A clinical investigation into the benefits of using charge codes in perioperative and critical care epidemiology: A retrospective cohort database study

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ABSTRACT

Context: Epidemiologic studies in critical care routinely rely on the codes listed in International Classification of Diseases (ICD) manuals which are primarily intended for reimbursement of claims to payers. Standardized billing codes may minimize the measurement error when used in conjunction with ICD codes.

Aims: The aim was to examine the impact of using charge codes in addition to ICD codes for ascertaining two common procedures in surgical intensive care unit (ICU) settings: hemodialysis (HD) and red blood cell (RBC) transfusions.

Settings and Design: This was a retrospective cohort study of Premier Inc. Database.

Subjects and Methods: Elective surgical patients aged >18 years treated in the ICU postoperatively were included in this study. This includes the ascertainment of HD and RBC transfusions in the population using a standard “ICD code” versus an “either ICD code or charge code” approach.

Statistical Analysis Used: Descriptive analysis using t-tests, Chi-square tests as appropriate was used.

Results: A total of 40,357 patients were identified as having undergone elective surgery, followed by admission to an ICU across 520 US hospitals. The use of “ICD codes only” uniformly underestimated rates of HD or RBC transfusions when compared to “Charge Codes only” and “ICD Codes or Charge Codes” (% increase of 15.4%–45.6% and 50.8%–93.1%, respectively). Differences varied with specific surgical populations studied. Patients identified using the “ICD code” approach had more comorbidities, were more likely to be female, and more likely to be Medicare beneficiaries.

Conclusions: Epidemiologic studies in critical care should consider using multiple independent data sources to improve ascertainment of common critical care interventions.

Key Words: Administrative research, charge codes, critical care medicine, perioperative medicine

INTRODUCTION

Codes listed in the International Statistical Classification of Diseases and Related Health Problems (ICD) manuals are primarily intended for the reimbursement of claims submitted to payers,¹ but epidemiological research routinely relies on these diagnosis and procedure codes. Compared with the clinical data contained in medical records (chart review), claims data (International Classification of Diseases [ICD] codes) are less sensitive.²⁻³

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We sought to determine whether charge codes can help decrease this measurement error. Used for internal cost-accounting purposes by hospitals and health-care systems, charge codes represent standardized billing codes for goods and services and such codes are available in several databases including those maintained by Premier Inc. (Charlotte, NC).[1,4,5] Epidemiological research in perioperative and critical care settings is likely to continue, given the increasing access to inexpensive Health Insurance Portability and Accountability Act compliant claims data in large repositories,[1] and growing transformation into a common data model.[6,7] In this report, we sought to describe whether there were any meaningful differences in the rates of two common procedures, hemodialysis (HD) and red blood cell (RBC) transfusions, when measured using three different approaches in the Premier database: only ICD codes, only charge codes, and “either ICD or charge codes.” Specifically, our aim was to measure the incidence of HD and RBC transfusions in surgical intensive care unit (ICU) settings when using the above query approaches. We hypothesized that adding the use of charge codes to database queries would increase the measured incidence of various common ICU procedures when compared to using ICD codes alone. We also examined differences in the characteristics of patients identified using these alternative approaches, to determine if the underestimation of these procedures by an “ICD codes only” approach would be differential.

SUBJECTS AND METHODS

The Premier Health Care database (Premier Inc., Charlotte, NC) includes standard administrative ICD codes, patient and facility demographics, and detailed date-stamped billing codes. The latter represent charges for diagnostic testing, therapeutic procedures, medications, and other items that hospitals routinely charge patients for. Before data are incorporated in the Premier database, a rigorous validation process is performed, including an iterative data validation and audit process. Analyses examined the overlap, and lack thereof, between ICD codes and charge codes.

After the institutional review board approval, under a data use agreement with Premier Inc., we extracted the following data on all patients aged >18 years discharged from a hospital within the Premier alliance after elective surgery with ICU admission in 2012: demographics, comorbidities, the operative procedure, other procedures during ICU stay, and hospital length of stay. We restricted the analysis to 2012 because estimates could – by other investigators – be compared with the National Inpatient Sample, which became a nationally representative sample of US hospitals participating in the Healthcare Cost and Utilization Project that year.[8] Using publicly available Clinical Classification Software,[8] we classified each patient as having undergone a surgical procedure on one of the following systems: endocrine, cardiovascular, digestive, or musculoskeletal. Patients undergoing procedures on these organ systems have a greater incidence of HD or RBC transfusions, versus other surgeries, given underlying patient attributes or due to procedure-related blood loss or renal injury.

The rate of HD and RBC transfusions in this retrospective cohort was estimated using three approaches: only ICD codes, only charge codes, and “either ICD or charge codes.” Since case-mix varies by type of procedure, we stratified measurement within each of the major classes of surgery. ICD-9-CM procedure codes 39.95 and 99.04 were used to identify the HD and RBC transfusions, respectively. Charges corresponding to HD (such as charges for dialysate fluid, equipment, and nursing time) and RBC transfusions (supplies needed to transfuse red cells, charges for each unit of red cells etc.,) are standardized across all member hospitals within the Premier alliance, and we identified patients based on charge codes related to HD and RBC transfusions. Using t-tests or Chi-square tests as appropriate, we compared demographics, comorbidities (a composite comorbidity score and selected comorbidities present-on-admission), and lengths of stay, across patients grouped as recipients of HD or RBC transfusions based on only ICD codes, only charge codes, and “either ICD or charge codes.” The van Walraven score (range from −14 to +56) was used as the composite comorbidity measure.9 Hospital lengths of stay were compared as a distinct surrogate for comorbidities.

RESULTS

We identified 40,357 patients as having undergone elective surgery, followed by admission to an ICU at one of 520 US hospitals (in the Premier alliance in 2012); the majority were admitted after cardiovascular surgery (28,356) and the remaining had undergone surgery on the digestive (6444), endocrine (838), or musculoskeletal systems (4719). Regardless of which class of surgery patients had undergone, the use of “only ICD codes” uniformly underestimated rates of HD or RBC transfusions when compared to “only charge codes” and “either ICD or charge codes” [Table 1]. In addition, we found potential for differential misclassification when using only ICD codes. Compared to patients without ICD codes, patients with ICD codes were more likely to be white, female, and sicker (higher van Walraven score, more anemia, and more renal failure). The increased acuity of sickness in patients identified as recipients of HD or RBC transfusions using “only ICD codes” was confirmed by their longer lengths of stay.
We found that the rates of HD and RBC transfusions in perioperative and critical care settings are significantly increased with an “either ICD codes or charge codes” approach. This extends previous similar findings where charge codes are standardized billing codes used for internal cost accounting.

We sought to determine whether charge codes can decrease the high “false negative” rate, previously identified as a source of error in epidemiological research that uses administrative data when chart review is not possible.\textsuperscript{1-4} We found that the rates of HD and RBC transfusions in perioperative and critical care settings are significantly increased with an “either ICD or charge codes” approach. This extends previous similar findings for both invasive and noninvasive mechanical ventilation, where an “either ICD or charge code” approach improved ascertainment and was validated using chart review.\textsuperscript{4}

Our study supports the use of independent methods of measurement (such as ICD codes and charge codes) when feasible, i.e., a “capture-recapture” approach to improve ascertainment.\textsuperscript{10} Furthermore, as we found significant variation in the percentage increase in ascertainment across types of surgery [Table 1], a single “correction” factor is unlikely to be accurate. Improved ascertainment with the “either ICD or charge code” approach identified more patients with a lower comorbidity burden, reducing differential misclassification [Table 1].

Our report has limitations. We did not review medical records and therefore cannot quantify the extent to which charge codes are being incorrectly entered or missed (“false positives” and “false negatives,” respectively). Arguably, as hospitals and health-care systems have an incentive to maintain accurate internal cost-accounting records, errors in charge codes are unlikely to be significant versus errors in ICD codes (which are well described).\textsuperscript{2,3} Next, Premier data can be used to effectively describe national benchmarks of various outcomes at the hospital level; these data are unable to capture specific diagnostic information about patients at the granular level (e.g., laboratory data). Finally, studies of administrative claims data are by nature, retrospective, and subject to all the usual limitations of such studies, including selection bias, heterogeneity of sample data leading to unaccounted for confounders, and inability to obtain previous clinical history before hospital admission.

### DISCUSSION

ICD codes are primarily intended for the reimbursement of claims from external entities (payers),\textsuperscript{1} whereas charge codes are standardized billing codes used for internal cost accounting.

### CONCLUSIONS

Epidemiologic studies in perioperative and critical care settings should use multiple measurement approaches when feasible. The use of an “either ICD code or charge code” approach is possible in several datasets, and this can decrease information bias, thereby improving validity.

### Research quality and ethics statement

The authors of this manuscript declare that this scientific work complies with reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require Institutional Ethics Committee, Research Cell, King George’s Medical University, Lucknow and appropriate approval (84th ECM
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**Conflicts of interest**
There are no conflicts of interest.

**Ethical conduct of research**
This study was approved by the Institutional Review Board / Ethics Committee. The authors followed applicable EQUATOR Network (http://www.equator-network.org/) guidelines during the conduct of this research project.

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