Best Practices in Data Use for Achieving Successful Implementation of Enhanced Recovery Pathway

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BACKGROUND: Although enhanced recovery pathways (ERPs) have demonstrated promising results in published literature, their effectiveness has been inconsistent. The objective of this study was to identify the most important data use practices associated with successful implementation of ERPs.

STUDY DESIGN: As part of a national ERP implementation initiative, data regarding hospitals' previous ERP implementation experience were collected. Specifically, 4 data use practices (data collection, report generation, feedback to leadership, and feedback to frontline providers) and 2 data types (process measures and outcome measures) were correlated with ERP implementation outcomes (hospital-reported success and patient outcomes from the American College of Surgeons [ACS] NSQIP data).

RESULTS: Of 140 hospitals evaluated, 73 (52.1%) reported previous ERP implementation, with wide variations in data use practices. Of these, 33 (45.2%) reported successful implementation. Feedback of both process and outcome measure data was performed by only 15.1% of hospitals, but was associated with significantly higher likelihood of successful implementation when compared with no feedback (relative risk [RR] 2.45, 95% CI 1.69 to 3.56; $p < 0.001$) and feedback of only outcome measure data (RR 2.73, 95% CI 1.06 to 7.00; $p = 0.037$). Using ACS NSQIP data from 6,888 colorectal surgery patients from 52 hospitals with colorectal ERPs, hospital-reported success was associated with significantly lower surgical site infection rates (6.6% vs 8.1%; $p = 0.011$) and shorter length of stay (6.2 vs 7.0 days; $p < 0.001$).

CONCLUSIONS: The most important data use practice associated with successful ERP implementation was data feedback to frontline providers of both process and outcome measures. However, this was rarely performed in a national cohort of hospitals and represents a substantial but straightforward opportunity for improvement. (J Am Coll Surg 2019;229:626–632.

Enhanced recovery pathways (ERPs)—standardized and evidence-based perioperative protocols that span the continuum of care from the decision to operate to after discharge from the hospital—have proven to be an effective strategy to improve perioperative surgical outcomes. Since their introduction more than 2 decades ago, many studies have demonstrated improved patient outcomes and experience as well as reduced health care

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Abbreviations and Acronyms
ACS = American College of Surgeons
ERP = enhanced recovery pathway
ISCR = Improving Surgical Care and Recovery
LOS = length of stay
RR = relative ratio
SSI = surgical site infection

use with effective implementation.[1-9] Despite these encouraging findings in the literature, ERP adoption has been slow, and results after implementation have been inconsistent.[10-12]

Perioperative quality improvement work is complex, and it is increasingly recognized that efforts need to blend both technical and adaptive elements. Successful ERP implementation requires transdisciplinary collaboration between surgeons, anesthesia providers, nurses, and others to shift care from individual physician preference-driven processes to standardized and evidence-based processes that are embraced by all providers who participate in the care.[13] Further, bundled approaches to perioperative care are successful only when the processes are adhered to across all phases of care, from preoperative evaluation through inpatient hospitalization, to after discharge.[14-18] In 1 study, adherence to at least 10 components of a 13-component ERP achieved the best clinical results, yet was performed in only 34% of patients.[16] However, complete adherence is unlikely to occur immediately upon program launch, and regular review of performance data is essential for driving iterative improvement through increasing awareness, gaining consensus around the pathway, and identifying and addressing barriers to adherence. Finally, previous studies have reported on the importance of using objective, validated clinical data to assure the success of quality improvement efforts.[19-24] However, data collection is routinely insufficient on its own, as is suggested by the variability in improvement observed among those participating in registry-based quality improvement initiatives.[25-27] All told, it remains unclear what the most effective processes are for successful implementation of ERPs.

In 2016, the Agency for Healthcare Research and Quality (AHRQ; funder) partnered with the Johns Hopkins Armstrong Institute for Patient Safety and Quality and the American College of Surgeons (ACS) to accelerate adoption of ERPs in the United States through launch of the AHRQ Safety Program for Improving Surgical Care and Recovery (ISCR). The multi-component program supports hospitals through provision of a toolkit for ERP implementation, which blends the technical aspects of pathway implementation and the adaptive aspects from the Comprehensive Unit-based Safety Program (CUSP), and regular coaching and support from the national project team.[28] The first cohort of hospitals focusing on colorectal surgery began participation in the program in July 2017. Given this unique platform and broad inclusion of hospitals across diverse geographic regions and practice settings, this study sought to identify the most important processes related to the use of data that are associated with successful implementation of ERPs.

METHODS

Study context

As part of the onboarding evaluation for hospitals volunteering to participate in the national program, structured interviews with the hospitals' identified project lead(s) were conducted. Information regarding each hospital's previous experience with ERP implementation was collected. In those hospitals reporting previous ERP implementation, 8 specific questions were asked relating to their past data use practices as part of their implementation effort (eDocument 1). This project was approved by the Advarra Institutional Review Board and Johns Hopkins University Institutional Review Board.

Study participants

All participating hospitals evaluated between August 2017 and January 2018 reporting previous experience with ERP implementation were included in this analysis. Hospital demographic information was obtained from the American Hospital Association Annual Survey database, including hospital bed size and teaching affiliation status. Per American Hospital Association definitions, a small hospital has fewer than 99 beds, a medium hospital has between 100 and 399 beds, and a large hospital has more than 400 beds. A major teaching hospital is designated by participation in the Council of Teaching Hospitals and a minor teaching hospital is designated by participation in the Accreditation Council for Graduate Medical Education, American Osteopathic Association, or American Medical Association.

Data use practices and data types

The 4 data use practices evaluated were data collection, report generation, feedback to leadership, and feedback to frontline providers. Data collection was defined as having a platform for collecting clinical data, such as participation in the ACS NSQIP or another clinical registry or an internal database. Report generation was defined as creating summary reports from the collected data.

Feedback to leadership represented reviewing the generated reports with leaders, such as hospital leaders (eg, chief quality officer, chief medical officer, or chief nursing officer) or surgical quality leaders (eg, department chair or NSQIP surgeon champion). Finally, feedback to frontline providers meant sharing the data with the surgeons, anesthesia providers, nurses, or others directly involved in patient care. Each of these 4 practices was evaluated for 2 types of data: process measures, such as removing urinary catheters or ambulating patient postoperatively, and outcome measures, such as surgical site infections (SSI).

Enhanced recovery pathway implementation outcomes

The main outcome evaluated was hospital-reported success of previous ERP implementation effort. More specifically, participants were queried on whether their local ERP implementation efforts were successful, with success defined as improved patient outcomes (eg, decreased length of stay [LOS], reduced complications, etc). Additionally, because the primary data source was self-reported interview responses, objective patient outcomes were obtained from ACS NSQIP Semi-Annual Report data for hospitals that participated in ACS NSQIP in the year before enrollment (July 1, 2016 to June 30, 2017).

Statistical analysis

Descriptive analyses were performed of each data use practice (ie data collection, report generation, feedback to leadership, and feedback to frontline providers) and data type (ie process measures and outcome measures). The proportion of hospitals reporting success was compared for each data use practice using Pearson's chi-squared test. For data use practices that were significantly associated with successful implementation, the type of data used (ie outcome measures only, both outcome and process measures, or neither) was also compared using Pearson's chi-squared test. Additionally, to determine the relative likelihood of successful implementation for having performed each data use practice, relative ratios (RRs) of successful implementation were calculated for the performance of both outcome measures and process measures vs only outcome measures or neither.

Finally, validation analyses were performed to evaluate whether hospital-reported success was associated with objective patient outcomes. Using ACS NSQIP data, clinical outcomes of patients who underwent colorectal surgery at hospitals reporting successful previous ERP implementation in colorectal surgery were compared with those of patients at hospitals reporting unsuccessful implementation. Multivariable logistic regression models were performed to determine the association between hospital-reported successful implementation and 5 standard binary ACS NSQIP outcomes, including 30-day death or serious morbidity, overall surgical site infection (SSI), venous thromboembolism, urinary tract infection, and readmission, while accounting for patient clustering within hospitals. Variables considered for risk adjustment included patient demographics (ie age, sex, and race), baseline medical condition (eg medical comorbidities, American Society of Anesthesiologists [ASA] class, functional status, etc) and hospital characteristics (ie hospital size and teaching affiliation). Variables were selected for inclusion in the models using backward selection with $\alpha = 0.05$. Multivariable negative binomial regression was used to assess the association between hospital-reported success and the continuous outcome, hospital LOS. All tests of statistical significance were 2-sided, with $\alpha = 0.05$. All statistical analyses were performed in SAS, version 9.4 (SAS Institute).

RESULTS

A total of 140 hospitals were enrolled in this study, with respondents from 37 states and all 4 regions of the country (Northeast, South, Midwest, West). Because the interview was part of the enrollment process, the response rate was 100%. Seventy-three hospitals (52.1%) reported previous ERP implementation experience (Fig. 1). Of these, 93.2% of hospitals had ERPs in colorectal surgery. Most hospitals were large (47.2%) or medium (48.6%) sized, with some level of teaching affiliation (33.3% major and 47.2% minor).

Data use practices and data types

Both data use practices and data types were sequential—data collection must be performed in order to generate reports, reports must be generated in order to feedback the data, and so on. Similarly, all hospitals that used process measure data also used outcome measure data. Most hospitals with previous ERP implementation experience incorporated some level of data use practices into their implementation efforts, though the percentage of hospitals performing each data use practice decreased with each sequential level: 69 (94.5%) hospitals collected either outcomes or process measure data, 56 (76.7%) hospitals generated reports from the collected data, 51 (69.9%) hospitals fed the data back to leadership, and only 20 (27.4%) fed the data back to frontline providers. The sequential decrease in data use practices was most notable for the use of both outcome and process measure data, with only 11 (15.1%) feeding both

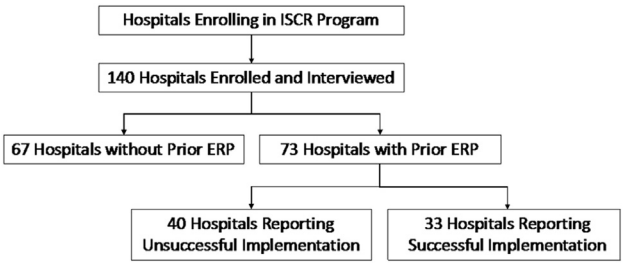

Figure 1. Hospital inclusion flow diagram. ERP, enhanced recovery pathway; ISCR, Improving Surgical Care Recovery.

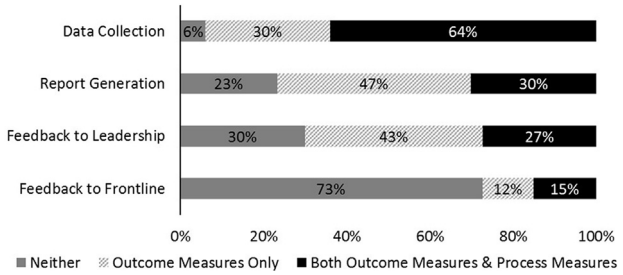

Figure 2. Hospital reported data use practices by data type.

outcome and process measure data back to frontline providers (Fig. 2).

Data use practices associated with successful enhanced recovery pathway implementation

Of the 73 hospitals that implemented ERPs previously, 33 (45.2%) reported successful implementation. Metrics hospitals used to define success included decreased LOS, reduced complications, and improved patient satisfaction. There were no differences in reported successful implementation by hospital size ($p = 0.27$) or teaching affiliation ($p = 0.69$). Significantly more hospitals that performed feedback of either outcome or process measure data reported successful implementation (feedback to leadership 52.9% vs 27.3%; $p = 0.043$; feedback to frontline providers 65.0% vs 37.7%; $p = 0.037$). However, data collection or report generation alone were not associated with implementation success.

Further, for feedback to frontline providers but not feedback to leadership, the use of both outcomes and process measure data was critically important (Fig. 3). Sharing both outcome and process measure data with frontline providers was associated with more than double the likelihood of success when compared with only outcome measure data (relative risk [RR] 2.73, 95% CI 1.06 to 7.00; $p = 0.037$) and when compared with neither (RR 2.45, 95% CI 1.69 to 3.56; $p < 0.001$).

Validation of hospital-reported success with objective patient outcomes

Of the 68 hospitals with previous ERP implementation in colorectal surgery, 52 (76.5%) hospitals also contributed patient data to ACS NSQIP in the year before ISCR program enrollment. Between July 1, 2016 and June 30, 2017, 6,888 patients underwent colorectal surgery at one of these hospitals. Compared with patients from hospitals that reported unsuccessful ERP implementation, patients from hospitals that reported successful ERP implementation had significantly lower rates of SSI (6.6 % vs 8.1%; $p = 0.011$) and shorter LOS (6.2 vs 7.0 days; $p < 0.001$; Table 1). After multivariable adjustment for patient and hospital characteristics, hospital-reported implementation success was still significantly associated with reduced SSI (odds ratio [OR] 0.76, 95% CI 0.60 to 0.96; $p = 0.024$) and hospital LOS (incidence rate ratio [IRR] 0.90, 95% CI 0.87 to 0.93; $p < 0.001$; Table 1).

DISCUSSION

Although ERPs were first described more than 2 decades ago, their adoption has been slow in the US.[1,12] There have been multiple reports of success with ERPs, but findings from this analysis demonstrate that a significant number of hospitals that tried to implement ERPs previously did not yield the meaningful improvements reported in the literature.[5-8] Further corroborating these findings, this study identified substantial variation in hospital practices related to data use that likely explain much of the lackluster results with previous ERP implementation. Hospitals that had developed infrastructure and standardized protocols for measuring and sharing data with frontline providers were more likely to report successful ERP implementation and, among those with ACS NSQIP data, had lower rates of SSIs and shorter LOS as compared with hospitals that did not have the infrastructure and workflows in place. Of the hospitals included in this study, only 15% of hospitals fell into this group, representing a very large opportunity for improvement.

Successful and demonstrable improvement must combine both technical and adaptive interventions with effective leadership, teamwork, and data use. This study found that strong evidence-based interventions, such as ERP, need still need to be coupled with engagement of all frontline providers who may be potentially affected by the program. Further, any improvement effort must contend with the dynamics of the "team," including the surgeons, anesthesiologists, nurses, hospital leaders, and others. Although theoretically straightforward, the actual implementation is often more difficult, as this study involving a

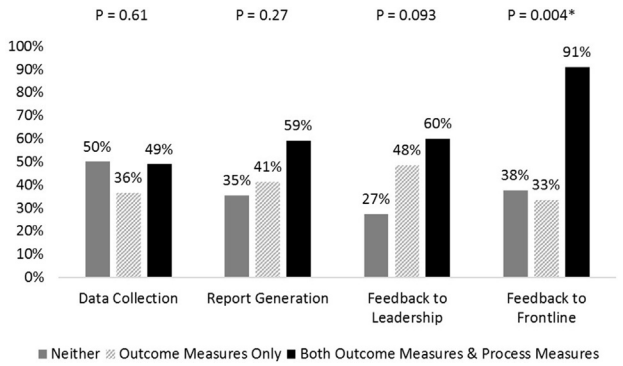

Figure 3. Percentage of hospitals reporting successful implementation by data use practice and data type performed. *Statistically significant.

diverse group of hospitals reveals. The results of this study suggest that actively working to engage these team members with frequent review of performance data—both outcome and process measures—can help promote a more collaborative culture and, ultimately, success.

The importance of audit and feedback is often stressed in ERP implementation resources and recommendations, but few studies have empirically examined the specific data use practices needed for programmatic success, and none in practice settings as broad as those represented here.[10] This study is the first to delineate best practices for data use in diverse practice settings across the country and demonstrate that all 4 steps—data collection, report generation, feedback to leadership, and feedback to frontline providers—are necessary to achieve optimal results. Surprisingly, this study also revealed that performance of these steps was rare, even in a sample of hospitals that already exhibited investment in perioperative quality improvement through previous ERP implementation efforts and voluntary participation in a national ERP program.

This study has several important limitations. First, data were collected from a convenience sample of hospitals initiating participation in a national quality improvement program. Although geographically representative of the nation, these hospitals may not be reflective of all hospitals in the US. However, inclusion of only hospitals choosing to participate in a national collaborative should, in fact, bias the sample toward hospitals with better results, suggesting that the findings may represent a conservative estimate of the actual state of ERP implementation in the US. Second, due to the nature of telephone interviews, the data collected are subjective regarding a hospital's previous experiences. To address this issue as best as possible, the interviews were conducted with structured questions to address specific components. Further, data collection was performed with the hospital's project leads for the ISCR program, who were the most likely to be familiar with the previous ERP work at the hospital. Finally, because the temporal relationship between data use practices and ERP implementation outcome was not available in this retrospective study, only conclusions relating to association, not causation, can be made. Similarly, detailed information regarding specific ERP components implemented and compliance rates were not collected as part of the interview regarding previous ERP experiences. However, timing of implementation, process measure compliance rates, and patient outcomes are being collected as part of the ISCR program, and these data will allow more in-depth investigation into the relationship between implementation practices and outcomes in the future. Nevertheless, this study identified important processes for ERP implementation that are linked to successful implementation. It also revealed that these processes are currently rarely performed, demonstrating significant and persistent opportunities in improving perioperative surgical care.

Table 1. Association of Hospital-Reported Successful Enhanced Recovery Pathway Implementation with Postoperative Outcomes of 6,888 Colorectal Surgery Patients from 52 American College of Surgeons NSQIP Hospitals

	Unadjusted result			Adjusted result	
Postoperative outcome	Unsuccessful implementation	Successful implementation	p Value	Odds ratio (95% CI)	p Value
Death or serious morbidity, n (%)	496 (15.6)	521 (14.1)	0.078	0.90 (0.74–1.10)	0.29
Surgical site infection, n (%)	261 (8.2)	244 (6.6)	0.011*	0.76 (0.60–0.96)	0.024*
Venous thromboembolism event, n (%)	85 (2.7)	69 (1.9)	0.024*	0.71 (0.44–1.17)	0.17
Urinary tract infection, n (%)	50 (1.6)	57 (1.5)	0.92	0.98 (0.65–1.49)	0.94
Readmission, n (%)	332 (10.4)	379 (10.2)	0.79	0.97 (0.80–1.18)	0.73
Length of stay, mean ± SD†	7.0 ± 6.9	6.2 ± 6.3	<0.001*	0.90 (0.87–0.93)	<0.001*

*Statistically significant.
†Continuous outcome, presented as mean ± SD and incidence rate ratio (95% CI) from negative binomial regression.

CONCLUSIONS

Data measurement is a cornerstone of quality improvement, but best practices with regard to data extend beyond just data collection. Although there are many reports of successful ERP programs, as well as general recommendations for best practices for successful implementation, this study is the first to delineate the specific data use practices associated with successful implementation. The finding that feeding data back to the frontline providers is important to successful implementation has considerable face validity, yet was performed only 15% of the time. This might in part explain why only a minority of hospitals in this study reported success from their previous ERP efforts. In summary, this study suggests that successful ERP implementation requires collection of both process and outcome measure data and feedback of collected data to the frontline providers. Because these practices are rare, these study findings represent a substantial and straightforward opportunity for improvement in realizing the maximum benefit of ERPs in a generalizable and scalable way.

Author Contributions

Study conception and design: Hu, Wick, Ko
Acquisition of data: Hu, Liu, Hobson
Analysis and interpretation of data: Hu, Liu, Cohen, Ko
Drafting of manuscript: Hu
Critical revision: Hu, Liu, Cohen, Hall, Wick, Ko

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APPENDIX

eDocument 1. Hospital Interview Questions

Prior enhanced recovery pathway (ERP) implementation experience

1. Does your institution have prior experience with ERPs?
   a. Yes
   b. No
   c. Unknown
2. If so, what types of surgery did you target?
   a. Colorectal
   b. Orthopaedic
   c. Gynecology
   d. Other

Data use practices

3. Did you collect any process measure data?
   a. Yes
   b. No
   c. Unknown
4. Did you create reports with the process measure data?
   a. Yes
   b. No
   c. Unknown
5. Did you feedback the process measure data to leadership?
   a. Yes
   b. No
   c. Unknown
6. Did you feedback the process measure data to the frontline?
   a. Yes
   b. No
   c. Unknown
7. Did you collect any outcomes measure data?
   a. Yes
   b. No
   c. Unknown
8. Did you create reports with the outcomes measure data?
   a. Yes
   b. No
   c. Unknown
9. Did you feedback the outcomes measure data to leadership?
   a. Yes
   b. No
   c. Unknown
10. Did you feedback the outcomes measure data to the frontline?
    a. Yes
    b. No
    c. Unknown

ERP implementation results

11. Were your enhanced recovery efforts successful?
    a. Yes
    b. No
    c. Unknown
12. What metrics did you use to define success or failure? [Free response]