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Failure to Rescue as a Surgical Quality Indicator

Current Concepts and Future Directions for Improving Surgical Outcomes

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ABSTRACT

Over the past decade, failure to rescue—defined as the death of a patient after one or more potentially treatable complications—has received increased attention as a surgical quality indicator. Failure to rescue is an appealing quality target because it implicitly accounts for the fact that postoperative complications may not always be preventable and is based on the premise that prompt recognition and treatment of complications is a critical, actionable point during a patient's postoperative course. Although numerous patient and macrosystem factors have been associated with failure to rescue, there is an increasing appreciation of the key role of microsystem factors. Although failure to rescue is believed to contribute to observed hospital-level variation in both surgical outcomes and costs, further work is needed to delineate the underlying patient-level and system-level factors preventing the timely identification and treatment of postoperative complications. Therefore, the goals of this narrative review are to provide a conceptual framework for understanding failure to rescue, to discuss various associated patient- and system-level factors, to delineate the reasons it has become recognized as an important quality indicator, and to propose future directions of scientific inquiry for developing effective interventions that can be broadly implemented to improve postoperative outcomes across all hospitals.

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Postoperative complications are common adverse events after surgical procedures and are estimated to occur in roughly 18 to 23% of patients.[1,2] Complications represent a major source of patient morbidity and are one of the biggest drivers of healthcare utilization and costs in the perioperative period.[3,4] With approximately 36.5 million operations performed annually in the United States and surgical care estimated to account for ~8% of the gross domestic product over the coming decade, there is ever-increasing attention on the quality, safety, and cost-effectiveness of surgical care.[5,6] Over the past decade, several specific postoperative complications have become the focus of publicly reported, federal surgical quality improvement initiatives. However, a notable challenge when focusing on postoperative complications as a quality target is that even when timely and appropriate perioperative care is provided, complications still can, and do, occur.

While prevention of certain postoperative complications remains the focus of numerous national quality improvement initiatives, the impact and benefits of these programs are unclear. For example, the Surgical Care Improvement Project was implemented to decrease the rate of postoperative surgical site infections.[7] Despite increased adherence to Surgical Care Improvement Project measures in a variety of patient populations and care settings, improved measure adherence has not clearly translated to decreased surgical site infection rates.[8–10] Similarly, hospital venous thromboembolic event rates are identified as a Patient Safety Indicator by the Agency for Healthcare Research and Quality (PSI-12), and venous thromboembolic event prophylaxis is the target of two Surgical Care Improvement Project measures (SCIP-VTE-1 and 2). However, concerns have been raised about the validity of such measures.[11,12] Several factors can potentially explain the limitations of quality improvement efforts focused on the prevention of postoperative complications. Although such programs identify specific care processes (*e.g.*, timely antibiotic administration or venous thromboembolic event prophylaxis) believed to directly translate into better patient outcomes (*e.g.*, lower rates of surgical site infections or venous thromboembolic event), any given healthcare outcome is very likely to be simultaneously impacted by a variety of other factors not captured by the process measure(s) of interest.[13] Thus, improving measure adherence alone may not be associated with the desired outcome (*i.e.*, higher measure adherence rates translating into decreased postoperative surgical site infections or venous thromboembolic event rates). Put differently, although quality improvement programs may focus on the specific aspects of care believed to be associated with improved performance on a given outcome, there may be several other important unknown or unmeasured factors affecting the exact same outcome. As such, currently identified process measures may not be addressing the correct factor(s) that actually contribute to a given outcome. For these reasons, postoperative complications may not always be entirely preventable and, as such, focusing on complication prevention as a surgical quality target may be suboptimal.[14]

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Failure to rescue, or the death of a patient after one or more potentially treatable complications, in many ways could be a more appealing target for surgical quality improvement initiatives.[15] Failure to rescue was first described by Silber *et al.* in the early 1990s, but has only relatively recently become an important outcome in the surgical literature and a nationally endorsed quality indicator.[16,17] Failure to rescue has gained traction among investigators interested in the quality of surgical care for three important reasons: (1) failure to rescue implicitly accounts for the fact that postoperative complications occur, even when the care provided may have been appropriate; (2) although complications are primarily associated with patient characteristics, by comparison failure to rescue is associated with the setting and context in which care is delivered (*i.e.*, hospital characteristics); and (3) failure to rescue is based on the premise that prompt recognition and treatment of complications can profoundly impact a patient's eventual outcome.[17] Importantly, the latter represents a clear, potentially actionable point of focus for hospital quality improvement teams. A study published by Ghaferi *et al.* in 2009[18] provided data supporting these points and suggested that failure to rescue was an important contributory factor to national hospital-level variation in postoperative outcomes. The Centers for Medicare and Medicaid Services (Baltimore, Maryland) subsequently began tracking failure to rescue in 2010 as part of the Agency for Healthcare Research and Quality Patient Safety Indicator Program, and it is currently publicly reported as part of the Centers for Medicare and Medicaid Services Hospital Compare program.[19,20] Since that time, the body of literature regarding failure to rescue and its value as a potential measure of surgical quality has grown substantially.

Failure to rescue has been described across numerous surgical specialties and is believed to be an important contributing factor to variation in mortality across U.S. hospitals, suggesting it is a generalizable quality measure.[18,21] Therefore, an understanding of the relevant concepts around failure to rescue and its potential application to current and future practice is valuable for all stakeholders involved in the care of surgical patients. To this end, the goals of this narrative review are to provide a conceptual framework for understanding failure to rescue, to discuss various patient- and system-level factors associated with failure to rescue, to delineate possible reasons failure to rescue has become recognized as an important quality indicator, and to propose future directions of scientific inquiry for developing effective interventions that can be broadly implemented to improve surgical outcomes across all hospitals.

Conceptual Framework for Failure to Rescue

Figure 1 portrays a simplistic conceptual model of failure to rescue.[22] After an operation, a patient either has an uncomplicated postoperative recovery or develops a postoperative complication. Patients who develop a complication will then either recover (*i.e.*, complication rescue) or will progress down a cascade that ends in death (*i.e.*, failure to rescue). However, this model can quickly become more complex when the dynamic nature of the healthcare system and healthcare teams are taken into account.

To this end, the Donabedian model for evaluating healthcare quality provides a useful adjunct to break an episode of care into the component parts of structure, process, and outcome (fig. 2).[23] *Structure* refers to the setting in which health care is provided. In the well described association between higher surgical volume and improved perioperative outcomes, a hospital's surgical case volume would be an example of a structural healthcare factor associated with the outcomes of surgical care.[24–26] *Process* refers to the actual care that is provided. For example, the Surgical Care Improvement Project endorses several process-based measures (*e.g.*, timely administration of appropriately chosen perioperative antibiotics) that should be incorporated into the perioperative care of surgical patients to help decrease their risk of developing surgical site infections. *Outcome* in the Donabedian model is the end product of the episode of care.

Studies of failure to rescue can be broken down into those that consider factors at the patient level and those at the system or hospital level. More specifically, at the patient level, preexisting comorbidities, as well as the acute condition for which surgery is being performed, can have an important influence on each patient's perioperative risk and eventual outcome. Furthermore, the patient's performance status at the time of surgery can provide important information as to their expected physiologic resiliency should adverse events occur during their postoperative recovery. In terms of the impact that hospitals and health systems have on failure to rescue, most studies have considered macrolevel factors such as the type of hospital (*e.g.*, academic and critical access, among others), the size of the hospital, and resource availability. However, there is an increasing appreciation that microsystem factors, such as the local safety culture and attitudes about quality, also play a critical role.[27]

Failure to Rescue as a Measure of Surgical Quality

There are four main characteristics of a desirable quality indicator.[28] The first is reliability and validity. In other words, the measure has both internal and external validity and measurement results in a reproducible result. The second is a low cost for acquiring the data needed to evaluate performance on the measure. Third is that the measure must be actionable. Put differently, there must be a point in the care pathway where a provider, hospital, or system can intervene to improve performance. Finally, the measure must have a well defined objective. For example, the objective of the American College of Surgeons National Surgical Quality Improvement Program is to provide performance-based quality improvement data to participating hospitals.

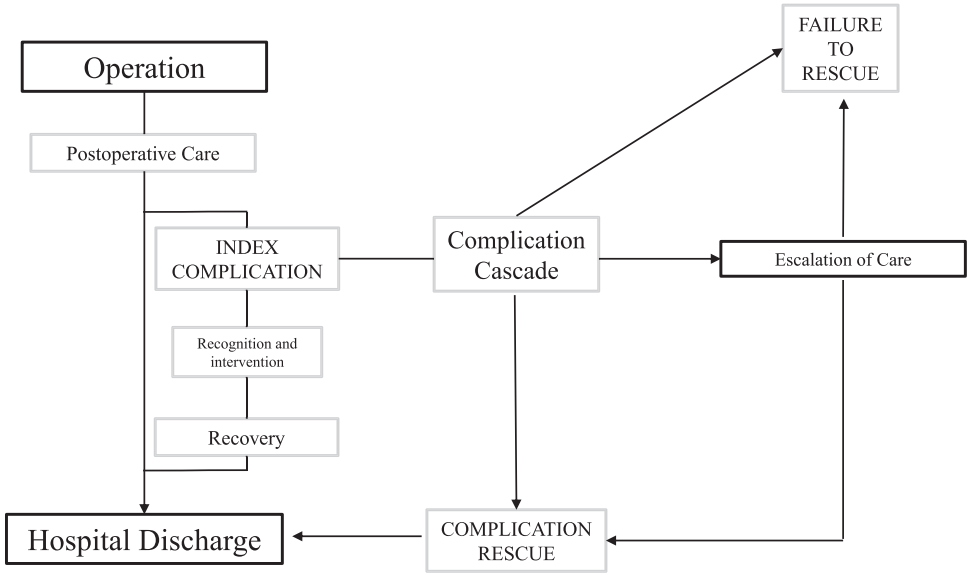

Fig. 1. Conceptual model for the evaluation of failure to rescue. In this model, there are two pathways a postoperative patient can follow: (1) eventual discharge or (2) death. In the case of the former, the patient can either progress to discharge in an uncomplicated fashion or can have one or more postoperative complications that are identified and treated and from which the patient recovers. In the case of the latter, the complications are not successfully identified and/or treated, and the patient progresses to death. Adapted in part from Ghaferi AA: Variation in mortality after high-risk cancer surgery: Failure to rescue. Surg Oncol Clin N Am 2012; 21:389–95.

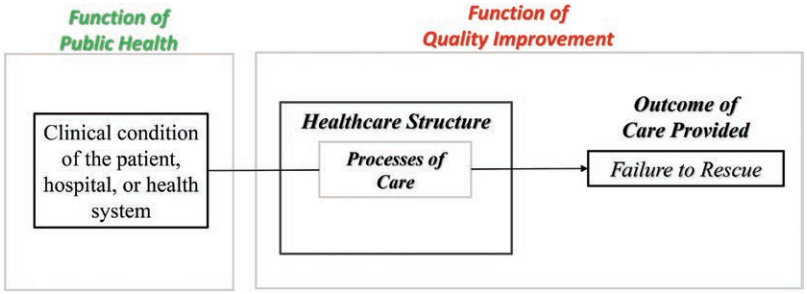

Fig. 2. Donabedian conceptual model for evaluating healthcare quality at the levels of structure, process, and outcome. "Healthcare structure" refers to the environment or apparatus in which care is provided. "Process of care" refers to the actual care that is provided. "Outcome of care" is the end product of the care that is administered and in this case refers to failure to rescue.

One of the main shortcomings of contemporary surgical quality improvement initiatives focused on complications is that operations are associated with an inherent rate of morbidity, even when everything has been done correctly and it is unclear that current quality improvement programs have identified the correct contributory factor(s). As such, it is not entirely clear that all forms of complications are always preventable or that they represent an actionable outcome.[14] By comparison, when considering prevention of failure to rescue, there is a clear, potential action point in the postoperative care pathway—the early identification of complications and the institution of appropriate rescue therapy. Additionally, in an era where local and regional healthcare collaboratives play a critical role in surgical quality improvement, it is possible for providers and hospitals to use their own data, as well as the experiences of their peers, to learn how to improve their own performance at this important point in the surgical care pathway.

Another important aspect of failure to rescue is its consistency across the surgical literature. Not only has failure to rescue been described across nearly all surgical specialties, but there is documented variation in performance across

hospitals.[18,21] The consistency of these findings would appear to support not only the external validity (*i.e.*, generalizability) of failure to rescue, but also its reliability as a potentially important quality improvement target. This is an important characteristic of any measure purportedly tied to surgical quality because physician payment and hospital reimbursement are likely to be increasingly tied to performance in future payment models (*i.e.*, value-based care). Although an important benefit of failure to rescue is its ability to discriminate between high- and low-performing hospitals, the fact that it is potentially actionable and is readily interpretable to patients, providers, hospitals, and other stakeholders adds to its appeal. This stands in contrast to many other contemporary programs intended to measure and report quality. For example, the Leapfrog Group (Washington, DC) is a national consortium of healthcare purchasers that utilizes a composite Hospital Safety Score to grade hospitals.[29] However, this grading system is only able to identify poor performing hospitals without any additional granularity in terms of discriminating between hospitals who are average performers or who perform well.[30] Similarly, the Centers for Medicare and Medicaid Services implemented a Star Rating system in 2016, but numerous issues underlying the scoring methodology brought the validity of hospitals' star rankings into question.[31,32]

Similarly, there are several important limitations to consider regarding failure to rescue as a quality indicator.[33] The measure definition currently used by the Centers for Medicare and Medicaid Services as part of the Hospital Compare program is based on administrative data, which is known to be suboptimal for the identification of postoperative complications. Focusing on the prevention of death as a measure of surgical quality may not always be entirely patient-centric. For example, complication rescue may prevent death (failure to rescue) but could be associated with an undesired (by the patient and/or the patient's family) decrement in either functional status or quality of life (*i.e.*, rescue to failure). Finally, the available data regarding failure to rescue may not provide the level of granularity required to really drive surgical quality improvement. Although the identification of reliable quality targets in surgery remains a challenge, because there are several associated patient and hospital factors that are potentially modifiable, failure to rescue could represent a useful starting point for the evaluation of hospitals' surgical quality in future value-based payment models.

Patient-level Factors Associated with Failure to Rescue

Mortality through the Phases of Surgical Care

Surgical care can be broken down into three main component parts: (1) preoperative; (2) intraoperative; and (3) postoperative (fig. 3). Mortality in a surgical patient can happen at any point along this continuum. Mortality in the preoperative periods encompasses patients who are diagnosed with a surgical problem requiring either an elective or emergent operation but die before the procedure can be performed. This can include patients deemed poor operative candidates and those who die while awaiting or preparing for an operation (*e.g.*, a cancer patient who dies while receiving neoadjuvant treatment; a trauma patient with a gunshot wound to the abdomen who dies in the emergency center). Intraoperative mortality, or a death that occurs within the operating room during the conduct of an operation, is fortunately a rare occurrence in contemporary surgical practice.

The postoperative period remains the primary focus of most surgical quality improvement efforts. It is generally accepted that most postoperative mortality occurs after some form of adverse event, whether that be iatrogenic in nature (*i.e.*, medication error) or a complication. However, there is likely an important interplay between factors across the phases of surgical care with several preoperative patient factors as well as intraoperative factors impacting an individual patient's postoperative outcome. In fact, prior work has demonstrated that the vast majority (~95%) of postoperative deaths occur among a specific subgroup of patients at highest risk of developing complications.[34] However, how best to identify these high-risk patients and implement measures to mitigate their risk remains an ongoing challenge. Furthermore, aspects of the healthcare environment and the interface between the surgical care team, other healthcare providers involved in the episode of surgical care, and the patient also play essential roles. Below we discuss potentially modifiable patient-level factors during each of the three phases of surgical care that can impact a given patient's risk for failure to rescue.

Preoperative

The preoperative identification of specific factors that can influence a patient's outcome would make potentially appealing quality improvement targets. In thinking about these factors, it is helpful to consider those that are modifiable and those that are nonmodifiable. For example, patients with low socioeconomic status and African American patients have been shown to be at higher risk for adverse postoperative outcomes.[35,36] However, factors like low socioeconomic status or a patient's race clearly cannot be modified before surgery. As shown in figure 2, these represent patient factors that are likely best targeted by public health interventions rather than surgical quality improvement programs. As such, identification of nonmodifiable factors are useful inasmuch as they can provide an early warning sign to the surgical care team that the patient may have a heightened risk during postoperative recovery or they may prompt efforts to medically optimize these types of conditions before surgery to mitigate associated perioperative risk (at least to the extent possible) and/

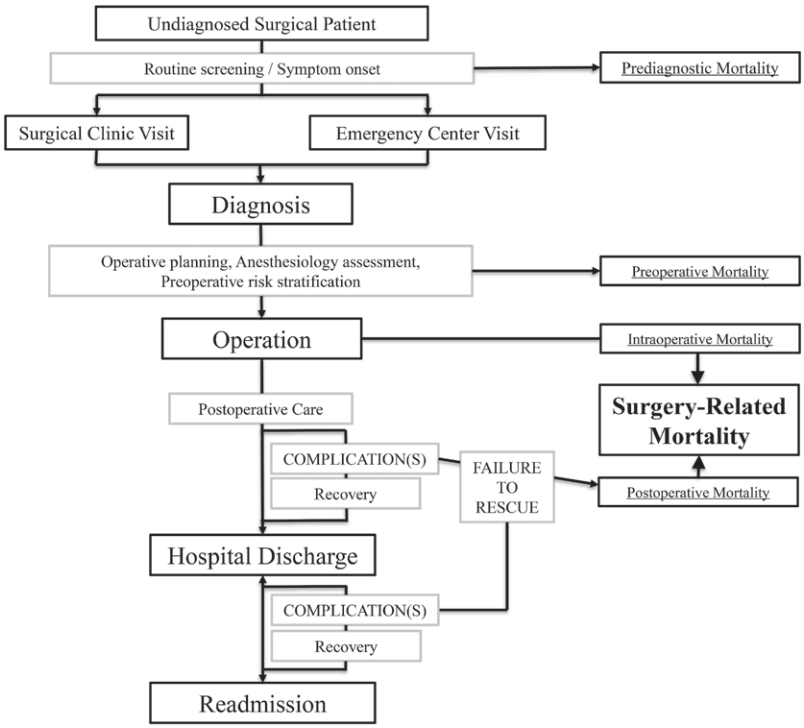

Fig. 3. Conceptual model of mortality in (potential) surgical patients throughout the phase of surgical care. As a surgical patient progresses through an episode of surgical care, there are numerous points at which an adverse outcome can occur. Once a patient undergoes an operation and is recovering postoperatively, death is most frequently associated with the occurrence of a complication. Patients who have complications can either recover and be discharged or deteriorate and progress to death. Complications can also occur among patients who are successfully discharged. These complications are either detected and promptly treated either as an outpatient or with readmission and inpatient care, or they lead to deterioration and death.

or ameliorate patients' symptoms. Other examples of such nonmodifiable factors that can impact the level of perioperative care patients receive or require and that may also be associated with postoperative adverse events include preexisting cardiac diseases (*e.g.*, history of acute myocardial infarction or congestive heart failure) and pulmonary diseases (*e.g.*, history of chronic obstructive pulmonary disease or obstructive sleep apnea).

In terms of potentially modifiable factors, traditionally the presence of comorbid conditions have been viewed as the main indicator of a given patient's perioperative risk. However, patient frailty is a multidimensional construct that considers more than just comorbidities and has been shown to be an important factor associated with both complications and failure to rescue. In patients undergoing low-risk or high-risk noncardiac surgery, an increasing degree of frailty is directly associated with an increased risk of both complications and failure to rescue.[37] Furthermore, in this study one in five patients in the highest two strata of frailty were under the age of 55 yr, suggesting not all elderly patients or those with comorbid conditions are frail and not all young, seemingly healthy patients are robust.

Preoperative "prehabilitation" programs are intended to prepare frail patients for surgery by improving their functional status and exercise tolerance, thereby theoretically improving physiologic resiliency to intraoperative and/or postoperative adverse events. Prehabiliation programs have been shown to be efficacious in reducing the risk of postoperative complications, but it is unclear whether patients who complete such programs and demonstrate an improvement in their frailty also have an improvement in their risk for failure to rescue.[38–40] Prehabiliation programs clearly improve patients' exercise tolerance and preoperative functional status,[41] but it is less certain that their perioperative risk then becomes similar to those who were not frail to begin with or whether their risk remains similar to the established baseline before completing prehabilitation. In the case of the former, this would suggest a patient's resiliency to physiologic stress should become the focus of preoperative programs designed to identify and address frailty. In the latter case, this would suggest perioperative risk associated with frailty is tied to as yet unmeasured physiologic factors inherent to that specific patient.

Intraoperative

At this time, little is known about possible intraoperative factors that may influence failure to rescue. However, there are numerous potential factors that could influence a patient's postoperative outcome such as the type of anesthesia used (*i.e.*, general *vs.* regional), restrictive *versus* liberal fluid management, and intraoperative transfusion of blood products. In addition, there are factors potentially related to the operating room team that may play a role—although these factors are not necessarily directly attributable to the patient, the impact of these factors is at the patient level. For example, the risk of failure to rescue is higher in cases in which a nonanesthesiologist licensed physician, a nurse anesthetist, or an unsupervised anesthesia resident directs anesthesia care as opposed to an anesthesiologist.[42] Although the data used to conduct this study were from the 1990s, a more recent and comprehensive study from Canada suggests continuity of anesthesia care is a potentially important and previously underappreciated factor playing a role in surgical patients' postoperative recovery. In this study of more than 300,000 patients undergoing a variety of surgical procedures, at least one turnover of anesthesia care during a case was associated with a 45% increase in the risk of 30-day mortality and a 25% increase in the risk of 30-day complications.[43]

Although there are no data specifically examining the association between characteristics of the operating surgeon and failure to rescue, there is recent and ongoing debate. Overlapping operations are cases performed or supervised simultaneously by the same surgeon in different operating rooms. In a recent study from Canada, overlapping surgery during specific orthopedic procedures was associated with a significantly increased risk of perioperative complications.[44] By comparison, in a U.S. study using data from more than 12,000 concurrent operations performed by more than 1,400 surgeons, there was no clear association with the risk of perioperative complications or mortality.[45] The effect of sleep deprivation on the performance of elective surgical cases the day after a surgeon is on call is another controversial topic. However, the best available data suggest that a surgeon operating the night before an elective case is not associated with an increased risk of adverse perioperative events.[46]

Taken together, these data suggest that there are likely as yet unidentified team dynamics between those involved in the intraoperative care of surgical patients that may have an important role in postoperative patient recovery. Importantly, these factors seem to also include nonsurgical members of the intraoperative care team. More work is needed to better understand the complex interactions that occur among all individuals providing care in the operating room while a patient is under general anesthesia and how these might impact that patient's recovery while on the hospital ward.

Postoperative

Nearly all postoperative deaths occur among patients at highest risk of developing complications.[34] Among patients who develop a postoperative complication, approximately 60% only have one, but among those who die as a result of failure to rescue, roughly two-thirds have more than one complication.[21] These data support a "complication cascade" conceptual model for how this may occur—a patient has an initial complication that leads to a series of domino complications eventually resulting in the patient's death.

Given well characterized regional and hospital-level variation in the quality of U.S. health care, a relevant question is whether hospitals and providers vary in their ability to prevent and/or successfully treat complications. Two national studies have both clearly demonstrated complication rates are similar across hospitals, but there is significant variation in perioperative mortality across hospitals once complications occur. Using data from American College of Surgeons National Surgical Quality Improvement Program, Ghaferi *et al.*[18] demonstrated that while complication rates were similar across hospitals ranked by risk-adjusted mortality, failure to rescue rates varied nearly two-fold from the lowest to the highest mortality quintile hospitals. In a subsequent analysis using Veterans Affairs Surgical Quality Improvement Program data, rates of both overall and specific numbers of complications were similar across Veterans Affairs hospitals, but there was a clear dose-response relationship between the number of complications and failure to rescue.[21] Importantly, although failure to rescue rates again varied across hospitals, the magnitude of mortality risk associated with an increasing number of complications was similar across strata of hospital risk-adjusted mortality. This implies that when patients develop multiple complications, this can dramatically and incrementally impact the eventual outcome—even when a patient is receiving care at a high-performing hospital.

Because the majority of failure to rescue occurs in patients who develop multiple postoperative complications, there may be identifiable seminal complications that more frequently put a patient on the path to failure to rescue.[21] For example, in patients whose index complication is either pneumonia, acute myocardial infarction, deep space surgical site infections, acute renal failure, or bleeding/transfusion, there is nearly a 30-fold difference in the rate of mortality associated with these five index complications (comparing deep space surgical site infections [mortality rate of 0.5%] to acute myocardial infarction [mortality rate of 14.2%]), and there is notable variation in the pattern of secondary complications.[47] Furthermore, when hospitals are stratified based on the rate at which surgical patients have secondary complications, there are clear differences in the rates of both secondary complications and failure to rescue.[1] This suggests there may be merit in focusing local quality improvement efforts on the prompt management of certain major

index complications to mitigate the risk of secondary complications and eventual failure to rescue. However, because hospital-level failure to rescue rates vary dramatically, there are likely also important differences in how hospitals and/or surgical care teams address index complications that may translate into the observed variation in rates of secondary complications across hospitals.

Taken together, these data support three important takeaways. First, an initial postoperative complication should signal a potentially important change in the clinical status of a patient and prompt the institution of timely and appropriate treatment to mitigate the risk of additional complications that are associated with incremental increases in the risk of mortality. Second, secondary complications play an important intermediary role between the index complication and mortality. Finally, there are likely important differences in how hospitals and/or local surgical teams identify patients who have evolving complications and institute rescue therapy. As a specific example, given wide variation in postoperative opioid prescription practices (even after common general surgical procedures), there may also be important differences in the degree to which patients prescribed postoperative narcotics are monitored that could translate into variable rates of postoperative respiratory depression.[48–51]

Whereas these three points may seem intuitive, the significant national variation in hospital failure to rescue rates suggests some providers, hospitals, and/or health systems are better equipped or able to identify these critical junctures in a patient's postoperative care and promptly intervene. In addition, recognition that there may be demonstrable patterns of secondary complications that occur after specific index complications could be used to inform surgical teams as to which index complications put patients at greatest risk and should inspire more prompt treatment and/or ongoing, closer monitoring. For example, relative to a patient who develops an index deep space surgical site infection, a patient who develops postoperative pneumonia has an increased risk of a subsequent myocardial infarction.[47] Recognition of the contributory factors accounting for the observed differences in postoperative patient outcomes, such as the experience of and/or communication between the surgical and nursing teams involved in the care of postoperative patients, would represent useful data that could be used to develop, disseminate, and teach evidence-based best practices to local quality improvement teams at underperforming hospitals.

Hospital Factors Associated with Failure to Rescue

An important, but as yet unanswered, question in the ongoing conversation about U.S. healthcare reform is where higher risk surgical procedures should be performed. Initiatives like "Take the Volume Pledge" and the Leapfrog Group's Evidence-Based Hospital Referral initiative are intended to preferentially direct the surgical care of all patients undergoing specific high-risk operations to hospitals meeting established annual volume benchmarks[52,53] The premise underlying these initiatives is that higher-volume hospitals have experienced practitioners and the resources necessary to provide safe and high-value health care to patients undergoing higher-risk surgical procedures.

This argument would seem intuitive and appears to have face validity. However, a decreased risk of failure to rescue does not immediately follow the availability of resources—for example, there is no difference in the risk of failure to rescue comparing hospitals that offer advanced cardiology services, a fully implemented electronic medical record, and advanced imaging and endoscopic interventions relative to those that do not have these resources available.[54] Furthermore, hospital-level factors account for the minority of variability in failure to rescue across hospitals.[55] To what, then, can differences in hospital failure to rescue rates be attributed? There is an increasing appreciation for the complexity of the interface between a postoperative patient, his or her healthcare providers, and the system in which that care is being provided. Although macrosystem factors, like the hospital's nurse-to-bed ratio or the availability of specialty services (like gastroenterology or interventional radiology), are important features of a system that is potentially capable of identifying patients with an evolving complication and instituting prompt treatment, it has been hypothesized that microsystem factors, like attitudes and behaviors of the surgical care team may be just as, if not more, critical in the failure to rescue pathway.[27] Put differently, a hospital may have the resources necessary to successfully rescue a patient from a postoperative complication, but if the organizational dynamics do not support the prompt recognition and timely institution of this therapy, failure to rescue may still occur.

Surgical care at high-volume centers is associated with better perioperative outcomes after many complex, high-risk surgical procedures.[24,25] One possible explanation is the idea that "practice makes perfect"—providers and hospitals that provide a certain type of surgical care frequently develop an in-depth understanding of the nuances of the disease process, as well as the perioperative care required, and are therefore better positioned to identify when a patient's postoperative course deviates from the norm. However, the organizational dynamics of high-performing hospitals (whether they are high volume or not) could also represent an alternative explanation. For example, higher-volume hospitals are more frequently teaching hospitals.[56] Relative to patients receiving surgical care in community settings, surgical residents often provide more direct and readily available care at the bedside, which could result in the more prompt recognition of a complication and has been associated with lower failure to rescue rates.[34] Although the teaching status of the hospital might be considered a macrosystem factor, the available line of communication between the attending surgeon and the resident physician at the bedside could exemplify the hospital's culture and surgical care team's

attitude toward patient safety. Along these same lines, hospitals with more favorable nursing environments have lower rates of intensive care unit utilization and transfers and failure to rescue, in particular among higher-risk patients.[57] Because nurses represent the front line of postoperative care and can play a critical role in the early identification of patients who may be developing a complication, these data point to the importance of both communication and teamwork across all providers involved in a patient's postoperative care. For example, a greater number of hours of patient care provided by nurses is associated with lower failure to rescue rates; meanwhile, mortality rates are higher at hospitals with suboptimal levels of nurse staffing.[58,59] These data suggest that nursing interactions with patients should be viewed as a sensitive, upstream point of postoperative care for detecting patients who have deviated (or are deviating) from the expected clinical course.[60] Local surgical quality improvement efforts should ensure that nurse staffing levels are appropriate relative to the patient load and find ways to better integrate nursing input into care pathways designed to mitigate the adverse impact of postoperative complications and to institute prompt rescue therapy. If the culture of the local healthcare environment supports and empowers those who are consistently and directly in contact with the patient during potentially critical points in their postoperative care, important opportunities for early intervention may be better appreciated, allowing for more timely care to be provided.

Failure to Rescue as an Indicator for Value-based Care Models

As the U.S. healthcare system evolves away from traditional fee-for-service toward more value-based payment models, stakeholders are increasingly interested in identifying measures that are best able to capture both components of the value equation:

$$\text{Value} = \text{Quality} / \text{Cost}$$

The costs of surgical inpatient hospitalizations have steadily climbed over the past decade and are presently estimated at nearly $160 billion per year.[61] A major driver of variation in the costs of surgical care are postoperative complications.[3,4] In addition, there appear to be meaningful differences across hospitals in the costs associated with complication rescue. Among patients who experience a postoperative complication and do not die, there is a two- to three-fold difference between hospitals in the total costs of a given surgical episode—in most cases, the majority of this difference is accounted for by the cost of the index hospital admission when the operation is performed.[62] Although these findings are not entirely surprising, when considered in the context of the available literature on failure to rescue, they support two notable conclusions. First, failure to rescue could provide relevant information about the value of surgical care at hospitals or within a health system. The intensity of care provided in hospitals varies 10-fold but only accounts for a small amount of hospital-level failure to rescue variation.[63] This implies that although the intensity of health care and healthcare spending may be viewed by some to be an indicator of receiving higher quality care, this may not necessarily be an efficient or beneficial perspective as it pertains to the prevention of failure to rescue. As such, identifying those hospitals or providers who are more effective and efficient at treating patients who develop postoperative complications may represent an opportunity to learn which are the critical resources or care processes needed to institute prompt rescue therapy.

The second, and perhaps more fundamental, conclusion is that failure to rescue is likely to be an actionable quality indicator. Because there is such dramatic variation in both costs and outcomes across hospitals when considering failure to rescue, there may be identifiable elements of postoperative care at high-performing hospitals providing more cost-effective care associated with better outcomes. This makes failure to rescue a highly relevant and potentially appealing target for the identification of hospitals and/or health systems capable of providing high value health care. In an era of increasing health system integration, accountable care organizations, and alternative payment models, there remain many unknowns about how best to evaluate and measure surgical value within populations of patients. Stakeholders are seeking to identify relevant, valid surgical quality measures that can be tied to reimbursement, and failure to rescue may represent a useful starting point because of the variation in the costs of complication rescue and its actionability. Future work will be needed to develop appropriate benchmarks and to understand how best to tie this measure to surgical reimbursement (*i.e.*, whether it should be measured at the provider, hospital, or health system level).

Future Areas for Failure to Rescue Research

There remain several, critical blind spots for which future failure to rescue research is required. As alluded to previously, patients who develop multiple postoperative complications account for the majority failure to rescue.[21] Additional research is needed to understand whether it is possible to preoperatively identify these patients at risk for developing multiple complications or whether their adverse outcome is more a function of the system in which they are receiving surgical care. If adverse postoperative outcomes are a function of identifiable preoperative patient factors, then clearly delineating what these factors are (*e.g.*, frailty) and developing and implementing preoperative interventions (*e.g.*, prehabilitation) that can help mitigate the associated risk could be a broadly applicable approach for improving the outcomes, and potentially the costs, of surgical care at all hospitals.

Although there are almost certainly some patient factors that could be addressed through preoperative optimization

programs, most patient factors are likely to be nonmodifiable. Given the existing variation in both costs and outcomes across hospitals, the underlying reasons for this variation have yet to be clearly elucidated. One reason for this knowledge gap is that presently the majority of the failure to rescue literature is derived from quantitative studies using either large administrative or quality improvement data sources. Unfortunately, data characterizing nonmodifiable structural and contextual factors associated with failure to rescue (*e.g.*, hospital surgical volume and hospital resource availability, among others) are limited in their ability to influence the costs or quality of care. Although such studies and data are without question useful for describing the frequency with which failure to rescue occurs, as well as the identification of associated factors and potential targets for quality improvement initiatives, what is needed moving forward are data that can provide a deeper and more nuanced understanding of: (1) process-level and microsystem factors that are integral to the early identification of a patient who has deviated from the expected postoperative course; (2) granular information about differences in the dynamics between care team members and the patient at high-performing relative to lower-performing hospitals; and (3) processes of care and team dynamics that result in optimal patient outcomes. For example, prior work by Gaba *et al.*[64] has demonstrated that in simulated clinical crises, important differences in team behavioral and technical performance can be identified. As the use of simulation continues to develop in surgical training programs for teaching the technical aspects of surgical care, so too might it be used to identify errant team dynamics and enhance the care delivered during critical and evolving phases of a patient's care—such as detecting a complication and instituting prompt rescue therapy. This type of information could provide critical insights as to what lessons can be taught and learned and potential best practices to be disseminated.

If the goal of surgical quality improvement initiatives is to improve the overall quality of surgical care in the United States, then a better understanding of how care is delivered by high-performing hospitals and/or providers is needed. Although quantitative studies are the mainstay of the current surgical research, the ability of future failure to rescue research to truly influence and improve surgical care will require qualitative, mixed methods, and comparative effectiveness approaches that can better "drill down" onto the specific aspects of the care environment, the care team, and the care provided that is associated with improved patient outcomes. Large data sets should be used to identify potential signals that can then inform more focused qualitative data to understand processes and develop best practices that can be implemented and disseminated. Specific examples of future areas of investigation include[65]:

- Are there differences in staff training or experience that allow for earlier identification of postoperative patients who are not following an expected course? If there are, how can these knowledge and/or practice gaps be bridged?
- Do high-performing hospitals have systems that provide redundancy and built-in resiliency? If so, what are the critical factors needed to alert the care team of changes in a patient's clinical status?
- Are there differences in local culture, attitudes, or behaviors toward patient safety that either empower nursing staff or ancillary providers to alert the surgical care team to minor changes in a patient's clinical status?

Conclusions

Failure to rescue has emerged as an important outcome for surgical quality improvement initiatives and in the surgical literature. Although failure to rescue is likely an important contributing factor to the observed hospital-level variation in both surgical outcomes and costs, further work is needed to delineate the underlying patient-level, care team–level, and system-level factors that prevent the timely identification and treatment of postoperative complications. As surgical quality improvement programs are aiming to improve the overall quality of surgical care nationally, failure to rescue could be used to identify hospitals who are performing well and those who could be performing better. A more in-depth and refined understanding of the contextual factors around the surgical care of patients provided at high-performing hospitals could lead to the development and dissemination of tools and strategies that ensure all patients receiving surgical care have a desirable outcome and receive high value care.

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Competing Interests

The authors declare no competing interests.

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