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Disability symposium

Disability as a covariate in risk adjustment models for predicting hospital deaths

Lisa I. Iezzoni MD, MSc *

Mongan Institute for Health Policy, Massachusetts General Hospital, Department of Medicine, Harvard Medical School, Boston, MA

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ABSTRACT

Risk-adjusted hospital mortality rates are frequently used as putative indicators of hospital quality. These figures could become increasingly important as efforts escalate to contain U.S. health care costs while simultaneously maintaining or improving quality of care. Most risk adjustment methods today employ coded diagnostic information sometimes supplemented with more detailed clinical data obtained from medical records. This article considers whether risk-adjusted hospital mortality rates should account for baseline patient disability. Accounting for baseline disability when calculating hospital mortality rates makes clinical sense, especially for conditions such as heart failure or coronary artery bypass grafting surgery, where patients' cardiac-related functional status strongly predicts their imminent outcomes. A small body of research suggests the strength of disability in predicting hospital mortality, even in comparison with indicators of acute physiologic status and comorbid illness. However, the feasibility of obtaining complete and accurate data on patients' baseline disability will be challenging and requires further investigation. The risk of not adjusting for baseline disability could be efforts by physicians and hospitals to avoid treating patients with significant disabilities.

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Introduction

For more than four decades, researchers have worked to develop clinically meaningfully, administratively feasible, and statistically rigorous methods for risk adjusting hospital mortality rates [1]. These efforts have gained fresh urgency with current initiatives to identify quality metrics for pay-for-performance schemes and other programs aiming to control health care costs while maintaining quality. This impetus is heightened as the nation moves forward with implementing the Patient Protection and Affordable Care Act (P.L. 111-148), after its approval by the U.S. Supreme Court on June 28, 2012. Affordable Care Act provisions to control Medicare and other health care costs require credible quality metrics, many of which will need risk adjustment to account for differences in patient mixes across providers.

Evaluations of the clinical meaningfulness of risk adjustment methods generally examine the range of demographic and clinical factors used to adjust for patients' risks. Most risk adjustment methods today employ coded diagnostic information that is sometimes supplemented with more detailed clinical data obtained from medical records. My purpose here is not to review the extensive literature on risk adjustment methods [1]. Instead, I consider one very specific question: Should risk-adjusted calculations of acute care hospital mortality rates adjust for patients' baseline disability? For this purpose, I define disability as impaired functional status that limits persons' ability to perform daily activities or participate in various life activities and that results from interactions among physical and mental health conditions and barriers in the physical and social environments. Given the acute hospital context, I define baseline disability as limitations in the period before becoming acutely ill or before entering the hospital (in the case of elective admissions, such as certain surgeries).

Background

Public health practitioners began tracking patterns of population mortality in depth as the Industrial Revolution took hold in early nineteenth-century Europe [2]. Although they used simple epidemiologic approaches and largely observational data, their findings elucidated sources of contagion and provided insights into social determinants of health (e.g., effects of crowded slums). Nations worldwide continue tracking population mortality today, slicing and adjusting the data using basic demographic characteristics—primarily age, gender, and race/ethnicity—findings that spur public health interventions that save countless lives. These basic statistical adjustments allow public health officials to use mortality data most productively to understand the implications of differential mortality rates and intervene to reduce deaths within specific population subgroups.

* Corresponding author. Mongan Institute for Health Policy, Massachusetts General Hospital, 50 Staniford Street, Room 901B, Boston, MA.
E-mail address: liezzoni@partners.org.

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In the mid-nineteenth century, Florence Nightingale and her statistician colleague William Farr used epidemiologic techniques to calculate hospital-level mortality. With these figures, Nightingale published the "MORTALITY per Cent. on Inmates" for groups of English hospitals in her 1863 book *Notes on Hospitals* [3,4]. Nightingale and Farr aimed to draw inferences from differences in mortality rates across hospital types to suggest strategies for reducing inpatient deaths. London hospitals, which catered to downtrodden urban populations, seemed to have substantially greater mortality than rural hospitals, which drew their patients from surrounding supposedly "healthy" communities. Angry denunciations ensued, with London physicians excoriating their statistical methods and failure to account for differences in patient populations. Farr's technique for calculating mortality rates—generating mortality per person-year spent in hospital—had confused interpretation of the hospital mortality statistics for readers unfamiliar with epidemiologic methods [4].

Today in the U.S. health care delivery sector, calculating risk-adjusted hospital mortality rates has become a high-stakes undertaking, evoking considerable controversy and interest. Public reporting of mortality rates at specific hospitals is the linchpin of such putative quality indicators as hospital mortality rates posted on Medicare's *Hospital Compare* web site and hospital rankings published by *U.S. News and World Reports*. Hospital mortality ratings have been drawn into discussions about controlling soaring health care costs, with the possible use of such presumptive hospital quality indicators in pay-for-performance schemes and other cost containment programs. Despite important questions about the relationship of hospital mortality rates to hospital quality [5], they remain a popular measure with intuitive appeal. Nonetheless, the "devil is in the details"—calculating meaningful hospital mortality rates is complicated.

Need to risk adjust hospital mortality rates

As Nightingale and Farr learned from the uproar of London physicians, comparisons of mortality rates across hospitals require adjustment for the health risks of each hospital's patient population. Today, considerable energy and effort goes into risk adjustment, defined by the Institute of Medicine as a "statistical tool [that] allows data to be modified to control for variations in patient populations. . . . Risk adjustment makes it possible to take [differences in patients' health risks] into account when resource use and health outcomes are compared" [6]. Risk adjustment frequently uses standard epidemiologic approaches, such as indirect standardization, and such statistical techniques as hierarchical logistic regression [7,8]. A large literature reviews basic principles of risk adjustment [1] and highlights concerns about current methods for hospital mortality reporting and linking death rates to hospital quality [5,9].

In the end, risk adjustment is only useful to facilitate clinically credible comparisons that clinicians and the public will believe and would be sufficient to determine hospital payment levels or bonuses if it accounts for critical patient risk factors. As mentioned, vital statistics reports of population mortality rates often account for only basic demographic characteristics (e.g., age, gender, race/ethnicity). Such minimal adjustments are insufficient for adjusting hospital mortality rates for quality reporting or payment programs; instead, much more detail about specific patient health risks is required to yield clinically meaningful findings [1].

Public reporting of physician-specific hospital morality for coronary artery bypass grafting (CABG) surgery and percutaneous coronary interventions has precipitated one other troubling concern about inadequate risk adjustment: This concern involves fears that physicians might avoid the highest risk patients whose deaths could raise physician-specific mortality rates [10–12]. Beginning in the early 1990s, New York state was the first to report surgeon-specific mortality rates for CABG operations. Anecdotal reports soon followed of very sick patients being unable to find surgeons willing to operate on them. Although observational data suggest that physicians might avoid the highest risk patients needing CABG or coronary interventions, questions remain about how widespread this avoidance is and whether, in fact, it has negative consequences for patients' outcomes (i.e., whether more patients die) [10–14]. Despite these lingering uncertainties, the likelihood that physicians will seek to avoid high-risk patients when mortality is used to judge their performance is widely believed in the clinical community.

Data considerations in choosing risk factors for hospital mortality reports

Despite compelling conceptual arguments for risk adjustment, practical considerations, such as the cost and feasibility of obtaining information about crucial risk factors, often dictate the final content of risk-adjustment algorithms. Because of its ready availability, the primary source of risk factors for risk adjusting hospital mortality rates is coded administrative information generated through hospital billing: Diagnosis codes (and sometimes procedure codes) from claims and discharge abstracts submitted after hospital discharge. An important current example is the mortality risk-adjustment models produced for the *Hospital Compare* web site from the Centers for Medicare & Medicaid Services (CMS), which shows hospital mortality rates for selected conditions for Medicare beneficiaries enrolled in the traditional fee-for-service program [15]. Recognizing that different hospitals have varying length of stay practices, CMS sets a uniform "window of observation," examining deaths of Medicare beneficiaries from any cause within 30 days of hospital admission.

Today, *Hospital Compare* posts individual hospitals' risk-adjusted 30-day mortality rates only for Medicare beneficiaries admitted for one of three conditions: Heart attacks, heart failure, and pneumonia. Within each condition, CMS calculates 30-day hospital mortality rates for patients admitted over the course of a year, adjusting for age, gender, past medical history, and other diagnoses (comorbidities) present at the time of admission [15]. To identify the clinical risk factors, CMS uses coded information from hospital claims and claims submitted for other hospital admissions, outpatient hospital services, and physician services from the year before the admission. Examples of the risk factors (covariates) included in CMS's 30-day risk-adjustment model for heart failure patients include [15]:

- Age and gender;
- History of percutaneous transluminal coronary angioplasty, history of CABG, history of heart failure, history of myocardial infarction;
- Severity indicators coded as present on admission (cardiorespiratory failure, shock); and
- Comorbid conditions (e.g., hypertension, diabetes, chronic obstructive pulmonary disease, stroke, dementia, major psychiatric disorder, trauma in prior year, protein-calorie malnutrition).

Diagnoses are reported using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes.

The credibility and thus utility of risk-adjusted hospital mortality reports depend primarily on the clinical covariates included in the risk adjustment model. Does the model include patient attributes that are considered essential clinical predictors of imminent

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