Database & Methods Cyberseminar Series

Applying Comorbidity Measures-A Deeper Dive

VIReC
RESEARCHERS' GUIDE TO VA DATA

This session is dedicated to

James F. Burgess, Jr., PhD

Today's objectives

At the end of this session, the participant will be able to:

- Distinguish terms: disease burden, multimorbidity, and comorbidity
- Describe how the CCI and the ECM measures are applied
- Name and understand the steps in SAS to apply comorbidity measures with clinical administrative data
- Find resources to support application of the CCI and ECM and adaptations of these comorbidity measures

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Examples Comparing CCI & ECM
- Summary
- Additional Resources

Poll Question #1: *What is your role in applying comorbidity measures?*

- I am leading/designing a study that requires risk adjustment
- I am/will be extracting the data to construct the measure
- I am adapting existing measures or developing new measures
- All of the above
- Other – please describe via the Q&A function

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Examples Comparing CCI & ECM
- Summary
- Additional Resources

Concept Review

Comorbidity

- A concomitant but unrelated pathological or disease process (Am Heritage Medical Dictionary)
- Assuming focal condition, comorbidities are unrelated and specific, separate from health status
- Measures may be simple ‘flags’ or composite measures and may be validated and tested in relation to a particular outcome

(Valderas, JM, Starfield, B, Sibbald, B, et al., 2009; Austin et al. 2015)

Other Terms to Distinguish

Multi-morbidity

- Co-occurrence of diseases (acute or chronic) within one person at one point in time

Frailty

- Focuses on a physiologic state of vulnerability to stress, be they physical or mental

Functional status

- Ability to perform daily tasks

Disease Burden

- May focus on a single disease or multiple/more population focused
- Example: Disability-adjusted life years (DALYs) incorporates mortality and the burden of living from the Global Burden of Disease Study

While there may be associations among these different concepts/measures they are considered separate entities, and may have independent effects on outcomes…

Questions to ask yourself…

What are your outcome measures?
Are you interested in comorbidities in relation to a focal condition?
General or specific risk adjustment?
What type of study data?

Commonly Used Comorbidity Measures Using Clinical Administrative Data

- Charlson (CCI)
  - Deyo-Romano-Klabunde-VIReC adaptations
- Elixhauser Comorbidity Method (ECM) & adaptations
- Quan (CCI & ECM)

- HCC/DCG
- RxRisk
- Nosos
- ACG
- Functional Comorbidity Index
- Others

CCI & ECM and Adaptations Developed to Predict Specific Outcomes

- In-hospital mortality
- One-year mortality
- Hospital readmissions
- Length of stay and charges (ECM)

- Many have applied these measures and reported associations with costs and health care use

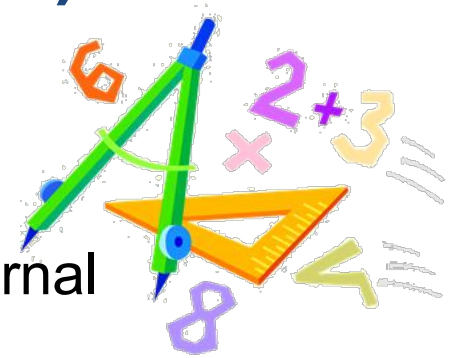
Poll # 2: What level of experience do you have with the CCI or ECM with VA data?

- **Very experienced with CCI/ECM--**I have applied one of these measures using VA data in my research
- **Experience with CCI/ECM & non-VA-**I have applied these measures with non-VA data (e.g. HCUP)
- **Experience only with other Comorbidity Measures & VA-**I have applied other measures using VA data (e.g. NOSOS, CAN scores)
- **Beginner-**learning about it!

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Examples Comparing CCI & ECM
- Summary
- Additional Resources

Charlson Comorbidity Index (CCI)



- Developed to predict mortality
  - Constructed based on the mortality rates of 607 patients admitted to the general internal medicine service
  - Now includes 19 chronic conditions
    - Each has a weight from 1-6
  - CCI Score = Sum of weights
- Extended/adapted by Deyo, Romano, Klabunde, VIReC, and others independently for use with clinical administrative data
- Commonly used as a general risk adjustment tool

VIReC Adaptation of CCI for Use with VA Data

- Adapted existing Charlson-based macro code that resulted in a new comorbidity index that:
  - Updates and combines approaches for use with mixed inpatient and outpatient data
  - Adds VA and Medicare outpatient procedures to achieve greater ascertainment of conditions
  - Replaces previous VA data sources with the VA data from the VA Corporate Data warehouse (CDW)
  - Incorporates the ICD10 and ICD9 coding schema
  - **Caveat:** Needs validation

Reference see: VIReC. Calculating a Comorbidity Index for Risk Adjustment Using VA or Medicare Data. Available at: https://vaww.virec.research.va.gov/Tutorials/CALC-CCI/Tutorial-CALC-CCI.pdf

Constructing the Measure in Three Steps

- Step 1: Construct Input Dataset
- Step 2: Screen Input Dataset
- Step 3: Calculate Comorbidity Index Weights & Score

VIReC CCI -- Step 1: Construct Input Dataset

Step	Action
1	Download the Zip file containing comorbidity tutorial programs from the “Tutorials” page on VIReC’s website: (see Appendix B for URL).
2	Download the most current version of the Alpha-Numeric HCPCS File from the “Alpha-Numeric HCPCS” page on the CMS website (see COMORBIDITY file for URL).
3	Unzip these files and save them in a SAS library.
4	Open the spreadsheet within the Alpha-Numeric HCPCS File and create a BETOS crosswalk file as a tab-delimited text file containing the HCPCS and BETOS code variables only.
5	Open the COMORBIDITY.sas file.
6	Associate a SAS library with each libref.
7	Replace unique identifier and anchor date variables with those relevant to the study cohort dataset.
8	Customize the COMORBIDITY program by modifying data sources and years so they are relevant to the study.
9	Run COMORBIDITY to create the input dataset.

VIReC CCI -- Step 2: Screen Input Dataset

Step	Action
1	Review Variables and Variable Values in Healthcare System Datasets to Screen for Non-Clinician Assigned Diagnoses to determine the appropriate variables and variable values for removing non-clinician assigned records.
2	Determine the maximum number of diagnosis code variables (or fields) in the input dataset.
3	Open the CALL_REMOVE_RULEOUT_MACRO.sas file.
4	Associate a SAS library with each libref.
5	Customize the program to include or exclude any necessary variables and variable values for removing non-clinician assigned records.
6	Customize the program by entering the maximum number of diagnosis code variables (or fields).
7	Run CALL_REMOVE_RULEOUT_MACRO to create the rule-out dataset.

Klabunde et al “Rule-Out” MACRO -- Selecting records to exclude

```
        Klabunde CN, Potosky AL, Legler JM, Warren JL.  Development of a comorbidity index
        using physician claims data.  J Clin Epidemiol 2000; 53(12):  1258-67
*******************************************************************************/

/* MAIN MACRO RULEOUT */
%MACRO RULEOUT(INDATA, PATID, CLMDTE, START, FINISH, DXVARSTR, FILETYPE, OUTDATA);

/*******************************************************************************
The following parameters are supplied to the macro:
        INDATA:         Input dataset name
        PATID:          Unique ID for each patient. &INDATA must be sorted by &PATID.
                                There may be more than 1 record per patient.
        CLMDTE:         Date of the record found on the file.
                                Should be a SAS date format.
        START:          Date the comorbidity window opens, i.e. Dx date-12 months
                                Should be a SAS date format.
        FINISH:         Date the comorbidity window closes, i.e. Dx date-1 month
                                Should be a SAS date format.
        DXVARSTR:               Diagnosis code variables in ICD-9, i.e. 'DX01-DX11'.
        FILETYPE:               Source of the record.  Only important value is 'M' for
                                inpatient hospital records.  If the value is 'M', all
                                ICD-9 diagnosis codes are accepted.
        OUTDATA:                Output dataset name
*******************************************************************************/

DATA &OUTDATA;
        SET &INDATA;
        IF &START <= &CLMDTE <= &FINISH;
        RUN;

PROC SORT DATA = &OUTDATA;
        BY &PATID &CLMDTE;
        RUN;

/* SEPARATE DATA INTO VARIABLE OF INTEREST AND VARIABLES UNAFFECTED BY THIS MACRO */
DATA TEST (KEEP = &PATID &CLMDTE ICD9DX CNT J &FILETYPE) &OUTDATA (DROP = J CNT &CLMDTE ICD9DX &DXVARSTR);
```

This MACRO returns the dataset “&OUTDATA” which contains records within the specified window from which the unreliable ICD-9/ICD10 diagnosis codes have been excluded.

VIReC CCI -- Step 3: Calculate Comorbidity Index Weights & Score

Step	Action
1	Determine the maximum number of diagnosis and procedure code variables (or fields) in the rule-out dataset.
2	Open the CALL_COMORBIDITY_MACRO.sas file.
3	Associate a SAS library with each libref.
4	Customize COMORBIDITY_MACRO and CALL_COMORBIDITY_MACRO by removing any comorbidity that is the condition of study.
5	Customize CALL_COMORBIDITY_MACRO by entering the maximum number of diagnosis and procedure code variables (or fields).
6	Run CALL_COMORBIDITY_MACRO to create the comorbidity output file dataset.

Example of Output to Calculate CCI

CCI Theoretical Range: 1-29

Unique Pt ID	MI	CHF	PVD	CVD	DEMENTIA	CPD	RHEUM	ULCER	LIVER1	DIABETES1	DIABETES2	PARALYSIS	RENAL	CANCER	LIVER2	METAS	AIDS	CCI
Weights	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	6	6	
123456789	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	27
287654321	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	23
323456780	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	22
456789012	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	4
523456789	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
687654321	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
728416282	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	5
823456789	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For this patient Liver1, Diabetes1 and Cancer flags were superseded by the more severe DX in calculating the CCI=27

For related conditions, the scoring algorithm for the CCI summary measure only counts the more severe one

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Example Comparing CCI & ECM
- Summary
- Additional Resources

```
/*  Define dataset that has 29 comorbidity (CM) variables. */
/*************************************************************/
%Let    DS_   = Severity_data;
    ***if 29 variables are from HCUP standard severity file;
%Let    nv_   = 29;

/*************************************************************/
/*  Define logic to calculate scores.                        */
/*  The first 29 parameters are CM variables                 */
/*  rscore_ for readmit index score                          */
/*  mscore_ for mortality index score                        */
/*************************************************************/

/*************************************************************/
/*      If the 29 comorbidity variables have different names */
/*      in your data, fill in the variable names here (when  */
/*      calling the macro get_cmscore)                       */
/*************************************************************/

%macro get_cmscore(
aids_     =CM_AIDS,
alcohol_  =CM_ALCOHOL,
anemdef_  =CM_ANEMDEF,
arth_     =CM_ARTH,
bldloss_  =CM_BLDLOSS,
chf_      =CM_CHF,
chrnlung_ =CM_CHRNLUNG,
coag_     =CM_COAG,
depress_  =CM_DEPRESS,
dm_       =CM_DM,
dmcx_     =CM_DMCX,
drug_     =CM_DRUG,
htn_c_    =CM_HTN_C,
hypothy_  =CM_HYPOTHY,
liver_    =CM_LIVER,
lymth_    =CM_LYMPH,
lytes_    =CM_LYTES,
mets_     =CM_METS,
neuro_    =CM_NEURO,
obese_    =CM_OBESE,
para_     =CM_PARA,
perivasc_ =CM_PERIVASC,
psych_    =CM_PSYCH,
pulmcirc_ =CM_PULMCIRC,
renlfail_ =CM_RENLFAIL,
tumor_    =CM_TUMOR,
ulcer_    =CM_ULCER,
valve_    =CM_VALVE,
wghtloss_ =CM_WGHTLOSS,
rscore_   =readmit_score,
mscore_   =mortal_score
      );
```

Elixhauser Comorbidity Method

- Developed to provide a comprehensive set of comorbidity measures for use with large administrative inpatient datasets
- Construction based on adult, nonmaternal inpatients from 438 acute care hospitals in California in 1992 (*n* = 1,779,167).
- Outcome measures: length of stay, hospital charges, and in-hospital death
  - Includes 29/30 chronic conditions
  - ECM Summary Indices now include Readmission and Mortality score= Sum of weights
- Commonly used as a general risk adjustment tool

Elixhauser 29 Comorbidity Measures

Var Name	Description		
CHF	Congestive Heart Failure	LYMPH	Lymphoma
VALVE	Valvular disease	METS	Metastatic cancer
Pulmcirc	Pulmonary circulation disorders	TUMOR	Solid tumor wo mets
Perivasc	Peripheral vascular disease	ARTH	Rheumatoid arthritis/ collagen vascular diseases
Htn_c (Use HTN & HTNCX)	Hypertension (combine un-and complicated	COAG	Coagulation deficiency
PARA	Paralysis	OBESE	Obesity
NEURO	Other neurological disorders	WGHTLOSS	Weight loss
CHRNLUNG	Chronic pulmonary disease	LYTES	Fluid and electrolyte disorders
DM	Diabetes wo complications	BLDLOSS	Blood loss anemia
DMCX	Diabetes w complications	ANEMDEF	Deficiency anemias
HYPOTHY	Hypothyroidism	ALCOHOL	Alcohol abuse
RENLFAIL	Renal failure	DRUG	Drug abuse
LIVER	Liver disease	PSYCH	Psychoses
ULCER	Chronic peptic ulcer disease	DEPESS	Depression
AIDS	HIV and AIDS	*(Elixhauser et al, Med Care 1998)*	

AHRQ HCUP Revision of the ECM

ORIGINAL ARTICLE

Identifying Increased Risk of Readmission and In-hospital Mortality Using Hospital Administrative Data

The AHRQ Elixhauser Comorbidity Index

Brian J. Moore, PhD, Susan White, PhD,† Raynard Washington, PhD, MPH,‡ Natalia Coenen, MPH,§ and Anne Elixhauser, PhD‖*

Objective: We extend the literature on comorbidity measurement by developing 2 indices, based on the Elixhauser Comorbidity measures, designed to predict 2 frequently reported health outcomes: in-hospital mortality and 30-day readmission in administrative data. The Elixhauser measures are commonly used in research as an adjustment factor to control for severity of illness.

Data Sources: We used a large analysis file built from all-payer hospital administrative data in the Healthcare Cost and Utilization Project State Inpatient Databases from 18 states in 2011 and 2012.

Methods: The final models were derived with bootstrapped repli-

with limited clinical information, especially when small samples sizes are an issue.

Key Words: Elixhauser comorbidity system, comorbidity index, State Inpatient Databases, in-hospital mortality, hospital readmission

(*Med Care* 2017;55: 698–705)

The Elixhauser comorbidity measures were developed in 1998 for use with hospital administrative discharge data as a set of clinical conditions that exist before hospital

Moore, et al Med Care, 2017

Obj:
To develop 2 indices, based on the ECM to predict in-hospital mortality and 30-day readmission

Data:
HCUP Inpatient 2011-2012
ICD9 Only

Methods:
Bootstrapped replications on each outcome
Produced Odds ratios and index weights for each Elixhauser comorbidity to create a single index score per record

Model validation with *C*-statistics

Moore et al 2017 Revision of the ECM

Mortality index:

Weight range:

7 (drug abuse) to +14 (metastatic cancer)

9 of the 29 comorbidities had a negative weight

C statistic range: 0.66-0.81

Readmission index:

Weight range:

3 (obesity) to 21 (metastatic cancer)

2 of the 29 comorbidities had negative weights

C statistic range: 0.57-0.65

Limitations

- Only ICD9 so needs validation for ICD10
- Need to adapt for VA data, which lacks DRGs

H·CUP

Beta Elixhauser Comorbidity Software for ICD-10-CM

The Elixhauser Comorbidity Software for ICD-10-CM is one of the HCUP tools that can be applied to HCUP and other similar databases. These created by AHRQ through a Federal-State-Industry partnership.

HCUP Home | Databases | Tools & Software | Reports | Fast Stats | News & Events | Purchase HCUP Data | Technical Assistance | Inno

Caution: These ICD-10-CM/PCS tools were created prior to the availability of ICD-10-CM/PCS-coded data. AHRQ is con unexpected discontinuities between the tools based on ICD-9-CM and those based on ICD-10-CM/PCS. See this page w undergo periodic updates and corrections as data using ICD-10-CM/PCS codes come into greater use. You are advised tools for your data throughout your research process.

Beta Elixhauser Comorbidity Software for ICD-10-CM

The Elixhauser Comorbidity Software is one in a family of databases and software tools developed as part of the Healthcare Cost and Healthcare Research and Quality. HCUP databases, tools, and software inform decision making at the national, State, and community

Contents:

- Overview of the Elixhauser Comorbidity Software for ICD-10-CM Tool
- Description of the Elixhauser Comorbidity Software for ICD-10-CM Tool
- Technical Guidance for the Elixhauser Comorbidity Software for ICD-10-CM Tool
- Downloading Information for the Elixhauser Comorbidity Software for ICD-10-CM Tool
- Publications Using the Elixhauser Comorbidity Software for ICD-10-CM Tool
- For More Information, Comments, or Questions About the Elixhauser Comorbidity Software for ICD-10-CM Tool

Overview of the Elixhauser Comorbidity Software for ICD-10-CM Tool

The Elixhauser Comorbidity Software for ICD-10-CM assigns variables that identify comorbidities in hospital discharge records using original ICD-9-CM comorbidity measures reported by Elixhauser et al. [1]

The Elixhauser Comorbidity Software for ICD-10-CM consists of two SAS computer programs for personal computers. Although these adapted to other programming languages.

The first program, Creation of Format Library for Elixhauser Comorbidity Groups, creates a SAS format library that maps diagnosis c complications or that may be related to the principal diagnosis

- ComformatYYYY_N.txt is designed for files that include fiscal year (FY) YYYY ICD-10-CM codes and corresponding MS-DRG. Th after the initial fiscal year release.

The second SAS program, Creation of Elixhauser Comorbidity Variables, applies the formats created above to a data set containing a

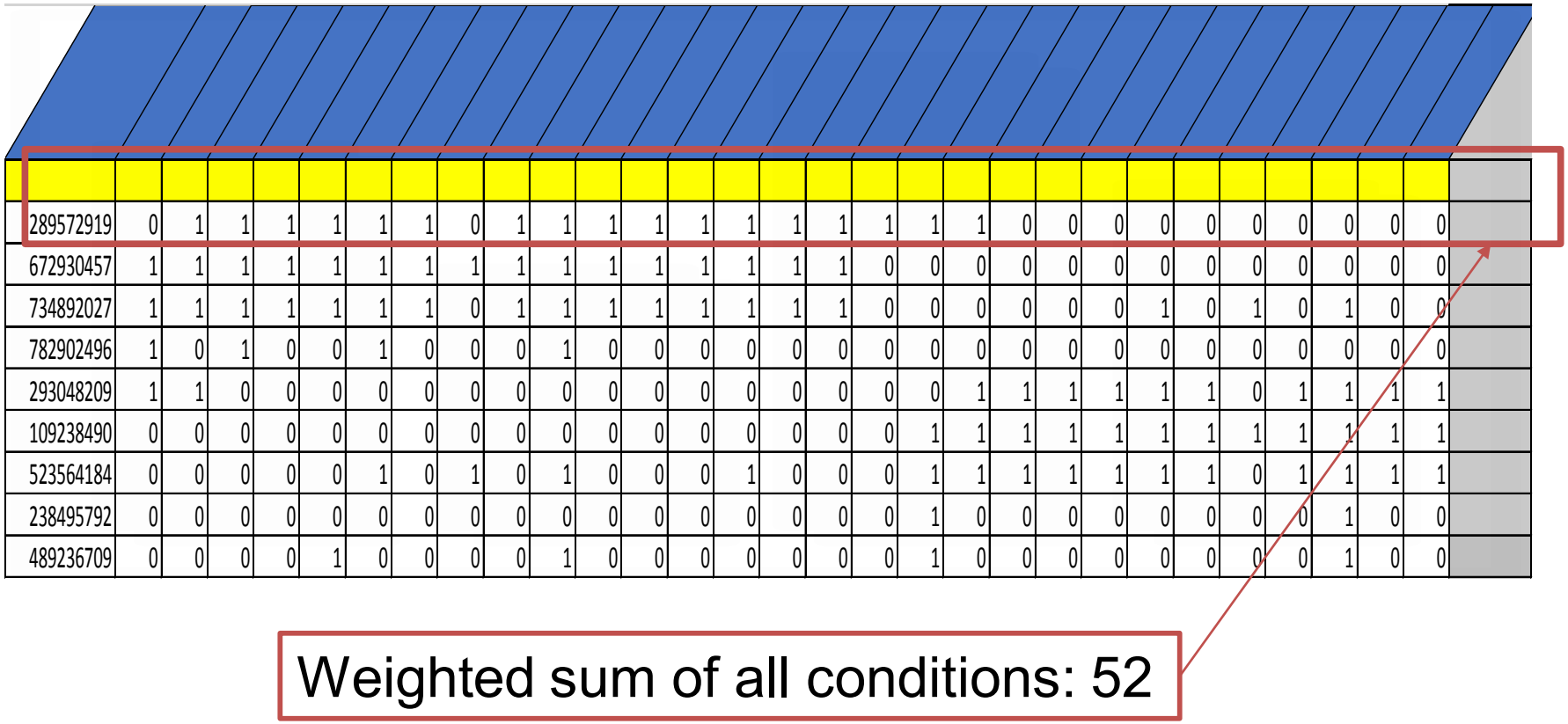
AHRQ HCUP Website provides:

- Software documentation and download instructions
- SAS programs
- Bibliography

https://www.hcup-us.ahrq.gov/toolssoftware/comorbidityicd10/comorbidity_icd10.jsp

Example of Output to Calculate the ECM Mortality Index

ECM Mortality Index Theoretical range: -32 to 99



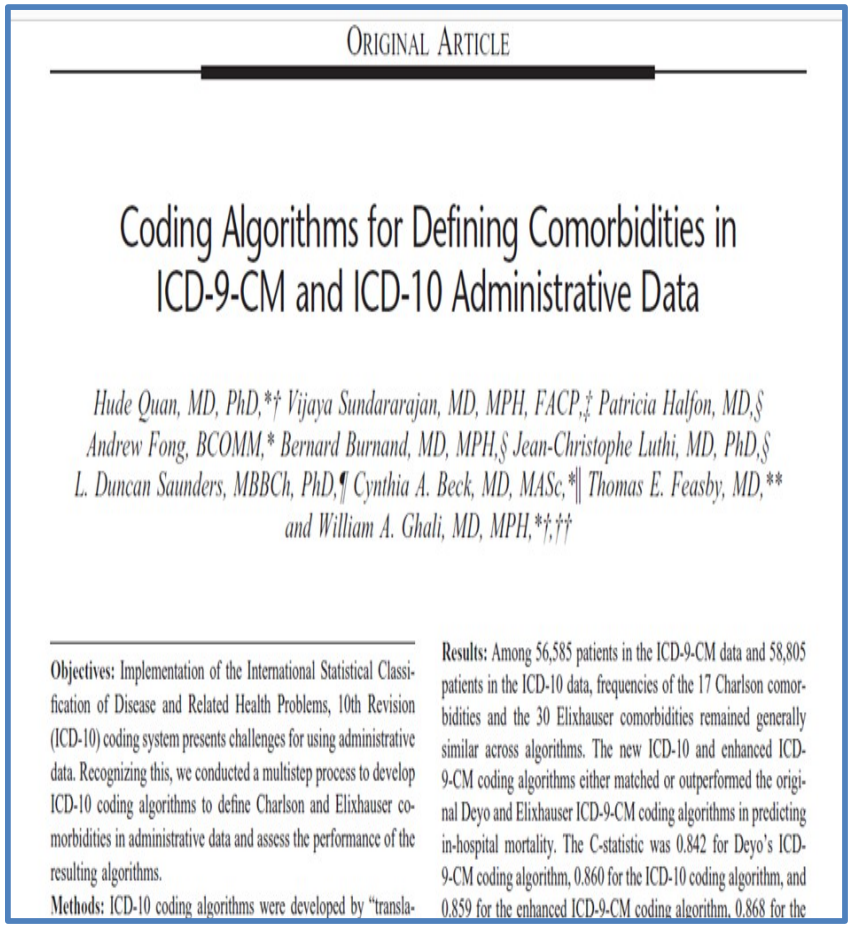
289572919	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
672930457	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
734892027	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	1	0	1	0	0
782902496	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
293048209	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1
109238490	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
523564184	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1
238495792	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
489236709	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0

Weighted sum of all conditions: 52

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Examples Comparing CCI & ECM
- Summary
- Additional Resources

Quan Revised & Compared Deyo-CCI & ECM ICD9 & ICD10 Versions



ORIGINAL ARTICLE

Coding Algorithms for Defining Comorbidities in ICD-9-CM and ICD-10 Administrative Data

Hude Quan, MD, PhD,† Vijaya Sundararajan, MD, MPH, FACP,‡ Patricia Halfon, MD,§ Andrew Fong, BCOMM,* Bernard Burnand, MD, MPH,§ Jean-Christophe Luthi, MD, PhD,§ L. Duncan Saunders, MBBCh, PhD,¶ Cynthia A. Beck, MD, MASc,*‖ Thomas E. Feasby, MD,** and William A. Ghali, MD, MPH,*†,††*

Objectives: Implementation of the International Statistical Classification of Disease and Related Health Problems, 10th Revision (ICD-10) coding system presents challenges for using administrative data. Recognizing this, we 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.

Methods: ICD-10 coding algorithms were developed by "transla-

Results: Among 56,585 patients in the ICD-9-CM data and 58,805 patients in the ICD-10 data, frequencies of the 17 Charlson comorbidities and the 30 Elixhauser comorbidities remained generally similar across algorithms. The new ICD-10 and enhanced ICD-9-CM coding algorithms either matched or outperformed the original Deyo and Elixhauser ICD-9-CM coding algorithms in predicting in-hospital mortality. The C-statistic was 0.842 for Deyo's ICD-9-CM coding algorithm, 0.860 for the ICD-10 coding algorithm, and 0.859 for the enhanced ICD-9-CM coding algorithm, 0.868 for the

Quan et al, Med Care, 2005

Approach

- Developed ICD10 and enhanced ICD9 version of Deyo-CCI and ECM

Results

- Similar frequencies for 17 CCI and 30 ECM comorbidities-See Tables!
- Algorithms matched or outperformed original Deyo-CCI and ECM ICD9 algorithms in predicting in-hospital mortality

Quan Revision—Limitations and Lessons

- ICD-9-CM and ICD-10 coding algorithms were assessed with different years of data (2001 & 2002) and before ICD was in practice in US
- Validity relative to a criterion standard not done
- Restricted the ICD-10 codes selected to the 4th digit

"The decision of whether to include or exclude specific codes or conditions from a coding algorithm depends to a large extent on a given study's objectives."

Quan et al. 2005

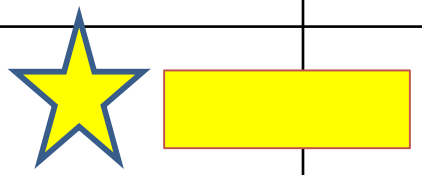
Example from an Ongoing VA Cohort Study

- **Cohort:** VA patients with a diagnostic sleep study during FY2016-2018
- **Obj:** Identify comorbidities during a specific time period leading up to a procedure
  - 1 year 'look-back' prior to procedure
  - 2 year 'look-back' prior to procedure

- **Outcome Measures:** Venue of care, care coordination needs, quality of care

- **Data:** VA CDW
  - Inpatient and Outpatient
  - VA, Community, and Fee basis, PIT

VA CDW Datasets: Diagnosis & Procedure Codes

Dataset**	ICD-9/ICD-10 Diagnosis Code	ICD-9/ICD-10 Procedure Code	CPT Procedure Code
Inpat.inpatient			
InpatientDiagnosis InpatientDischargeDiagnosis InpatientFeeDiagnosis PatientTransferDiagnosis PresentonAdmission SpecialtyTransferDiagnosis	ICD9SID ICD10SID		
InpatientCDProcedure InpatientSurgicalProcedure		ICD9ProcedureSID ICD10ProcedureSID	
InpatientCPTProcedure			CPTSID
WorkloadVDiagnosis WorkloadVProcedureDiagnosis	ICD9SID ICD10SID		
WorkloadVProcedure			CPTSID
FeeInpatInvoiceCDDiagnosis	ICD9SID ICD10SID	ICD9ProcedureSID ICD10ProcedureSID	
FeeInpatInvoiceCDProcedure			
FeeServiceProvided	ICD9SID ICD10SID		ServiceProvidedCPTSID

Example: Ongoing VA Sleep Study Cohort

Exploring VIReC CCI & ECM Measures with 1- & 2-Year 'Look-backs'

Number of Individuals (N) = 648,960	One Yr Look-back		Two Yr Look-back	
Measure	N	%	N	%
VIReC CCI*				
Diabetes 1	121,055	18.67	159,0098	24.51
Diabetes 2	55,116	8.50	78,203	12.05
Overall CCI	1.0145 (Range 0-29)		1.3782 (Range 0-29)	
Elixhauser^				
Diabetes	67,279	10.37	161,489	24.88
Diabetes w Complications	45,546	7.02	116,675	17.98
Overall ECM-Mortality	-0.3082 (Range -29 to 70)		-0.4928 (Range -29-79)	

* Based on VIReC adaptation of the CCI with the "Rule-out" & "VA non clinician assigned Dx" Macro turned off. Available here: https://vaww.virec.research.va.gov/Tutorials/CALC-CCI/Tutorial-CALC-CCI.pdf

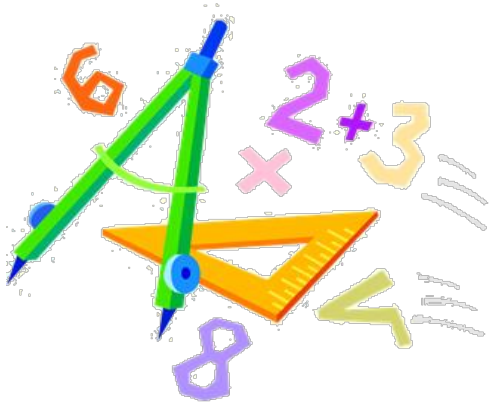
^ ECM Version with DRG codes for inpatient not applied: https://www.hcup-us.ahrq.gov/toolssoftware/comorbidityicd10/comorbidity_icd10.jsp

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Examples Comparing CCI & ECM
- Summary
- Additional Resources

Issues to Consider Using Either/Any Measure

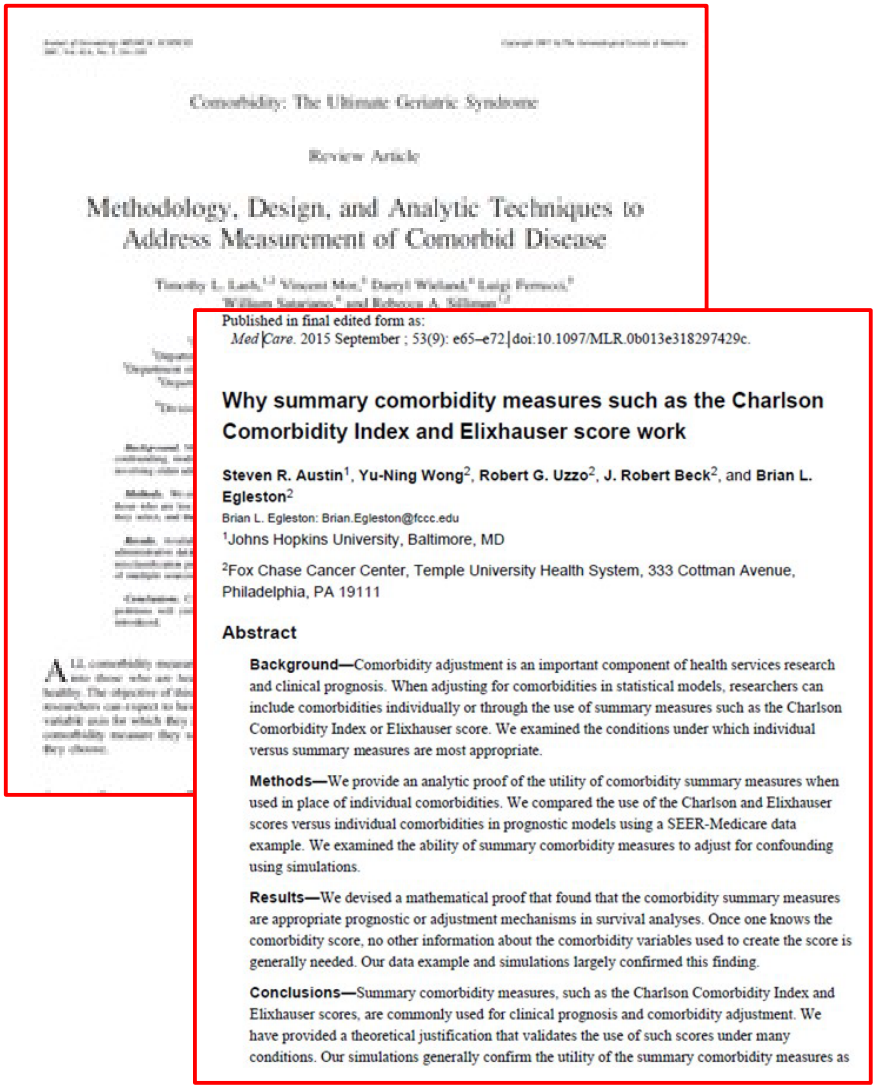
- Individual disease flags or composite score
- Look-back periods
- Any coding changes during period of interest e.g., ICD9/ICD10 transition
- Validity relative to a standard
- Quality of your data



"…a summary measure may only be as good as the variables used to create it."

Austin, et al, 2015

Other References on Comorbidity in General



Comorbidity: The Ultimate Geriatric Syndrome

Review Article

Methodology, Design, and Analytic Techniques to Address Measurement of Comorbid Disease

Published in final edited form as:
Med Care. 2015 September ; 53(9): e65–e72. doi:10.1097/MLR.0b013e31829742 9c.

Why summary comorbidity measures such as the Charlson Comorbidity Index and Elixhauser score work

Steven R. Austin[1], **Yu-Ning Wong**[2], **Robert G. Uzzo**[2], **J. Robert Beck**[2], and **Brian L. Egleston**[2]

Brian L. Egleston: Brian.Egleston@fccc.edu

[1]Johns Hopkins University, Baltimore, MD

[2]Fox Chase Cancer Center, Temple University Health System, 333 Cottman Avenue, Philadelphia, PA 19111

Abstract

Background—Comorbidity adjustment is an important component of health services research and clinical prognosis. When adjusting for comorbidities in statistical models, researchers can include comorbidities individually or through the use of summary measures such as the Charlson Comorbidity Index or Elixhauser score. We examined the conditions under which individual versus summary measures are most appropriate.

Methods—We provide an analytic proof of the utility of comorbidity summary measures when used in place of individual comorbidities. We compared the use of the Charlson and Elixhauser scores versus individual comorbidities in prognostic models using a SEER-Medicare data example. We examined the ability of summary comorbidity measures to adjust for confounding using simulations.

Results—We devised a mathematical proof that found that the comorbidity summary measures are appropriate prognostic or adjustment mechanisms in survival analyses. Once one knows the comorbidity score, no other information about the comorbidity variables used to create the score is generally needed. Our data example and simulations largely confirmed this finding.

Conclusions—Summary comorbidity measures, such as the Charlson Comorbidity Index and Elixhauser scores, are commonly used for clinical prognosis and comorbidity adjustment. We have provided a theoretical justification that validates the use of such scores under many conditions. Our simulations generally confirm the utility of the summary comorbidity measures as

- Austin, SR, Wong, Y-N, Uzzo, RG, Beck, JR, Egleston, BL. *Med Care*. 2015; 53(9): e65–e72.
- Lash TL, Mor V, Wieland D, Ferrucci L, Satariano W, Silliman RA. *J Gerontol A Biol Sci Med Sci.* 2007;62(3):281-285.

Summary

- Selecting the right method always depends on the research questions and the type and quality of your study data
  - There is no one-size-fits-all approach!!!
- There are coding algorithms readily available, yet it is up to you to know where to go with these tools!

Session roadmap

- Concept Review
- Understanding & Applying Two Methods
  - Charlson Comorbidity Index (CCI) and adaptations
  - Elixhauser Comorbidity Method (ECM)
  - Examples Comparing the CCI & ECM
- Summary
- Additional Resources

VIReC Comorbidity Measurement Resources

- Tutorial providing step-by-step guidance on constructing VIReC CCI (Updated in 2017)
  https://vaww.virec.research.va.gov/Tutorials/CALC-CCI/Tutorial-CALC-CCI.pdf

- SAS Programs available as zip files (2015 and 2017 versions) here:
  https://vaww.virec.research.va.gov/Comorbidity/Overview.htm
  - Includes **5 SAS programs** that can be used with Medicare claims and/or VA CDW data for data extraction
  - Includes **3 Excel workbooks** describing details for:
    - ICD-9/ICD-10 codes used
    - All procedure and diagnosis code variables used
    - Explanation of the VA codes for non-clinician assigned dx

- **VIReC** Comorbidity Bibliography (Last updated in 2017)
  https://vaww.virec.research.va.gov/Comorbidity/BIB-Comorbidity.pdf

AHRQ Resources for the ECM

- Software documentation for Elixhauser et al
  - ICD10 Version:

    https://www.hcup-us.ahrq.gov/toolssoftware/comorbidityicd10/comorbidity_icd10.jsp
  - ICD9 Version 3.7:

    https://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp
- Site also numerous updates for each year since 2011
- Bibliography of applications of the ECM

VIReC Options for Specific Questions

- Community knowledge sharing
- ~1,360 VA data users
- Researchers, operations, data stewards, managers
- Subscribe by visiting http://vaww.virec.research.va.gov/Support/HSRData-L.htm (VA Intranet)

- Individualized support

virec@va.gov

(708) 202-2413

Contact information

Denise M. Hynes, MPH, PhD, RN
Core Investigator
Center to Improve Veteran Involvement in Care (CIVIC)
Portland, OR

Denise.Hynes@va.gov
Hynesd@oregonstate.edu

Quick links for VA data resources

Quick Guide: Resources for Using VA Data
http://vaww.virec.research.va.gov/Toolkit/QG-Resources-for-Using-VA-Data.pdf (VA Intranet)

VIReC: http://vaww.virec.research.va.gov/Index.htm (VA Intranet)

VIReC Cyberseminars: http://www.virec.research.va.gov/Resources/Cyberseminars.asp

VHA Data Portal: http://vaww.vhadataportal.med.va.gov/Home.aspx (VA Intranet)

VINCI: http://vaww.vinci.med.va.gov/vincicentral/ (VA Intranet)

Health Economics Resource Center (HERC): http://vaww.herc.research.va.gov (VA Intranet)

CDW: https://vaww.cdw.va.gov/Pages/CDWHome.aspx (VA Intranet)

Selected References on Concepts

- Agur, K., McLean, G., Hunt, K., Cuthrie, B., & Mercer, S. W. (2016). How does sex influence multimorbidity? Secondary analysis of a large nationally representative dataset. International Journal of Environmental Research and Public Health, 13, 391–402.
- Akker, M. V. D., Buntix, F., Metsemakers, J. F. M., Roos, S., & Knottnerus, J. A. (1998). Multimorbidity in general practice: Prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. Journal of Clinical Epidemiology, 51, 367–375.
- Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613–9.
- D'Hoore W, Sicotte C, Tilquin C. Risk adjustment in outcome assessment:the Charlson comorbidity index. Methods Inf Med 1993;32: 382–387.
- D'Hoore W, Bouckaert A, Tilquin C. Practical considerations on the use of the Charlson comorbidity index with administrative databases.J Clin Epidemiol 1996;49:1429–33.
- Ghali WA, Hall RE, Rosen AK, Ash AS, Moskowitz MA. Searching for an improved clinical comorbidity index for use with ICD-9-CM administrative data. J Clin Epidemiol 1996;49:273–8.
- Gonsoulin, M, Durazo-Arvizu, RA, Goldstein, KM, Cao, G, Zhang, Q, Ramanathan, D, Hynes, DM. Disease Clusters among Senior-Aged Women Veterans: A latent class analysis of multimorbidities. *Innovation in Aging*. 2017, 1: 1–12.
- Marengoni, A., Rizzuto, D., Wang, H. Z., Winblad, B., & Fratiglioni, L. (2009). Patterns of chronic multimorbidity in the elderly population. *Journal of the American Geriatrics Society*, **57**, 225–230.
- Murray CJ, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2197–223.
- Murray CJ, Lopez AD. Measuring the global burden of disease. N Engl J Med. 2013;369(5):448–57
- Romano PS, Roos LL, Jollis JG. Further evidence concerning the use of a clinical comorbidity index with ICD-9-CM administrative data. J Clin Epidemiol 1993;46:1085–90.
- Van Doorn C, Bogardus ST, Williams CS, Concato J, Towle VR, Inouye SK. Risk adjustment for older hospitalized persons: a comparison of two methods of data collection for the Charlson index. J Clin Epidemiol 2001;54:694–701.