Tutorial on Comorbidity Indices in Medical Research

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ABSTRACT

Background: Comorbidity indices, such as Charlson Comorbidity Index (CCI) and Elixhauser Comorbidity Measure (ECM), are essential tools for assessing the influence of comorbid health conditions on patient outcomes. This study aims to review comorbidity indices by assigning weighted scores to a spectrum of comorbidities; these instruments play a critical role in predicting mortality rates and evaluating healthcare resource utilization.

Methods: In this narrative review study, we reviewed all comorbidity indices and important points were mentioned.

Results: CCIand ECIhave proven to be highly effective tools for predicting mortality and healthcare outcomes across a wide range of patient populations. This review examines four comorbidity indices: CCI, ECI, Acute Myeloid Leukemia (AML), and the Chronic Disease Index (CDI).

Conclusion: Among four types, CCI and ECM were the most applied, and the researcher should know different types of comorbidity indices to use in research.

Keywords: CCI (Comorbidity by Charlson Index); ECI (Elixhauser comorbidity index; AML (Acute myeloid leukemia); CDI (Chronic disease index); Indices; Research

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Introduction

Comorbidity is a term of Latin origins introduced by Alvan R. Feinstein (1925-2001), an American researcher and epidemiologist (1). According to him, it is a distinct additional clinical entity that exists or can be apparent during the clinical course of a disease that is under investigation (2). Condition of comorbidity has a potential impact on a patient's cause and alters the treatment plans with outcome. The condition of comorbidities coexists with the condition of disease interest (3), it leads to delayed diagnosis, and confounders in the analysis of course and clinical status raise the mortality and morbidity (4). Researchers investigate their statistical models to identify associations with comorbidities such as heart disease and diabetes. (5). It is widely used by researchers to summarize comorbidity measurement with adjusting outcomes via the use of health data (6). To the best of the authors' knowledge, there are four indices for comorbidity including Elixhauser comorbidity index (ECI), Charlson Comorbidity Index (CCI)), acute myeloid leukemia (AML) comorbidity index and chronic disease indicators (CDI). In the next session, the authors will review all of them.

1.Comorbidity indices

There were four type of CI such as CCI, ECI, AML, and CDI which will be introduced one by one in following sub-sections.

1.1 CCI

CCI was introduced by Charlson with his fellows in 1987, they classified the comorbidity conditions that can influence a risk of mortality (7). CCI is used to determine survival rates 1 year to 10 years in patients with multiple comorbidities used in longitudinal studies (8). CCI score estimates a patient's survival of 10 years rate with multiple comorbidities (9).

According to the protocol, CCI has assigned a numerical score for single comorbidity, and the sum of the score provides a quantitative measure of the patient's overall health (10). Before checking the CCI score, first we should identify medical professionals and document the comorbidity that the patient has (9). Chronic diseases have mostly had conditions in general, and many health issues can affect the patient's prognosis, treatment, and outcomes (11).

Table 1. CCI and its weight

Condition	Weight
Myocardial infarction	1
Congestive heart failure	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Dementia	1
Chronic pulmonary disease	1
Connective tissue disease	1
Ulcer disease	1
Mild liver disease	1
Diabetes without end-organ damage	1
Hemiplegia	2
Moderate or severe renal disease	2
Diabetes with end-organ damage	2
Any tumor	2
Leukemia	2
Lymphoma	2
Moderate or severe liver disease	3
Metastatic solid tumor	6
AIDS	6

Source: "Charlson Comorbidity Index: A Critical Review of Clinimetric Properties"(9)

A specific eight number for each comorbidity is assigned and scored depending on the severity and impact on his / her mortality(6). Once scores of comorbidities are identified, they are summed to calculate the CCI score, the score ranges from 0 to 37 or more (12), depending on comorbidities on the number and severity. If CCI score is higher, it indicates a high burden of comorbidities, and a high risk of complications with mortality, or adverse outcomes (13).

1.2 ECI

ECI has included 29 comorbidities (14). ECI is a widely applied tool in healthcare clinical practice and research for assessing comorbid conditions in patients (15). It was developed in 1998 by Elixhauser and aims to provide a standard and comprehensive measure of comorbidity by

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identifying and quantifying various medical conditions that coexist alongside a patient's primary diagnosis (16). The Elixhauser comorbidity index encompasses a wide range of conditions and is a valuable tool for clinicians, researchers, and policymakers (17).

Table 2. Table of the Elixhauser comorbidities, their descriptions, and van Walraven weights

Comorbidity	Description/Example	Van Walraven Weight
Congestive heart failure	Heart failure	7
Cardiac arrhythmias	Atrial fibrillation, ventricular tachycardia	5
Valvular disease	Mitral valve disease, aortic stenosis	-1
Pulmonary circulation disorders	Pulmonary hypertension, pulmonary embolism	4
Peripheral vascular disorders	Peripheral artery disease, claudication	2
Hypertension (uncomplicated)	High blood pressure without end-organ damage	0
Hypertension (complicated)	High blood pressure with end-organ damage (e.g., renal failure)	-1
Paralysis	Paraplegia, hemiplegia, quadriplegia	7
Other neurological disorders	Parkinson's disease, multiple sclerosis	6
Chronic pulmonary disease	COPD, asthma, pulmonary fibrosis	3
Diabetes (uncomplicated)	Diabetes without complications	0
Diabetes (complicated)	Diabetes with complications (e.g., retinopathy, neuropathy)	-3
Hypothyroidism	Underactive thyroid	0
Renal failure	Chronic kidney disease, end-stage renal disease	5
Liver disease	Cirrhosis, hepatitis	11
Peptic ulcer disease	Gastric or duodenal ulcers	0
AIDS/HIV	Acquired immunodeficiency syndrome	0
Lymphoma	Hodgkin's or non-Hodgkin's lymphoma	9
Metastatic cancer	Cancer with metastasis	12
Solid tumor without metastasis	Localized cancer	4
Rheumatoid arthritis/collagen vascular diseases	Lupus, rheumatoid arthritis, scleroderma	0
Coagulopathy	Bleeding disorders, clotting disorders	3
Obesity	Body mass index (BMI) ≥ 30	-4
Weight loss	Malnutrition, cachexia	9
Fluid and electrolyte disorders	Hyponatremia, hyperkalemia	5
Blood loss anemia	Anemia due to acute blood loss	-2
Deficiency anemia	Iron deficiency anemia, vitamin B12 deficiency	-2
Alcohol abuse	Alcohol dependence or abuse	0
Drug abuse	Substance abuse	-7
Psychoses	Schizophrenia, bipolar disorder	-5
Depression	Major depressive disorder	-3

Source: "Development and validation of a structured query language implementation of the Elixhauser comorbidity index"(18).

The Elixhauser Comorbidity Index (ECI) is a method for categorizing comorbidities in patients, based on diagnosis codes from the International Classification of Diseases (ICD) (16), and it is found in administrative data, like hospital abstracts data. ECI scoring ranges from −7 to +12 (19) (20). The score of >15 is used as a cut-off value (21) and it is with a 1-year mortality of 38% (22).

1.3 AML

AML comorbidity index is another comorbidity index. The panel of international expert in 2010, with the recommendation of the European Leukemia Net (ELN), published advice for the diagnosis and management of AML. AML-C is the most important tool in hematology and oncology field and is designed to assess the presence of comorbidities diagnosed with acute myeloid leukemia (AML) patients (23). AML's relative

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survival rate in 5 years is 29.8% (24), but it depends on age, health condition, and genetically specific mutations present in the leukemia cells. In general, a 5-year relative survival rate for AML is 29.8% (25), the viewpoint for an individual will depend on age, health condition, the particular hereditary changes displayed within the leukemia cells with other variables (26).

2.4 CDI

CDI is a critical metric used in epidemiology and public health research for assessing the prevalence and impact of chronic diseases in specific populations (27). This index has a role in understanding the burden of chronic diseases on healthcare systems individually. The CDI provides a comprehensive picture of the occurrence of chronic diseases like hypertension, diabetes, heart, cancer, stroke, and arthritis in a given population over an extended period (28).

In the research, various factors were calculated by researchers in the CDI, such as cases, disease duration, and overall population size (29). The aim was to make a standardized measure used to compare the prevalence of chronic diseases in different regions, timeframes, and demographics. CDI is a valuable tool for policymakers and healthcare professionals (30). It helps them to identify a high-burden area of chronic diseases, allocate resources effectively, and help target interventions to mitigate the impact of these conditions.

Table 3. The advantages and disadvantages of different comorbidity indices

Comorbidity indices	Advantages	Disadvantages
CCI	Simple and widely validated for mortality prediction. Easy to apply in clinical and research settings. Focuses on a concise set of comorbidities.	Limited to 17 conditions, potentially overlooking other significant comorbidities. Less comprehensive than newer indices. Does not include mental health conditions
ECI	Includes 30 comorbidities, offering a broader scope. Superior in predicting in-hospital mortality. Can be weighted (e.g., van Walraven score) for enhanced precision.	More complex to implement due to the larger number of conditions Requires detailed administrative data May overcomplicate risk assessment in some settings
AML	Specific to hematologic malignancies, providing tailored risk assessment Useful for stratifying patients in oncology settings Incorporates genetic and molecular factors	Limited to AML patients, not generalizable to other conditions. Requires specialized knowledge and data. Less applicable for non-cancer populations.
CDI	Focuses on chronic diseases, relevant for long-term health management Useful for population health studies Can be adapted to specific chronic conditions	Less standardized compared to CCI or ECI May lack specificity for acute outcomes like mortality Limited validation in diverse clinical settings

Conclusion

ECIand CCI are among the most widely used assessment tools globally. Among these, the ECI demonstrates superior accuracy in predicting in-hospital mortality. When a weighted scoring system is applied to evaluate patient outcomes, ECI score proves to be particularly precise. Its comprehensive inclusion of comorbidities enhances its predictive capability, making it a valuable tool for assessing healthcare outcomes and resource allocation.

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Conflicts of interest

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All authors have declared no conflicts of interest.

Ethical considerations

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Code of ethics

Not applicable.

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Authors' contributions

M. A. D. drafted the manuscript; A. A, M. T. S, and F. M, all helped with data analysis and critical appraisal of the manuscript. All co-authors read and approved the final draft of the manuscript.

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