European Journal of Internal Medicine 26 (2015) 182–189

Contents lists available at ScienceDirect

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Original Article

Multimorbidity in risk stratification tools to predict negative outcomes in adult population

Edurne Alonso-Morán [a], Roberto Nuño-Solinis [a], Graziano Onder [b,c], Giuseppe Tonnara [b,*]

[a] O+berri, Basque Institute for Healthcare Innovation, Torre del BEC (Bilbao Exhibition Centre), Ronda de Azkue 1, 48902 Barakaldo, Spain
[b] Department of Geriatrics, Centro Medicina dell'Invecchiamento, Università Cattolica del Sacro Cuore, Rome, Italy
[c] Agenzia Italiana del Farmaco (AIFA), Rome, Italy

ARTICLE INFO

Available online 6 March 2015

Keywords:
Multimorbidity
Stratification tools
Predictive models
Adverse outcomes

ABSTRACT

Introduction: Risk stratification tools were developed to assess risk of negative health outcomes. These tools assess a variety of variables and clinical factors and they can be used to identify targets of potential interventions and to develop care plans. The role of multimorbidity in these tools has never been assessed.
Objectives: To summarize validated risk stratification tools for predicting negative outcomes, with a specific focus on multimorbidity.
Methods: MEDLINE, Cochrane Central Register of Controlled Trials and PubMed database were interrogated for studies concerning risk prediction models in medical populations. Review was conducted to identify prediction models tested with patients in both derivation and validation cohorts. A qualitative synthesis was performed focusing particularly on how multimorbidity is assessed by each algorithm and how much this weighs in the ability of discrimination.
Results: Of 3674 citations reviewed, 36 articles met criteria. Of these, 29 had as outcome hospital admission/readmission. The most common multimorbidity measure employed in the models was the Charlson Comorbidity Index (12 articles). C-statistics ranged between 0.5 and 0.85 in predicting hospital admission/ readmission. The highest c-statistics was 0.83 in models with disability as outcome. For healthcare cost, models which used ACG-PM case mix explained better the variability of total costs.
Conclusions: This review suggests that predictive risk models which employ multimorbidity as predictor variable are more accurate; CHF, cerebro-vascular disease, COPD and diabetes were strong predictors in some of the reviewed models. However, the variability in the risk factors used in these models does not allow making assumptions.

1. Introduction

Progressive aging of the population in Western population represents a challenge for healthcare systems. Typically, older adults show the co-occurrence of multiple chronic and acute diseases (multimorbidity) [1], leading to increase rate of negative health outcomes, including mortality, hospital admission and disability and therefore determining a substantial impact on healthcare costs [2]. Indeed, among older people the prevalence of multimorbidity is very high, with more than 60% of people aged 65 or older presenting with multiple diseases [3,4].

For this reason in the past decades several interventions were developed in order to target multimorbidity and to prevent its negative effects. A key issue to make these interventions successful is to identify characteristics of patients associated with a high rate of resource consumption and negative health outcomes. Indeed, multimorbidity alone cannot fully explain complexity of older adults and other clinical and non-clinical factors might impact on care needs. Stratification of general older population based on risk of negative health outcomes and resource consumption, is necessary to better identify targets of potential interventions and to develop personalized, cost-efficient and patient-centered care plans.

In this context, prediction models (PMs) represent relevant tools since they can provide clinically relevant risk stratification and help to allocate resources. Necessary attributes for these purposes are: appropriate derivation sample and validation sample; clinical coherence of model variables; an appropriate outcome and standardized period of outcome assessment; high quality and easy obtainable data; and a good predictive power [5].

To date, many PMs have been developed in different care settings. It should be emphasized, however, that most of them are hospital admission or readmission PMs, which have been the subject of two recent systematic reviews [6,7]. Beyond the individual predictive powers, which are modest in most cases, there is a lack of robust evidence to support

* Corresponding author at: Department of Geriatrics, Centro Medicina dell'Invecchiamento, Università Cattolica del Sacro Cuore, Largo F. Vito n° 1, 00168 Rome, Italy. Tel.: +39 3482695680.
E-mail address: giuseppe.tonnara@gmail.com (G. Tonnara).

http://dx.doi.org/10.1016/j.ejim.2015.02.010
0953-6205/

many of the hospital-avoidance interventions that are being offered. Moreover, while rehospitalization accounts for a significant portion of healthcare costs, other multimorbidity-related outcomes deserve appropriate interest, such as disability, institutionalization, and overall healthcare costs. Given this background, the aim of the present study is to perform a systematic review of validated models predicting not only hospitalization risk, but also other negative health outcomes with a specific focus on how multimorbidity is considered in each model.

2. Methods

2.1. Data sources and searches

We searched MEDLINE, Cochrane Central Register of Controlled Trials and PubMed database from 1994 to 2014 for English-language studies of risk prediction models in medical populations. All citations were imported into an electronic database (Zotero reference management software).

The following keywords were used to search these databases: Cost; Disability; Expenditure; Hospital admissions; Readmission; Quality of life; Rehospitalisation; Resource; Risk model; Patient classification; Predictive modeling; Risk prediction tools; Risk profiling; Risk Stratification; Risk tool; Screening tool; Chronic conditions; Chronic disease; Comorbidity; Long term conditions; Multimorbidity; Non-communicable disease; Polypathology; Frailty; and Complex patient. Non-English articles were also included in the search. Letters to the editor, commentaries, editorials and observational studies were not included. Systematic reviews and meta-analysis of existing studies were included. Bibliographies of the retrieved articles were searched to identify other eligible studies, and information from colleagues was used to identify more recently published articles. Additional studies were identified by scanning reference list of relevant studies and by using "related articles" function, where available.

2.2. Study selection

Two reviewers (EAM and GT) independently reviewed the title and abstract of the papers extracted by the search for their relevance. When considered relevant by both reviewers, the full-text paper was retrieved. Any disagreement between the reviewers was resolved by consensus.

Papers were eligible if they: (1) developed or validated risk prediction models; (2) assessed the risk of one of the following outcomes: unplanned hospital admission and/or readmission, institutionalization, and disability or resource consumption; (3) studied a cohort of community-dwelling adults or adult patients admitted to a medical service (post-surgical and pediatric patients were excluded); and (4) were not performed in developing countries. Because a set of predictive factors derived in only one population may lack validity and applicability, we included only studies of models that were tested in both a derivation and validation cohort, even if these results were presented in separate papers. We did not pre-specify the method of validation, nor did we exclude studies in which the derivation and validation cohorts were drawn from the same population (i.e., split-half validation). We excluded studies focused on psychiatric, surgical, and pediatric populations as factors contributing to risk of hospitalization, institutionalization, disability and resource consumption might be considerably different in these patient groups as well as those focused on risk prediction models developed and tested only in a population with a single disease (e.g. diabetes or heart failure). Finally, we excluded studies from developing nations as these were unlikely to provide directly applicable results. These selection criteria were in line with those used by another review focused on identification of risk prediction models for hospital readmission [6].

2.3. Data extraction and quality assessment

Informations extracted from included studies were: (1) study design; (2) number and characteristics of patients; (3) items of the predictive algorithm; and (4) outcome. This process was performed independently by EAM and GT; disagreements were resolved through discussion and, if ineffectual, consultation to a third author. Retrieved articles were classified into four groups, according to the outcome assessed.

We report the c-statistic to describe model discrimination. The c-statistic with 95% confidence intervals is usually employed to describe the goodness of fit of predictive models. It is equivalent to the area under the receiver operating characteristic curve and it is a measure of how effectively the algorithm stratifies patients according to their degree of expected risk. Values range from 0.5 to 1.0: a value of 0.5 indicates that the model is no better than chance at making a prediction of membership in a group and a value of 1.0 indicates that the model perfectly identifies those within a group and those not. Models are typically considered reasonable when the c-statistic is higher than 0.7 and strong when it exceeds 0.8. If the c-statistic was not available, we took into consideration other statistics as indication of model discrimination such as sensibility, specificity and predictive value.

2.4. Data synthesis

Since the retrieved studies were too heterogeneous to allow a meta-analysis, we performed a qualitative synthesis, focusing particularly on how multimorbidity is assessed by each algorithm and how much this weighs in the ability of discrimination.

3. Results

3.1. Study identification

The search strategy identified 3853 articles through electronic databases and other 39 articles were retrieved through other sources. After removal of duplicated records, 3674 articles were checked by title and abstract and 89 of them were reviewed in full text. Finally, 36 publications met inclusion criteria (see Fig. 1).

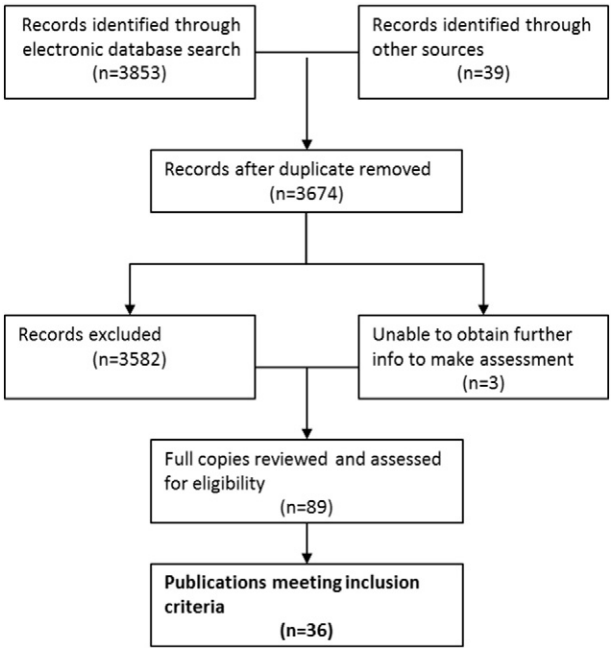

Fig. 1. Flow diagram of study identification.