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ORIGINAL SCIENTIFIC REPORT

# Preventable Morbidity and Mortality Among Non-trauma Emergency Surgery Patients: The Role of Personal Performance and System Flaws in Adverse Events

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## Abstract

*Background* Preventable morbidity and mortality among emergency surgery patients is not adequately analyzed. We aim to describe and classify preventable complications and deaths in this population.

*Methods* The medical records and quality control documents of patients with emergency, non-trauma, surgical disease admitted between September 1, 2006, and August 31, 2018, and recorded to have a preventable or potentially preventable morbidity and mortality were reviewed. The primary outcome was a classification of the complications and deaths by a panel of experts, as attributable to issues of personal performance or system deficiencies.

*Results* One hundred and fifty patients were identified (127 complications and 23 deaths). The most commonly encountered preventable complications were surgical-site infection (17%), bleeding (13%), injury to adjacent structures (12%), and anastomotic leak (8%). The majority of complications seemed to stem from personal performance (97%), due to either technical or judgment issues, and only 3% were linked with system flaws, either in the form of communication or inadequate protocols. Alcohol use disorder and duration of operation were different between patients with preventable adverse events related to technical issues and patients related to judgment issues; furthermore, more patients who experienced judgment issues died during hospital stay ($p < 0.05$).

*Conclusion* Among emergency surgery patients, who suffer preventable complications and deaths, issues related to personal performance are more frequent than system flaws. Whereas the effort to improve systems should be unwavering, the emphasis on the surgeon's personal responsibility to avoid preventable complications should not be derailed.

## Introduction

Several studies in the trauma surgery literature have shown that by understanding the nature of preventable complications, systems are developed to identify populations at risk and avoid related adverse events [1–3]. These rigorous, quality control systems have been widely reported to reduce morbidity and mortality across trauma centers [4, 5]. Whereas the causes and types of preventable complications have been exhaustively explored in the trauma literature, studies on preventable complications for non-traumatic emergency cases are sparse [6, 7].

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Over the last two decades, non-traumatic surgical emergencies have been increasingly managed by dedicated acute care surgery teams, which are guided in their quality control systems by principles established in trauma surgery [8, 9]. However, understanding of the root causes of complications after emergency non-trauma surgery is lagging behind its trauma counterpart. Defining the various types of preventable complications in emergency non-trauma cases will aid in the development of specific, quality control systems, which may reduce morbidity and mortality.

The objective of our study is to describe and classify the types of preventable and potentially preventable morbidity and mortality in emergency, non-trauma populations. Specifically, we aim to understand the impact of personal performance versus systematic process-of-care gaps in the development of such complications. We hypothesize that preventable morbidity/mortality can be grouped in easily identifiable and potentially correctable categories. Also, given the lack of trauma-like, established quality control systems, we hypothesize that system deficits, rather than personal performance issues, are more prevalent in this population.

## Material and methods

### Patients

Following institutional review board approval, we reviewed the medical records of all patients who were admitted as an inpatient, between September 1, 2006, and August 31, 2018, with emergency surgery diagnoses and a preventable or potentially preventable complication/death. We also reviewed the records of a dedicated Emergency Surgery Registry that we had created since 2006 and which paralleled the format of our Trauma Registry. Finally, we reviewed the records of our morbidity and mortality conference. All such patients were managed by a dedicated acute care surgery team in our tertiary, academic, urban medical center, which includes a mature Level 1 Trauma Center. Patients with morbidity and mortality were identified on a weekly basis by two independent sources: the treating clinicians and the quality control team of the group. All such patients were presented at a weekly morbidity and mortality conference. Whereas the trauma cases from our division are presented at a multidisciplinary trauma conference per the requirements of a Level 1 Trauma Center, the non-trauma emergency surgery cases are presented together with all other general surgery cases at the weekly departmental M&M. We included a peer review process where, at conclusion of the presentation and discussion at M&M, a group of surgical peers made a judgment on whether the complication was preventable, potentially preventable, or non-preventable. A group of physicians and quality control nurses, who were not involved in the patient's care made this classification. There was no systematic classification system used.

### Outcomes

Our primary outcome was the classification of the root cause of complication, either as an issue in personal performance or as one in a system of care. Personal performance issues were subclassified as those of judgment and those of technique. Errors of judgment included issues of medical management (e.g., pulmonary embolism in the absence of indicated thromboprophylaxis) and issues of inappropriate choice of a procedure (e.g., choosing to close a frankly infected wound). Errors of technique were related to a procedure, which was felt to have been sub-optimally performed, resulting in postoperative infection, bleeding, anastomotic leak, injury to adjacent structures, bowel ischemia, re-operation, or another occurrence. Examples of such technical issues included an anastomosis, which leaked in 48 h; bleeding from a vessel, which was found and ligated on re-operation; inadvertent injury to the common bile duct during cholecystectomy; dissection around the splenic curve that devascularized the colon, requiring colectomy. On the other hand, system issues included a variety of deficiencies in the process of care, such as breakdowns in communication, lack of established protocols, inadequate equipment, delays in reporting results or providing requested material, disconnect between teams, and others.

The authors were divided into two teams, classifying the events independently. Although patients could have developed multiple complications, some of which may have been preventable, while others non-preventable—the two teams sought to identify the root preventable complication. For disagreements, a discussion was upheld to achieve consensus. In the absence of consensus, a neutral senior attending, from within our group, made a final decision.

### Statistical analysis

Data were collected on demographics, disease characteristics, hemodynamic parameters, diagnostic tests, interventions, operative findings, and clinical outcomes. Comparisons between the groups of personal performance versus systems errors and, within the personal performance category, between the groups of judgment versus technique were performed. Continuous variables, expressed as a mean with standard deviation, were compared by Student t test. Categorical variables, expressed as an actual value

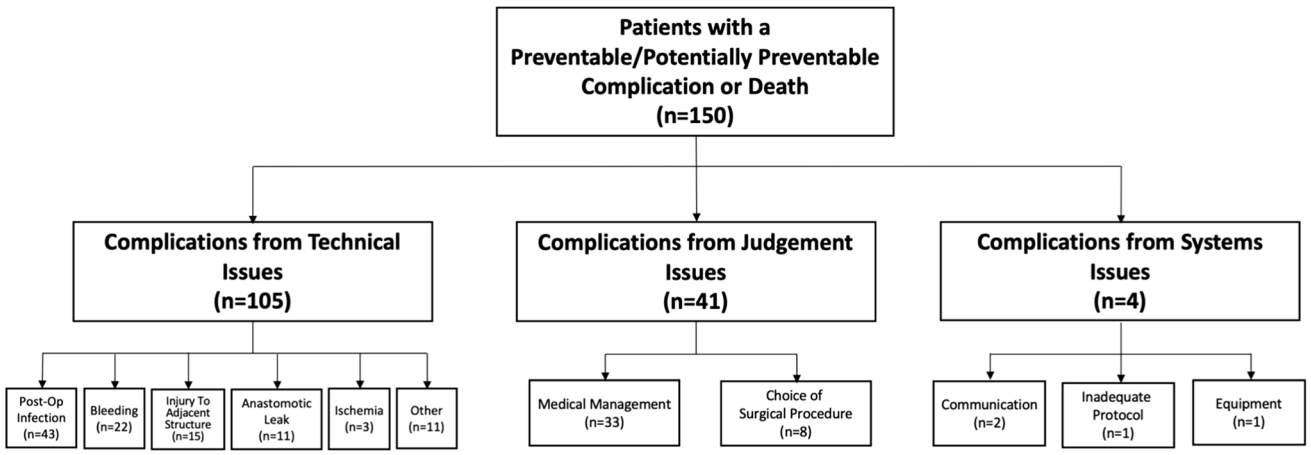


**Fig. 1** Breakdown of issues leading to preventable complications

with proportion, were compared by Chi-square test and Fisher's exact test. A p value of 0.05 was considered significant for all comparisons.

## Results

Of 15,618 patients admitted with or consulted on an emergency surgery non-trauma diagnosis, 10,047 (64%) underwent emergency surgery, 595 (4%) developed complications and/or died, and 150 (1%) were recorded with preventable or potentially preventable complications or deaths. Of the 150 patients, 23 died (15%). The average age and Charlson comorbidity index in this population were 59 ± 18 years old and 3.2 ± 2.8, respectively, and the majority of patients were white (71%), male (67%), and with no history of alcoholism (83%) or smoking (92%) (Table 1). The most common index operations among these patients were exploratory laparotomies for a wide variety of gastrointestinal issues (36%), cholecystectomies for acute biliary disease (21%), and appendectomies for acute appendicitis (11%).

### Classification of complications and deaths

The breakdown of preventable and potentially preventable morbidity and mortality is shown in Figure 1. Most events were attributable to issues of personal performance than system issues. Complications arose 6 ± 7 days after operation. The most common ones were surgical-site infection, bleeding, injury to adjacent structure, and anastomotic leak (Table 2). A comparison between patients with preventable adverse events due to issues of judgment and those due to issues of technique did not identify statistical significant differences except alcohol use disorder and duration of operation; furthermore, more patients died among those with judgment issues (Table 3).

## Discussion

With the explosion of the concept of acute care surgery around the country, an essential part of it, emergency non-trauma surgery, has lagged behind in quality control processes, compared to its other two counterparts, trauma surgery and critical care, which have been regulated for years by well-established protocols and meticulously tested systems. As emergency surgery is now subject to increasing scientific scrutiny, the analysis and improvement of its outcomes become paramount. In our study, we described and classified preventable and potentially preventable morbidity and mortality after emergency non-traumatic diseases and expected that systems flaws will be at the core of preventability.

Over the past 20 years, the surgical literature has consistently pointed to system failures, rather than personal ones, when accounting for surgical adverse events [10–12]. *To err is human* rose to national prominence by arguing that most medical errors arise from the design of health systems and not from capable, well-intentioned physicians [13]. Miscommunication, intra-operative flow disruption, and patient-related factors have been listed as the principal root cause of disrupted systems that allow errors. Nearly 80% of adverse events related to surgical execution were attributed to faulty equipment and lack of adequate training [14]. As a result, the medical community focused on systems improvement, as the main—sometimes the exclusive—source of medical errors. While we agree with this position and set out to prove it by our study, we surprisingly found the majority of preventable complications to be associated with personal performance issues.

**Table 1** Demographics of patients with preventable complications

| | Non-trauma emergency surgery patients ($n$ = 150) |
|---|---|
| Age at operation (years) | 59 ± 18 |
| Charlson comorbidity index | 3.2 ± 2.8 |
| ASA at operation | 2.8 ± 1.0 |
| BMI at operation | 28.7 ± 6.9 |
| Race: | |
| White | 107 (71%) |
| Black | 11 (7%) |
| Hispanic/Latino | 8 (5%) |
| Male | 100 (67%) |
| Insurance status: | |
| Private | 80 (53%) |
| Public | 62 (41%) |
| Smoking history: | |
| Current | 34 (22%) |
| Past | 26 (17%) |
| Never | 86 (57%) |
| Alcohol abuse: | |
| Current | 23 (15%) |
| Past | 3 (2%) |
| Never | 123 (83%) |
| Drug abuse: | 15 (5%) |
| Current | 9 (6%) |
| Past | 3 (2%) |
| Never | 137 (92%) |
| Preoperative sepsis | 31 (21%) |
| Transfer from OSH | 36 (24%) |

ASA, American Society of Anesthesiologists; Physical Status Classification System; BMI, body mass index; OSH, outside hospital

**Table 2** Characteristics and types of preventable complications

| | Non-trauma emergency surgery patients ($n$ = 150) |
|---|---|
| Time to complication after admission (days) | 9 ± 8.2 |
| Time to complication after operation (days) | 5.8 ± 6.6 |
| Post-discharge complication | 35 (23%) |
| Types of complications: | |
| Surgical-site infection | 26 (17%) |
| Bleeding | 20 (13%) |
| Injury to adjacent structure | 18 (12%) |
| Anastomotic leak | 12 (8%) |
| Respiratory (pneumonia, acute respiratory failure, unplanned intubation, etc.) | 10 (7%) |
| Bowel obstruction | 9 (6%) |
| Wound dehiscence | 8 (5%) |
| Bile leak | 5 (3%) |
| Myocardial infarction/stroke | 4 (3%) |
| Acute renal failure | 4 (3%) |
| Ischemia | 3 (2%) |
| Thromboembolic | 3 (2%) |
| Sepsis | 1 (1%) |
| Biliary obstruction | 1 (1%) |
| In-hospital death | 23 (15%) |
| Readmissions: | |
| 1 Readmission within 30 days | 58 (39%) |
| >1 Readmission within 30 days | 14 (9%) |
| Readmissions related to index operation | 51 (34%) |

Only in a minority of cases was a system clearly at fault in the examined population. Obviously, salient points related to process of care cannot be easily discovered through retrospective review. Poor documentation of communication issues or team dynamics can definitely confound our conclusions. The multiple, complex decisions that surgeons make during major operations, such as exploratory laparotomies, are not always documented accurately in the medical record, yet these judgments may contribute to the difference in complications and overall outcome observed in one patient versus another for a rather similar operation. On the other hand, an injury to the common bile duct during a laparoscopic cholecystectomy seems to have a straightforward relationship to the surgical technique of the individual surgeons performing the operation. Similarly, a fascial dehiscence owing to a knot found inadequately tied during re-operation can again point to a direct issue in technique. Thromboembolism related to lack of prescription for otherwise indicated thromboprophylaxis could very well be an oversight in plan of care. A severe wound infection after closing a wound, which was heavily contaminated and inadequately protected intra-operatively, could be an adverse event related to misjudgment.

Even in those instances, the always-blame-the-system supporters will claim that behind every personal performance transgression there is a system that could have prevented it. To an extent they are right, and the issue becomes almost philosophical. A system of better training to identify the critical view of safety in laparoscopic cholecystectomy will decrease the number of inadvertent injuries to adjacent structures [15]. An electronic medical record alert, which prompts thromboprophylaxis in appropriate patients, will reduce the likelihood of forgetting it [16]. A policy of using wound protectors in operation at

high risk for enteric contamination will reduce the incidences of wound infection [17]. There is little doubt that systems can and should be created for nearly everything. However, like others, we are worried that the emphasis on systems may abdicate physicians from their personal responsibility and attention to detail [18, 19]. Whereas one can always claim that the reason for a failed anastomosis is the use of a new stapler without warning, there is an element of personal duty in knowing the instruments that one uses. Assigning blame is rarely constructive but assigning responsibility is universally appropriate. On occasions, colossal system changes have happened in the belief that the system is always at fault, not the individual, only to realize that the benefits on patient outcomes were not that great [20]. The analysis of our experience with a robust quality control process on emergency non-surgical cases over a period of 12 years showed that personal performance issues are not uncommon. In these situations, physicians who seem to perform below the standard of care repeatedly are identified via two processes: either by statistical comparison of their outcomes compared to their peers or by the simple observation of recurrent adverse events that could have been avoided.

The limitations of a study that seeks to analyze surgical judgment, technique, and systems retrospectively are obvious. Our review of medical records, as rigorous as it was, could not possibly extract every detail that determines the root cause of a complication. In reality, patients often develop multiple complications, occurring in a simultaneous or overlapping fashion. Deciding which was truly preventable versus non-preventable and which one constituted the root cause for all others is hard to identify by reviewing the records. However, in line with nearly every single study that exists in the literature, we tried to identify the issues through a thorough examination of all the data available to us and based on our deep knowledge of our hospital systems and processes. Another limitation is the classification of errors that we used. A number of categorization systems exist, including the Clavien-Dindo classification and others [21, 22]. We chose to use a relatively easy classification that is easily understood by most and agreed on by our group. Moving forward, we intend to populate our database with additional intra-operative and complication-related fields. When we reanalyze the augmented data, we aim to improve our understanding of the relationship between index operations and complications observed. Our study did not seek to identify factors that place patients at risk for preventable complications, and therefore, we did not compare our group to the group of patients with non-preventable complications, like other groups have done [23]. We only sought to analyze the preventability and compare patients who were subjected to predominantly judgment issues and those with technical issues. There were no major demographic, disease severity, or other preoperative factors that distinguished the two groups. Furthermore, our analysis of various pre- and postoperative variables, such as mean time to complication, was in agreement with the surgical literature's conclusions about such variables. For example, the mean time from operation to complication in our population was 6 days, which is a well-accepted interval for the development of anastomotic leaks, intra-abdominal infections, thromboembolic events, etc. [24–26]. Furthermore, timing indicated a rather direct link between operation and complication. On average, operations were longer among patients with technical issues, attesting to the evident fact that longer duration indicates a harder operation with increased demands on technical competence. Another limitation is the generalizability of our findings to an international audience. In the USA, quality control is primarily provided at the divisional or departmental level. Issues of particular concern, whether considering a system or an individual, may be elevated to hospital quality control committees. In parallel, the medical board of each state requires automatic report of certain adverse occurrences (such as wrong-site surgery or retained foreign body) with subsequent correcting action to be taken. The quality control systems in other countries may vary. Finally, we accept that objectivity is very hard to establish at every step of the way in a study like that. Despite attempts for standardization of judgments regarding preventability, the decisions are made by physicians based on local conditions, personal biases, evidence-based learned practices, and available resources. What may be preventable for one group may be non-preventable for another. We do not proclaim here to make an irrefutable argument regarding preventability but rather to advance the debate of personal responsibility versus system deficiency in the field of emergency non-trauma surgery.

In conclusion, our study identified that personal performance issues, related to either judgment or technique, accounted for the majority of preventable morbidity and mortality in the examined population. While we strive to improve systems, physicians simultaneously should be keen to uphold a sense of personal responsibility, which can foster individual growth, improve patient safety, and be a source of pride for every physician.

**Table 3** Comparison between patients with complications related to technical issues versus judgment issues

| | Patients with complications from technical issues ($n$ = 105) | Patients with complications from judgment issues ($n$ = 41) | $p$ Value |
|---|---|---|---|
| Age at operation (years) | 57 ± 18 | 61 ± 17.8 | 0.31 |
| BMI at operation | 29 ± 7.0 | 28 ± 6.8 | 0.29 |
| CCI at operation | 3 ± 2.7 | 4 ± 2.9 | 0.28 |
| ASA at operation | 3 ± 0.9 | 3 ± 1.0 | 0.6 |
| Race: | | | |
| White | 74 (70%) | 31 (75%) | 0.53 |
| Black | 7 (6%) | 2 (5%) | 1 |
| Hispanic/Latino | 7 (6%) | 1 (3%) | 0.44 |
| Male | 73 (68%) | 24 (59%) | 0.25 |
| Public insurance | 55 (52%) | 18 (43%) | 0.46 |
| Smoking history: | | | |
| Current | 24 (23%) | 9 (22%) | 1 |
| Past | 20 (19%) | 5 (12%) | 0.46 |
| Never | 51 (48%) | 23 (56%) | 0.46 |
| Alcohol abuse: | | | |
| Current | 15 (14%) | 33 (80%) | <0.001 |
| Past | 3 (3%) | 0 (0%) | 0.56 |
| Never | 87 (82%) | 8 (20%) | <0.001 |
| Drug abuse: | | | |
| Current | 7 (6%) | 2 (5%) | 1 |
| Past | 3 (3%) | 0 (0%) | 0.56 |
| Never | 95 (90%) | 39 (95%) | 0.51 |
| Time to complication after admission (days) | 9.0 ± 8.8 | 9.1 ± 7.0 | 0.99 |
| Time to complication after operation (days) | 5.6 ± 6.2 | 6.5 ± 7.8 | 0.56 |
| Preoperative sepsis | 18 (17%) | 12 (29%) | 0.11 |
| Post-discharge complication | 26 (25%) | 9 (22%) | 0.83 |
| Laboratory values: | | | |
| Hematocrit | 34.9 ± 7.8 | 35.5 ± 7.5 | 0.68 |
| Hemoglobin | 12.0 ± 3.6 | 12.0 ± 2.5 | 0.92 |
| Creatinine | 1.2 ± 1.1 | 1.4 ± 1.1 | 0.55 |
| Glucose | 130 ± 43.5 | 136 ± 41.9 | 0.47 |
| PT-INR | 1.3 ± 0.4 | 1.3 ± 0.5 | 0.69 |
| Lactate | 2.0 ± 1.9 | 2.4 ± 2.2 | 0.52 |
| Albumin | 3.6 ± 0.9 | 3.5 ± 0.9 | 0.53 |
| Blood urea nitrogen | 20.2 ± 15.9 | 24.4 ± 15.7 | 0.18 |
| PRBC transfusion: | | | |
| Perioperative transfusions | 36 (33%) | 10 (24%) | 0.32 |
| Blood units transfused | 4.7 ± 6.5 | 3.8 ± 4.3 | 0.61 |
| OR duration (minutes) | 164 ± 123 | 123 ± 88 | 0.02 |
| Operation during night shift | 36 (33%) | 15 (36%) | 0.84 |
| In-hospital deaths | 9 (8%) | 13 (39%) | 0.001 |
| Transfers from OSH | 23 (22%) | 14 (40%) | 0.14 |
| Readmissions: | | | |
| 1 Readmission within 30 days | 43 (40%) | 14 (40%) | 0.57 |
| >1 Readmission within 30 days | 11 (10%) | 2 (5%) | 0.34 |
| Readmission related to index operation | 37 (35%) | 13 (39%) | 1 |

CCI, Charlson comorbidity index; PT-INR, prothrombin time/international normalized ratio; PRBC, plasma red blood cells; OR, operating room

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**Compliance with ethical standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

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