Making Healthcare Safer IV

Use of Report Cards and Outcome Measurements To Improve the Safety of Surgical Care

Rapid Response

Main Points

- Report cards have emerged as a method of measuring and reporting surgical outcomes, and they serve as a stimulus for quality improvement and increased patient safety. The purpose of this rapid response was to summarize recent literature on the use of report cards and outcome measurements to improve the safety of surgical care and ways these can be implemented.
- Our literature search identified thirteen new original research studies that evaluated the effectiveness of surgical report cards in improving outcomes. Nine pre-post or longitudinal study designs as well as four controlled before-and-after studies were included. Five quality collaboratives using surgical report cards and one systematic review were identified. No randomized trials were identified. All studies, with the exception of one, were at moderate or high risk of bias.
- ACS-NSQIP was the most frequently used report card in the included studies, used in seven out of thirteen, not including the studies on collaboratives or the systematic review.
- Of the studies included, pre-post or longitudinal studies, which use report card data to implement quality improvement initiatives, often reported decreases in morbidity and/or mortality. Studies with stronger internal validity tended to show no statistically significant benefits, but 95% confidence intervals were wide and thus clinically important benefits could not be excluded. In these latter studies, links between the report card and the use of a targeted quality improvement intervention are generally not known.
- Few studies addressed the critical aspects of surgical report cards such as implementation of outcomes-based quality improvement programs, sustainability over time, or ways to address barriers and facilitators.

Agency for Healthcare Research and Quality
PATIENT SAFETY

1. Background and Purpose

The Agency for Healthcare Research and Quality (AHRQ) Making Healthcare Safer (MHS) reports consolidate information for healthcare providers, health system administrators, researchers, and government agencies about practices that can improve patient safety across the healthcare system—from hospitals to primary care practices, long-term care facilities, and other healthcare settings. In spring 2023, AHRQ launched its fourth iteration of the MHS report (MHS IV). The use of surgical report cards and outcome measurements as a patient safety practice (PSP) was identified as high priority for inclusion in the MHS IV reports by a technical expert panel (TEP) that met in December 2022. The TEP included 15 experts in patient safety with representatives of governmental agencies, healthcare stakeholders, clinical specialists, experts in patient safety issues, and a patient/consumer perspective. The Evidence-based Practice Center (EPC) team used a modified Delphi technique to obtain a consensus from the TEP on the PSPs that merited the highest priority for a review. The prioritization took into consideration the team's assessments of whether a proposed practice meets the definition of a PSP, the likelihood to harm a patient and scope of the condition addressed by the PSP, how widely the PSP is used, whether a review would help establish certainty about the effectiveness of the PSP, whether there are enough studies to merit an updated review on the PSP, and whether guidelines or high-quality systematic reviews on the PSP have been published within the last 5 years. See the MHS IV Prioritization Report for additional details.

The need for transparency and accountability in healthcare has led to the development of outcomes reporting, a tool aimed at informing patients and healthcare providers about the quality of care provided in a specific healthcare setting. Public reporting of surgical outcomes began in the 1980s in New York State, given concerns over the variation in mortality rates following coronary artery bypass graft (CABG) surgery (CABG).[1] Data collected from this registry, NY State Cardiac Surgery Reporting System (CSRS),were published widely, and subsequent analyses reported reduced CABG mortality in New York State, likely because of the transparency.[2,3] Physician report cards—the prospective collection of clinical data that are used to provide risk-adjusted assessments of outcomes that are fed back to the hospitals and surgeons for comparative purposes—have evolved substantially in the last 40 years, and progress has accelerated in the last 10 years following the implementation of the Affordable Care Act (ACA). The ACA established the Hospital Readmission Reduction Program, which started a process to reduce hospital payments for certain 30-day readmissions.[4] Surgical volumes have greatly expanded since the 1980s. A 1998 study estimated that more than 40–50 million operations are performed in the United States each year in hospital settings and ambulatory care centers.[5] Postoperative complications occur frequently and can increase the need for hospitalizations, costs and length of stay.[6-8] Surgical report cards have the potential to improve operative and perioperative morbidity and mortality by providing usable

clinical data to highlight areas in need of improvement, and by delivering feedback across participating sites. Thus, centers can benefit from each other's strengths and weaknesses.[9] Reporting risk-adjusted postoperative outcomes can provide benchmarks intended to spur local and larger scale quality improvement efforts to produce better patient outcomes.

The use of report cards and outcome measurements to improve safety of surgical care topic was addressed in MHS II. During the TEP prioritization process, 100 percent of the panel advised including this topic in the MHS IV report with no changes to the definition or scope.

1.1 Overview of the Patient Safety Practice

Surgical report cards involve defining and reporting a wide range of outcomes (such as surgical site infections and postoperative venous thromboembolism) related to surgical interventions. Outcomes data can be compared across institutions and fed back to participating individual sites to help them develop best practices intended to promote patient safety. The largest and best-known program for measuring and reporting surgical outcomes in the United States. is the American College of Surgeons (ACS) National Surgical Quality Improvement Project (NSQIP). Born out of efforts initiated by Veterans Affairs (VA) Health System researchers and clinicians in the late 1980s (the Veterans Affairs National Surgical Quality Improvement Project, or VASQIP), this multicomponent intervention provided a method to feed data back to facilities and surgeons on their performance. This served as a stimulus for quality improvement and increased patient safety. The current ACS NSQIP collects prospective, clinical data that are used to provide risk-adjusted assessments of outcomes that are fed back to the hospitals and surgeons for comparative purposes, with the ultimate goal of quality improvement. A bench-marked, peer-controlled database allows hospitals to compare 30-day outcomes across hospital types. With support from ACS NSQIP, individual sites work to design quality initiatives to achieve better outcomes and care in the areas of need. While ACS NSQIP is the largest and best known, there are many others including the Society of Thoracic Surgeons (STS) national databases, the VASQIP, the Trauma Quality Improvement Program (TQIP), the Vascular Quality Initiative (VQI), the American College of Surgeons Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), the ACS NSQIP Pediatric, the American Hernia Society Quality Task Force (ACHQC), and the Collaborative Endocrine Surgery Quality Improvement Program (CESQIP).

For this review, we included evidence for the benefits or harms of any of the above-named programs, and quantitative information describing how these programs were implemented. The focus is on report cards used for any intervention that is specifically designed to promote patient safety, increase reporting of outcomes, or offer feedback to institutions to reduce patient safety events and associated harms. For the purposes of this review, surgery is defined to be a therapeutic or diagnostic

procedure involving incision or excision or suturing of tissue that requires an operating room and anesthesia.

1.2 Purpose of the Rapid Response

The overall purpose of this rapid response is to summarize the most relevant and recent literature on PSPs focused on the use of report cards and outcome measurements to improve the safety of surgical care and how these can be implemented. The response is organized around the following review questions:

1.3 Review Questions

1. What are the frequency and severity of harms addressed by report cards and outcomes measurements to improve the safety of surgical care?
2. What measures or indicators are used in report cards to examine the safety of surgical care?
3. What report cards and outcomes measurements to improve the safety of surgical care are used to prevent, report, or mitigate harms to patients, and in what settings have they been used?
4. What is the reported rationale for the use of report cards and outcome measurements to prevent, report, or mitigate the harms associated with surgical care?
5. What studies assessing the effectiveness of report cards and outcome measurements to improve the safety of surgical care and unintended effects were published since the Making Healthcare Safer II report?
6. What are the most common barriers and facilitators to implementing report cards and outcome measurements to improve the safety of surgical care?
7. What resources (e.g., cost, staff, time) are required for implementation of report cards and outcome measurements to improve the safety of surgical care?
8. What toolkits are available to support implementation of report cards or outcome measurements to improve the safety of surgical care?

2. Methods

We followed processes proposed by the Agency for Healthcare Research and Quality (AHRQ) EPC Program.[10] The rapid response is intended to present the end-user with an answer based on the best available evidence, but does not attempt to formally synthesize the evidence into conclusions. While the steps are similar to those of a typical systematic review, the methods are different (i.e., streamlined systematic review methods).[11]

For this rapid response, strategic adjustments were made to streamline traditional systematic review processes and deliver an evidence product in the allotted time. Adjustments included being as specific as possible about the questions, limiting the number of databases searched, modifying search strategies to focus on finding the most valuable studies (i.e., being flexible on sensitivity to increase the specificity of the search), and restricting the search to studies published recently (i.e., between November 2011 when the search was done for the MHS II report and May 2023 in English and performed in the United States.

We answered Review Questions 1 and 2 by focusing on the harms and patient safety measures or indicators addressed in the studies identified for Review Question 5. For Review Question 2, we focused on identifying relevant measures included in the Centers for Medicare & Medicaid Services (CMS) patient safety measures, AHRQ's Patient Safety Indicators, or the National Committee for Quality Assurance (NCQA) patient safety–related measures. For Review Question 3, we focused on interventions identified in Review Question 5 (i.e., those interventions with studies evaluating their effectiveness). We asked our content experts to answer Review Question 4 by citing selected references, including explanations of the rationale presented in the studies we found for Review Question 5. For Review Questions 6 and 7, we focused on the barriers, facilitators, and required resources reported in the studies identified in Review Question 5. For Review Question 8, we searched publicly available patient safety toolkits developed by AHRQ and other organizations that could help to support implementation of the PSPs, including AHRQ's Patient Safety Network (PSNet) (https:/psnet.ahrq.gov) and AHRQ's listing of patient safety–related toolkits (see https://www.ahrq.gov/tools/index.html?search_api_views_fulltext=&field_toolkit_topics=14170&sort_by=title&sort_order=ASC). We included any toolkits mentioned in the studies found for Review Question 5.

2.1 Eligibility Criteria for Studies of Effectiveness

We searched for original studies and systematic reviews on Review Question 5 according to the inclusion and exclusion criteria presented in Table 1.

Table 1. Inclusion and exclusion criteria

Study Parameter	Inclusion Criteria	Exclusion Criteria
Population	Adult and pediatric surgical patients	Patient representatives or public representatives who are not patients or family members
Intervention	Any intervention intended to measure and report surgical outcomes (surgeon- or hospital-level) to improve patient safety and clinical outcomes	Studies assessing surgical clinical outcomes that did not include participation in report card processes or programs
Comparator	Usual practice or comparing report card types (or assessing data quality of a report card)	No clear description of comparator
Outcome	**Safety** • Adverse events **Quality of care measures** (including morbidity and mortality) **Implementation** • Barriers and facilitators • Resources (cost, staff, time)	Measures of only patient knowledge or only levels of engagement. No outcome of interest.
Timing	Original studies published from November 2011 (the year of the search done for the MHS II report on this topic) through May 2023	Published in 2010 or earlier
Setting	Inpatient and outpatient surgical care settings in the United States	Setting outside the United States
Type of studies	Systematic reviews Original studies (published November 2011-May 2023): Randomized controlled trials or observational studies with a comparison group, including pre-post studies Observational studies of report card collaboratives that report outcomes data. Collaboratives defined as a group aimed at collecting outcomes data and implementing changes.	Narrative reviews, scoping reviews, editorials, commentaries, and abstracts

MHS = Making Healthcare Safer; PSP = patient safety practices

2.2 Literature Searches for Studies of Effectiveness

We searched PubMed, Web of Science, Scopus, and the Cochrane Library for systematic reviews and original studies published since November 2011 to May 2023 that address the review questions. In addition, we searched PubMed and Google Scholar for grey literature (see Appendix A for the full search strategy).

2.3 Selection of Studies

The title and abstract of each citation were screened independently by two team members based on predefined eligibility criteria (Table 1), and then conflicts were

resolved during team meetings. The full text of each potentially eligible article was reviewed independently by two team members to confirm eligibility and prepare a summary of the study, including author, year, study design, number of study participants, and main findings relevant to each of the review questions. Data extraction was done by one team member and checked by another.

2.4 Risk of Bias (Quality) Assessment

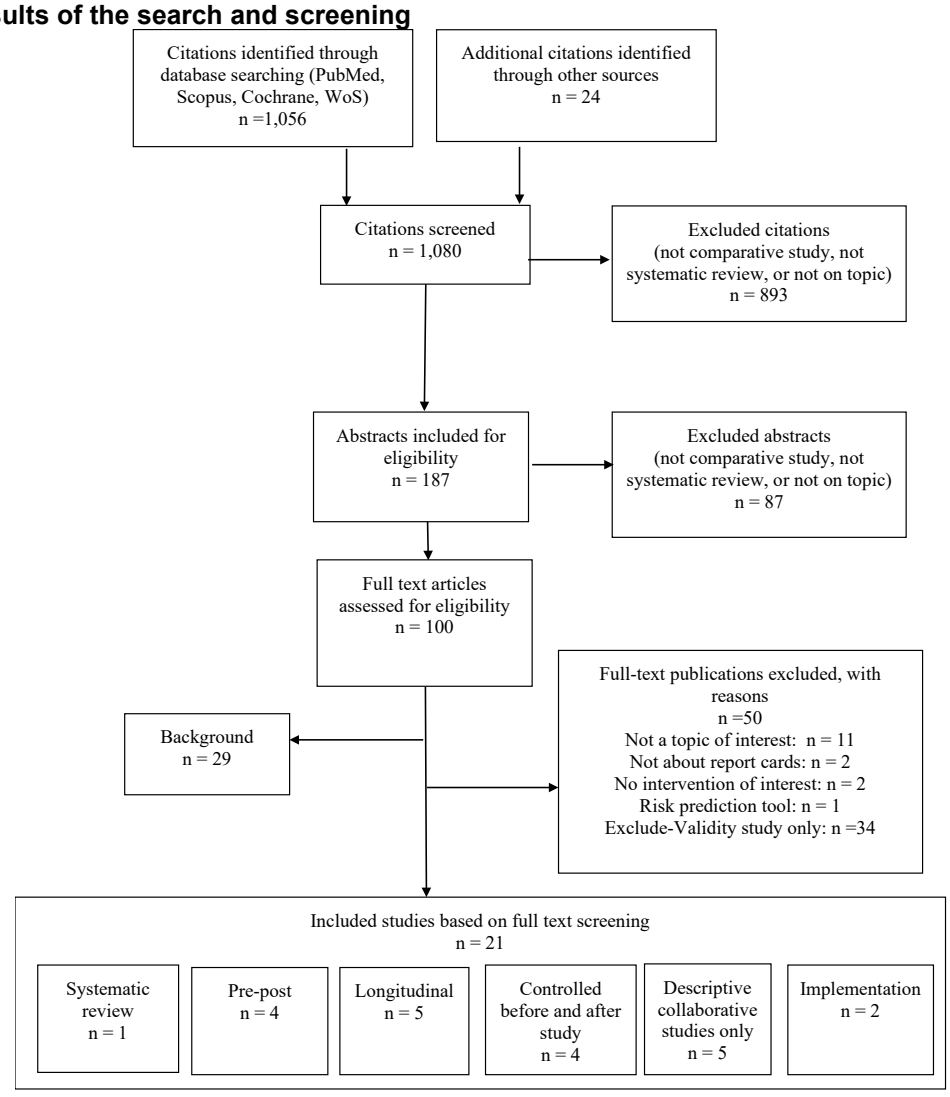
For studies that addressed Review Question 5 about the effectiveness of PSPs, we assessed the risk of bias. We did not identify any randomized controlled trials for inclusion. For nonrandomized studies with a concurrent control group or a regression discontinuity design, we used specific items in the ROBINS-I tool that assess bias due to confounding, bias in selection of participants into the study, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in measurement of outcomes, and bias in selection of the reported results.[12] For pre-post studies we used a modification of the NIH Tool for pre-post studies.[13] The risk of bias assessments focused on the main outcome of interest in each study.

3. Evidence Base

3.1 Number of Studies

Our search retrieved 1,056 unique titles and abstracts, and an additional 24 came from other sources of which we reviewed 100 full-text articles for eligibility. We found one systematic review[14] and 20 studies[15-34] that met the inclusion criteria (Figure 1). The list of excluded studies is in Appendix B along with background studies, which were studies that did not meet eligibility criteria but provided historical or contextual information on the report cards of interest. Appendix C contains the data tables as well as the critical appraisal tables.

Figure 1. Results of the search and screening



3.2 Findings for Review Questions

3.2.1 Review Question 1. What Are the Frequency and Severity of Harms Addressed by Report Cards and Outcomes Measurements To Improve the Safety of Surgical Care?

In the United States, a staggering 40 to 50 million operative procedures are performed per year.[5] Postoperative adverse events occur all too commonly; rates vary widely based on the type and complexity of the operation. Ninety-day complication rates for complex operations such as gastrectomy and pancreatic resection were estimated at nearly 43.9 percent and 50 percent, respectively.[35,36] Even after colectomy, a less complex operation where about 250,000 cases are performed each year, at least one postoperative complication occurs in approximately one-third of cases.[37] These adverse events increase hospitalization length of stay (LOS) and cost. A surgical site infection (SSI) is estimated to increase hospitalization costs by more than $20,000 per admission and extends LOS by 9.7 days.[38,39] An uncomplicated urinary tract infection (UTI) can add $372 or up to $2,800 if accompanied by bacteremia.[40,41] Following colorectal surgery, anastomotic leaks incurred additional LOS of 7.3 days and hospital costs of $24,129.[42] Postoperative respiratory complications increase LOS by 5 days on average.[8] Postoperative pneumonia increases costs ranging from $9,227 to $12,995.[43] Patients who develop postoperative pulmonary embolism or deep venous thrombosis after cancer surgery require readmission in 34.3 percent of cases, with LOS between 3 and 7 days, and increased costs between $5,311 to $10, 982.[44]

3.2.2 Review Question 2. What Measures or Indicators Are Used in Report Cards To Examine the Safety of Surgical Care?

There are few publicly reported measures related to surgical patient safety. Not all of these are used in current surgical report cards, but all are potential targets for this use and for patient safety initiatives.

Currently, Medicare's publicly accessible "Hospital Compare" is focused solely on orthopedic joint surgery (specifically knee or hip arthroplasty) and measures include:

- 30-day standardized readmission rate
- 90-day standardized complication measures—which includes surgical site bleeding, other surgical site complications, pulmonary embolism, death, joint or wound infection, or other wound complication

The AHRQ Patient Safety Indicators are the other source of well known, publicly reported measures relevant to surgical patient safety. The indicators most relevant to surgery are:

- PSI 04 – Death rate among surgical inpatients with serious treatable conditions
- PSI 05 – Retained surgical item or unretrieved device fragment count
- PSI 06 – Iatrogenic pneumothorax rate
- PSI 07 – Central venous catheter-related blood stream infection rate
- PSI 08 – Postoperative hip fracture rate
- PSI 09 – Perioperative hemorrhage or hematoma rate
- PSI 10 – Postoperative physiologic and metabolic derangement rate
- PSI 11 – Postoperative respiratory failure rate
- PSI 12 – Perioperative pulmonary embolism or deep vein thrombosis rate
- PSI 13 – Postoperative sepsis rate
- PSI 14 – Postoperative wound dehiscence rate

3.2.3 Review Question 3. What Report Cards and Outcomes Measurements To Improve the Safety of Surgical Care Are Used To Prevent, Report, or Mitigate Harms to Patients, and in What Settings Have They Been Used?

There are many well-known programs in the United States that utilize report cards and outcome measurements with the overarching goal of making surgical care safer. The American College of Surgeons has several such programs including the National Surgical Quality Improvement Program (ACS NSQIP) and the Veterans Affairs National Surgical Quality Improvement Program (VASQIP), both report on a variety of procedures and surgical specialties. Additionally, ACS and other surgical societies have created numerous specialty-specific programs, examples include Society of Thoracic Surgeons (STS) national databases, Trauma Quality Improvement Program (TQIP), Vascular Quality Initiative (VQI), American College of Surgeons Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), ACS NSQIP Pediatric, American Hernia Society Quality Task Force (ACHQC), and Collaborative Endocrine Surgery Quality Improvement Program (CESQIP).

Surgical reports cards have been applied at the hospital or the individual surgeon level.

3.2.4 Review Question 4. What Is the Reported Rationale for the Use of Report Cards and Outcome Measurements To Prevent, Report or Mitigate the Harms Associated With Surgical Care?

The use of report cards and outcome measurements in surgical care is grounded in the fundamental principles of transparency, accountability, and quality improvement. By providing a structured framework to evaluate surgical outcomes and identify areas for improvement, report cards and outcome measurements play a pivotal role in enhancing patient safety, informing clinical decision making, and driving continuous advancements in healthcare practices. Forms of reporting outcomes in surgical care date as far back as the early 20th century. Staff surgeon Ernest Amory Codman publicly called for measurement and reporting outcomes in medicine and surgery over 100 years ago in his seminal work titled, "A Study in Hospital Efficiency: As Demonstrated by the Case Report of First Five Years of Private Hospital."[45]

The VA NSQIP and the New York State Cardiac Surgery Reporting System helped inform the rationale for systematic surgical outcomes reporting. In the 1980s, there was a great deal of public scrutiny regarding the high surgical complication rates in the VA, which led to the formalized system of collecting and reporting clinical variables. The VA embarked on a Surgical Risk Study and collected preoperative, intraoperative, and 30-day outcome variables on more than 100,000 major operations across over 40 VA sites. To level the playing field across institutions, investigators developed a risk-adjustment model that incorporated Lisa Iezzoni's "algebra of effectiveness," which states that outcomes of healthcare can be described by this equation: Patient Factors + Effectiveness of Care + Random Variation = Outcome.[46,47] These risk-adjusted outcomes were then fed back to hospitals and surgeons to prompt quality improvement. Over time, VA hospitals saw a 27 percent drop in post-operative mortality and 45 percent drop in morbidity rates.[48]

The second precedent was the success of the New York State Cardiac Surgery Reporting System (CSRS), which began in the 1990s as a result of variation in mortality outcomes in CABG. Release of the data publicly led to changes in practices across New York hospitals and studies that examined the impact of this reporting system show an overwhelmingly positive benefit to reduce post-CABG mortality.[2,49,50] The concepts of the New York State CSRS have spread to other States (California, Pennsylvania) and is the foundation for the Society of Thoracic Surgery (STS) Registry.[51]

In brief, the foundation for how surgical report cards improve care is multidimensional. By collecting high-quality data and processing it with adequate risk-adjustment methods, surgeons can understand how their outcomes compare to others of similar characteristics. Hospitals can utilize this information to identify problems and swiftly enact corrective data-driven measures. The report cards can

also highlight areas in which improvements occur as a result of interventions.[52] Regular monitoring of outcomes also supports the identification of disparities in care, ensuring that all patient populations receive equitable treatment.[53] Healthcare organizations can tailor interventions to specific populations, improving overall surgical outcomes and reducing health disparities.[54] Finally, publicly sharing this data can incentivize healthy competition and kindle a foundation for actively seeking improvement and change.[55]

3.2.5 Review Question 5. What Studies Assessing the Effectiveness of Report Cards and Outcome Measurements To Improve the Safety of Surgical Care and Their Unintended Effects Were Published Since the Making Healthcare Safer II Report?

Our literature search identified one systematic review relevant to this question.[14] This review searched for studies published after November 2011 that reported data from a National Surgical Quality Improvement Program hospital before and after either the beginning of monitoring the NSQIP Individual Site Summary report or implementation of a formal quality improvement program in addition to monitoring the report. This review, which we judged to be of good quality, identified 11 studies meeting their eligibility criteria. All came from the United States and involved a diverse array of surgical procedures, including colorectal, hepatopancreatobiliary, vascular, general, and head-and-neck surgery. Nine of the 11 studies involved a quality improvement program. The most commonly reported outcomes across studies were surgical site infections (superficial and deep) and organ/abdominal infections. Random effects pooled estimates for all 3 infections yielded results that in each case were statistically significant reductions in infections after implementing ACS NSQIP (example: random effects pooled estimate for 9 studies reporting surgical site infections was a risk ratio of 0.77, 95% confidence interval [CI] 0.39. 0.77, I2 statistic = 51%). The authors concluded that "these data suggest that ACS NSQIP is effective in reducing surgical morbidity." Thus, although this systematic review relies entirely on pre/post studies, has a somewhat narrower focus, and overlaps substantially in timeframe with the review on this topic in Making Health Care Safer II, both reviews came to similar conclusions about the effectiveness of ACS NSQIP.

Our literature search identified 13 new original research studies[17,20-22,24-31,33] assessing the effectiveness of surgical report cards at improving the outcomes of interest. Of these, 9 used a pre-post or longitudinal study design[17,20,25-29,31,33] and 4 used stronger study designs, such as a controlled before-and-after study or regression discontinuity analysis.[21,22,24,30] None were randomized trials. Six of the studies were about ACS NSQIP.[17,21,28-31] Five studies were from single institutions,[17,25,27,29,33] the remainder included 9 to greater than 700 hospitals. All studies, with the exception of one, were at moderate or high risk of bias. Details of studies

are presented in the evidence table in Appendix C. None of these studies were included as evidence in the 1 systematic review identified.

Our search also identified 5 new studies of quality collaboratives that were using surgical report cards.[15,16,19,23,32]

In MHS II, examples of successful program implementation were described, as well as the challenges facing different hospital types, including varieties of collaboratives. Two examples of collaborative program implementations were described: the Tennessee Surgical Quality Collaborative and the Florida Hospital Association. These collaborations had similar traits, consisting of a combination of the payer, insurance, hospital administrations, surgical data reviewers, and surgeon leaders at individual sites.

Since then, five new studies of collaborative initiatives using surgical report cards and which include outcomes data have been published. First, Davis et al. in 2017 described a collaboration among 20 hospitals under ACS NSQIP and Texas Alliance for Surgical Quality to reduce surgical site infection (SSI) rates.[19] They identified 6 major categories such as attire, antibiotics, and postoperative care and picked different infection control practices within them to be scored on a 4-point scale for general surgery cases by selected Surgeon Champions at each site. They compared these scores to risk-adjusted general surgery SSI odds ratios from the 2016 ACS NSQIP report. Their results suggested that a subset of infection control practices including transparent display of the SSI data, correlated with SSI rates and that these areas ought to be the focus of future interventions in lower performing hospitals.

In 2016, Poulouse et al. described the design and implementation of the Americas Hernia Society Quality Collaborative (now named the Abdominal Core Health Quality Collaborative) to improve value in care due to wide variation in cost, management, and outcome in abdominal wall hernias. They described the initiation of the collaboration between multiple stakeholders that form the governance of the society including surgeons, hospitals, industry partners, the U.S. Food and Drug Administration (FDA), and importantly, patients. This body will define dynamic quality improvement goals that reflect regular assessment of data accrued. They created a data registry focused on adults with hernia disease with a plan to gradually increase the reported pathologies, and the outcomes focused on. Data are transparent both among the partner groups and published regularly. Unique features include the involvement of industry, the FDA, and patients in the decision-making process to help identify key quality metrics, streamline device adopting, and improve technology that is delivered to the patient. Additionally, they sought to embed a mechanism by which hernia research can be accomplished and disseminated, including making clinical trials in hernia surgery more feasible. Finally, they describe a goal to incorporate an international expansion of the society in order to address quality hernia care globally.[32]

Within a single center, Halpin et al. in 2016 delineated the effectiveness of benchmarking and linking outcomes to improve the performance-improvement

cycle at their hospital, the Inova Heart and Vascular Institute. Their hospital participates in both the STS national database and the Virginia Cardiac Surgery Initiative. Their workflow is centered around a clinical outcome specialist who reviews and cleans clinical data from every cardiac surgery patient. The outcomes are shared quarterly with surgeons, nurses, and the operating room staff, along with a multidisciplinary quality improvement team. Indicators that are above or below STS benchmarks are discussed, and the quality improvement team targets interventions for these below average benchmarks. An in depth-study of the problem is completed and an action plan is presented. The intervention efficacy is tracked with similar data reporting and the cycle continues. They provide multiple examples of how this collaboration has helped improve many STS benchmark indicators such as the incidence of sternal infections, the use of intraoperative blood loss, and length of stay in the intensive care unit.[23]

In 2015, Chang et al. published outcomes data following the recent establishment of the Michigan Spine Surgery Improvement Collaborative (MSSIC) in 2013.[16] This collaborative established a registry focused on lumbar and cervical spine surgery, including surgical procedure indications and details, immediate postoperative hospitalization details, adverse events or complications within 90 days of surgery, and patient-reported outcomes. Their aim is also to establish a platform for quality improvement. Twenty-two hospitals statewide were included in the registry (hospitals must perform 200 or more spinal procedures annually). Members of the collaborative include hospitals, both an orthopedic surgeon and neurosurgeon champion at each hospital, directors, data managers, program directors, quality assurance officers, and other administrative support. MSSIC holds quarterly meetings to discuss de-identified data and topics including data quality and potential quality improvement initiatives. Participating surgeons have access to their own outcomes data as well as de-identified data from hospitals, including their own. They report preliminary outcomes from the 6,397 cases entered to date.

Similarly, Asher et al in 2016 described the establishment of the National Neurosurgery Quality and Outcomes Database (N^2QOD), a multicenter collaborative involving 53 clinical centers, of which 45 were academic in 29 States. Their goal was to create a prospective outcomes registry to provide practice groups with infrastructure to analyze morbidity and mortality quality data in real time as well as generate quality and efficacy data. Patient enrollment occurs via a sampling methodology by site-specific data extractors/coordinators.[15] The collaborative specifically employed Vanderbilt Institute for Medicine and Public Health and the Vanderbilt Department of Biostatistics. Patient safety and patient-related outcomes are reported.

These examples of collaborative use of surgical report cards demonstrate similar features: Individuals organizing to identify unmet needs in their fields and building a task force to best design interventions, outcomes metrics that are guided from society outlines yet are flexible to fit the need of the environment, transparent reporting to provide real time data for comparisons within and between hospitals,

and implementation of dynamic tracking systems with regular meetings to incentivize constant improvement.

3.2.6 Review Question 6. What Are the Most Common Barriers and Facilitators To Implementing Report Cards and Outcome Measurements To Improve the Safety of Surgical Care?

Our literature search identified one study that was specifically about barriers to adoption.[18] This was a qualitative study of 22 trauma medical directors and 22 trauma program managers from trauma centers participating in the ACS Trauma Quality Improvement Program (TQIP). Technical strengths to the TQIP data were perceived to be: TQIP data were more accurate than performance data being collected by other initiatives; the ability to drill down in the data, facilitating identification of the most relevant themes and projects for quality improvement. Technical barriers were the perception that, even if more accurate than other initiatives, the data still were insufficiently accurate; and insufficient statistical knowledge to understand some of the statistical detail in the report cards. A key cultural strength was the ability to use the reports to advocate for additional resources to remediate problems identified in the report cards. Key cultural barriers were insufficient buy-in at many institutions from neurosurgery, and the tendency for personnel at institutions performing at average or above to lose interest.

One study [34] described surgeons' experience at one institution, but did not explicitly discuss barriers and facilitators. The study found that 4 out of 23 surgeons surveyed spent less than 1 minute reviewing their own surgeon-specific reports. About half of surgeons spent 10 minutes or less. A perceived benefit of surgeon-specific report cards was viewed as the knowledge of individual performance because "most of them do not record personal case logs and are therefore not generally aware of their outcomes." Perceived limitations of the report cards were, again, the possibility of inaccurate data, in some cases small sample sizes, and that some of the factors in an outcome were beyond the surgeon's control.

3.2.7 Review Question 7. What Resources (e.g., Cost, Staff, Time) Are Required for Implementation of Report Cards and Outcome Measurements To Improve the Safety of Surgical Care?

Our literature search did not identify any study that specifically discussed the resources needed to implement surgeon report cards. One of the above studies[18] did state that trauma program administrative personnel often felt they needed to add staff with skills such as biostatistical expertise and quality improvement experience in order to interpret the report card data and conduct quality improvement initiatives.

One additional study reported hospital costs as an outcome of using report cards. Osborne and colleagues analyzed Medicare data to determine whether ACS NSQIP participation was associated with reduced Medicare payments (for index hospitalization and any readmissions) for patients undergoing general and vascular surgery.[30] They reported no difference in mean total Medicare payments between ACS NSQIP following 3 years of participation compared with nonparticipating hospitals ($40, 95% CI -$268 to $348) in their difference-in-differences model using price-standardized payments, adjusting for multiple patient and hospital characteristics.

3.2.8 Review Question 8. What Toolkits Are Available To Support Implementation of Report Cards or Outcome Measurements To Improve the Safety of Surgical Care?

We did not find any toolkits available to support implementation. However, at least some of the sponsors of surgical report cards provide member hospitals with access to quality improvement tools to facilitate changes in response to report card results.

4. Discussion

4.1 Interpretation of Findings

In MHS II the topic of surgical report cards was reviewed for the first time. That review cited five published studies and a number of studies presented only on the ACS NSQIP site; most were pre-post studies and none were randomized controlled trials. While noting that pre-post studies have serious limitations, the review stated, "in aggregate these reports consistently show that hospitals identified as high outliers in some particular outcome that respond by implementing a targeted intervention experience a decrease in that outcome." Two longitudinal studies identified in that review yielded mixed results. In this update, nine new pre-post or longitudinal studies were identified, along with four studies of stronger internal validity. In MHS II all the included studies were about ACS NSQIP; in this review about half of studies are about new types of report cards. The findings of the included studies in this update in general mirror that seen in MHS II: pre-post studies of report-card prompted QI programs yielded improvements in outcomes, whereas studies with higher internal validity were more mixed, mostly showing no statistically significant benefit (but also not excluding the possibility of a clinically important effect). One systematic review, consisting entirely of pre-post studies and not including any studies reported in MHS II or in this update, concluded that NSQIP data "is effective in reducing surgical morbidity."

4.2 Limitations

This rapid response has several limitations. First, rapid responses use streamlined processes to complete the effort in a short timeline. We limited the studies to published works since 2011, published after our review on this similar topic, performed within the clinical practices and healthcare systems of the United States. Secondly, the included studies reported on observational data. Thirdly, there may be publication bias toward publishing studies that have positive benefits. While we could not test for the presence of publication bias statistically, it is likely that researchers and organizations would be more inclined to publish studies about their quality improvement successes than about the situations where they did not observe any improvement in quality. Lastly, we found few studies that addressed the critical aspects of surgical report cards such as implementation of outcomes-based quality improvement programs, sustainability over time, and how to address barriers and facilitators.

4.3 Implications and Conclusions

The measurement and reporting of hospital outcomes with the purpose of improving quality of care and patient safety has a long history beginning more than 100 years ago. Significant advancements in surgical outcome reporting have arisen since then, in particular, with the advent of ACS NSQIP followed by numerous surgical specialty-specific quality improvement programs. Consequently, hospitals and providers can use risk-adjusted assessments of outcomes to compare their outcomes across hospital types or within one hospital to implement change. Of the studies included, those which use report card data to implement a quality improvement initiative demonstrate a trend towards decreased morbidity and/or mortality, while those studies which longitudinally follow hospitals participating in reports cards only, trend towards no change in morbidity or mortality. As reported in previous reviews, knowing the outcomes from a report card-based quality improvement program does not inherently result in superior outcomes. Rather it provides a means to identify areas in need of an improvement process. In this review, only one study was found that specifically addressed barriers to adoption of report cards and no toolkits were available to support implementation. Thus, there is a need for future studies which address the practicalities of quality improvement initiatives based on report cards.

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The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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Afterword

Recognized for excellence in conducting comprehensive systematic reviews, the Agency for Healthcare Research and Quality (AHRQ) Evidence-based Practice Center (EPC) Program is developing a range of rapid evidence products to assist end-users in making specific decisions in a limited timeframe. AHRQ recognizes that people are struggling with urgent questions on how to make healthcare safer. AHRQ is using this rapid format for the fourth edition of its Making Healthcare Safer series of reports, produced by the EPC Program and the General Patient Safety Program. To shorten timelines, reviewers make strategic choices about which processes to abridge. However, the adaptations made for expediency may limit the certainty and generalizability of the findings from the review, particularly in areas with a large literature base. Transparent reporting of the methods used and the resulting limitations of the evidence synthesis are extremely important.

AHRQ expects that these rapid evidence products will be helpful to health plans, providers, purchasers, government programs, and the healthcare system as a whole. Transparency and stakeholder input are essential to AHRQ. If you have comments related to this report, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to MHS@ahrq.hhs.gov.

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Appendixes

Appendix A. Methods

Search Strategies for Published Literature

Databases:

- PubMed (NLM/NIH)
- Web of Science (Clarivate)
- Scopus (Elsevier)
- Cochrane Database of Systematic Reviews (Cochrane Library)

Grey literature:

- PubMed for "Cited By" for Maggard-Gibbons article
- Google Scholar for "Cited By" for Maggard-Gibbons article

Limits:

- November 2011 – May 2023

Table A-1. PubMed search strategy

Set #	Search	# of Results
1	reporting*[tiab] OR "report card*"[tiab] OR "outcome measure*"[tiab] OR "outcomes measure*"[tiab] OR "Outcome Assessment, Health Care"[MAJR]	578,052
2	"National Surgical Improvement Program"[tiab] OR "NSQIP"[tiab] OR VASQIP[tiab] OR "VA surgical quality improvement program"[tiab] OR "vascular quality initiative"[tiab] OR VQI[tiab] OR "Society of Thoracic Surgeons National Database"[tiab] OR "Trauma Quality Improvement Program"[tiab] OR TQIP[tiab] OR "Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program"[tiab] OR MBSAQIP[tiab] OR "NSQIP Ped*"[tiab] OR "Americas Hernia Society Quality Collaborative"[tiab] OR AHSQC[tiab] OR "Abdominal Core Health Quality Collaborative"[tiab] OR ACHQC[tiab] OR "Collaborative Endocrine Surgery Quality Improvement Program"[tiab] OR CESQIP[tiab]	5,904
4	#1 AND #2	561
5	#4 AND ((2011/11/1:2023/6/30[pdat]) AND (english[Filter]))	**529**

Table A-2. Web of Science Core Collection search strategy: Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Emerging Sources Citation Index (ESCI)

Set #	Search	# of Results
1	TS=(reporting* OR "report card*" OR "outcome measure*" OR "outcomes measure*")	559,705
2	TS=("National Surgical Improvement Program" OR "NSQIP" OR VASQIP OR "VA surgical quality improvement program" OR "vascular quality initiative" OR VQI OR "Society of Thoracic Surgeons National Database" OR "Trauma Quality Improvement Program" OR TQIP OR "Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program" OR MBSAQIP OR "NSQIP Ped*" OR "Americas Hernia Society Quality Collaborative" OR AHSQC OR "Abdominal Core Health Quality Collaborative" OR ACHQC OR "Collaborative Endocrine Surgery Quality Improvement Program" OR CESQIP)	6,703
3	#1 AND #2	473
4	#3 AND ((LA==("ENGLISH") AND DT==("ARTICLE" OR "REVIEW" OR "EARLY ACCESS")) NOT (PY==("2006" OR "2007" OR "2008" OR "2009" OR "2010"))) Limits: 2011-2023; English; Article, Review, Early Access	**441**

Table A-3. Scopus

Set #	Search	# of Results
1	TITLE-ABS-KEY(reporting* OR "report card*" OR "outcome measure*" OR "outcomes measure*")	687,321
2	TITLE-ABS-KEY("National Surgical Improvement Program" OR "NSQIP" OR VASQIP OR "VA surgical quality improvement program" OR "vascular quality initiative" OR VQI OR "Society of Thoracic Surgeons National Database" OR "Trauma Quality Improvement Program" OR TQIP OR "Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program" OR MBSAQIP OR "NSQIP Ped*" OR "Americas Hernia Society Quality Collaborative" OR AHSQC OR "Abdominal Core Health Quality Collaborative" OR ACHQC OR "Collaborative Endocrine Surgery Quality Improvement Program" OR CESQIP)	725,464
3	#1 AND #2	488
4	#3 Limits: 2011-2023; English; Articles, Reviews	**402**

Table A-4. Cochrane Database of Systematic Reviews (CDSR)

Set #	Search	# of Results
1	reporting*:ti,ab,kw OR "report card*":ti,ab,kw OR "outcome measure*":ti,ab,kw OR "outcomes measure*":ti,ab,kw	48,761
2	"surger*":ti,ab,kw OR "surgical":ti,ab,kw OR "surgeon*":ti,ab,kw	304,687
3	"quality improvement":ti,ab,kw OR "patient safety":ti,ab,kw	11,806
4	("National Surgical Improvement Program":ti,ab,kw OR NSQIP:ti,ab,kw OR VASQIP:ti,ab,kw OR "VA surgical quality improvement program":ti,ab,kw OR "vascular quality initiative":ti,ab,kw OR VQI:ti,ab,kw OR "Society of Thoracic Surgeons National Database":ti,ab,kw OR "Trauma Quality Improvement Program":ti,ab,kw OR TQIP:ti,ab,kw OR "Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program":ti,ab,kw OR MBSAQIP:ti,ab,kw OR "NSQIP Ped*":ti,ab,kw OR "Americas Hernia Society Quality Collaborative":ti,ab,kw OR AHSQC:ti,ab,kw OR "Abdominal Core Health Quality Collaborative":ti,ab,kw OR ACHQC:ti,ab,kw OR "Collaborative Endocrine Surgery Quality Improvement Program":ti,ab,kw OR CESQIP:ti,ab,kw)	192
5	#1 AND #2 AND (#3 OR #4)	
	#4 (Cochrane Reviews = **4** + Cochrane Central Register of Controlled Trials= 150 Trials Limits: 2011 – 2023	**154**

Appendix B. List of Excluded Studies Upon Full-Text Review

Excluded Studies

The reasons for exclusion are noted at the end of each citation.

1. Aiello FA, Shue B, Kini N, et al. Outcomes reported by the Vascular Quality Initiative and the National Surgical Quality Improvement Program are not comparable. J Vasc Surg. 2014 Jul;60(1):152-9, 9.e1-3. doi: 10.1016/j.jvs.2014.01.046. PMID: 24630871. *Validity study only*

2. Allen MS, Blackmon S, Nichols FC, et al. Comparison of Two National Databases for General Thoracic Surgery. Ann Thorac Surg. 2015 Oct;100(4):1155-61; discussion 61-2. doi: 10.1016/j.athoracsur.2015.05.031. PMID: 26319486. *Validity study only*

3. Asher AL, McCormick PC, Selden NR, et al. The National Neurosurgery Quality and Outcomes Database and NeuroPoint Alliance: rationale, development, and implementation. Neurosurg Focus. 2013 Jan;34(1):E2. doi: 10.3171/2012.10.Focus12311. PMID: 23278263. *Not a topic of interest*

4. Ban KA, Cohen ME, Ko CY, et al. Evaluation of the ProPublica Surgeon Scorecard "Adjusted Complication Rate" Measure Specifications. Ann Surg. 2016 Oct;264(4):566-74. doi: 10.1097/sla.0000000000001858. PMID: 27433895. *Validity study only*

5. Bedard NA, Pugely AJ, McHugh M, et al. Analysis of Outcomes After TKA: Do All Databases Produce Similar Findings? Clin Orthop Relat Res. 2018 Jan;476(1):52-63. doi: 10.1007/s11999.0000000000000011. PMID: 29529616. *Validity study only*

6. Bergquist JR, Thiels CA, Etzioni DA, et al. Failure of Colorectal Surgical Site Infection Predictive Models Applied to an Independent Dataset: Do They Add Value or Just Confusion? J Am Coll Surg. 2016 Apr;222(4):431-8. doi: 10.1016/j.jamcollsurg.2015.12.034. PMID: 26847588. *Validity study only*

7. Chen AD, Kamali P, Chattha AS, et al. The National Surgical Quality Improvement Program 30-Day Challenge: Microsurgical Breast Reconstruction Outcomes Reporting Reliability. Plast Reconstr Surg Glob Open. 2018 Mar;6(3):e1643. doi: 10.1097/gox.0000000000001643. PMID: 29707443. *Validity study only*

8. Chiang MF, Sommer A, Rich WL, et al. The 2016 American Academy of Ophthalmology IRIS(®) Registry (Intelligent Research in Sight) Database: Characteristics and Methods. Ophthalmology. 2018 Aug;125(8):1143-8. doi: 10.1016/j.ophtha.2017.12.001. PMID: 29342435. *Not a topic of interest*

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Appendix C. Data Tables

Table C-1. Evidence table of studies assessing the effectiveness of participation in a surgery report card initiative

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Etzioni et al., 2015[21] Difference-in-differences Logistic regression adjusting for multiple patients, surgery covariates, temporal trends, and hospital random effects	ACS-NSQIP Participation in NSQIP	To compare complications, serious complications, and mortality in NSQIP vs. non-NSQIP hospitals in an elective general and vascular surgery sample using University HealthSystem Consortium (UHC) data, 2009-2013	Institutions: UHC hospitals (NSQIP and non-NSQIP participating): 113Hospitalizations: 345,357 (complications), 320,501 (serious complications cohort); 200,572 (mortality cohort)	No difference in complications (adjusted odds ratio [aOR], 1.00; 95% CI, 0.97-1.03), serious complications (aOR, 0.98; 95% CI, 0.94-1.03), or mortality (aOR 1.04; 95% CI, 0.94-1.14)	Moderate

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Hemmila et al., 2018[24] Difference-in-differences Logistic regression adjusting for multiple patients, injury, time trends, and hospital random effects	ACS Trauma Quality Improvement Program (TQIP) and Michigan Trauma Quality Improvement Program (MTQIP) Participation in MTQIP	To evaluate association of ACS-TQIP or MTQIP with mortality or hospice, major complications, and VTE events in MTQIP vs ACS-TQIP vs non-participating hospitals using NTDB data, 2009-2015	Institutions: 23 MTQIP, 98 ACS TQIP 429 non-participating) 2,373,130	Adjusted outcomes after (vs before) collaborative enrollment: MTQIP compared to non-participating: Lower odds of major complications (OR 0.89, 95%CI, 0.83-0.95), mortality or hospice (OR 0.88, 95% CI, 0.81-0.96), VTE (OR 0.78, 95% CI, 0.69-0.88). No difference in mortality. MTQIP compared to ACS TQIP: Lower odds of major complications (OR, 0.88; 95%CI, 0.82-0.95) and VTE (OR 0.84, 95% CI 0.74-0.95). No difference in mortality, mortality or hospice outcomes. ACS TQIP vs non-participating: No difference in major complications. Lower odds of VTE (OR 0.93, 95% CI 0.89-0.98), mortality (OR 0.91,95% CI 0.88-0.95), mortality or hospice (OR 0.90; 95% CI 0.87-0.93)	Serious

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Osborne et al., 2015[30] Difference-in-differences Logistic regression adjusting for multiple patients, surgery covariates, time trends, and hospital clustering, additionally propensity matched the comparison hospitals, as well as multivariate adjustment	ACS-NSQIP Enrollment in ACS-NSQIP	To evaluate the association of ACS-NSQIP participation with mortality, complications, re-operation, readmissions and costs of general and vascular surgeries using Medicare data, 2003-2012	Institutions: 263 ACS-NSQIP hospitals, 526 non-participating hospitals Participants: 1,226,479	No difference in risk-adjusted 30-day mortality (relative risk [RR] 0.96, 95% CI, 0.89–1.03), serious complications (RR 0.96, 95% CI, 0.91–1.00), re-operations (RR 0.97, 95% CI, 0.77–1.16), readmissions (RR 1.01, 95% CI, 0.98–1.03) at 3 years post-enrollment. No difference from ACS-NSQIP enrollment in mean total Medicare payments ($40, 95% CI −$268–348), or index admission (-$11, 95% CI, -$278-257), readmission ($245, 95% CI, -$231-721) or outlier payments ($-$86, 95% CI, -$1666, 1495).	Moderate
Glance et al., 2014[22] Prospective cohort study Regression discontinuity adjusting for patient and injury covariates, secular trends, and hospital-fixed effects	National Trauma Data Bank Introduction of nonpublic reporting	To determine association of in-hospital mortality among trauma patients before (2006-2007) vs after (2008-2010) providing hospitals with reports of their risk-adjusted trauma mortality rates, using NTDB	Institutions: 44 NTDB hospitals Participants: 326,206	No association of nonpublic reporting with trauma mortality (aOR 0.89; 95%CI, 0.68-1.16), nor among subgroups of low vs high risk patients nor by blunt vs penetrating mechanism. No association of nonpublic reporting with outcomes at low-, average- or high-performance hospitals.	Low

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Joseph et al., 2018[26] Longitudinal Multivariable regression controlling for demographics and injury mechanism and severity	ACS Trauma Quality Improvement Program (TQIP) No intervention	Describe utilization of resuscitative thoracotomy and survival trends over 5 years in TQIP, 2010-2014	Institutions: 721 ACS-TQIP hospitals Participants: 2,229	Decrease in emergency resuscitative thoracotomy use (331/100 000 to 243/100 000 trauma admissions, p=0.002) and increase survival rate (7.9% to 11.3%, p<0.001). In regression, significant survival predicters were age <60 years (OR 2.7 (1.9-3.8)), penetrating mechanism (OR 4.7 (2.9-7.6)), prehospital CPR (OR 0.76 (0.67-0.82)), signs of life on arrival (OR 1.9 (1.4-2.6)). Other independent predictors included injury severity score, systolic blood pressure, heart rate.	High

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Lucas & Pawlik, 2014[28] Longitudinal Multivariable regression adjusting for comorbidities, risk factors, case mix, operation type	ACS-NSQIP No intervention	To describe national NSQIP surgical outcome data for GI oncologic resections over 6 years (2006-2011)	Institutions: 316 ACS-NSQIP hospitals Cases: 6,076 surgeries	No change in risk of mortality over time (OR 1.03, 95% CI 0.99-1.07); Decreased risk of any complication over study years (28% to 24%, OR 0.95 per year, 95% CI 0.94-0.96). Stratifying by procedure, there was a decrease in any complication among esophagectomy, colectomy, proctectomy, not for gastrectomy, pancreatectomy or hepatectomy. Decreased risk of number of complications per patient by an adjusted rate of 1.9% per year (95% CI 1.1-2.6%)	High

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Maturo et al., 2017[29] Longitudinal n/a	ACS-NSQIP No intervention	To describe single-center San Antonio Military Medical Center (SAMMC) NSQIP surgical outcome data for 5 years (2009-2014) and compare these outcomes to national NSQIP averages	Institution: 1, largest DoD hospital (SAMMC) Cases: 19, 265 surgeries	No change in O/E mortality across years. Decrease O/E morbidity (overall p=0.0025; by year: 0.1239/0.0676 (p=0.02, '09), 0.1013/0.0563 (p=0.001, '10), 0.1003/0.0581 (p<0.001, '11), 0.0824/0.0565 (p=0.004, '12), 0.0768/0.0525 (p=0.02, '13), 0.0376/0.0535 (p=0.41, '14)). Complication rates decreased (SSI, ventilation >48h, unplanned intubation) or remained stable (cardiac, pneumonia, renal failure, UTI, return to operating room).	High
Ozhathil et al., 2011[31] Longitudinal n/a	ACS-NSQIP No intervention	To examine mortality, perioperative and postoperative complications, and length of stay after laparoscopic and open colectomies in ACS-NSQIP, 2005-2008	Institutions: all ACS-NSQIP enrolled institutions (number not reported) Participants: 48,427	No change in morbidity or mortality by year in overall cohort; increase open colectomy mortality (r=0.03, p<0.001); decrease mortality in laparoscopic (r= -0.04, p<0.0001) over time. Decrease in unadjusted SSI, deep SSI, pneumonia, sepsis, septic shock, LOS; increase in CVA. Greater complications in emergent group compared to elective operations.	High

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Sarkar et al., 2011[33] Longitudinal n/a	Performance improvement and patient safety (PIPS) program Implementation of trauma PIPS program	To assess the impact of a comprehensive PIPS program on in-hospital trauma mortality rates for a PIPS institution versus National Trauma Data Bank (NTDB), 2004-2009	Institution: 1, midwestern academic level 1 trauma center Participants:5,320	Lower in-hospital mortality for severely injured patients (30.1% to 18.3%, p=0.011, vs 31% in NTDB); institution mortality O/E from NTDB 0.61 (0.39–0.82) in 2009. Decrease in older adult trauma mortality (58% to 34% over study). 2008 O/E 0.54 (0.15-0.91) for blunt injury and 0.78 (0.51-1.06) for blunt multisystem injuries; changes sustained in 2009 O/E for all trauma patients, blunt single and blunt multi-system injured patients. Report decrease catheter infections (5.5/1000 catheter days to 1.7/1000 catheter days) and decrease ventilator-associated PNA.	High
Chiang et al., 2018[17] Pre-post n/a	ACS-NSQIP VTE prophylaxis program implementation as part of an Enhanced Recovery After Surgery (ERAS) protocol	To evaluate VTE before (2011-2015) vs after (2015-2017) implementing VTE prophylaxis program as part of an ERAS protocol using NSQIP data	Institution: 1, quaternary referral center hospital Participants:319	Lower VTE rates post-intervention (6.2% to 0.9%; p = 0.04) and lower LOS (6 vs 7 d; p = < 0.01). No change in complications, perioperative bleeding, readmissions due to bleeding, or mortality. Higher overall readmissions (21% vs 33%; p = 0.02)	High

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Dunn, Weaver & Woo, 2015[20] Pre-Post n/a	Southern California Vascular Outcomes Improvement Collaborative (SoCal VOICe) Outreach to SoCal VOICe participants on key QI measures 1) statin and antiplatelet prescribing, 2) vascular guidance access (2011)	To evaluate the impact of the regional quality group on 2 key QI initiatives among vascular surgery patients (2011-2014)	Institutions: 9 participating SoCal VOICe hospitals Cases: 2,957 surgeries	Increase pre-op statin use (58.87% to 71.81%; p=0.0082), increase discharge statin use (69.09% to 80.37%; p=0.0037); increase pre-op antiplatelet use (60.8% to 78.38%; p<0.0001), and increased discharge antiplatelet (80.47% to 88.11%; p=0.0148); Improved use of vascular access guidance (32.89% to 76.23%; p<0.0001)	High
Johns et al., 2021[25] Pre-post n/a	ACS Trauma Quality Improvement Program (TQIP) Multicomponent quality improvement initiative with PDSA cycles	To describe and evaluate a multicomponent performance improvement project to achieve a sustained decrease PE incidence in trauma patients using TQIP reports from 2017-2020	Institution: 1, urban, southeastern, academic level 1 trauma center Participants: 4,711	Decrease in observed vs expected PE (1.73 to 0.74). Low-molecular weight heparin use rose from 69% to 81%. TBI patients with no chemoprophylaxis decreased (56% to 24%). VTE data abstraction accuracy rates from 40% to greater than 94%.	High

Author, Year **Study Design** **Additional Statistical Adjustment Methods in Analysis** (if beyond or separate from report card risk adjustment)	**Patient Safety Practice/Report Card** **Intervention**	**Objective**	**Setting** # of institutions	**Findings**	**Risk of Bias**
Konstantinidis et al., 2014[27] Pre-Post n/a	ACS-NSQIP Introduction of pre-operative risk assessment and intervention program (2010)	To assess general, vascular, or multispecialty surgery mortality before (2007-2009) and after (2010-2012) implementing intervention using NSQIP data	Institution: 1, tertiary care hospital Participants: 6,950 (Pre: 3,888, Post: 3,062)	Decrease in 30-day mortality OR over time (1.26, 1.19, 1.14, 0.86, 0.82, 0.84, 0.89). Decrease general surgery mortality rate (3.5% to 1.7%; p=0.007). No change in mortality among emergent procedures; elective procedure mortality decreased from 1.57% to 0.77% (p<0.05).	High

Abbreviations: ACS-NSQIP = American College of Surgeons - National Surgical Quality Improvement Program; ACS-TQIP = American College of Surgeons Trauma Quality Improvement Program; aOR = adjusted odds ratio; CVA = cerebrovascular accident; ERAS = enhanced recovery after surgery; GI = gastrointestinal; NTDB = National Trauma Data Bank; O/E = observed vs expected ratio; PDSA = Plan Do Study Act; PE = pulmonary embolism; RR = relative risk; PIPS = Performance improvement and patient safety; QI = quality improvement; SSI = surgical site infection; VTE = venous thromboembolism; n/a = "not applicable," see tables C-3 and C-4.

Table C-2. Summary of studies describing collaboratives

Author, Year Study Design	PSP/Name of Collaborative	Intervention/Focus or Objective of Collaborative	Setting – Who Is in the Collaborative [# of institutions] [description]	Characteristics of Collaborative	Results to Date
Asher et al, 2014[15] Descriptive	National Neurosurgery Quality and Outcomes Database (N^2QOD)	To form a prospective outcomes registry, provide practice groups and hospitals immediate infrastructure for analyzing morbidity and mortality quality data in real time, generate quality and efficacy data based off providers, practice specialty and procedure.	53 clinical centers (45 academic, 8 private practice) in 29 US states, enrollment of 7300 patients	Involves data extractors/coordinators, Vanderbilt Institute for Medicine and Public Health/Department of Biostatistics epidemiologists, health services researchers, and biostatisticians	Patient Safety (all operations): 30-day major adverse event rate 2.2%, 3-month mortality 0.3%, 30-day readmission 3.7%, 90-day reoperation 2.3%, 90-day readmission rate 8.9%. 12-month PROs (all operations): 60.5% of patients reported surgery met their expectations and 81.3% stated they would undergo the same procedure again. 9.3%-18.4% failed to report improvement in disability scores, varying by procedure.
Chang et al, 2015[16] Descriptive	Michigan Spine Surgery Improvement Collaborative (MSSIC)	To form a registry focusing on lumbar and cervical spine surgery including indications, surgical procedure details, immediate postoperative hospitalization details, adverse events or complications within 90 days of surgery, and patient reported outcomes as well as a platform for quality improvement.	22 hospitals statewide, 6,397 cases entered (4824 eligible for analysis, 1573 excluded)	Involves hospitals, orthopedic surgeons, and neurosurgeons, co-directors, associate directors, data manager, program manager, abstractors, quality assurance officers, and administrative support. Hospitals must perform at least 200 spinal procedures annually.	90-day outcomes: pulmonary embolism 0.85%, wound dehiscence 1.11%, and death 0.29%, hospital readmission 8.49%. 90-day lumbar fusion procedure patient-reported outcomes (PROs): % of patients with a minimum clinically important difference (MCID) in 0-10 rating of leg pain ranged from 60-91% and 32-80% for Oswestry Disability Index

Author, Year Study Design	PSP/Name of Collaborative	Intervention/Focus or Objective of Collaborative	Setting – Who Is in the Collaborative [# of institutions] [description]	Characteristics of Collaborative	Results to Date
					90-day cervical fusion procedure PROs: percentage of patients with MCID in 0-10 rating of arm pain ranged from 25-60% and 35-60% for Neck Disability Index. 63% of patients felt their surgery met expectations and 22% felt their improvement was short of expectations but would be willing to undergo the same operation for the same results.
Davis et al, 2017[19] Retrospective cohort	Texas Alliance for Surgical Quality ACS NSQIP Collaborative	To determine which infection control practices (ICPs) are associated with lower postoperative surgical site infection rates via a multi-institution survey	29 hospitals in Texas (20 participated in study)	Not discussed	Variable adherence to multiple ICPs; Postoperative shower, skin prep technique, clean instruments/gowns/gloves for wound closure and dressing changes, transparent internal reporting were all associated with lower odds ratios of surgical site infections when comparing low vs high compliance sites.

Author, Year Study Design	PSP/Name of Collaborative	Intervention/Focus or Objective of Collaborative	Setting – Who Is in the Collaborative [# of institutions] [description]	Characteristics of Collaborative	Results to Date
Halpin et al, 2016[23] Descriptive	PSP: Society of Thoracic Surgeons National Database (STSND), Collaborative: Inova Heart & Vascular Institute quality improvement (QI) team	To describe the QI methodology and performance improvement cycle used for STSND data outcome management	Single center (Participant in STSND and state-wide Virginia Cardiac Surgery Initiative)	Clinical outcomes coordinator, surgeons, anesthesiology professionals, cardiovascular operating room staff, other perioperative staff members	- Decrease in average ICU time from 84 to 75 hours - Increased number of patients extubated within 6 hours post-op - Decreased post-op atrial fibrillation in CABG patients - Decreased blood product use during cardiac procedures
Poulose et al, 2016[32] Descriptive	Americas Hernia Society Quality Collaborative (AHSQC)	To provide health care professionals real-time information for maximizing value in hernia care, starting with incisional and parastomal hernia repairs	38 institutions, 82 surgeons, 2,377 patients in clinical registry (as of 2014)	- Focus is continuous quality improvement -Began with establishment of clinical registry	Overall readmission rate of 7%, 30-day surgical site infection rate of 4.8% and surgical site occurrence rate of 16.7%.

Notes: ACS-NSQIP = American College of Surgeons - National Surgical Quality Improvement Program; AHSQC = Americas Hernia Society Quality Collaborative; CABG = Coronary artery bypass grafting; ICPs = Infection Control Practices; ICU = Intensive Care Unit; MCID = minimum clinically important difference; MSSIC = Michigan Spine Surgery Improvement Collaborative; N^2QOD = National Neurosurgery Quality and Outcomes Database; PROs = patient-reported outcomes; QI = Quality Improvement; STSND = Society of Thoracic Surgeons National Database

Table C-3. ROBINS-I risk of bias assessment for nonrandomized studies

Author, Year	Confounding	Patient Selection	Classifying Interventions	Deviations From Intended Interventions	Missing Data	Measurement Outcomes	Selection of Reported Results	Overall Assessment
Etzioni et al., 2015[21]	Moderate	Moderate	Low	Low	NR	Low	Low	Moderate
Glance et al, 2014[22]	Low	Low	Low	Low	Low	Low	Low	Low
Hemmila et al., 2018[24]	Serious	Moderate	Low	Moderate	Low	Moderate	Low	Serious
Osborne et al., 2015[30]	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate

Table C-4. Risk of bias in pre-post and longitudinal studies

Author, Year	Were Eligibility/Selection Criteria for the Study Population Prespecified and Clearly Described?	Was the Sample Size Sufficiently Large To Provide Confidence in the Findings?	Was the Test/Service/ Intervention Clearly Described and Delivered Consistently Across the Study Population?	Were the Outcome Measures Prespecified, Clearly Defined, Valid, Reliable, and Assessed Consistently Across all Study Participants?	Was the Loss to followup After Baseline 20% or Less? Were Those Lost to Followup Accounted for in the Analysis?
Chiang et al., 2020[17]	Yes	No	Yes	Yes	Unclear
Dunn et al., 2015[20]	Yes	Yes	Yes	Yes	Unclear
Johns et al., 2021[25]	Yes	Unclear	Unclear	Yes	Unclear
Joseph et al., 2018[26]	Yes	Yes	Yes	Yes	Unclear
Konstantinidis et al, 2014 [27]	Yes	Yes	Yes	Yes	Unclear
Lucas and Pawlik, 2014[28]	Yes	Yes	Yes	Yes	Unclear
Maturo et al, 2017[29]	Yes	Unclear	Yes	Yes	Unclear
Ozhathil et al, 2011[31]	Yes	Yes	Yes	Yes	Unclear
Sarkar et al, 2011[33]	Yes	Unclear	Yes	Yes	Unclear