

Beyond incidence: Costs of complications in trauma and what it means for those who pay

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Introduction. Trauma patients have greater rates of complications than general surgery patients; however, existing surgical pay-for-performance (P4P) guidelines have yet to be adapted for trauma care. To better understand whether current P4P measures are applicable to trauma, this study used nationally representative data to determine the mortality and attributable costs associated with the presence or absence of both Centers for Medicare and Medicaid Services–recognized complications (urinary tract infections, surgical site infections [SSIs], and pneumonia) and other major trauma-related complications.

Methods. Trauma admissions were extracted from the 2008 National Inpatient Sample using primary ICD-9-CM diagnosis codes (range, 800–905, 910–939, 950–958). Patients aged 18–65 years with a duration of hospital stay of > 3 days and isolated complications were included. To account for differences in patient factors, coarsened-exact matching was used to create comparable cohorts of adult patients with and without complications. Multivariable regression was then performed within matched groups to determine differences in cost and mortality, controlling for hospital characteristics and wage index.

Results. Of 493,372 trauma patients, 78,156 met inclusion criteria, of whom 24.4% had an isolated complication. Consistent with surgical P4P guidelines, SSI, urinary tract infections, and pneumonia had the greatest incidence (8.0%, 5.2%, and 4.4%, respectively); however, mortality in matched patients with complications was greatest for sepsis (odds ratio [OR], 9.76; 95% CI, 3.84–24.80), myocardial infarction (MI; OR, 4.21; 95% CI, 1.70–10.44) and stroke (OR, 3.02; 95% CI, 1.40–6.52). Excess costs associated with a complication were similarly greatest for sepsis (relative cost, 1.84; 95% CI, 1.57–2.17), followed by acute respiratory distress syndrome (ARDS; relative cost, 1.84; 95% CI, 1.7–1.99) and MI (relative cost, 1.73; 95% CI, 1.51–1.99).

Conclusion. Consideration of attributable costs and mortality suggest that additional complications have a substantial impact among trauma patients, beyond the conditions used in general surgery P4P guidelines. These aspects of trauma should be prioritized to capture the influence of complications in trauma that the incidence of frequent but less costly conditions overlooks. (*Surgery* 2015;158:96–103.)

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ACCORDING TO INFORMATION published by the Centers for Medicare and Medicaid Services (CMS), national health expenditure in the United States increased by 3.7% from 2011 to 2012, reaching a total annual cost of \$2.8 trillion dollars, a number that accounted for 17.2% of the US gross domestic product.¹ Over the subsequent decade (2012–2022), health care spending is further projected to grow at an average rate of 5.8% per year,

reaching 19.9% of the US gross domestic product by 2022.¹ Each year, medically treated injuries account for some \$80 billion in health care costs, making it 1 of the 5 costliest conditions in the United States.^{2,3}

In an effort to decrease the increasing costs and improve the quality of American health care, pay-for-performance (P4P) initiatives are being promulgated increasingly by health care payers, such as CMS.⁴ P4P initiatives pay physicians per procedure, similar to a fee-for-service model, while also linking provider payment in the form of incentives with results of various measures of structure, process, and outcome. Incentives can be financial or nonfinancial and include enticements, such as bonuses for meeting threshold measures, bonuses for improvement, performance-based fee schedules, public recognition, and decreases in administrative requirements for providers who perform at or above expected levels.⁵ As the single largest payer in general surgery and trauma surgical care, CMS (responsible for the Medicare and Medicaid programs) has put together a P4P program intended to inform payment for general surgical care.⁶ CMS has also defined a set of quality measures used to evaluate providers' performances in surgical interventions, based primarily on measures of morbidity, mortality, and surgical complication rates.⁷⁻⁹

In an era of increasing emphasis on the use of P4P measures, it remains unclear how applicable such measures would prove were they to be applied to patients specifically receiving trauma care. Compared with general surgery patients, trauma patients are known to have an increased risk of complications owing in large part to the emergent nature of care. Moreover, trauma patients with complications have greater risks of mortality, greater average durations of hospital stay, and more expensive medical care.^{10,11} Despite the different risk profile of trauma patients relative to general surgery patients, P4P guidelines to date have only been determined for the broadly defined scope of general surgical care, relying on incident identification of the three most frequent complications—urinary tract infections (UTI), surgical site infections (SSI), and pneumonia—to inform overall assessment of quality of care.⁸ The incidence of these limited measures is believed to poorly capture the complex reality of trauma surgical care, making it difficult to determine the extent to which such measures would apply. Disparities within complication subtypes further obfuscate the match, causing some providers and institutions to

question how effective and efficient P4P measures could prove in terms of decreasing the number of surgical complications, decreasing costs, and increasing the overall quality of care.⁸

Lack of representation for trauma-related complications, such as adult respiratory distress syndrome (ARDS), acute kidney failure, and sepsis, has further been cited as a major limitation of P4P guidelines.¹⁰⁻¹⁴ For many such complications, cost of treatment exceeds reimbursement,¹⁰⁻¹⁴ yet available guidelines do nothing to target this additional expense. Bearing these criticisms and discrepancies in mind, the objective of the present study was to use a nationally representative sample of trauma patients to determine the mortality and attributable cost associated with the presence or absence of specific complications in trauma patient. Both CMS-recognized complications (UTI, SSI, pneumonia) and major complications known to occur among trauma patients (described in detail elsewhere in this article) were assessed to determine the appropriateness of trauma's fit within P4P guidelines.

METHODS

To obtain a nationally representative cross-section of trauma patients, we used hospital discharge data from the 2008 National Inpatient Sample (NIS). The NIS is the largest all-payer inpatient care database in the United States and contains data from 42 states totaling approximately 8 million annual hospital stays. It represents a 20% stratified sample of hospitals in the United States that are selected based on geographic region, ownership control, urban or rural location, teaching status, and number of hospital beds. The sampling frame consists of 90% of all hospital discharges. Available data elements include patient age, sex, race/ethnicity, primary payer, duration of stay, total charges, disposition, and up to 15 procedure and diagnosis codes.¹⁵

Adult trauma patients were extracted from this dataset using International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) primary diagnosis codes (range, 800–905, 910–960), excluding patients with late effects of injury (905–909.9). We excluded patients with burns (940–949) and unspecified injuries (959–959.9), who were missing cost information, who were outside the age range of 18–65 years (or with missing age information), who had a hospital duration of stay of <3 days, and with nonisolated complications. The [Figure](#) provides a schematic of the inclusion and exclusion criteria leading to selection of the final study population.

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