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Complication timing and association with mortality in the American College of Surgeons' National Surgical Quality Improvement Program database



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ABSTRACT

Background: The relationship between timing of postoperative complications on mortality is unknown. We investigated the time-variable mortality risks of common surgical complications.

Methods: We identified patients undergoing nonemergent, in-patient surgery in the National Surgical Quality Improvement Program (NSQIP) database during 2005–2011 who experienced any of 13 complications within 2 wk of surgery. “Expected timing” was defined as the median postoperative day of occurrence. Hazard ratios (HRs) for complications earlier or later than expected were calculated using Cox proportional hazards, adjusted for age, procedure, American Society of Anesthesiology (ASA), and functional status. A secondary analysis evaluated the effect of preceding complication burden on the relationship between complication timing and mortality.

Results: Among 77,443 patients experiencing complications, significantly higher mortality was observed with early wound infections (superficial HR 1.30, confidence interval [CI] 1.01–1.70; deep HR 1.52, CI 1.07–2.16; and organ space HR 1.38, CI 1.11–1.70) despite adjustment for patient and operative factors and complication burden. Early cardiac arrest and unplanned intubation were associated with lower mortality, which persisted after adjustment (HR 0.59, CI 0.51–0.68; HR 0.38, CI 0.33–0.43, respectively). By contrast, late occurrence of acute myocardial infarction, pneumonia, and cerebrovascular accident was associated with significantly greater mortality risk (HR 1.41, CI 1.18–1.69; HR 1.37, CI 1.24–1.52; and HR 1.61, CI 1.31–1.98, respectively), but these associations became nonsignificant after adjustment for complication burden.

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Conclusions: Timing of complications plays an important role in mortality. Surgeons and trainees should be aware of these patterns and tailor their clinical care and monitoring practices to account for the implications of complication timing on mortality.

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1. Introduction

Complication rates have classically been used as quality measures to evaluate surgeon and hospital performance [1,2]. More recently, however, complication outcomes, and not simply occurrences, have emerged as measures of surgical quality. The concept of failure-to-rescue (FTR), or death after postoperative complications, has emerged as a quality metric, but strategies to improve rates of FTR have yet to be elucidated [3,4]. There is consensus that patient rescue is dependent on two main processes—recognition of the complication and implementation of appropriate treatment [5]. Recognition of complications is a critical step, and failures in recognition may stem from multiple sources, including inadequate nurse staffing [6], inadequate or inappropriate surveillance [7], or providers' cognitive biases [8] that interfere with correct and timely diagnosis.

However, a lack of contemporary information regarding the epidemiology of postoperative complications may also contribute to errors in the accurate formulation of differential diagnoses. Surgical education on the diagnosis of postoperative complications has historically relied on informal mnemonics (such as the “Rule of W’s” [9]), which may aid in formulating a differential diagnosis based on prevalence, but provide little insight into how the underlying diagnoses contribute to mortality. Better information on the epidemiology and mortality implications for the most common surgical complications would be useful for surgeons and would provide information for those in training to help increase awareness and recognition of the most dangerous postoperative situations. Furthermore, there is a critical need for surgeons and trainees to understand how the mortality risks associated with specific complications may vary when these complications occur in patterns that do not fit the conventional expectation. For example, although the timing of wound infection has been studied [10], and a general belief exists that early wound infections portend poor prognosis, this has never been demonstrated or quantified using contemporary clinical data. To more effectively rescue patients with complications, it is important to understand when to expect them and what significance their timing has in terms of subsequent mortality risk.

The purpose of our study was to use national data to evaluate the timing and mortality risk for 13 common postoperative complications with the goal of providing clinical insights for practicing surgeons and trainees engaged in the care of postoperative patients. We hypothesized that the timing of complications in the postoperative period would have a variable effect on mortality, and that complications diagnosed at unexpected time points during recovery (when they were less likely) would result in greater mortality, potentially due to “failure to recognize” on the part of providers, differences in complication severity, or differences in

patient physiology during the course of recovery. Secondly, because complications tend to cluster in individuals, and we sought to determine if the mortality effects of specific complications were associated with the presence of multiple complications at different time points in the postoperative period.

2. Methods

2.1. Population and data source

We used data from the National Surgical Quality Improvement Program (NSQIP) Participant Use File from 2005–2011. The NSQIP is a clinical outcomes registry developed by the Veterans Administration and the American College of Surgeons [11]. The details of the NSQIP have been outlined previously [12]. In brief, the NSQIP uses trained surgical clinical reviewers to examine medical records and classify perioperative clinical data and outcomes using standard definitions. Reliability of the data is ensured through structured training and data audits. At the time of this study, the NSQIP included the records of approximately 1.7 million surgical patients.

We first identified 1,154,395 patients in the database who underwent in-patient surgery. Patients were included if they underwent nonemergent general, cardiovascular, orthopedic, urologic, and gynecologic surgery and experienced a qualifying complication within 14 d after surgery because the vast majority of complications occur in this period. Although 21 complications are available with the NSQIP data set, we selected complications that are primary diagnoses, are common, and are applicable to all operations and important to quality improvement efforts. We eliminated complications that were not primary diagnoses (i.e., secondary to another complication, such as sepsis or shock) because the timing of these complications may be determined by the underlying diagnoses (i.e., timing of sepsis will be driven by the source from which it arises such as urinary tract infection, pneumonia (PNA), or wound infection, which all have different patterns of incidence). We also excluded those complications that are specific to certain operations (e.g., graft failure was excluded because it applies to certain operations only). Finally, bleeding and/or transfusion events are defined as only occurring within 72 h of operation by NSQIP criteria, and thus, time-based analyses are not possible.

Therefore, complications included in the primary analysis comprised the following: acute myocardial infarction (MI), cardiac arrest, PNA, deep vein thrombosis requiring therapy, pulmonary embolism (PE), urinary tract infection, unplanned reintubation, dehiscence, acute renal failure (ARF), superficial surgical site infection (SSI), deep SSI, organ space SSI, and cerebrovascular accident (CVA). This resulted in a final cohort of 77,443 unique patients suffering a total of 99,787

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