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Claims-Based ICU Research; Learning from Imperfect Data

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Much of what we know about intensive care unit (ICU) epidemiology and outcomes has been learned from studying hospital claims. Hospitals submit these statements of services and costs to obtain payment from insurers¹. The limitations of this sort of administrative data are well-known². Yet, in the case of mechanical ventilation (MV), we have been reassured by a prior validation study showing high sensitivity (87.0%) and high specificity (99.7%) of the *International Classification of Diseases*, 9th revision, Clinical Modification (ICD-9-CM) code 97.x “continuous invasive mechanical ventilation”³. Indeed, nearly 200 studies have cited this validation as evidence that hospital claims can accurately distinguish patients who received MV from those who did not.

When one digs deeper into this validation study, however, there is reason to be concerned. The 2004 study compared claims to careful chart review in three Canadian hospitals³. The study sought to assess the validity of procedural codes in general—and only 43 (3.6%) of the 1200 hospitalizations reviewed had an ICD-9-CM code for MV³. So, data from a limited number of mechanically ventilated patients in another country have been extrapolated to gauge the quality of U.S. administrative coding for MV.

In this issue of *Critical Care Medicine*, Wunsch and colleagues⁴ provide much needed information on the validity of MV codes in U.S. Medicare beneficiaries, as well as the validity of intensive care unit codes. While most studies validating ICD-9-CM codes compare claims to chart review, Wunsch *et al.* take a different approach. They linked hospital claims for elderly U.S. Medicare beneficiaries to clinical data in the APACHE Outcomes database. This novel data linkage facilitated the multi-center study of over 50,000 hospitalizations—far more than would be feasible using chart review.

APACHE Outcomes is a voluntary subscription service from Cerner⁵. After providing patient-level data, subscribing ICUs receive risk-adjusted data on their unit’s outcomes relative to national benchmarks and comparable institutions⁵. As ICUs pay to participate, they are presumably motivated to provide accurate data to the APACHE Outcomes database. However, hospitals enrolled in APACHE tend to be larger teaching institutions, so the quality of administrative coding may not be perfectly reflective of all hospitals^{6,7}.

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The data linkage worked well: 80% of older patients in the APACHE Outcomes database were matched to Medicare claims. The 20% non-match rate is easily explained by the 23%–27% of Medicare population enrolled in Advantage Plans (managed care plans administered by private health insurance companies) during 2009–2012, for whom Medicare does not require claims.

The study found that MV codes were highly specific, but not sensitive. Of mechanically ventilated patients in APACHE, over 40% were missing a MV code in their hospital claim. Rates of missingness for MV codes ranged from 7% to 78% across individual hospitals.

Patients with missing MV codes were younger, with lower severity of illness, shorter duration of MV, and lower mortality. They were also more likely to be in the ICU because of an elective surgical hospitalization. Thus, claims identified a sicker subset of the mechanically ventilated population than the clinical database, concordant with another recent validation⁸.

Of patients in APACHE Outcomes (and therefore physically bedded within an ICU), 97.3% had an ICU (or cardiac care unit) bed charge on their hospital claim. The other 2.7% were presumably either “boarding” in an ICU bed or were inadvertently not billed for their ICU-level care.

Length of ICU stay was more difficult to validate. Median duration differed by 2 days—but much of this discrepancy can be explained by incomplete capture of ICU days in APACHE Outcomes. Medicare counts all ICU days, while APACHE Outcomes can measure only those days in which a patient is admitted to an ICU enrolled in APACHE Outcomes. If a patient gets transferred to another ICU (or intermediate ICU) that is not enrolled in APACHE Outcomes, then those ICU days would not be measured.

The discrepancies between claims and APACHE data are not surprising. Mechanical ventilation for greater than 96 hours is a criterion for certain diagnosis-related groups (DRGs) used to determine hospital payment⁹. Thus, hospitals face a strong incentive to correctly capture prolonged MV, but less motivation to capture briefer durations of MV. Moreover, the longer a patient remains on MV, the more opportunity there is to document and code MV.

What should researchers (and consumers of research) do when faced with the limitations of the underlying data? Some may write off research based on this imperfect data, under the mantra of “garbage in, garbage out”. Alternatively, some may downplay the limitations, deciding to simply accept the data as “good enough”.

We recommend that researchers learn the underlying process by which the data was generated, and consider the likely direction and magnitude of bias that may be introduced into a study because of this process. By reporting and interpreting epidemiologic findings within the context of known or suspected biases, we can still learn from imperfect data. For example, the present study suggests not merely that our estimates of mechanical ventilation incidence are incorrect, but also that they should be revised upward by about 40%. However,

we should not revise our estimates of ICU length of stay, after considering the limitations of the APACHE Outcomes database for validating this variable.

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