Concept: Elixhauser Comorbidity Index

Concept Description

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Introduction

This concept contains information on the Elixhauser Comorbidity Index including: a basic description of the Elixhauser Comorbidity Index, how the Index is used at MCHP, and a brief historical perspective on the development and changes to the Index over time as presented in different research. The concept also includes access to different versions of SAS® code for running the Elixhauser Comorbidity Index.

Description of the Elixhauser Comorbidity Index

The Elixhauser Comorbidity Index is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, such as hospital abstracts data. Each comorbidity category is dichotomous -- it is either present or it is not. The Index can be used to predict hospital resource use and in-hospital mortality (Elixhauser et al., 1998).

Over time, there have been changes to the Index based on different research. A summary of these variations include:

- the original Index was developed with 30 categories (Elixhauser et al., 1998) and at MCHP we use 31 categories (Garland et al., 2012); and
- the list of specific ICD diagnosis codes that are used to identify different categories of comorbidity have been modified and updated from ICD-9-CM to work with ICD-10 coding (Quan et al., 2005); and
- a weighting algorithm was developed, based on the association between comorbidity and death, in order to produce an overall score for the Elixhauser Index (van Walraven et al., 2009).

For more information on these changes, please read the section titled Historical Research Perspective on the Elixhauser Comorbidity Index below.

Use of the Elixhauser Comorbidity Index at MCHP

This section describes the use of the Elixhauser Comorbidity Index at MCHP. It identifies the source of diagnosis codes in the MCHP Data Repository and how they are relevant for use in the Elixhauser Comorbidity algorithm, describes and provides access to the SAS code that is available at MCHP for running the Elixhauser Comorbidity Index and calculating the Index score, and lists the published MCHP research that have used the Elixhauser Comorbidity Index and briefly describes how it was used in the research.

NOTE: The Elixhauser Comorbidity Index developed at MCHP can be used to measure the comorbidity of individual episodes of hospital care or it can be used to create a longitudinal index based on multiple hospital episodes and physician visits over time, if so desired, depending on the purpose of the specific research project.

Source of Diagnosis Codes for the Elixhauser Comorbidity Index

The diagnosis codes required for use in the Elixhauser Comorbidity Index are available in the hospital abstracts data and in the medical services (physician claims) data.

Hospital data contains all the relevant diagnoses during an episode of care as an inpatient. For each diagnosis recorded in the hospital data, a corresponding variable called *diagnosis type* is used to identify whether the diagnosis is considered a comorbidity (pre-existing condition) or a complication (a condition arising during the hospital stay). Complications are identified by a *diagnosis type* = "C" (complication) in the data prior to April 1, 2004 (for use with ICD-9-CM codes) or by a *diagnosis type* = "2" (post-admit comorbidity) in the data beginning on April 1, 2004 (for use with ICD-10 codes). At MCHP, complications can be included or excluded in the Elixhauser Comorbidity Index algorithm.

The Medical Services (Physician Claims) data contain only one diagnosis code per record, relevant to the reason for the visit to the physician. Although the Elixhauser Comorbidity Index is originally designed to work with hospital data only, at MCHP we have developed a method that can include 3-digit diagnosis codes from the Medical Services data, if warranted by the research, to expand the scope of comorbidity found in the population. **Note:** In December 2018, a 5-digit diagnosis code variable was added to the Medical Services data. If recorded, the first 3-digits of both the 3-digit and 5-digit diagnosis code variables will match exactly. The 5-digit diagnosis code variable applies to records from 2015/16 forward.

See the section titled MCHP Elixhauser Comorbidity Index SAS Code for 3-Digit Codes in the Medical Services (Physician) Data for more information on using 3-digit codes from the Medical Services data.

Lists of Elixhauser Comorbidity Index Categories and the Associated ICD Codes

- For a current list of the 31 categories in the Elixhauser Comorbidity Index used in MCHP research, along with the ICD-9-CM and ICD-10-CA diagnosis codes from both Hospital Abstracts (hosp) and Medical Services (med) data, please see the relevant table from Lix et al. (2016).

- For a list of 31 categories used in the Elixhauser Comorbidity Index, please see Table 1. ICD-9-CM and ICD-10 Coding Algorithms for Elixhauser Comorbidities from Quan et al., 2005.

MCHP Elixhauser Comorbidity Index SAS Code

At MCHP there are different SAS programs available that can be used to generate the Elixhauser Comorbidity Index score - a total of the number of comorbidity categories. The process involves producing category indicators at the record level from hospital abstracts data and counting the number of categories for each episode of care, or if desired, reviewing multiple records from hospital abstracts and physician

visits data for the same individual over time, and then counting the overall number of categories indicated - a category is only counted once in this longitudinal approach. The SAS code includes:

- two SAS macros that identify the Elixhauser Comorbidity categories and the total number of categories for each individual record (hospital episode). One macro is based on ICD-9-CM diagnoses codes and the other is based on ICD-10 diagnoses codes;
- SAS code that identifies the appropriate Elixhauser Comorbidity category for each record from the Medical Services (Physician Visits) data based on 3-digit ICD-9-CM diagnosis codes; and
- SAS code that calculates a longitudinal Index score based on all of the episodes of hospital care and physician visits for an individual and each category of comorbidity present.

MCHP Elixhauser Comorbidity Index SAS Macros for Hospital Data - Individual Episodes of Care

There are two different SAS macros available for working with hospital data: one for use with ICD-9-CM diagnosis codes and one for use with ICD-10 diagnosis codes.

To run the MCHP Elixhauser Comorbidity Index SAS macro, a file containing individual hospital records with diagnosis codes and the corresponding diagnosis type is required. Although the Elixhauser Comorbidity Index was originally designed for use with comorbidities only, there may be times when the Index should consider all diagnoses. For example, if the Index is being used in a longitudinal study, all diagnoses could be included in the Index calculation. However, if the study period only covers a short period of time, including complications may over-estimate the burden of disease.

The MCHP Elixhauser Comorbidity Index SAS macros have a parameter option to include all types of diagnoses (type=off) or to limit the diagnoses by excluding complications (type=on). A research decision should be made on whether to include all diagnoses or exclude complications in the Index calculation.

The two MCHP SAS macros are available below:

- MCHP SAS Macro Code - ICD-9-CM Elixhauser Index
- MCHP SAS Macro Code - ICD-10 Elixhauser Index

NOTE: The MCHP SAS macro code is based on information in Quan's "Enhanced Elixhauser Diagnosis-Type SAS code" programs, but modified to be more generalized for use with other data sources and to run more efficiently at MCHP.

MCHP Elixhauser Comorbidity Index SAS Code for 3-Digit Codes in the Medical Services (Physician) Data

To run the MCHP Elixhauser Comorbidity Index SAS code with the Medical Services (Physician Claims) data, a file containing individual physician visit records with the diagnosis code is required.

CAUTION: the Medical Services data should not be used alone to create the Elixhauser Comorbidity Index, as many 3-digit ICD-9-CM codes lack the specificity required in the algorithm. The Medical Services data should only be used in conjunction with the Hospital Abstracts data to generate an Index score. In general, using Medical Services data alone to calculate the Elixhauser Comorbidity Index is not recommended and goes beyond the original intent of the Index.

NOTE: In December 2018, a 5-digit diagnosis code variable was added to the Medical Services data. If recorded, the first 3-digits of both the 3-digit and 5-digit diagnosis code variables will match exactly. The 5-digit diagnosis code variable applies to records from 2015/16 forward.

The use of 3-digit codes requires modifications in the original Elixhauser Comorbidity Index algorithm. These modifications include:

- combining the two diabetes conditions, "Diabetes With Complications" and "Diabetes Without Complications" into one category because it is not possible to differentiate between the two categories using 3-digit codes. Anyone with ICD code "250" is assigned to the less severe "Diabetes Without Complications" category.
- combining the two anemia conditions, "Blood Loss Anemia" and "Deficiency Anemia" into one category because it is not possible to differentiate between the two categories using 3-digit codes. Anyone with either ICD code "280" or "281" is assigned to the "Deficiency Anemia" category.
- deciding to include or exclude certain codes in specific categories due to the specificity issue. For example, the 3-digit codes do not provide enough specificity for classifying diagnoses properly into the "Peptic Ulcer Disease excluding bleeding" category. For a complete list of the 3-digit ICD-9-CM codes used for each category and the choices that were made for inclusion/exclusion of 3-digit codes in our research, please see Using 3-Digit ICD-9-CM Codes with the Elixhauser Comorbidity Index.

See the Notes, Cautions and Limitations section for more information on specificity and using 3-digit ICD codes in the algorithm.

The MCHP SAS code for working with 3-digit codes is available below:

- MCHP SAS Code - Elixhauser Index - Working with 3-digit ICD-9-CM Codes

NOTE: The 3-digit SAS code example is based on work at MCHP for generating the Index based on 3-digit ICD-9-CM diagnosis codes found in the Medical Services (Physician Claims) data.

MCHP Elixhauser Comorbidity Index SAS Code - Calculating a Longitudinal Index Score

This code will calculate a longitudinal Index score (the total number of comorbidity categories indicated) for an individual based on multiple Index records over time. It takes into account all of the comorbidity categories indicated for all episodes of hospital care and physician visits and the algorithm flags a comorbidity category as present only once during the calculation and does not increase the overall Index score when the same category occurs more than once. With the Elixhauser Comorbidity Index, we do not assign weights to the comorbidity categories.

The MCHP SAS code for calculating the longitudinal Index score is available below:

MCHP SAS Code - Calculating a Longitudinal Elixhauser Comorbidity Index Score

MCHP Research Using the Elixhauser Comorbidity Index

The following is a list of published MCHP research that have used the Elixhauser Comorbidity Index, and a brief description of how the Index is used in that research.

1. Garland et al. (2012)

In the MCHP Deliverable *The Epidemiology and Outcomes of Critical Illness in Manitoba* by Garland et al. (2012), they used the Elixhauser Comorbidity Index with 31 comorbidity categories as an independent variable in modeling resource use within a one-year period of hospital discharge. Their use of the Elixhauser Comorbidity Index was based on the work by Quan as one of three systems for assessing chronic comorbid health conditions. For more information on the use of the Elixhauser Comorbidity Index in this research, please read the following sections of the report:

- Methods: Chronic Comorbid Health Conditions
- Table 4.40: Frequency of Elixhauser Comorbid Conditions for Manitobans at the Level of ICU Episodes

2. Lix et al. (2016)

In the MCHP Deliverable *Cancer Data Linkage in Manitoba: Expanding the Infrastructure for Research* by Lix et al. (2016), additional SAS code has been developed by MCHP to incorporate the 3-digit ICD-9-CM codes available in the Medical Services (Physician Claims) data into the Elixhauser Comorbidity Index algorithm. Links will be provided to the research methodology and results when this becomes available.

For a list of the 31 categories in the Elixhauser Comorbidity Index used in this MCHP research, along with the ICD-9-CM and ICD-10-CA diagnosis codes from both Hospital Abstracts (hosp) and Medical Services (med) data, please see the relevant table from Lix et al. (2016).

For more information on using 3-digit codes from the Medical Services data, see the section titled MCHP Elixhauser Comorbidity Index SAS Code for 3-Digit Codes in the Medical Services (Physician Claims) Data in this concept.

3. Distribution of Elixhauser Scores - 2003-2005

Some preliminary information on the distribution of scores for the Elixhauser Comorbidity Index is available for 2003-2005, looking back two years among those aged 65+ in Manitoba. These tables include frequency distributions of total Elixhauser comorbidity counts for each year from 2003 to 2005, and a list for 2003 of the most common, ICD-9-CM most responsible diagnosis in the prior two years, for those with an Elixhauser Index score of zero. This information is available in a document in the Links section below: MCHP Documentation - Distribution of Elixhauser Scores - **(internal access only).**

Historical Research Perspective on the Elixhauser Comorbidity Index

The Elixhauser Comorbidity Index was originally developed in 1998 and designed to work with ICD-9-CM codes. The following is a list of some of the significant historical developments and changes in the Elixhauser Comorbidity Index that have occurred over time in published research:

1. Elixhauser et al. (1998)

In the publication *"Comorbidity measures for use with administrative data"* by Elixhauser et al. (1998), they develop the original index that contains 30 comprehensive categories of comorbidity based on ICD-9-CM coding found in hospital abstracts data. For patients with closely related comorbidities (e.g. diabetes and diabetes with complication), only the more severe comorbidity is counted. The purpose of this project is "to improve on measures of comorbidity for use with administrative databases" ... and ... "develop comorbidity measures to predict hospital charges, length of stay, and in-hospital mortality."

For more information on the original Elixhauser Index, including the software to run the Index, see:

- Healthcare Cost and Utilization Project (HCUP) Web Site - Comorbidity Software.

2. Southern et al. (2004)

In the publication *"Comparison of the Elixhauser and Charlson/Deyo methods of comorbidity measurement in administrative data"* by Southern et al. (2004), they compare the Charlson Comorbidity Index and Elixhauser Comorbidity Index in predicting in-hospital mortality for patients with myocardial infarction (MI), and find the Elixhauser Comorbidity measures perform better than the Charlson Comorbidity measures.

3. Quan et al. (2005)

In the publication *"Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data"* by Quan et al. (2005), they "conducted a multistep process to develop ICD-10 coding algorithms to define Charlson and Elixhauser comorbidities in administrative data and assess the performance of the resulting algorithms." They followed Elixhauser's coding algorithm, which led to modifications and enhanced coding algorithms for the index. Quan also noted that the Elixhauser algorithm has been revised twice and the recent version posted on the Agency for Healthcare Research Quality (AHRQ) website contained more ICD-9-CM codes but excludes the "cardiac arrhythmia" category, resulting in 29 categories.

Table 1. ICD-9-CM and ICD-10 Coding Algorithms for Elixhauser Comorbidities from Quan et al. (2005), identifies the ICD-9-CM codes for each category of comorbidity in Elixhauser's original and subsequent work on the AHRQ web site, as well as the ICD-10 and enhanced ICD-9-CM codes identified by Quan et al. in their work.

The Elixhauser Comorbidity Index SAS® code developed for this project is available below with Quan's permission:

- Quan's - ICD-9-CM Enhanced Elixhauser SAS Code
- Quan's - ICD-9-CM Enhanced Elixhauser Diagnosis-Type SAS Code
- Quan's - ICD-10 Enhanced Elixhauser SAS Code
- Quan's - ICD-10 Enhanced Elixhauser Diagnosis-Type SAS Code

NOTE: Quan's SAS code examples have not been validated at MCHP.

4. Li et al. (2008)

In the publication *"Risk adjustment performance of Charlson and Elixhauser comorbidities in ICD-9 and ICD-10 administrative databases"* by Li et al. (2008) , they assess the performance of the Charlson Comorbidity Index and the Elixhauser Comorbidity Index using ICD-9 and ICD-10 coding systems and find that the "change in coding algorithms did not influence the performance of either ... [index] ... in the prediction of outcome."

5. van Walraven et al. (2009)

In the publication *"A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data"* by van Walraven et al. (2009) they modified the Elixhauser Comorbidity Index by developing a scoring system that "reflected the strength of each comorbidity group's independent association with hospital death." They found the "Elixhauser comorbidity system can be condensed to a single numeric score that summarizes disease burden and is adequately discriminative for death in hospital".

Notes, Cautions and Limitations

The following list of notes, cautions and limitations should be considered when using the Elixhauser Comorbidity Index:

1. Although the original Elixhauser Comorbidity Index was designed to include only comorbidities, there may be times when the Index should consider all diagnoses recorded. For example, if the Index is being used in a longitudinal study, all diagnoses could be included in the Index calculation because they represent comorbidity over time. However, if the study period only covers a short period of time, then including complications may over-estimate the burden of disease.

   At MCHP, the SAS macro code for the Elixhauser Comorbidity Index has a parameter option to include all diagnoses or to exclude complications. A research decision should be made on whether to include all diagnoses or exclude complications in the Index calculation.

2. The Elixhauser Comorbidity Index is designed for use with very specific ICD coding (up to 5-digit ICD-9-CM codes and 7-digit ICD-10 codes) found in the Hospital Abstracts data. This is due to the specificity required to distinguish between diagnoses that should / should not be included in the index and to be able to properly identify and place codes into the appropriate category.

3. In general, using only 3-digit ICD codes to calculate the Elixhauser Comorbidity Index is not recommended because they lack the specificity required to properly categorize diagnoses in the Elixhauser Comorbidity Index.

SAS code and formats

- MCHP SAS Code - Calculating a Longitudinal Elixhauser Comorbidity Index Score
- MCHP SAS Code - Elixhauser Index - Working with 3-digit ICD-9-CM Codes
- MCHP SAS Macro Code - ICD-10 Elixhauser Index
- MCHP SAS Macro Code - ICD-9-CM Elixhauser Index
- Quan's - ICD-10 Enhanced Elixhauser Diagnosis-Type SAS Code
- Quan's - ICD-10 Enhanced Elixhauser SAS Code
- Quan's - ICD-9-CM Enhanced Elixhauser Diagnosis-Type SAS Code
- Quan's - ICD-9-CM Enhanced Elixhauser SAS Code

Related concepts

- Charlson Comorbidity Index
- Measures of Comorbidity

Related terms

- Comorbidity / Comorbidities
- Elixhauser Comorbidity Index
- Hospital Abstracts Data
- ICD-10
- ICD-9-CM
- International Classification of Diseases, 10th Revision (ICD-10)
- International Classification of Diseases, 9th Revision, with Clinical Modifications (ICD-9-CM)
- Medical Services Data

Links

- Elixhauser and Quan's ICD-9-CM and ICD-10 Coding Algorithms for Elixhauser Comorbidity Index

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Keywords

- comorbidity
- Elixhauser Comorbidity Index
- Health Measures
- mortality