

## Comparative Performance of Comorbidity Indices in Discriminating Health-related Behaviors and Outcomes

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### ABSTRACT

**BACKGROUND AND OBJECTIVE:** Although the predictive ability of the Charlson Index, Elixhauser Index (EI), Chronic Disease Score (CDS), and Health-related Quality of Life Comorbidity Index (HRQL-CI) for health care outcomes has been assessed individually, little research has compared the discriminative performance of these indices directly in a single study. The current study compared these indices in discriminating among type 2 diabetes patients varying in demographics and health care outcomes characteristics.

**STUDY DESIGN:** There were 9832 Medicaid patients with type 2 diabetes from 8 states evaluated. Endpoints included demographics (age, race), health care behaviors (physician's diabetes care standard adherence, patient's medication adherence), and health care utilization and expenditures. Discriminative power of comorbidity indices was determined by *c*-statistics from logistic regression, the shape of receiver operator characteristic curve, and area under the curve.

**RESULTS:** The CDS demonstrated the best ability in discriminating between age subgroups (*c* = 0.61) and patients who were or were not adherent to their medication (*c* = 0.56). The CDS and HRQL-CI mental index performed similarly in discriminating based on diabetes care standard adherence (*c* = 0.60). The EI had the best discrimination for health care utilization and costs, while HRQL-CI physical index performed similarly to EI in predicting hospitalization admission (*c* = 0.62), and the HRQL-CI mental index performed similarly to the EI in predicting outpatient visits (*c* = 0.74).

**CONCLUSIONS:** The CDS was found to be the best metric for differentiating among patients varying in demographics, physician's diabetes care standard adherence, and patient's medication adherence, while the EI should be the first choice to identify patients at risk of high medical resource use.

**KEYWORDS:** Comorbidity index; Discrimination; Health care behavior; Health care outcome; Medicaid; Type 2 diabetes

The construct “comorbidity” reflects the aggregate effect of all clinical conditions a patient might have, excluding the disease of primary interest.<sup>1</sup> Being able to capture an individual comorbid burden effectively is particularly important when analyzing health care data because comorbidities can influence many facets of health care outcomes, including mortality,<sup>2-7</sup> health care utilization,<sup>4,7,8</sup> and expenditures.<sup>4,9,10</sup> Because of the importance of comorbidity, health services studies commonly include a summary measure of an individual’s coexisting medical conditions along with demographics and other clinical characteristics within the multivariate framework. Comorbidity measure is an essential tool in health services research for adjusting confounding effect, predicting health care outcomes, and risk adjustment of health care payment.

However, to date there is no gold standard for quantifying patients’ comorbid burden, in part because the performance of comorbidity measure varies depending on the endpoints of interest, study population, and data source for obtaining comorbidity information.<sup>11</sup> It has been emphasized to re-evaluate the validity of a risk-adjustment tool when the population or the outcome of interest is varied.<sup>4,12,13</sup> Predictive and discriminating abilities are 2 important capacities of comorbidity measure.<sup>14</sup> A predictive prognostic tool like comorbidity score is used to predict future health care outcome (eg, spending), while a discriminating comorbidity measure is used to distinguish individuals varying in an outcome endpoint of interest (eg, mortality).<sup>14</sup> A promising use of comorbidity measure is to discriminate individuals at risk of premature disability, death, higher health care demand, or spending. The predictive ability of comorbidity measure has been compared between existing measures and across different outcomes (mortality,<sup>6</sup> health care utilization,<sup>4,8</sup> costs<sup>4,9,10</sup>), while comparative discriminative ability of comorbidity measures has received relatively little attention by researchers,<sup>8,9</sup> where most studies focus only on mortality.<sup>3,5,7,15,16</sup> So, the research aimed to assess discriminating ability of comorbidity measure comprehensively across different types of outcomes is expected to fill the gap in the evaluation of comorbidity measure. Understanding the comparative performance of comorbidity measures will provide evidence for the selection of an appropriate comorbidity measure that is specific to a given outcome of interest. Using an outcome-specific comorbidity measure is essential to ensure the validity of health services research.

Three commonly used comorbidity measures are the Charlson Comorbidity Index (CCI),<sup>17</sup> Elixhauser Index (EI),<sup>18</sup> and the Chronic Disease Score (CDS).<sup>19</sup> The CCI and EI are diagnosis-based comorbidity indices that use the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnoses to capture patients’ comorbid burden. They are often used by investigators focusing on mortality<sup>2-6,15</sup> or health care utilization<sup>4,7,9,10</sup> as outcomes. The CCI was developed using medical chart review data to predict 1-year survival in breast cancer patients.<sup>12</sup> The CCI originally identified 19 comorbidities weighted according to disease severity as 1, 2, 3, or 6,<sup>20</sup> which were derived from adjusted relative risk of death in the Cox proportional hazard regression in the study of index development. Subsequently, Deyo et al (1992)<sup>17</sup> adopted the CCI for administrative data, and today it has become a widely used risk-adjustment tool across different health care outcomes and disease populations.<sup>2,3,15</sup> However, recent studies have shown that the longer list of comorbidities proposed by Elixhauser<sup>18</sup> may have better predictive performance for mortality compared with the CCI.<sup>2,3,21</sup> The EI system was initially developed based on administrative data and originally as a model, which consists of 30 distinct disease conditions.<sup>18</sup> In contrast to diagnosis-based measures, the CDS is a risk-adjustment metric based on a history of dispensed drugs.<sup>22</sup> The RxRisk system<sup>23</sup> is a revised and expanded version of the original CDS risk assessment instrument.<sup>22</sup> For adults, the RxRisk identified 25 distinct comorbid conditions by linking them to medications used during treatment.<sup>23</sup> The RxRisk system has been shown to predict mortality, hospitalizations, and costs.<sup>19,22,23</sup> Recent comparison study showed that the predictive performances of the CCI and EI in health care costs were similar, while the RxRisk outperformed both.<sup>9</sup>

The Health-related Quality of Life Comorbidity Index (HRQL-CI) is a newer diagnosis-derived index that is predictive of HRQL as measured by the short-form-12 physical component summary score

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