VIEWPOINT

Can research based on health care management databases of patients records help us improve patient care?

Samuel D. VAILLANCOURT[1,2], **Michael J. SCHULL**[1,2,3]

[1]Division of Emergency Medicine, Department of Medicine, University of Toronto, Canada. [2]Institute for Clinical Evaluative Sciences, Toronto, Canada. [3]Sunnybrook Health Sciences Center, Toronto, Canada.

The challenge we are facing today – providing better care more efficiently– is not unique to emergency medicine. What is surprising is how little we know about how well – or poorly – we (and our patients) are doing, and about the key factors influencing our care of patients. A tactic commonly used to improve quality of care is to emphasize the delivery of evidence-based care, yet most of the evidence we base our practice on comes from clinical trials or observational studies performed in specific settings, which relate to varying degrees to our own.

Our efforts to introduce similar protocols, treatments or procedures in our own practice is rarely accompanied with a rigorous evaluation, so we rely on faith that what we are doing is similar to what was described in the literature, and that our patients are benefiting similarly. At the end of a shift, we are left with a belief that we appropriately treated and managed our patients (or sometimes tormented by doubts that we did not), but very little evidence to confirm it either way. Yet as more and more data are being routinely collected in many countries on the care we provide in emergency departments (EDs), powerful tools are emerging to help us explore some of the fundamental questions we face. New research methodologies are emerging to help us tap into the wealth of information contained in these administrative databases. Of course, they come with their own set of pitfalls and limitations that need to be properly understood.

Our objective here is to describe our experience with emergency medicine-focused administrative database research at the Institute for Clinical Evaluative Sciences (ICES) in Ontario, a Canadian province with a population of 13 million. Ontario has a single-payer, government-funded, healthcare system insuring nearly all its residents. For close to two decade, ICES has provided restricted access to anonymized, linked, databases that contain, hospital admissions, physicians' billings, patients' demographic characteristics, drug insurance use in the elderly and emergency department utilisation, among others. This data has offered new opportunities to inform emergency medicine practice.

Questions and answers beyond the study setting

Observational studies often arouse suspicion in the researcher and clinician alike. Alert to potential biases both obvious and occult in observational research, we prefer to rely on gold-standard randomized clinical trials to guide our decisions. Yet, the controlled settings of many clinical trials can look very dissimilar to the work environments of many emergency physicians. On the other hand, Emergency Department database research is by nature retrospective and observational, but it can help us understand emergency medicine the way it is being practiced in real EDs by average emergency physicians on representative patients, and the organisational and human factors that influence the way we care for our patients.

Like most emergency physicians, we pride ourselves on our ability to diagnose serious treatable conditions. A few years ago, we became interested in the issue of missed diagnosis of serious conditions, such as headache patients with subarachnoid haemorrhage who were not properly diagnosed in the ED. We realized that we really

Correspondence: Samuel Vaillancourt. G1 06, 2075 Bayview Avenue, Toronto, Ontario, M4N 3M5. Canada.
E-mail: sam.vaillancourt@utoronto.ca
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had no idea as to how frequent a problem this was or what factors caused some patients to be at higher risk of being missed. Furthermore, we knew that such questions would be difficult for ethical reasons to submit to a randomized trial, and impossible for feasibility reasons to study prospectively. Hence we designed a study using administrative data on all ED visits to 147 hospitals in Ontario over three years, and collected over 1500 individuals with a diagnosis of SAH. We then looked back in time at their prior emergency department visits and determined which patients were missed in the days leading up to the admission. It turned out that one in twenty confirmed SAH had been missed on a prior emergency department visit (a much lower rate than in some other studies, often single centre and/or based in neurosurgical centers), and that the rate varied substantially between hospitals (it was lower in teaching hospitals), but not according to accessibility of CT scanners at hospitals[1]. This demonstrates the power of administrative database research: it can determine the scale of a problem on a population level, and point to (or, in this case, point away) from a potential policy "quick-fix", that of installing more CT scanners.

Beyond understanding how we are doing as emergency physicians in Ontario, our experience with database research has helped us understand how non-medical factors influence patient care. For instance, Ontario, like many jurisdictions, has faced widespread emergency department overcrowding and delays. Over the past decade, research using administrative data has allowed us to link crowding with delays in treatment of serious illnesses such as acute myocardial infarctions (AMI)[2]. More recently we have determined that ED crowding is associated with increased short-term risk of subsequent mortality and hospitalization among the vast majority of ED patients, those discharged from the ED[5]. Such health system factors shape our practice and impact patient outcomes, yet fall outside the scope of information the clinical trial methodology can typically provide.

Pitfalls in the land of database research

If database research can answer questions that previously would have remained unanswered, it also brings with it risks of biases and false associations. Administrative databases can be incredibly vast. The ones we work with contain data on tens of millions of patient-encounters and billions of data points representing signals and noise that can easily be confused. Power is rarely the issue given the vast sample size available at the push of a button, but research designed as "fishing expeditions" can often yield results of doubtful significance. Out of 20 variables selected randomly as being potentially associated with an outcome, chances are high that one of them will turn out to be of statistical significance, but such analyses are unlikely to stand up to closer scrutiny. Numbers are often large and require careful analysis and interpretation. The strength of statistical association is important in any study, but it is crucial in observational studies that associations be carefully assessed for plausibility, and tested for potential for biases and confounding as there is no randomisation. Multi-variable regressions and case-control matching are frequently used and can rapidly become complex, requiring a team approach that includes statisticians and clinicians. Key to interpreting such data is a sensible a priori theoretical framework, which requires clinical experience, detailed understanding of available data, and consideration of the plausibility of physiological and health system events; all these are important to define the exposures, confounders and outcomes associated with a patient's care available in administrative records.

Moreover, administrative databases vary in the reliability of the information they contain. This poses issues when linking different databases together, but also when looking at different fields within the same database which may contain coding errors due to areas of clinical uncertainty (e.g. emergency department diagnosis), lack of coding knowledge of practitioners (e.g. death certificates), or linkage with payments. Another challenge is comparability of meaning of the "same" information in different datasets from different regions. For example, triage code is classified using different scales in Canada vs. the United States, therefore international comparisons first require a careful assessment of the scales used to determine how best to compare data. This problem can be repeated for many variables within a single study. Ultimately, results from a study can only be as good as the data they rely on no matter how good the numbers look.

As we have gained more experience as health service researchers, we have employed a variety of strategies to increase our confidence in our main quantitative analyses. For example, when seeking to strengthen the argument of an association between an exposure and an outcome, one strategy is to look for the absence of an association be-

tween a different exposure and the same outcome, where none would be expected clinically. For example, in a study where we hypothesized that Acute Myocardial Infarction (AMI) patients with a past history of depression would get lower quality AMI care in the ED due to a mistaken attribution of AMI symptoms to anxiety or depression, we also hypothesized that a past history of COPD or asthma would not have any effect on AMI care[6]. Similarly, mixed-methods research, where one looks for confirmatory data using other methods, such as qualitative research, can help strengthen the evidence from administrative databases.

Following the evolution of randomised clinical trials, there is a push to improve the reproducibility of database research and address the issues raised previous by developing a set of best practices and standards. Many researchers and scientific journal editors, as part of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) initiative have taken the lead, publishing a statement accompanied by a methodological checklist to help assess the quality and validity of retrospective database research[3,4]. Their guidelines emphasize the importance of a priori formulation of a research hypothesis that has a well thought out rational to avoid random associations and a detailed and transparent dataset creation plan documenting the potential changes in primary or secondary outcomes. As for the data itself, formal quality checks and data cleaning should be performed. It has also been our experience that precise study design and careful documentation are crucial to this type of research.

More data, more research, but not always more insight

More and better data is being gathered every day, creating new opportunities for database research, and new potential pitfalls. As electronic medical records get rolled out eventually to the emergency departments, the opportunities for such research will multiply. Meanwhile, the conversation is well under way on what constitutes best practice and how to achieve better, more valid results.

This field has the potential to profoundly alter the way the profession of emergency physicians. Traditionally, our follow up of our patients' outcomes has been anecdotal, laborious, or sometimes even impossible. Database research has the potential to close an important feedback loop that can link patient outcomes to not only improve on the gaps of our practice, but to also highlight gaps in the system in which we work, thus providing areas for organisational leadership and advocacy. A study we conducted of missed acute myocardial infarctions (AMIs), for example, showed that 17 percent of patients who were missed at a prior visit presented subsequently to a different hospital. It would be almost impossible to know of missed cases without looking at system-wide databases[7].

The evidence linking emergency department overcrowding to suboptimal care has become stronger over the last decade and has helped inform a province-wide plan to reduce emergency department delays here in Ontario. As this single indicator begins to improve, we are using administrative databases to try to find relevant ways to measure quality of care in the emergency department. The hope is that as we continue to work to provide better care in a timely manner, administrative data base research can enable us to see where we have been, and where we are going.

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