for finalizing all radiology reports in 24 hours or less	Mean report turnaround time	II
Campbell et al. [15]	Time series	42 family practices in England	Pay-for-performance on 136 indicators affecting up to 25% of income	Quality of care scores for diabetes, coronary heart disease, asthma	II
Christianson et al. [16]	Systematic review of 15 studies	Mixed	Mixed pay-for-performance	Mixed process and outcome measures	II
Chung et al. [17]	Randomized trial	Primary practice	2% bonus	Nine quality measures	I
Grossbart [28]	Cohort	10 hospitals	2% incentive for 35 quality measures	Composite quality scores for myocardial infarction, heart failure, and pneumonia	II
Herrin et al. [33]	Cohort	5 acute care hospitals	Bonus for administrators up to 125% of possible award on quality index of 12 measures	Process measures for acute myocardial infarction, heart failure, and pneumonia, and in-hospital mortality	II

Table A1. continued

Study	Design	Population	Intervention	Outcome	Level of evidence
Hillman et al. [34]	Randomized trial	52 primary care sites	10% or 20% bonus for top and most improved sites and performance feedback	Aggregate process measures for cancer screening guidelines	I
Hillman et al. [35]	Randomized trial	49 primary care practices	10% or 20% bonus for top and most improved sites and performance feedback	Aggregate process measures from pediatric preventive care guidelines	I
Lindenauer et al. [44]	Cohort	613 hospitals in US	1%–2% bonus for top-performing sites and public reporting	Composite score of 33 process measures for acute myocardial infarction, heart failure, and pneumonia	II
Mandel and Kotagal [48]	Time series	44 children's primary care practices	Up to 7% fee increase for quality indicators and capacity-building	Mixed process measures for asthma	II
Mehrotra et al. [49]	Systematic review of 8 studies	Hospitals in 3 programs in US	Mixed pay-for-performance programs	Mixed process, outcome, structure, safety, and cost measures	III
Petersen et al. [61]	Systematic review of 17 studies	Mixed	Mixed pay-for-performance programs	Mixed process and outcome measures	II
Rodriguez et al. [64]	Time series	Primary care	Mixed pay-for-performance	Mixed performance and outcome measures	II
Rosenthal and Frank [65]	Systematic review of 6 studies	Mixed	Mixed pay-for-performance programs	Mixed process and outcome measures	II
Roski et al. [66]	Randomized trial	37 primary care clinics	Award up to \$5000–\$10,000 per clinic, or award and smoker registry	Process measures and smoking cessation rate	I
Schatz [67]	Systematic review of 22 prospective trials	Mixed	Mixed pay-for-performance programs	Mixed performance and outcome measures	II
Van Herck et al. [72]	Systematic review of 128 studies	Mixed	Mixed pay-for-performance programs	Mixed performance and outcome measures	II
de Vries et al. [22]	Cohort	6 adult hospitals	Comprehensive checklist	Mortality and morbidity	II
Haynes et al. [31]	Cohort	8 hospitals	World Health Organization (WHO) checklist	Mortality and morbidity	II
Lingard et al. [45]	Cohort	Adult hospital	Structured checklist	Communication failures	II
Norton and Rangel [56]	Cohort	Children's hospital	Pediatric surgical safety checklist	Communication and multiple process measures	II
Weiser et al. [76]	Cohort	8 hospitals	WHO checklist	Morbidity and mortality	II
Albano et al. [1]	Randomized trial	75 pediatric primary care clinics in Italy	Acute gastroenteritis guidelines	Duration of diarrhea, difference in body weight, and process measures	I
Azocar et al. [4]	Randomized trial	Managed behavioral healthcare organization	Depression treatment guidelines	Mixed process, utilization, and cost measures	I
Azoulay et al. [5]	Cohort	26 intensive care units (ICUs) in France	ICU triage guidelines	Admission to ICU and process measures	II
Bahtsevani et al. [6]	Systematic review of 8 studies	Mixed	Mixed guidelines	Mixed process and outcome measures	II
Baker et al. [7]	Randomized trial	81 general practices in UK	Asthma or angina guidelines	10 asthma and 14 angina process measures and patient satisfaction	I

Table A1. continued

Study	Design	Population	Intervention	Outcome	Level of evidence
Bauchner et al. [8]	Randomized trial	12 pediatric primary care clinics	Antibiotic guidelines for acute otitis media	Subsequent antibiotic prescription	I
Bermejo et al. [10]	Controlled trial	44 private practices in Germany	Depression guidelines	Symptom reduction and mixed process and outcome measures	II
Bodi et al. [11]	Cohort	33 hospitals in Spain	Antibiotic guidelines	Mortality in ICU	II
Bousquet et al. [13]	Randomized trial	Primary care in UK, France, and Belgium	Rhinitis guidelines	Symptom and quality-of-life scores	I
Brignole et al. [14]	Cohort	47 hospitals in Italy	Syncope management guidelines	Hospitalization, mixed process and outcome measures, and cost	II
Cloutier et al. [18]	Cohort	6 children's primary care clinics	Asthma guidelines	Percent hospitalization and emergency department or outpatient visits and use of medications	II
Cuspidi et al. [20]	Cohort	6 outpatient hypertension hospital centers in Italy	Hypertension guidelines	Process measures	II
Daly et al. [21]	Cohort	197 clinical centers in 36 European countries	Stable angina guidelines	Mortality, myocardial infarction, and cardiovascular events	II
Duncan et al. [23]	Cohort	Veterans Affairs rehabilitation facility	Stroke rehabilitation guidelines	Composite score for motor function and outcome measures	II
Fine et al. [24]	Randomized trial	7 hospitals	Pneumonia guidelines	Duration of intravenous antibiotic therapy, length of stay, mortality, and other outcome measures	I
Gauthier et al. [25]	Cohort	Children's hospital	Ceftriaxone guidelines for acute otitis media	Appropriateness of ceftriaxone use	II
Gorecki et al. [26]	Cohort	Children's hospital	Prophylactic antibiotic guidelines	Duration of antibiotics	II
Grimshaw and Russell [27]	Systematic review of 59 studies	Mixed	Mixed "explicit" guidelines	Mixed process and outcome measures	II
Guterman and VanRooyan [29]	Cohort	Adult hospital	Cost-effective emergency medicine guidelines	Average outpatient hospital charge per patient	II
Heringer et al. [32]	Cohort	Nationwide newborn screening in Germany	Glutaric aciduria Type I guidelines	Mortality and outcome measures	II
Holroyd et al. [36]	Time series	4 hospitals in Edmonton, Canada	Ottawa ankle rules	Radiographic utilization	II
Humphreys et al. [37]	Cohort	8 Veterans Affairs opiate treatment clinics	Opiate substitute treatment guidelines	Days of heroin use, employment, and illegal activities other than drug use, global mental health, and urinalysis-confirmed abstinence	II
Jain et al. [38]	Randomized trial	58 ICUs in Canada	Nutrition support guidelines	Caloric intake, length of ICU and hospital stay, and mixed process and outcome measures	I
Katz et al. [40]	Randomized trial	8 community-based clinics	Smoking cessation guidelines	Mixed process and outcome measures	I
Krishnan et al. [41]	Cohort	2 ICUs	Nutritional support guidelines	Caloric intake, status on hospital discharge, and other outcome measures	II

Table A1. continued

Study	Design	Population	Intervention	Outcome	Level of evidence
Kulkarni et al. [42]	Randomized trial	27 mixed sites	Nutrition practice guidelines for Type I diabetes mellitus	Mixed process and outcome measures	I
Lallemant et al. [43]	Cohort	18 hospitals in France	Prophylactic antibiotic guidelines	Surgical site infection and process measures	II
Lougheed et al. [46]	Cohort	10 emergency departments in Ontario, Canada	Adult asthma care pathway	Mixed process and outcome measures	II
Lugtenberg et al. [47]	Systematic review of 20 studies	Mixed	Mixed guidelines	Mixed process and outcome measures	II
Micieli et al. [50]	Cohort	4 hospitals in northern Italy	Acute ischemic stroke with transient ischemic attacks guidelines	Mortality and effectiveness of treatment on disability score	II
Mitchell et al. [51]	Randomized trial	21 children's primary care groups in New Zealand	Children asthma care pathway	Percent hospitalization and emergency department attendance and use of medications	I
Morrison et al. [52]	Randomized trial	Primary care in Glasgow, Scotland	Infertility guidelines	Mixed process, outcome, and cost measures	I
Müller et al. [53]	Cohort	Teaching hospital in Zurich, Switzerland	Mixed clinical pathways	Costs of examinations and hospital stay, amount of examinations, and severity of in-hospital complications	II
Naughton et al. [54]	Randomized trial	10 skilled nursing facilities	Pneumonia guidelines	Antibiotic use, hospitalization, severity of pneumonia, and mortality	I
Noordzij et al. [55]	Cohort	38 dialysis units in The Netherlands	Bone metabolism and disease in chronic kidney disease guidelines	Calcium (CA), phosphorus (P), Ca x P, and iPTH concentrations and mortality	II
Onat et al. [57]	Cohort	26 clinics in Turkey	Prevention of coronary heart disease guidelines	Absolute and percent reduction of risk score, and plasma lipids and lipoproteins concentrations	II
Palazzi et al. [58]	Cohort	12 radiotherapy centers in Lombardy, Italy	Early breast cancer treatment guidelines	Treatment process measures	II
Panella et al. [59]	Cohort	Healthcare organizations in Italy	Mixed clinical pathways	Mixed process and outcome measures	II
Patterson et al. [60]	Cohort	5 regional hospitals	Trauma transfer guidelines	Trauma transfer	II
Quaglini et al. [62]	Cohort	4 hospitals in northern Italy	Ischemic stroke guidelines	Hospitalization cost and length of stay	II
Reader et al. [63]	Randomized trial	25 mixed sites	Gestational diabetes mellitus nutrition guidelines	Insulin use, glycated hemoglobin, and pregnancy outcome measures	I
Schneider et al. [68]	Cohort	10 hospitals in Germany	Depression guidelines	Depression, medication use, and process measures	II
Sellier et al. [69]	Cohort	33 hospital postacute care facilities in France	Venous thromboembolism prophylactic guidelines	Deep venous thrombosis, bleeding, and thrombocytopenia	II
Van der Sanden et al. [71]	Randomized trial	92 general dental practices in The Netherlands	Lower third molar management guidelines	Extraction referrals and knowledge	I
Van Kasteren et al. [73]	Cohort	13 hospitals in The Netherlands	Prophylactic antibiotic guidelines	Antibiotic process measures	II
Weingarten et al. [74]	Cohort	6 hospitals	Length of stay guidelines	Length of stay	II

Table A1. continued

Study	Design	Population	Intervention	Outcome	Level of evidence
Weingarten et al. [75]	Time series	Adult hospital	Pneumonia guidelines	Mixed process and outcome measures	II
Yealy et al. [78]	Randomized trial	32 emergency departments	Pneumonia guidelines	Percent low-risk and higher-risk treated as outpatients and mixed process and outcome measures	I

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