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REVIEW ARTICLES

A systematic review identifies valid comorbidity indices derived from administrative health data

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Abstract

Objectives: To conduct a systematic review of studies reporting on the development or validation of comorbidity indices using administrative health data and compare their ability to predict outcomes related to comorbidity (ie, construct validity).

Study Design and Setting: We conducted a comprehensive literature search of MEDLINE and EMBASE, until September 2012. After title and abstract screen, relevant articles were selected for review by two independent investigators. Predictive validity and model fit were measured using c-statistic for dichotomous outcomes and R^2 for continuous outcomes.

Results: Our review includes 76 articles. Two categories of comorbidity indices were identified: those identifying comorbidities based on diagnoses, using *International Classification of Disease* codes from hospitalization or outpatient data, and based on medications, using pharmacy data. The ability of indices studied to predict morbidity-related outcomes ranged from poor (C statistic $\leq$0.69) to excellent (C statistic $>$0.80) depending on the specific index, outcome measured, and study population. Diagnosis-based measures, particularly the Elixhauser Index and the Romano adaptation of the Charlson Index, resulted in higher ability to predict mortality outcomes. Medication-based indices, such as the Chronic Disease Score, demonstrated better performance for predicting health care utilization.

Conclusion: A number of valid comorbidity indices derived from administrative data are available. Selection of an appropriate index should take into account the type of data available, study population, and specific outcome of interest.

Keywords: Systematic review; Comorbidity; Multimorbidity; Administrative data; Claims data; Mortality; Health care utilization

1. Introduction

Administrative databases are being increasingly used for research purposes. They play an important role in epidemiologic, quality of care, pharmacovigilance, and outcome studies. These databases provide complementary information to randomized controlled trials because of their real-life setting, large samples, long follow-up duration, and their ability to provide population-based samples, free of selection bias. These data, however, have some limitations including lack of clinical, lifestyle, and demographic data and because of the observational nature, which can introduce biases. These biases include selection and channeling bias, as well as confounding by indication. These limitations can be minimized by careful adjustment in statistical analyses.

In observational studies, the outcomes of interest are often influenced by concurrent or preexisting comorbidities. Comorbidity may be defined as the total burden of illnesses unrelated to the principal diagnosis [1]. It is important to adequately adjust for comorbidities in studies in which comorbidities could act as confounders. Given the

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What is new?

- A number of comorbidity indices are available for use in studies with administrative health data, in order to control for the overall burden of comorbidities.
- To guide researchers and health policy makers in selecting the index most appropriate for their purpose, this systematic review describes the conceptual and methodological differences among the various indices and compares their ability to predict outcomes related to comorbidity (i.e. construct validity).
- The review reveals that a number of comorbidity indices demonstrate validity in predicting mortality.
- A diagnosis-based index, such as the Quan- or van Walraven- EI or Romano-CCI, is recommended in studies where the outcome of interest is mortality.
- For studies evaluating healthcare utilization, where medication data is available, a medication-based index, such as the RxRisk-V, is recommended.

large number of comorbidities that may be relevant to a given outcome, controlling for individual comorbidities may not be practical for methodological reasons, including loss of power. It may also be necessary to control for the overall burden of comorbidity, rather than the individual effect of each comorbidity.

For that purpose, a number of comorbidity indices have been developed to measure and weigh the overall burden of comorbidities. Some of these instruments have been developed exclusively for use with administrative data, such as the Elixhauser Index (EI) [2], whereas others have been developed in other contexts but adapted for use with administrative data, such as the Charlson Comorbidity Index (CCI) [3]. These comorbidity indices have been widely used in studies using administrative data to control for the overall burden of comorbidities.

However, given the large number of indices available in the literature and the conceptual and methodological differences among them, researchers and health policy makers wishing to control for comorbidity need guidance in selecting the index most appropriate for their specific study. Although previous studies have compared the validity of comorbidity indices, they were limited by not systematically reviewing all indices available or by not explaining the conceptual and methodological differences between indices [4–6]. Our systematic review will guide scientists' choice by reviewing all the indices available, explaining their conceptual and methodological differences, and comparing their construct validity. Because there is no "gold standard" in comorbidity measurement, indices are often validated by measuring how well they are able to predict outcomes related to comorbidity, such as mortality or health care utilization (ie, construct validity) [7–9].

Accordingly, our aim was to conduct a systematic review with the following objectives: (1) to identify the different instruments used in administrative data studies to measure comorbidity, (2) to compare the instruments at the conceptual level, that is, to describe how each index was developed and/or adapted for use with administrative data and what concept the index aimed to measure, and (3) to evaluate and compare their ability to predict comorbidity-related outcomes.

2. Methods

2.1. Search strategy

A methodological literature search was conducted as of September 2012, using the Ovid platform to search MEDLINE (MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily, and Ovid OLDMEDLINE(R) from 1946) and EMBASE (from 1980). The year limits were dictated by the scope of the databases. We searched for and combined with the Boolean operator "OR" all relevant subject headings, using the "explosion" function where needed, and keywords in titles and abstracts for the two concepts: "Administrative data" and "Comorbidity index." We combined these two concepts with the Boolean operator "AND." We excluded articles that were solely abstracts, comments, conference proceedings, editorials, letters, or news. We included only articles published in English. The titles and abstracts of the articles identified by this search were screened by one investigator (M.Y.) and selected for full-text review if relevant to our objectives. From this initial screen, a list of comorbidity indices potentially used in administrative data was identified. To ensure that we captured all relevant indices and their corresponding validation studies, an additional literature search was performed using the same databases. This involved searching titles and abstracts for specific index names. The same screening process was applied to select articles potentially relevant to our objectives.

2.2. Study selection

Full-length articles of studies identified as potentially relevant to our objectives were independently reviewed by two authors (M.Y. and J.T.) to determine if they met the prespecified inclusion criteria. Disagreements were settled by consensus. For inclusion, studies had to have developed or validated a comorbidity index for use with administrative data. Of note, we only included studies that related specifically to comorbidity indices and excluded studies that focused on the development or adaptation of risk scores or other groupers for risk adjustment. Adaptation of an index