

USER GUIDE:

AHRQ HCUP ELIXHAUSER COMORBIDITY SOFTWARE REFINED FOR ICD-10-CM DIAGNOSES, v2027.1

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New Hampshire Department of Health & Human Services
New Jersey Department of Health
New Mexico Department of Health
New York State Department of Health
North Carolina Department of Health and Human Services
North Dakota (data provided by the Minnesota Hospital Association)
Ohio Hospital Association
Oklahoma State Department of Health
Oregon Association of Hospitals and Health Systems
Oregon Health Authority
Pennsylvania Health Care Cost Containment Council
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South Carolina Revenue and Fiscal Affairs Office
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Utah Department of Health and Human Services
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Virginia Health Information
Washington State Department of Health
West Virginia Health Care Authority
Wisconsin Department of Health Services
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WHAT'S NEW IN v2027.1 OF THE AHRQ HCUP ELIXHAUSER COMORBIDITY SOFTWARE REFINED FOR ICD-10-CM?

- Added ICD-10-CM diagnosis codes valid starting in fiscal year 2027 so the tool now includes all ICD-10-CM codes valid from October 2015 through September 2027.
- Updated the names of two comorbidity measures: Drug abuse is now Drug use disorders and its abbreviation changed from DRUG_ABUSE to DRUG. Alcohol abuse is now Alcohol-related disorders (the abbreviation did not change from ALCOHOL).
- Two codes that were previously included in the DEMENTIA comorbidity measure were removed after clinical review found they do not correspond to dementia: F0670 and F0671.

Detailed changes for v2027.1 of the HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM are in the Change Log. A summary of key changes for all release versions of the Elixhauser Comorbidity Software Refined for ICD-10-CM is available in Appendix A.

WHAT ARE COMORBIDITIES?

- Comorbidities **are** conditions that affect patient care because they require clinical evaluation or therapeutic treatment, extend the length of stay, or increase nursing care and/or monitoring.[1]
- Comorbidities **are** identified through secondary diagnoses on an inpatient or outpatient record.
- Comorbidities **are** key predictors of length of stay, cost, readmission, and mortality.
- Comorbidities **are not** a comprehensive list of chronic conditions, nor are they necessarily chronic conditions.

[1] Please see ICD-10-CM Official Guidelines for Coding and Reporting FY 2027 for additional details. (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

INTRODUCTION

This report provides technical documentation for the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) Elixhauser Comorbidity Software Refined for International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnoses. Starting on October 1, 2015, diagnoses for hospital inpatient stays and outpatient encounters in the United States are reported using the ICD-10-CM coding system. The AHRQ HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM assigns data elements that identify 38 different pre-existing conditions based on secondary diagnoses (i.e., comorbidities) listed on hospital administrative data. The identified comorbidities *co-exist* at the time of hospitalization or outpatient encounter and were originally selected because they impacted resource allocation (e.g., length of stay or charges) and affect healthcare outcomes, such as in-hospital mortality and readmissions. The comorbidity measures provide an analyst with a way to determine how often a given comorbidity influences the treatment plan for that hospitalization. It is important to understand that in some cases, a person may have one or more of the comorbidity measures, but it is not listed on the inpatient or outpatient record because it did not affect the treatment provided. Additionally, these comorbidities do not reflect a comprehensive list of chronic conditions.[2]

The AHRQ HCUP Elixhauser Comorbidity Software was originally developed using ICD-9-CM diagnosis codes and focused on adult inpatient stays.[3] The software was translated into ICD-10-CM prior to the availability of ICD-10-CM-coded data and released as a beta version. Once ICD-10-CM-coded data became available, the beta version of the Elixhauser Comorbidity Software was evaluated by clinical experts. The recommended modifications (implemented in v2021.1) transitioned the software tool out of its beta status and into the Elixhauser Comorbidity Software Refined for ICD-10-CM.

The AHRQ HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM retains the same intent of the original ICD-9-CM version of the software of defining a comprehensive list of comorbidity measures for use with large administrative databases; however, refinements were made to some of the comorbidity measures. The number of comorbidity measures increases from 29 to 38, with three measures added, five measures modified to create 12 more specific measures, and one measure discontinued. The development of the Elixhauser Comorbidity Software Refined for ICD-10-CM did not explicitly focus on pediatric hospitalizations or outpatient visits. Additional and/or different comorbidity measures may apply to those

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[2] Although most diagnoses used to identify comorbidities indicate a chronic condition, some are not chronic (e.g., ICD-10-CM diagnosis code B33.21, Viral endocarditis, is included in the valvular disease comorbidity measure [CMR_VALVE] but is not a chronic condition).

[3] Elixhauser, Anne, et al. Comorbidity Measures for Use with Administrative Data. *Medical Care*, vol. 36, no. 1, 1998, pp. 8-27 JSTOR, https://www.jstor.org/stable/3766985.

populations. Additional information on the refinement process, including the clinical review and rationale for modifications is provided in Appendix A.

Starting with v2022.1, there is an additional SAS program to create the Elixhauser comorbidity indices for the risk of in-hospital mortality and the risk of 30-day, all-cause readmissions based on the 38 ICD-10-CM-based measures. The development of the ICD-10-CM version of the indices was consistent with the methodology used for the ICD-9-CM version of the tool.[4] Additional information on the development of the ICD-10-CM version of the indices is provided in Appendix B.

The AHRQ HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM is updated annually to coincide with fiscal year (FY) updates to the ICD-10-CM diagnosis coding system and retains diagnosis codes valid from the start of ICD-10-CM in October 2015. For this reason, it is advisable to always use the most recent version of the tool. Downloadable files for the CCSR for ICD-10-CM categories are available on HCUP User Support (HCUP-US) website.[5]

DESCRIPTION OF AHRQ HCUP THE ELIXHAUSER COMORBIDITY SOFTWARE REFINED FOR ICD-10-CM

Comorbidity Measures

The AHRQ HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM creates comorbidity measures that identify pre-existing medical conditions that are not directly related to the main reason for the hospital encounter and that, if present on admission, would likely be associated with a substantial impact on certain outcomes, such as an increase in length of stay, charges, or in-hospital mortality.

The 38 comorbidity measures are identified using secondary ICD-10-CM diagnoses on an inpatient discharge or outpatient record. Starting with the first refined versions (v2021.1), indicators that the secondary diagnosis was present on admission (POA) are used for a subset of the comorbidity measures where the condition could have arisen either prior to or during the hospital stay.[6] The remaining comorbidity measures do not use POA indicators because the condition can be assumed to be pre-existing and not the result of hospital care (e.g., diabetes, AIDS). In contrast, the Elixhauser Comorbidity Software for ICD-9-CM and the beta versions of the Elixhauser Comorbidity Software for ICD-10-CM used the Medicare Severity diagnosis-related groups (MS-DRGs) to exclude secondary diagnoses related to the principal diagnosis for the inpatient stay. Additional information on the changes implemented starting with the v2021.1 release, including background on why the changes were made, is included in Appendix A.

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[4] Moore BJ, White S, Washington R, Coenen N, Elixhauser A. Identifying Increased Risk of Readmission and In-hospital Mortality Using Hospital Administrative Data: The AHRQ Elixhauser Comorbidity Index. Med Care. 2017 Jul;55(7):698-705.
[5] The HCUP User Support website can be found at https://hcup-us.ahrq.gov/.
[6] POA indicators are only used for diagnoses that are not exempt from POA reporting.

Table 1 provides a list of the 38 comorbidity measures, associated abbreviations used for data element names in the accompanying SAS program, and an indication of whether POA indicators are used. The comorbidity measures are alphabetized based on the comorbidity measure's abbreviation in the Elixhauser Comorbidity Software Refined for ICD-10-CM, v2027.1.

Table 1. List of the 38 Comorbidity Measures (v2027.1) with Indication of Use of POA and Differences from the ICD-9-CM Version of the Measure

Abbreviation (SAS Data Element Name, v2027.1)	Comorbidity Measure, v2027.1	Uses POA in the Version Refined for ICD-10-CM? (blue highlighted rows indicate yes)
CMR_AIDS	Acquired immune deficiency syndrome	No
CMR_ALCOHOL	Alcohol-related disorders	No
CMR_ANEMDEF	Deficiency anemias *(Prior to v2023.1, this measure was referred to as Deficiency anemias)*	Yes
CMR_AUTOIMMUNE	Autoimmune conditions (*Measure name revised in v2022.1 to clarify the clinical content; measure was entitled Arthropathies in v2021.1.*)	No
CMR_BLDLOSS	Chronic blood loss (iron deficiency) *(Prior to v2023.1, this measure was referred to as Chronic blood loss anemia)*	Yes
CMR_CANCER_LEUK	Leukemia	No
CMR_CANCER_LYMPH	Lymphoma	No
CMR_CANCER_METS	Metastatic cancer	No
CMR_CANCER_NSITU	Solid tumor without metastasis, in situ	No
CMR_CANCER_SOLID	Solid tumor without metastasis, malignant	No
CMR_CBVD	Cerebrovascular disease	Yes
CMR_COAG	Coagulopathy	Yes
CMR_DEMENTIA	Dementia	No
CMR_DEPRESS	Depression	No
CMR_DIAB_CX	Diabetes with chronic complications	No
CMR_DIAB_UNCX	Diabetes without chronic complications	No
CMR_DRUG	Drug use disorders	No

Abbreviation (SAS Data Element Name, v2027.1)	Comorbidity Measure, v2027.1	Uses POA in the Version Refined for ICD-10-CM? (blue highlighted rows indicate yes)
CMR_HF	Heart failure (*Prior to v2022.1, this measure was referred to as congestive heart failure.*)	Yes
CMR_HTN_CX	Hypertension, complicated	No
CMR_HTN_UNCX	Hypertension, uncomplicated	No
CMR_LIVER_MLD	Liver disease, mild	Yes
CMR_LIVER_SEV	Liver disease and failure, moderate to severe	Yes
CMR_LUNG_CHRONIC	Chronic pulmonary disease	No
CMR_NEURO_MOVT	Neurological disorders affecting movement	Yes
CMR_NEURO_OTH	Other neurological disorders *(This measure includes brain disorders such as encephalopathy and cerebral edema, but also includes other disorders such as multiple sclerosis)*	Yes
CMR_NEURO_SEIZ	Seizures and epilepsy	Yes
CMR_OBESE	Obesity	No
CMR_PARALYSIS	Paralysis	Yes
CMR_PERIVASC	Peripheral vascular disease	No
CMR_PSYCHOSES	Psychoses	Yes
CMR_PULMCIRC	Pulmonary circulation disease	Yes
CMR_RENLFL_MOD	Renal (kidney) failure and disease, moderate	Yes
CMR_RENLFL_SEV	Renal (kidney) failure and disease, severe	Yes
CMR_THYROID_HYPO	Hypothyroidism	No
CMR_THYROID_OTH	Other thyroid disorders	No
CMR_ULCER_PEPTIC	Peptic ulcer with bleeding	Yes
CMR_VALVE	Valvular disease	Yes
CMR_WGHTLOSS	Weight loss	Yes

Comorbidity Measures that Require Indicators that the Diagnosis was Present on Admission (POA)

The Elixhauser Comorbidity Software Refined for ICD-10-CM requires POA indicators to assign 18 of the 38 comorbidity measures. As an example, POA indicators would be needed to identify if the paralysis was present on admission (e.g., occurred prior to admission) or if it occurred during the hospital stay. If the diagnosis was not present on admission, then it should be considered a complication of care (not a comorbidity).

For all 18 of the comorbidity measures that use POA information, the secondary diagnosis of interest must be present on admission, identified using the following values of POA:

- Y indicating the diagnosis was present at the time of admission
- W indicating provider is unable to clinically determine whether condition was present on admission or not.

For the cerebrovascular comorbidity measure, there is also criteria that certain diagnoses are not present on admission, identified using the following values of POA:

- N indicating the diagnosis was *not* present at the time of admission
- U indicating that documentation was insufficient to determine of the condition was present on admission.

Some ICD-10-CM diagnosis codes are exempt from POA reporting because they are for circumstances regarding the healthcare encounter or factors influencing health status that do not represent a current disease or injury or that describe conditions that are always present on admission. When exempt codes are included in clinical criteria for a measure that uses POA, the POA value of the code is not considered.

The Elixhauser Comorbidity Software Refined for ICD-10-CM will not assign the 18 comorbidity measures if the input data to the software does not include POA indicators. POA information is often reported in inpatient data and less frequently in outpatient data. Per the ICD-10-CM Coding Guidelines, the reporting of POA information is required for "all claims involving inpatient admissions to general acute care hospitals or other facilities that are subject to a law or regulation mandating collection of present on admission information."[7]

[7] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027, Appendix I (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

Comorbidity Measures That Do Not Require POA Indicators

Twenty of the 38 comorbidity measures do not require the use of POA indicators because the condition can be assumed to be pre-existing and not the result of hospital care (e.g., diabetes, AIDS). It should be noted that the ICD-10-CM diagnosis codes used to identify comorbidities may capture conditions that occurred immediately prior to the inpatient stay or outpatient encounter (that also meet the criteria above). Examples include alcohol diagnoses that might indicate a condition that is the result of recent, excessive binge-drinking rather than chronic alcohol abuse.

Mapping of ICD-10-CM Diagnosis Codes into More Than One Comorbidity Measure

Individual diagnosis codes may be assigned to more than one comorbidity measure in the Elixhauser Comorbidity Software Refined for ICD-10-CM.

For example, the combination ICD-10-CM diagnosis code I13.2, Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease, is included in three comorbidity measures:

- Heart failure (CMR_HF)
- Hypertension complicated (CMR_HTN_CX)
- Renal (kidney) failure and disease, severe (CMR_RENLFL_SEV)

Cross-classification of ICD-10-CM diagnoses is deemed necessary to identify all conditions specified within a given code description. See Appendix C for a list of codes that are cross-classified.

Handling of Clinically Similar Comorbidity Measures

There are some comorbidity measures that are clinically similar but differentiated by severity. It is possible for an input record to include an ICD-10-CM diagnosis code that triggers both the less severe and the more serve comorbidity measure. In these cases, the SAS analysis program will only assign the input record to the more severe comorbidity measure:

- Diabetes, complicated, is assigned over Diabetes, uncomplicated
- Hypertension, complicated, is assigned over Hypertension, uncomplicated
- Liver disease and failure, moderate to severe, is assigned over Liver disease, mild
- Renal (kidney) failure and disease, severe, is assigned over Renal (kidney) failure and disease, moderate
- Metastatic cancer is assigned over Solid tumor without metastasis, malignant and in situ
- Solid tumor without metastasis, malignant, is assigned over Solid tumor without metastasis, in situ.

Identification of the Comorbidity Measure for Cerebrovascular Disease

There are two separate clinical coding screens used to identify cerebrovascular disease as a comorbidity:

- Diagnosis codes that indicate cerebrovascular disease
- Diagnosis codes starting with I69 that indicate a sequela of cerebral infarction and other cerebrovascular disease. From the ICD-10-CM Coding Guidelines "Codes from category I69 may be assigned on a health care record with codes from I60-I67, if the patient has a current cerebrovascular disease and deficits from an old cerebrovascular disease."[8]

Many of the I69 codes do not require that information on whether the diagnosis was present on admission (POA) be reported with the code. This fact makes the identification of cerebrovascular disease as a comorbidity difficult because it is unclear if the sequela event happened during the current hospital stay or prior to the stay. We do not want to identify cerebrovascular disease as a comorbidity when a patient has two diagnoses related to cerebral infarction during a hospital inpatient stay – one coded as sequela and one not.

The SAS mapping program defines three data elements related to cerebrovascular disease:

- CMR_CBVD_POA = 1 if a secondary diagnosis for cerebrovascular disease was present on admission (POA=Y or W)
- CMR_CBVD_NPOA = 1 if a secondary diagnosis for cerebrovascular disease occurred during the hospital stay (POA=N or U).
- CMR_CBVD_SQLA = 1 if a secondary diagnosis for sequela of cerebrovascular disease was present on admission (POA=Y or W) or the diagnosis was exempt from POA reporting.

A comorbidity of cerebrovascular disease (CMR_CBVD = 1) is indicated by one of the following scenarios:

- A secondary diagnosis for cerebrovascular disease was present on admission (CMR_CBVD_POA=1)
- A secondary diagnosis for sequela of cerebrovascular disease was coded (CMR_CBVD_SQLA=1) and there was no mention of cerebrovascular disease occurring during the hospital stay (CMR_CBVD_POA=0 and CMR_CBVD_NPOA=0).

[8] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027, Section I.C.9.d.2 (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

ICD-10-CM Coding Guidelines that May Impact the Identification of Comorbidities

The following ICD-10-CM Coding Guidelines may impact the identification of comorbidities in inpatient and outpatient data: [9]

- The different coding guidelines for reporting diagnoses in inpatient and outpatient data
- The use of combination ICD-10-CM codes
    - A combination code is a single code used to identify two diagnoses or a diagnosis with an associated secondary manifestation or complication
- The reporting of paired codes as specified by ICD-10-CM Coding Guidelines
- Changes in coding instructions for which diagnosis should be coded first on a record.

Further details are described in the sections that follow.

<u>The Reporting of Diagnoses in Inpatient and Outpatient Data</u>

The Elixhauser Comorbidity Software Refined for ICD-10-CM can be applied to both inpatient and outpatient data.[10] However, there are some key differences in the ICD-10-CM Coding Guidelines[11] between these two settings of care that are important to note:

- Principal or first-listed diagnosis
    - In inpatient data, the term principal diagnosis is used (Section II). The principal diagnosis is defined as "that condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care (Section II)."
    - In outpatient data, the term first-listed diagnosis is used in lieu of principal diagnosis (Section IV.A). The instructions specify to list first the ICD-10-CM code for the diagnosis, condition, problem, or other reason for encounter/visit shown in the medical record to be chiefly responsible for the services provided. In some cases, the first-listed diagnosis may be a symptom when a diagnosis has not been established (confirmed) by the provider (Section IV.G). For ambulatory surgery, code the diagnosis for which the surgery was performed (Section IV.N).

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[9] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027, Section I.B.9 (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

[10] Prior to v2021.1, the Elixhauser Comorbidity Software was only applicable to inpatient data because of the use of DRGs to identify comorbidities.

[11] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027 (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

- Secondary diagnoses
    - Secondary diagnoses should indicate additional conditions that affect patient care in terms of requiring clinical evaluation, therapeutic treatment, diagnostic procedures, extended length of stay or increased nursing care and/or monitoring (Section III).
    - In inpatient data, if the secondary diagnosis documented at the time of discharge is qualified as “probable,” “suspected,” or other similar terms indicating uncertainty, code the condition as if it existed or was established (Section III.C).
    - In outpatient data, instructions indicate that uncertain diagnoses should not be coded. Rather, code the condition(s) to the highest degree of certainty for that encounter/visit, such as symptoms, signs, abnormal test results, or other reason for the visit (Section IV.H).

The comorbidity measures (which are based on secondary diagnoses) provide an analyst with a way to determine how often a given comorbidity influences the treatment plan for that hospitalization or outpatient encounter. Comorbidities may not be reported if they do not impact treatment. For example, consider an adult who has type II diabetes and is admitted to the hospital for an elective surgery. The diagnosis of diabetes will only be reported as a secondary diagnosis on the hospital record if the care in the hospital included the evaluation or treatment of diabetes or if diabetes complicated the surgery.

Combination ICD-10-CM Codes

Combination diagnosis codes include information on more than one condition in a single ICD-10-CM code. The comorbidity software may not always identify the pre-existing condition in a combination code as a comorbidity for the following reasons:

- If the combination ICD-10-CM diagnosis code is reported as a *principal or first-listed diagnosis*, the software will not identify the comorbidity because the software only considers secondary diagnoses. Consider a patient who is discharged with a principal diagnosis of I13.2, Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease. Hypertension as a comorbidity will not be identified because the software only considers secondary diagnoses.
- If the combination ICD-10-CM diagnosis code is reported as *secondary diagnosis*, the identification may depend on the POA indicator. The ICD-10-CM Coding Guidelines specify that the POA indicator should be assigned as *not* present on admission if any of the clinical concepts included in the code were not present on admission. Consider a secondary diagnosis code of K25.4, Chronic or unspecified gastric ulcer with hemorrhage. The code will be reported as not present on admission if the hemorrhaging occurred when the patient was in the hospital, even though the chronic gastric ulcer was present on admission. In this case, the diagnosis will not trigger the comorbidity measure

for peptic ulcer with bleeding (CMR_ULCER_PEPTIC). The software requires the condition be present on admission.

If an analysis needs to be sensitive to comorbidities reported as the principal or first-listed diagnosis, the SAS mapping program for the comorbidity software tool, can be modified to consider all diagnoses by changing the start of the diagnosis DO loop from 2 to 1:

```
DO I = 1 TO MIN(&MAXNDX,&NUMDX) ;
```

Reporting of Paired ICD-10-CM Codes

ICD-10-CM Coding Guidelines require two diagnosis codes be reported in tandem for certain conditions. For example, the type of heart failure is reported as a secondary diagnosis when hypertensive heart disease is the principal diagnosis.[12] The Elixhauser Comorbidity Software Refined for ICD-10-CM will identify the secondary diagnosis of the type of heart disease as a comorbidity when in fact it is related to the principal diagnosis.

If an analysis needs to be sensitive to eliminating the effect of paired codes in the identification of comorbidities, the SAS mapping program for the comorbidity software tool, can be modified as follows:

(1) Apply the SAS mapping as provided to assign comorbidities using only secondary diagnoses
(2) Revise the program to assign a second set of comorbidity data elements using only the principal or first-listed diagnosis (i.e., change the diagnosis DO loop to use only DX1)
(3) Compare the two sets of comorbidity indicators and excluding comorbidities if the principal or first-listed diagnosis was in the same comorbidity category as a secondary diagnosis.

Changes in Coding Instructions

Changes in clinical coding instructions, such as in the ICD-10-CM Clinical Coding Guidelines or clarifications through the *American Hospital Association* (*AHA) Coding Clinic*, may impact the identification of comorbidities within and across data years. For example, based on the 2016 and 2017 NIS, there is a large increase from 3.6 million to 4.7 million in inpatient stays identified as having complicated diabetes as a comorbidity (CMR_DIAB_CX) and a corresponding decrease from 4.3 million to 3.4 million in the comorbidity for uncomplicated diabetes (CMR_DIAB_UNCX). This vast change in the comorbidity is likely due to a clarification in the *AHA Coding Clinic* that impacted the recording of specific diagnoses on a medical record by a

[12] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027, Section I.C.9.a.1 (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

medical coder. In 2016, the *AHA Coding Clinic* provided clarification on the interpretation of the term "with" in the ICD-10-CM Alphabetic Index which essentially stated that a link could be assumed between the main term (such as diabetes) and another condition (such as chronic kidney disease) and did not have to be explicitly stated by the provider in the medical record. This guidance was not only for diabetes diagnoses but any index entry where "with" is a subterm. Linkage is permitted to be assumed UNLESS the provider specifically documents another cause for the condition.

USING THE DOWNLOADABLE ELIXHAUSER COMORBIDITY SOFTWARE REFINED FOR ICD-10-CM FILES

System Requirements

Using the AHRQ HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM requires a program to decompress or “unzip” files.[13] Approximately 2 megabytes of disk space available on one’s hard drive also will be needed to accommodate all the tool’s files. Additional space is necessary for saving the tool’s output files.

Downloadable Files

The following files related to the Elixhauser Comorbidity Software Refined for ICD-10-CM are contained in a downloadable zip file:

1. SAS format library program, which includes the formats for the mapping of ICD-10-CM diagnosis codes into the comorbidity measures, as well as formats that identify ICD-10-CM diagnoses exempt from POA reporting
2. SAS mapping program to add the comorbidity measures to the user’s data
3. SAS index program to calculate the Elixhauser comorbidity indices for the risk of in-hospital mortality and the risk of 30-day, all-cause readmissions
4. Elixhauser Comorbidity Software Refined for ICD-10-CM User Guide (PDF).
5. Elixhauser Comorbidity Software Refined for ICD-10-CM Reference File (Excel)
6. Change log with specific detail on coding changes between versions (Excel).

Table 2 includes additional detail on the names and purposes of the files contained in the Elixhauser Comorbidity Software Refined for ICD-10-CM zip file.

[13] Third-party zip utilities are available from the following reputable vendors on their official websites: ZIP Reader (Windows) (free download offered by PKWARE, Inc.), SecureZIP® for Mac or Windows (free evaluation and licensed/fee software offered by PKWARE, Inc.), WinZip (Windows) (evaluation and fee versions offered by the Corel Corporation), Stuffit Expander® (Mac) (free evaluation and licensed/fee software offered by Smith Micro Software Inc.).

Table 2. Contents of the Elixhauser Comorbidity Software Refined for ICD-10-CM Zip File

File Name	Purpose
CMR_Format_Program_vyyyy-r.sas where *yyyy* represents fiscal year and *r* represents a release number within the year. For example, the first release of the format program to include codes valid through fiscal year 2027 is named CMR_Format_Program_v2027-1.sas.	SAS format program that includes the formats needed to identify ICD-10-CM diagnosis codes in each of the comorbidity measures. Also included are formats that identify which ICD-10-CM diagnosis codes are exempt from POA reporting.
CMR_Mapping_Program_vyyyy-r.sas where *yyyy* represents fiscal year and *r* represents a release number within fiscal year	SAS mapping program that applies the formats defined in the format program to the user-provided input data and creates SAS data elements for each of the comorbidity measures. POA-sensitive comorbidity measures will be set to missing (SAS value = .) if the input data does not include POA information.
CMR_Index_Program_vyyyy-r.sas where *yyyy* represents fiscal year and *r* represents a release number within fiscal year	SAS index program that calculates the Elixhauser comorbidity indices for the risk of in-hospital mortality and the risk of 30-day, all-cause readmissions based on the ICD-10-CM-based comorbidity measures. POA indicators must have been available for the assignment of the comorbidity measures. For the correct calculation of the indices, all 38 comorbidity measures must be coded.
CMR-User-Guide-vyyyy-r.pdf where *yyyy* represents fiscal year and *r* represents a release number within fiscal year	This document (i.e., User Guide for the Elixhauser Comorbidity Software Refined for ICD-10-CM in PDF format).
CMR-Reference-File-vyyyyr.xlsx where *yyyy* represents fiscal year and *r* represents a release number within fiscal year	A reference file (Microsoft Excel) includes three tabs: (1) The first tab is a table of contents with links to the other tabs. (2) The second tab includes a list of comorbidity measures with abbreviations and indication whether POA is required for assignment. (3) The third tab lists the ICD-10-CM diagnosis codes with descriptions included in the software and the associated comorbidity (or comorbidities).
CMR-ChangeLog-vyyyyr-vyyyyr.xlsx where *yyyy* represents fiscal year and *r* represents a release number within fiscal year	A log of changes (Microsoft Excel) between two versions of the Elixhauser Comorbidity Software Refined for ICD-10-CM software including detail on specific coding changes.

Abbreviations: ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification

Data Elements Required for the Input Dataset to the SAS Mapping Program to Define the Comorbidity Measures

The input dataset **must** contain an array of ICD-10-CM diagnosis codes without decimals. In addition, to determine the 18 comorbidity measures that depend on knowing if the diagnosis was present on admission, the input dataset must include indicators of the diagnoses are present on admission (Table 3). The 20 comorbidity measures that do not depend on POA indicators will always be assigned.

Table 3. Required Input Data Elements to the SAS Mapping Program to Define the Comorbidity Measures

Data Element Name in Program	Purpose	How to Modify the Data Element Name Used in the Program	Data Element Name in HCUP Databases
DX1-DXn where n is the dimension of the diagnosis array. The dimension of the array must be at least 2 because the comorbidity measures are specific to secondary diagnoses.	Array of ICD-10-CM diagnoses (without decimals) used to assign comorbidity measures	Specify prefix for DX array using macro statement %LET DXPREFIX=	I10_DX1-I10DXn in all HCUP databases starting in data year 2016
YEAR	Discharge year (format YYYY), which is required to check whether ICD-10-CM diagnosis code is exempt from POA reporting	Not modifiable. Hard-coded into program.	YEAR
DQTR	Discharge quarter (values 1 for Jan-Mar, 2 for April-June, 3 for July-Sept, 4 for Oct-Dec), which is required to check whether the ICD-10-CM diagnosis code is exempt from POA reporting	Not modifiable. Hard-coded into program.	DQTR

Data Element Name in Program	Purpose	How to Modify the Data Element Name Used in the Program	Data Element Name in HCUP Databases
Required to assign 18 of the comorbidity measures: POA1-POAn where n is the dimension of the array of indicators that the diagnosis is present on admission. NOTE: The dimension of the array must be the same length as the diagnosis array.	Array of POA indicators required to assign the comorbidity measures for which coding is sensitive to the diagnosis being present on admission.	Specify prefix for POA array using macro statement %LET POAPREFIX=	DXPOA1-DXPOAn

The values of the DXPOAn variables should be consistent with the ICD-10-CM Coding Guidelines for POA reporting:[14]

- Y indicating the diagnosis was present at the time of admission
- N indicating the diagnosis was *not* present at the time of admission
- U indicating that documentation was insufficient to determine of the condition was present on admission
- W indicating provider is unable to clinically determine whether condition was present on admission or not.

[14] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027, Appendix I (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf).

Representation of ICD-10-CM Diagnosis Codes

ICD-10-CM diagnoses often are represented by 4- to 7-digit alphanumeric codes with explicit decimals. In the format program, the ICD-10-CM diagnosis codes are enclosed in quotation marks and do not contain decimals. Table 4 provides examples for how the ICD-10-CM diagnosis codes are represented in the format program.

Table 4. Example of Representation of ICD-10-CM Diagnosis Codes in the Comorbidity Software

Condition	ICD-10-CM Diagnosis Code	Alphanumeric Code (With Implicit Decimals) in the Format Program
Single liveborn infant, delivered vaginally	Z38.00	‘Z3800 ’
Sepsis, unspecified organism	A41.9	‘A419 ’
Pneumonia, unspecified organism	J18.9	‘J189 ’

Abbreviations: ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification

For the accurate assignment of comorbidity measures, the ICD-10-CM diagnosis codes in the input files must be reported as follows:

- Alphanumeric diagnosis codes must be left-justified, allowing trailing blanks to fill up the full length of 7 characters.
    - Example: Diagnosis J18.9 should be retained as ‘J189 ’ in the input file.
- Trailing blanks should never be zero-padded.
    - Example: Diagnosis ‘J189 ’ should *not* be represented as ‘J189000’.
- Only fully specified ICD-10-CM codes should be included. The comorbidity mapping program does not account for substrings or parent codes, such as three-digit code blocks
    - Example: Diagnosis E11 (Type 2 diabetes mellitus) or E11x cannot be used to capture all codes that begin with the characters E11.

Running the Three SAS Programs Included with the Elixhauser Comorbidity Measures Refined for ICD-10-CM

To download, modify, and run the software to apply the Elixhauser Comorbidity Software Refined for ICD-10-CM to an input dataset, follow these steps:

1. Users should download and extract the contents of the zip file containing the Elixhauser Comorbidity Software Refined for ICD-10-CM tool to a saved location on their computer. Files included in the zip file are described in Table 2 and referenced below.
2. Users must set up and run the three SAS programs in the following order
    a. CMR_Format_Program_vyyyy-r.sas
    b. CMR_Mapping_Program_vyyyy-r.sas
    c. CMR_Index_Program_vyyy-r.sas

For each program, users will need to specify file locations and modify macros variables to match the data element names and file structure of the input dataset. The sections below, detail the requirements for each program.

Running the SAS Format Program

The SAS format program creates a SAS format library needed for the mapping program. Table 5 provides the modifiable directory paths within the SAS Format Program.

Table 5. Modifiable Directory Paths in SAS Format Program

Description of Directory Paths	SAS Program Syntax
File Locations	
Specify the location for the SAS format library	LIBNAME LIBRARY

Running the SAS Mapping Program

The SAS mapping program adds the 38 comorbidity measures to the user's data. Table 6 provides the modifiable macro variables and directory paths within the SAS Mapping Program. A description of each directory path and macro variable is provided along with the corresponding SAS program syntax.

Table 6. Modifiable Macro Variables and Directory Paths in SAS Mapping Program by Type of Information

Description of Macro Variables and Directory Paths	SAS Program Syntax Example
File Locations	
Specify the location for the SAS format library	LIBNAME LIBRARY
Specify the location of the input dataset	LIBNAME IN1
Specify the location of the output dataset(s)	LIBNAME OUT1
Input File Characteristics	
Specify the prefix used to name the ICD-10-CM diagnosis data element array of the input dataset. In this example, the diagnosis data elements would be named I10_DX1, I10_DX2, etc., similar to the naming of ICD-10-CM data elements in HCUP databases.	%LET DXPREFIX=I10_DX;
Specify the maximum number of diagnosis codes on any record in the input file. In this example the maximum number of diagnosis codes on any record is 15. The value of NUMDX must be numeric and greater than or equal to 2 because comorbidities are defined from secondary diagnoses. If NUMDX is 1 the program assumes there is only a principal (first-listed) diagnosis and does not assign the comorbidity measures.	%LET NUMDX=15;
Specify the data element that identifies the number of diagnoses reported on the record. This is optional and can be left blank if no such data element exists. (In the HCUP databases, this is the variable I10_NDX).	%LET NDXVAR=I10_NDX;
Specify if indicators that diagnosis is present on admission (POA) are available (1=yes, 0=no). POA indicators are required to assign 18 of the comorbidity measures.	%LET POA = 1;

Description of Macro Variables and Directory Paths	SAS Program Syntax Example
Specify the prefix used to name the data element array for the POA indicators in the input dataset. In this example, the POA indicators would be named DXPOA1, DXPOA2, etc., similar to the naming of ICD-10-CM data elements in HCUP databases. If there are no POA indicators, the macro can be left blank.	%LET POAPREFIX=DXPOA;
Specify the number of observations to use from the input dataset. Use MAX to use all observations and use a smaller value for testing the program.	%LET OBS=MAX;
Input and Output File Names	
Specify the file member name of the input dataset	%LET CORE = YOUR_SAS_INPUT_FILE_HERE;
Specify the file member name for the output file	%LET OUT = YOUR_SAS_OUTPUT_FILE_HERE;

Abbreviation: ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification

Running the SAS Index Program

The SAS index program adds the two Elixhauser comorbidity indices—risk of in-hospital mortality and risk of 30-day, all-cause readmissions—to the user's data. The two indices were designed to use all 38 comorbidity measures which means the input data to the mapping program that assigns the comorbidity measures must have included indicators that the diagnoses were present on admission. Table 7 provides the modifiable macro variables and directory paths within the SAS Index Program. A description of each directory path and macro variable is provided along with the corresponding SAS program syntax.

Table 7. Modifiable Macro Variables and Directory Paths in SAS Index Program by Type of Information

Description of Macro Variables and Directory Paths	SAS Program Syntax Example
File Locations	
Specify the location of the input dataset	LIBNAME IN1
Specify the location of the output dataset(s)	LIBNAME OUT1
Input File Characteristics	
Specify the number of observations to use from the input dataset. Use MAX to use all observations and use a smaller value for testing the program.	%LET OBS=MAX;

APPENDIX A: BACKGROUND ON THE ELIXHAUSER COMORBIDITY SOFTWARE REFINED FOR ICD-10-CM

The Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) Elixhauser Comorbidity Software was originally developed using ICD-9-CM diagnosis codes and adult (ages 18 years and older) inpatient discharge data.[15,16] The software was translated into ICD-10-CM prior to the availability of ICD-10-CM-coded data and released as a beta version. Once ICD-10-CM-coded data became available, the beta version of the Elixhauser Comorbidity Software was evaluated by clinical experts. The recommended modifications (implemented in v2021.1) transitioned the software tool out of its beta status and into the Elixhauser Comorbidity Software Refined for ICD-10-CM.

The Elixhauser Comorbidity Software Refined for ICD-10-CM strived to retain the same intent of the original ICD-9-CM version of the software and focused on two types of changes:

- Modifications to the comorbidity measures included in the software tool
- Modifications to the clinical criteria used to identify comorbidities.

Further details on the two types of changes are described in the sections that follow.

Modifications to the Number of Comorbidity Measures

This process began with a literature review to understand how the Elixhauser Comorbidity Software had been used in health services research. Specifically, the team was interested in learning of any recommendations from researchers in terms of comorbidity measures to add or drop. Articles of interest included the following (in alphabetic order):

- Charlson ME, Pompei P, Ales KL, MacKenzie CR. A New Method of Classifying Prognostic Comorbidity in Longitudinal Studies: Development and Validation. 1987; J Chron Dis. 40(5): 373-383.
- Coleman CI, Kohn CG, Crivera C, Schein JR, Peacock WF. Validation of the multivariable In-hospital Mortality for Pulmonary embolism using Claims data (IMPACT) prediction rule within an all-payer inpatient administrative claims database. BMJ Open. 2015 Oct 28;5(10):e009251.
- Epstein RH, Dexter F. Development and validation of a structured query language implementation of the Elixhauser comorbidity index. J Am Med Inform Assoc. 2017 Jul 1;24(4):845-850.

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[15] Elixhauser, Anne, et al. Comorbidity Measures for Use with Administrative Data. *Medical Care*, vol. 36, no. 1, 1998, pp. 8-27 JSTOR, https://www.jstor.org/stable/3766985.

[16] Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. J Clin Epidemiol. 1993 Oct;46(10):1075-9; discussion 1081-90.

- Fortin Y, Crispo JA, Cohen D, McNair DS, Mattison DR, Krewski D. External validation and comparison of two variants of the Elixhauser comorbidity measures for all-cause mortality. PLoS One. 2017 Mar 28;12(3):e0174379.
- Glasheen WP, Cordier T, Gumpina R, Haugh G, Davis J, Renda A. Charlson Comorbidity Index: *ICD-9* Update and *ICD-10* Translation. Am Health Drug Benefits. 2019 Jun-Jul;12(4):188-197.
- Newman WC, Kubilis PS, Hoh BL. Validation of a neurovascular comorbidities index for retrospective database analysis. J Neurosurg. 2018 Jan 26;130(1):273-277.
- Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, Saunders LD, Beck CA, Feasby TE, Ghali WA. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005 Nov;43(11):1130-9.

After reviewing results from the literature search, the team decided to modify the original comorbidity measures as follows:

- Four measures were modified to account for disease severity:
    - Hypertension – uncomplicated and complicated
    - Liver disease – mild liver disease and moderate to severe liver disease and failure
    - Renal (kidney) failure and disease – moderate and severe
    - Solid tumor without metastasis – malignant and in situ.
- The heterogeneous category of neurological disorders was divided into four more specific categories:
    - Dementia
    - Seizures and epilepsy
    - Neurological disorders affecting movement
    - Other neurological disorders.
- Three comorbidity measures were added:
    - Cerebrovascular disease because of a significant increase (48%) from 2006 to 2014 in comorbid cerebrovascular events for patients aged 35 to 64 years old.[17]
    - Leukemia to make the reporting of cancer-related comorbidities more complete.
    - Other thyroid as a complement to hypothyroidism, to capture hyperthyroidism and other thyroid disorders.
- One measure, Fluid and electrolyte disorders, was discontinued because the diagnoses included in this comorbidity measure are typically considered acute and secondary to an underlying problem or comorbidity.

[17] Tong X, Yang Q, Ritchey MD, George MG, Jackson SL, Gillespie C, et al. The Burden of Cerebrovascular Disease in the United States. Prev Chronic Dis 2019;16:180411.

Cerebrovascular disease, dementia, and leukemia were considered for the original ICD-9-CM list of comorbidity measures but were excluded because the analysis did not show their presence was related to length of stay, total charges, or in-hospital mortality. The original study was based on 1992 data from 439 hospitals in the California HCUP State Inpatient Databases (SID).[18] The clinical review team decided that these comorbidities were important to include for current data.

Modifications to the Clinical Criteria Used to Identify Comorbidities

The clinical criteria used to identify comorbidities were modified in two ways:

- The ICD-10-CM diagnosis codes included in each comorbidity measure
- The criteria used to identify secondary diagnoses as a comorbidity.

Review of ICD-10-CM Diagnosis Coding

The ICD-10-CM coding for each of the 38 comorbidity measures was reviewed by clinical experts. The review compared the diagnosis codes included in the beta version of the Elixhauser Comorbidity Software for ICD-10-CM with three other sources of information: (1) codes included in similar categories of the Clinical Classifications Software Refined (CCSR) for ICD-10-CM diagnoses, (2) codes identified as chronic in the beta version of the Chronic Condition Indicator for ICD-10-CM, and (3) coding criteria specified in articles in the literature search. Also considered was information on the frequency of codes reported as principal and secondary diagnoses with the corresponding counts by the different values of the POA indicators. Frequency counts were based on the 2017 HCUP SID from 43 States with POA indicators. The coding review was also applicable to the newly added comorbidity measures. Included in Table A.1 is a summary of the decisions for the individual comorbidity measures included in the refined ICD-10-CM version in terms of similarity to ICD-9-CM and coding included in the ICD-10-CM beta versions.

[18] Elixhauser, Anne, et al. Comorbidity Measures for Use with Administrative Data. *Medical Care*, vol. 36, no. 1, 1998, pp. 8-27 JSTOR, https://www.jstor.org/stable/3766985.

Table A.1. Summary of Clinical Coding Changes by Comorbidity Measure

Comorbidity Measure	ICD-10-CM Coding Decisions Made for the Version Refined for ICD-10-CM (Starting with v2021.1)
CMR_AIDS: Acquired immune deficiency syndrome	• Clinical content is similar to ICD-9-CM comorbidity measure AIDS. • Added O98 codes for Human immunodeficiency virus [HIV] disease complicating pregnancy, childbirth and the puerperium to ensure that pregnancy-related conditions are captured. • Added Z21, Asymptomatic human immunodeficiency virus [HIV] infection status. Z21 is coded on the hospital record if the physician documents that the patient is “HIV positive,” “known HIV,” “HIV test positive,” or similar terminology.
CMR_ALCOHOL: Alcohol-related disorders	• Clinical content is similar to ICD-9-CM comorbidity measure ALCOHOL. • Alcohol use codes are only included if the code is (1) complicating pregnancy or (2) in combination with a psychiatric disorder recognized under Diagnostic and Statistical Manual of Mental Disorders (DSM). ○ Added O99.3 codes for Alcohol use complicating pregnancy, childbirth, and the puerperium to ensure that pregnancy-related conditions are captured. • Added codes indicative of serious conditions complicating alcohol abuse or dependence (e.g., alcoholic hepatitis, alcoholic gastritis)
CMR_ANEMDEF: Anemias due to other nutritional deficiencies	• Clinical content is similar to ICD-9-CM comorbidity measure ANEMDEF. • Added 099.01 codes for Anemia complicating pregnancy in the first, second or third trimester. Not added were O99 codes for Anemia complicating childbirth and the puerperium as these anemias are considered more frequently due to acute blood loss.
CMR_AUTOIMMUNE: Autoimmune conditions (Prior to v2022.1, this comorbidity was entitled Arthropathies [CMR_ARTH])	• Clinical content is similar to ICD-9-CM comorbidity measure ARTH for Rheumatoid Arthritis/Collagen Vascular Diseases. • Added codes indicative of vasculitis and systemic lupus erythematosus (SLE)-related disorders. • In v2022.1, removed codes indicative of other specified spondylopathies as these appear inconsistent of the ICD-9-CM comorbidity measure, which is more often related to degenerative disorders as opposed to inflammatory.

Comorbidity Measure	ICD-10-CM Coding Decisions Made for the Version Refined for ICD-10-CM (Starting with v2021.1)
CMR_BLDLOSS: Chronic blood loss (iron deficiency)	• Clinical content is similar to ICD-9-CM comorbidity measure BLDLOSS. • In v2021.1, moved O99.01 codes for Anemia complicating pregnancy to the comorbidity measure, Deficiency anemias. • In v2023.1, removed diagnosis codes O90.81, Anemia of the puerperium, O99.02, Anemia complicating childbirth, and O99.03, Anemia complicating the puerperium because these obstetric codes indicate acute, not chronic, blood loss.
CMR_CANCER_LEUK: Leukemia	• New comorbidity measure included only in the revised version of the ICD-10-CM software tool.
CMR_CANCER_LYMPH: Lymphoma	• Clinical content similar to ICD-9-CM comorbidity measure LYMPH. • Moved diagnosis codes indicative of leukemia to the newly added Leukemia comorbidity measure.
CMR_CANCER_METS: Metastatic cancer	• Clinical content is similar to ICD-9-CM comorbidity measure METS. • Removed C80.1, Malignant (primary) neoplasm, unspecified, and R180, Malignant ascites, as these are not indicative of metastatic cancer.
CMR_CANCER_SOLID: Solid tumor without metastasis, malignant	• Clinical content is similar to ICD-9-CM comorbidity measure TUMOR. • Focused this measure on solid malignant tumors without metastasis, starting with v2021.1. • Added diagnosis codes that align with the National Cancer Institute's classification of cancer, such as myelodysplastic syndrome. Additionally, added diagnosis codes indicative of cancers of the skin.
CMR_CANCER_NSITU: Solid tumor without metastasis, in situ	• New comorbidity measure included only in the revised version of the ICD-10-CM software tool and focused on cancer in situ. Melanoma in situ diagnosis codes had been included under the ICD-9-CM measure for Solid tumor without malignant metastasis (TUMOR), but not other types of in situ diagnosis codes. • Included D00-D09 codes related to carcinoma and melanoma in situ.
CMR_CBVD: Cerebrovascular disease	• New comorbidity measure included only in the revised version of the ICD-10-CM software tool. • Diagnosis codes indicating a cerebral infarction and other cerebrovascular diseases must be present on admission. • Sequela codes for cerebral infarction and other cerebrovascular diseases are used if and only if there is no indication of cerebrovascular disease present on admission or occurring during the hospital stay.

Comorbidity Measure	ICD-10-CM Coding Decisions Made for the Version Refined for ICD-10-CM (Starting with v2021.1)
CMR_ HF: Heart failure (Beginning with v2022.1, the name of this comorbidity measure no longer includes the descriptor “congestive” but the coding criteria remained the same.)	• Clinical content is similar to ICD-9-CM comorbidity measure CHF. • Added I51.81, Takotsubo Syndrome (syndrome characterized by transient regional systolic dysfunction of the left ventricle), and R57.0, Cardiogenic shock. • Added diagnosis codes indicative of other heart failures including those following surgery, anesthesia; and other status codes that reasonably demonstrate ongoing heart failure (e.g., Presence of heart assist devices). • Added O29.12 codes for Cardiac failure due to anesthesia during pregnancy. • Added Z95.81 codes for Presence of heart assist device and fully implantable artificial heart.
CMR_COAG: Coagulopathy	• Clinical content is similar to ICD-9-CM comorbidity measure COAG. • Added D61 codes for Other aplastic anemias and other bone marrow failure syndromes related to thrombocytopenia (e.g., idiopathic aplastic anemia).
CMR_DEMENTIA: Dementia	• Under ICD-9-CM there was one comorbidity measure for Neurological disorders (NEURO). In the revised version for ICD-10-CM there are separate measures for dementia, seizures and epilepsy, neurological disorders affecting movement, and other neurological disorders. • The ICD-10-CM dementia measure includes Alzheimer’s disease, Pick’s disease, Alpers disease, vascular dementia, and other indications of dementia. Similar diagnoses were included under the original ICD-9-CM neurological comorbidity measure.
CMR_DEPRESS: Depression	• Clinical content is similar to ICD-9-CM comorbidity measure DEPRESS. • Added F06.3 codes indicative of mood disorders with depressive features. • Removed code R43.21, Adjustment disorder with depressed mood, as it does not meet the clinical criteria as a form of classic depression.
CMR_DIAB_CX: Diabetes with chronic complications	• Clinical content is similar to ICD-9-CM comorbidity measure DMCX. • Removed code P70.2, Neonatal diabetes mellitus, as it does not specify a diabetes mellitus complication.
CMR_DIAB_UNCX: Diabetes without chronic complications	• Clinical content is similar to ICD-9-CM comorbidity measure DM. • Added O24.4 codes related to Gestational diabetes mellitus complication pregnancy, childbirth, and the puerperium.

Comorbidity Measure	ICD-10-CM Coding Decisions Made for the Version Refined for ICD-10-CM (Starting with v2021.1)
CMR_DRUG: Drug use disorders	• Clinical content is similar to ICD-9-CM comorbidity measure DRUG. • Removed F55 codes related to the abuse of non-psychoactive substances, antacids, herbal remedies, laxatives, vitamins, and hormones. • Drug "use" codes (new under ICD-10-CM) were not added to the clinical criteria for this comorbidity measure. Unless a patient has been diagnosed by a psychiatrist, physicians may be reluctant to report drug dependence. This makes it hard to say whether the drug use codes indicate a comorbidity. Additional analysis on the reporting of these codes is needed before they are included in the drug abuse measure.
CMR_HTN_CX: Hypertension, complicated	• Under ICD-9-CM there was one comorbidity measure for Hypertension (HTN_C). In the revised version for ICD-10-CM there are separate measures for complicated and uncomplicated hypertension. • Added H35.03 codes related to Hypertensive retinopathy.
CMR_HTN_UNCX: Hypertension, uncomplicated	• Under ICD-9-CM there was one comorbidity measure for Hypertension (HTN_C). In the revised version for ICD-10-CM there are separate measures for complicated and uncomplicated hypertension.
CMR_LIVER_MLD: Liver disease, mild	• Under ICD-9-CM there was one comorbidity measure for Liver disease (LIVER). In the revised version for ICD-10-CM there are separate measures for mild liver disease and moderate to severe liver disease and failure. • Added diagnosis codes related to alcoholic hepatitis. • Added O98.4 codes for Viral hepatitis complicating pregnancy, childbirth, and the puerperium.
CMR_LIVER_SEV: Liver disease and failure, moderate to severe	• Under ICD-9-CM there was one comorbidity measure for Liver disease (LIVER). In the revised version for ICD-10-CM there are separate measures for mild liver disease and moderate to severe liver disease and failure. • Added diagnosis codes for hepatorenal syndrome and gastric varices.
CMR_LUNG_CHRONIC: Chronic pulmonary disease	• Clinical content is similar to ICD-9-CM comorbidity measure CHRNLUNG. • Added diagnosis codes indicative of chronic lung disorders (e.g., pneumoconiosis associated with tuberculosis).

Comorbidity Measure	ICD-10-CM Coding Decisions Made for the Version Refined for ICD-10-CM (Starting with v2021.1)
CMR_NEURO_MOVT: Neurological disorders affecting movement	• Under ICD-9-CM there was one comorbidity measure for Neurological disorders (NEURO). In the revised version for ICD-10-CM there are separate measures for dementia, seizures and epilepsy, neurological disorders affecting movement, and other neurological disorders. • The new comorbidity measure for neurological disorders affecting movement includes diagnosis codes related to Huntington's disease, hereditary ataxia, spinal muscular atrophy and related syndromes, and other neurological conditions affecting movement. Similar diagnoses were included under the original ICD-9-CM neurological comorbidity measure.
CMR_NEURO_SEIZ: Seizures and epilepsy	• Under ICD-9-CM there was one comorbidity measure for Neurological disorders (NEURO). In the revised version for ICD-10-CM there are separate measures for dementia, seizures and epilepsy, neurological disorders affecting movement, and other neurological disorders. • The new comorbidity measure for seizures and epilepsy includes diagnosis codes G40 for Epilepsy and recurrent seizures, R56.1 for Post traumatic seizures, and R569, Unspecified convulsions. Similar diagnoses were included under the original ICD-9-CM neurological comorbidity measure.
CMR_NEURO_OTH: Other neurological disorders	• Under ICD-9-CM there was one comorbidity measure for Neurological disorders (NEURO). In the revised version for ICD-10-CM there are separate measures for dementia, seizures and epilepsy, neurological disorders affecting movement, and other neurological disorders. • The new comorbidity measure for other neurological disorders includes brain disorders such as encephalopathy and cerebral edema, but also includes other disorders such as multiple sclerosis. • Removed codes for the following: unspecified disorientation, unspecified altered mental status, aphasia, and febrile convulsions.
CMR_OBESE: Obesity	• Clinical content is similar to ICD-9-CM comorbidity measure OBESE. • No changes were made to the coding for this comorbidity measure.
CMR_PARALYSIS: Paralysis	• Clinical content is similar to ICD-9-CM comorbidity measure PARA. • Removed code G804, Ataxic cerebral palsy.
CMR_PERIVASC: Peripheral vascular disease	• Clinical content is similar to ICD-9-CM comorbidity measure PERIVASC. • Added diagnosis codes for conditions affecting peripheral vasculature, such as cardiovascular syphilis and atheroembolism of extremities.

Comorbidity Measure	ICD-10-CM Coding Decisions Made for the Version Refined for ICD-10-CM (Starting with v2021.1)
CMR_PSYCHOSES: Psychoses	• Clinical content is similar to ICD-9-CM comorbidity measure PSYCH. • Added diagnosis codes indicative of psychotic disorders, including those due to substance use, abuse or dependence.
CMR_PUMLCIRC: Pulmonary circulation disease	• Clinical content is similar to ICD-9-CM comorbidity measure PULMCIRC. • Added diagnosis codes for conditions affecting pulmonary circulation such as pulmonary hypertension and arteriovenous fistula of pulmonary vessels.
CMR_RENLFL_MOD: Renal (kidney) failure and disease, moderate	• Under ICD-9-CM there was one comorbidity measure for Renal failure (RENLFAIL). In the revised version for ICD-10-CM there are separate measures for moderate and severe renal (kidney) failure and disease.
CMR_RENLFL_SEV: Renal (kidney) failure and disease, severe	• Under ICD-9-CM there was one comorbidity measure for Renal failure (RENLFAIL). In the revised version for ICD-10-CM there are separate measures for moderate and severe renal (kidney) failure and disease.
CMR_THYROID_HYPO: Hypothyroidism	• Clinical content is similar to ICD-9-CM comorbidity measure HYPOTHY. • Added diagnosis codes indicative of iodine-deficiency goiters, thyroid atrophy and myxedema coma.
CMR_THYROID_OTH: Other thyroid disorders	• New comorbidity measure included only in the revised version of the ICD-10-CM software tool.
CMR_ULCER_PEPTIC: Peptic ulcer with bleeding	• Clinical content is similar to ICD-9-CM comorbidity measure ULCER. • Added K25-K28 codes for Gastric ulcer; Duodenal ulcer; Peptic ulcer, site unspecified; and Gastrojejunal ulcer.
CMR_VALVE: Valvular disease	• Clinical content is similar to ICD-9-CM comorbidity measure VALUE. • Added diagnosis codes indicative of conditions that significantly affect the valves (e.g., endocarditis); and status codes where a diseased heart valve is implied (e.g., presence of heart valve prosthesis). • Additionally, added diagnosis codes for congenital valve malformations.
WGHTLOSS: Weight loss	• Clinical content is similar to ICD-9-CM comorbidity measure WGHTLOSS. • Added diagnosis code R64, Cachexia, and O25 codes for Malnutrition in pregnancy, childbirth, and the puerperium. • Removed diagnosis code R63.6, Underweight.

Criteria Used to Identify Secondary Diagnoses as a Comorbidity

The Elixhauser Comorbidity Software was initially developed for ICD-9-CM and used DRGs to identify secondary diagnoses directly related to the principal diagnosis. The software was developed based on 1992 data from 439 hospitals in the California SID.[19] For example, if a secondary diagnosis indicated unspecified heart failure, it was only counted as the comorbidity for Congestive heart failure if that record was not assigned a cardiac-related DRG. The decision to use the DRG exclusion was made because, at the time, information on diagnoses being present (or not present) on admission was rarely reported on administrative data.

Beginning October 1, 2007, the Centers for Medicare and Medicaid Services (CMS) required Inpatient Prospective Payment System (IPPS) hospitals to submit POA information on inpatient claims for both principal and secondary diagnoses. Per the ICD-10-CM Coding Guidelines, the reporting of POA information is now required for "all claims involving inpatient admissions to general acute care hospitals or other facilities that are subject to a law or regulation mandating collection of present on admission information."[20] The importance of POA has prompted integration into software algorithms for hospital claims and discharge data, as seen with the MS-DRGs and the AHRQ Quality Indicators (QIs). POA indicators are now widely available on inpatient data and some outpatient data.

The Elixhauser Comorbidity Software Refined for ICD-10-CM uses POA indicators for 18 of the 38 comorbidity measures. POA information is used to identify secondary diagnoses that were present on admission and, therefore, identify pre-existing conditions, as opposed to medical conditions that arise during the hospital stay. This change increases the number of records considered for inclusion in the comorbidity measures. Table A.2 shows the number of records that would be identified for each comorbidity measure using the beta version v2020.1 software (with and without the DRG exclusion) and with the v2021.1 software based on the 2017 SID from 43 States with POA indicators.

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[19] Elixhauser, Anne, et al. Comorbidity Measures for Use with Administrative Data. *Medical Care*, vol. 36, no. 1, 1998, pp. 8-27 JSTOR, https://www.jstor.org/stable/3766985.

[20] ICD-10-CM Official Guidelines for Coding and Reporting FY 2027, Appendix I (https://www.cms.gov/files/document/fy-2027-icd-10-cm-coding-guidelines.pdf

Table A.2. Comparison of the Number of Discharges Identified by the Elixhauser Comorbidity Software Refined for ICD-10-CM (v2021.1) and the Beta Version of the Elixhauser Comorbidity Software for ICD-10-CM (v2020.1)

Comorbidity Measure	N, v2021.1 (first refined version) with POA	N, v2020.1 (beta version) using DRG exclusion	N, v2020.1 (beta version) with no DRG exclusion
AIDS: Acquired immune deficiency syndrome	183,722	74,471	95,624
ALCOHOL: Alcohol-related disorders	1,470,271	1,335,728	1,431,046
ANEMDEF: Deficiency anemias (Beginning in v2023.1, this comorbidity was renamed Anemias due to other nutritional deficiencies)	4,916,307	5,188,557	5,237,486
ARTH: Arthropathies (Beginning in v2022.1, this comorbidity was renamed Autoimmune conditions and diagnosis codes that did not align with the intended clinical concept were removed.)	929,163	851,012	857,617
BLDLOSS: Chronic blood loss anemia (Beginning in v2023.1, this comorbidity was renamed Chronic blood loss (iron deficiency) and the measure is limited to the ICD-10-CM diagnosis code D50.0, Iron deficiency anemia secondary to blood loss (chronic), and no longer includes diagnosis codes O90.81, Anemia of the puerperium, O99.02, Anemia complicating childbirth, and O99.03, Anemia complicating the puerperium.)	564,223	827,104	832,194
CANCER_LEUK: Leukemia (new in v2021.1)	213,098	NA	NA
CANCER_LYMPH: Lymphoma	270,848	216,864	271,457
CANCER_METS: Metastatic cancer	862,016	667,408	885,240
CANCER_SOLID: Solid tumor without metastasis, malignant (Included under TUMOR in v2020.1)	776,913	628,054	698,108
CANCER_NSITU: Solid tumor without metastasis, in situ (Included under TUMOR in v2020.1)	8,893	Included in the count above	Included in the count above
CBVD: Cerebrovascular disease (new in v2021.1)	1,144,909	NA	NA

Comorbidity Measure	N, v2021.1 (first refined version) with POA	N, v2020.1 (beta version) using DRG exclusion	N, v2020.1 (beta version) with no DRG exclusion
CHF: Congestive heart failure (Beginning with v2022.1, the name of this comorbidity measure no longer included the descriptor “congestive”, but the coding criteria remained the same.)	4,627,929	2,927,779	4,685,117
COAG: Coagulopathy	1,778,501	1,745,127	1,749,638
DEPRESS: Depression	3,563,110	3,597,195	3,603,282
DIAB_CX: Diabetes with chronic complications	4,426,261	4,246,308	4,427,084
DIAB_UNCX: Diabetes without chronic complications	3,223,752	3,051,050	3,056,267
DRUG: Drug use disorders	1,491,899	1,360,701	1,494,404
HTN_CX: Hypertension, complicated (Included under HTN_C in v2020.1)	5,681,730	13,827,150	15,072,883
HTN_UNCX: Hypertension, uncomplicated (Included under HTN_C in v2020.1)	9,391,842	Included in the count above	Included in the count above
LIVER_MLD: Liver disease, mild (Included under LIVER in v2020.1)	1,366,020	1,240,031	1,429,189
LIVER_SEV: Liver disease and failure, moderate to severe (Included under LIVER in v2020.1)	428,601	Included in the count above	Included in the count above
LUNG_CHRONIC: Chronic pulmonary disease	6,034,669	5,751,843	6,101,979
NEURO_MOVT: Neurological disorders affecting movement (Included under NEURO in v2020.1)	674,993	2,507,863	3,078,792
NEURO_SEIZ: Seizures and epilepsy (Included under NEURO in v2020.1)	1,666,118	Included in the count above	Included in the count above
NEURO_OTH: Other neurological disorders (Included under NEURO in v2020.1)	1,123,519	Included in the count above	Included in the count above
DEMENTIA: Dementia (Included under NEURO in v2020.1)	1,859,260	Included in the count above	Included in the count above
OBESE: Obesity	4,762,238	4,558,242	4,762,238
PARALYSIS: Paralysis	1,204,762	978,665	1,246,567

Comorbidity Measure	N, v2021.1 (first refined version) with POA	N, v2020.1 (beta version) using DRG exclusion	N, v2020.1 (beta version) with no DRG exclusion
PERIVASC: Peripheral vascular disease	1,716,275	1,583,027	1,606,317
PSYCHOSES: Psychoses	1,238,299	1,114,623	1,237,675
PUMLCIRC: Pulmonary circulation disease	1,058,539	204,450	271,739
RENLFL_MOD: Renal (kidney) failure and disease, moderate (Included under RENLFAIL in v2020.1)	2,850,371	4,207,562	4,207,562
RENLFL_SEV: Renal (kidney) failure and disease, severe (Included under RENLFAIL in v2020.1)	1,658,886	Included in the count above	Included in the count above
THYROID_HYPO: Hypothyroidism	3,599,635	3,566,909	3,584,334
THYROID_OTH: Other thyroid disorders (new in v2021.1)	305,051	NA	NA
ULCER_PEPTIC: Peptic ulcer with bleeding	282,471	226,956	282,260
VALVE: Valvular disease	1,864,954	1,107,831	1,836,953
WGHTLOSS: Weight loss	1,800,443	1,768,471	1,819,992

Abbreviations: NA, not applicable.
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2017, 42 States and the District of Columbia with indicators that diagnoses were present on admission

Verification of the Elixhauser Comorbidity Measures Revised for ICD-10-CM

After deciding on the clinical criteria for the comorbidities, the team reviewed the following information using inpatient data in 2017 for each measure based on 43 SID, pooled together:

- Distribution of stays by the principal diagnosis, grouped into categories using the Clinical Classifications Software Refined (CCSR) for ICD-10-CM.
- Distribution of stays by age and sex
- Differences in average length of stay, total hospital charge, and in-hospital mortality rates for records included and not included in the comorbidity measure.

The measures under ICD-9-CM had been selected based on their association with increases in resource use (length of stay and hospital total charges) and healthcare outcomes such as in-hospital mortality, so it was important to recheck these relationships. Table A.3 summarizes the percentage change in the average length of stay, average total hospital charge, and average in-

hospital mortality rate for 2017 inpatient stays in 43 SID that were included and not included in each comorbidity measure. The percentage change was calculated as follows:

$$\frac{\text{(Average for stays included in the comorbidity - Average for stays } \textit{not} \text{ included in the comorbidity)}}{\text{Average for stays } \textit{not} \text{ included in the comorbidity}} * 100$$

If the percentage change is positive than the average for records included in the comorbidity is higher than the average for records *not* included in the comorbidity.

It should be noted that the stays included in the comorbidity may also have other comorbidities. For example, an inpatient stay included in the average for AIDS may also have hypertension. In addition, stays *not* included in the comorbidity may have other comorbidities. For example, an inpatient stay not included in the average for AIDS may have hypertension. For this reason, the percent change is presented in ranges (increase or decrease by less than 5 percent, 5 to 10 percent, 11 to 25 percent, or more than 25 percent) instead of absolute values.

Table A.3. Percentage Change in the Average Length of Stay, Average Total Hospital Charge, and In-Hospital Mortality Rate Between Inpatient Stays in 2017 Not Included in the Comorbidity Measure and Included in the Comorbidity Measure, Elixhauser Comorbidity Software Refined for ICD-10-CM (v2021.1)

Comorbidity Measure	Percentage Change in the Average Length of Stay	Percentage Change in the Average Total Hospital Charge	Percentage Change in the Average In-Hospital Mortality Rate
AIDS: Acquired immune deficiency syndrome	Increase 11-25%	Increase 11-25%	Increase < 5%
ALCOHOL: Alcohol-related disorders	Increase 11-25%	Increase 11-25%	Increase 11-25%
ANEMDEF: Deficiency anemias (Beginning in v2023.1, this comorbidity was renamed Anemias due to other nutritional deficiencies)	Increase > 25%	Increase > 25%	Increase > 25%
ARTH: Arthropathies (Beginning in v2022.1, this comorbidity was renamed Autoimmune conditions.)	Increase 11-25%	Increase > 25%	Increase 11-25%

Comorbidity Measure	Percentage Change in the Average Length of Stay	Percentage Change in the Average Total Hospital Charge	Percentage Change in the Average In-Hospital Mortality Rate
BLDLOSS: Chronic blood loss anemia (Beginning in v2023.1, this comorbidity was renamed Chronic blood loss (iron deficiency) and the measure is limited to the ICD-10-CM diagnosis code D50.0, Iron deficiency anemia secondary to blood loss (chronic), and no longer includes diagnosis codes O90.81, Anemia of the puerperium, O99.02, Anemia complicating childbirth, and O99.03, Anemia complicating the puerperium.)	Increase > 25%	Increase > 25%	Increase > 25%
CANCER_LEUK: Leukemia	Increase > 25%	Increase > 25%	Increase > 25%
CANCER_LYMPH: Lymphoma	Increase > 25%	Increase > 25%	Increase > 25%
CANCER_METS: Metastatic cancer	Increase > 25%	Increase > 25%	Increase > 25%
CANCER_NSITU: Solid tumor without metastasis, in situ	Increase < 5%	Increase 11-25%	Decrease 11-25%
CANCER_SOLID: Solid tumor without metastasis, malignant	Increase 11-25%	Increase > 25%	Increase > 25%
CBVD: Cerebrovascular disease	Increase > 25%	Increase > 25%	Increase > 25%
CHF: Congestive heart failure (Beginning with v2022.1, the name of this comorbidity measure no longer included the descriptor “congestive” but the coding criteria remained the same.)	Increase > 25%	Increase > 25%	Increase > 25%
COAG: Coagulopathy	Increase > 25%	Increase > 25%	Increase > 25%
DEMENTIA: Dementia	Increase > 25%	Increase 5-10%	Increase > 25%
DEPRESS: Depression	Increase 11-25%	Increase 5-10%	Decrease 11-25%
DIAB_CX: Diabetes with chronic complications	Increase > 25%	Increase > 25%	Increase > 25%
DIAB_UNCX: Diabetes without chronic complications	Decrease < 5%	Increase 5-10%	Increase 5-10%
DRUG: Drug use disorders	Increase 11-25%	Decrease 5-10%	Decrease > 25%
HTN_CX: Hypertension, complicated	Increase > 25%	Increase > 25%	Increase > 25%

Comorbidity Measure	Percentage Change in the Average Length of Stay	Percentage Change in the Average Total Hospital Charge	Percentage Change in the Average In-Hospital Mortality Rate
HTN_UNCX: Hypertension, uncomplicated	Increase < 5%	Increase 11-25%	Decrease 11-25%
LIVER_MLD: Liver disease, mild	Increase > 25%	Increase > 25%	Increase > 25%
LIVER_SEV: Liver disease and failure, moderate to severe	Increase > 25%	Increase > 25%	Increase > 25%
LUNG_CHRONIC: Chronic pulmonary disease	Increase 11-25%	Increase 11-25%	Increase > 25%
NEURO_MOVT: Neurological disorders affecting movement	Increase 11-25%	Increase 11-25%	Increase > 25%
NEURO_OTH: Other neurological disorders	Increase > 25%	Increase > 25%	Increase > 25%
NEURO_SEIZ: Seizures and epilepsy	Increase > 25%	Increase > 25%	Increase > 25%
OBESE: Obesity	Increase 5-10%	Increase > 25%	Decrease 11-25%
PARALYSIS: Paralysis	Increase > 25%	Increase > 25%	Increase > 25%
PERIVASC: Peripheral vascular disease	Increase > 25%	Increase > 25%	Increase > 25%
PSYCHOSES: Psychoses	Increase > 25%	Increase < 5%	Decrease > 25%
PUMLCIRC: Pulmonary circulation disease	Increase > 25%	Increase > 25%	Increase > 25%
RENLFL_MOD: Renal (kidney) failure and disease, moderate	Increase > 25%	Increase > 25%	Increase > 25%
RENLFL_SEV: Renal (kidney) failure and disease, severe	Increase > 25%	Increase > 25%	Increase > 25%
THYROID_HYPO: Hypothyroidism	Increase 5-10%	Increase 11-25%	Increase > 25%
THYROID_OTH: Other thyroid disorders	Increase 11-25%	Increase 11-25%	Decrease 11-25%
ULCER_PEPTIC: Peptic ulcer with bleeding	Increase > 25%	Increase > 25%	Increase > 25%
VALVE: Valvular disease	Increase > 25%	Increase > 25%	Increase > 25%
WGHTLOSS: Weight loss	Increase > 25%	Increase > 25%	Increase > 25%

Note: If the percentage change is positive than the average for records included in the comorbidity is higher than the average for records not included in the comorbidity.
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2017, 42 States and the District of Columbia with indicators that diagnoses were present on admission

Limitations on Using the Elixhauser Comorbidity Software Refined for ICD-10-CM

Consistent with the development of the ICD-9-CM version of the comorbidity measures, the refinement process for ICD-10-CM focused on adult inpatient stays. The development of the Elixhauser Comorbidity Software Refined for ICD-10-CM did not explicitly focus on pediatric hospitalizations or outpatient visits. Additional and/or different comorbidity measures may apply to those populations.

Summary of Key Changes in the Versions of the Elixhauser Comorbidity Software Refined for ICD-10-CM

The following is a summary of key features and changes between released versions of the Elixhauser Comorbidity Software Refined for ICD-10-CM:

- v2027.1 (released October 2026)
    - Added ICD-10-CM diagnosis codes valid starting in fiscal year 2027 so the tool now includes all ICD-10-CM codes valid from October 2015 through September 2027.
    - Updated the names of two comorbidity measures: Drug abuse is now Drug use disorders and its abbreviation changed from DRUG_ABUSE to DRUG. Alcohol abuse is now Alcohol-related disorders (the abbreviation did not change from ALCOHOL).
    - Two codes that were previously included in the DEMENTIA comorbidity measure were removed after clinical review found they do not correspond to dementia: F0670 and F0671.
- v2026.1 (released October 2025)
    - Added ICD-10-CM diagnosis codes valid starting in fiscal year 2026 so the tool now includes all ICD-10-CM codes valid from October 2015 through September 2026.
    - Removed ICD-10-CM diagnosis code R93.9 *Diagnostic imaging inconclusive due to excess body fat of patient* from the Obesity comorbidity because body fat may be localized in areas that interfere with imaging interpretation without obesity.
- v2025.1 (released November 2024)
    - Added ICD-10-CM diagnosis codes valid starting in fiscal year 2025 so the tool now includes all ICD-10-CM codes valid from October 2015 through September 2025.

- v2024.1 (released March 2024)
    - Added ICD-10-CM diagnosis codes valid starting in fiscal year 2024 so the tool now includes all ICD-10-CM codes valid from October 2015 through September 2024.

- v2023.1 (released November 2022)
    - Added ICD-10-CM diagnosis codes valid starting in fiscal year 2023 so the tool now includes all ICD-10-CM codes valid from October 2015 through September 2023.
    - The criteria for identifying the comorbidity measure for chronic blood loss (iron deficiency) (CMR_BLDLOSS) is specific to the diagnosis code D50.0, Iron deficiency anemia secondary to blood loss (chronic), and no longer includes diagnosis codes O90.81, Anemia of the puerperium, O99.02, Anemia complicating childbirth, and O99.03, Anemia complicating the puerperium. These obstetric codes indicate acute, not chronic, blood loss. Codes indicating anemia complicating pregnancy continue to be part of the comorbidity measure for Anemias due to other nutritional deficiencies (CMR_AMENDEF).
    - Updated the comorbidity indices for risk of in-hospital mortality and risk of 30-day, all-cause readmissions to reflect the coding change in the comorbidity measure for chronic blood loss (iron deficiency) (CMR_BLDLOSS).

- v2022.1 (released October 2021)
    - Added ICD-10-CM diagnosis codes that became effective in FY 2022 so the tool includes ICD-10-CM codes valid from October 2015 through September 2022.
    - A SAS program has been added to calculate the Elixhauser comorbidity indices for the risk of in-hospital mortality and the risk of 30-day, all-cause readmissions based on the comorbidity measures, v2022.1.
    - The comorbidity measure for Arthropathies has been updated by removing diagnosis codes that did not align with the intended clinical concept. In addition, the comorbidity measure has been renamed Autoimmune Conditions to clarify the clinical intent. This comorbidity measure now includes select ICD-10-CM diagnosis codes in the range M05-M08, M12.0, M30-M36, and M45. The full list of ICD-10-CM codes for Autoimmune Conditions is included in the Reference File (Excel format) provided with the software tool. In addition, the list of excluded ICD-10-CM codes is provided in the Change Log (Excel format) also included with the software tool. This change in the coding criteria is expected to reduce the number of records identified by the comorbidity by about 3 percent.
    - Six ICD-10-CM codes have been removed from the clinical criteria of the comorbidity Peripheral vascular disease because of the vagueness of the conditions identified by the codes. The list of excluded ICD-10-CM codes is provided in the Change Log (Excel format) included with the software tool. This

change is expected to reduce the number of records identified by the comorbidity by about 4 percent.
    - The name of the comorbidity measure for heart failure no longer includes the descriptor congestive. The clinical coding criteria did not change.
    - The SAS variable names have been modified to have the prefix “CMR_” to identify them as derived from the Elixhauser Comorbidity Software Refined for ICD-10-CM.

- v2021.1 (released October 2020)
    - Transitioned the software out of beta status after empirical testing and clinical review.
    - Includes ICD-10-CM diagnosis codes valid from October 2015 through September 2021.

APPENDIX B: BACKGROUND ON THE AHRQ HCUP ELIXHAUSER COMORBIDITY INDICES REFINED FOR ICD-10-CM

The Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) Elixhauser Comorbidity Indices were originally developed using ICD-9-CM diagnosis codes and adult (ages 18 years and older), nonmaternal inpatient discharge data.[21] The development of the ICD-10-CM version of the indices was consistent with the methodology used for the ICD-9-CM version of the tool but used more recent 2018 data.

The Elixhauser Comorbidity Indices Refined for ICD-10-CM is designed to predict two frequently reported health outcomes:

- Risk of in-hospital mortality
- Risk of 30-day, all-cause readmission.[22]

Each index is a separate composite score based on the 38 individual comorbidity measures. Using the indices can be preferable to the individual measures because they account for interaction between comorbidities and reduces the necessary degrees of freedom required for estimation—especially helpful when working with small sample sizes.

Index for Risk of In-Hospital Mortality

The development of the in-hospital mortality index used the 2018 HCUP State Inpatient Databases (SID) for 45 of the possible 48 States. The SID for Connecticut, Delaware, and Wyoming were excluded because their 2018 SID did not include indicators that the diagnosis was present on admission (POA). The SID were limited to community hospitals, excluding rehabilitation and long-term acute care facilities. The discharges were limited to nonmaternal adults, aged 18 years and older with a non-missing discharge disposition that did not indicate a hospital transfer or that the patient left against medical advice. In addition, discharges that failed the POA edits available on the 2018 SID were excluded from the analysis. The resulting 23.8 million discharges were randomly split into a 75 percent development file and a 25 percent validation sample. The Elixhauser Comorbidity Software Refined for ICD-10-CM, v2022.1, was applied to the data.

The development file was used to run 100 bootstrapped replications (each based on a 5 percent random sample) of backward stepwise logistic regression models with in-hospital mortality as the dependent variable. Two comorbidities were excluded from consideration because they had

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[21] Moore BJ, White S, Washington R, Coenen N, Elixhauser A. Identifying Increased Risk of Readmission and In-hospital Mortality Using Hospital Administrative Data: The AHRQ Elixhauser Comorbidity Index. Med Care. 2017 Jul;55(7):698-705.

[22] All-cause readmissions excluded planned and potentially planned readmissions consistent with the definition of all-cause readmissions in the Center for Medicare & Medicaid Services (CMS) Hospital-Wide Readmission Measure.

a very low observed in-hospital mortality rate and were highly correlated with another comorbidity measure (diabetes without chronic complications and uncomplicated hypertension). Three comorbidities that were retained in less than 20 percent of the bootstrapped replications were excluded from the final logistics model (solid tumor without metastasis, in situ; peptic ulcer with bleeding; valvular disease). The final logistic regression model using maximum likelihood fit included the remaining 33 comorbidity measures. The weights for risk of in-hospital mortality index were calculated from the final regression using the same methodology as the ICD-9-CM-based weights. The index weight for each comorbidity was calculated as the value of its regression coefficient divided by the absolute value of the regression coefficient for the comorbidity with the smallest absolute value, rounded to the nearest integer. Standardizing the weights in this manner means that a comorbidity with a weight of 5 has five times the weight of a comorbidity with a weight of 1. Some comorbidity weights carry a negative sign, reflecting a protective relationship with in-hospital mortality in the context of the model. Table B.1 provides the frequency of the 38 comorbidity measures in the development files, the observed in-hospital mortality, and the index weight.

The derived weights were used to determine the risk of in-hospital mortality index for the 5.6 million discharges in the validation sample. The performance and goodness of fit was similar to the ICD-9-CM version of the index (*c*-Statistic of 0.777).

Table B.1. In-Hospital Mortality Index Weights Based on the 38 Elixhauser Comorbidity Measures, v2022.1[23]

Comorbidity Measure	Frequency in 2018 Development File		Observed in-hospital mortality rate	Risk of In-Hospital Mortality Index Weight, v2022.1[21]
	N	Percent of Total	Per 100 Discharges	
CMR_AIDS	128,289	0.7	2.15	-4
CMR_ALCOHOL	1,077,635	5.9	2.59	-1
CMR_ANEMDEF	3,417,074	18.8	3.53	-3
CMR_AUTOIMMUNE	667,292	3.7	2.57	-1
CMR_BLDLOSS	168,160	0.9	2.95	-4
CMR_CANCER_LEUK	141,775	0.8	5.63	9
CMR_CANCER_LYMPH	201,266	1.1	4.78	6
CMR_CANCER_METS	647,975	3.6	8.81	23
CMR_CANCER_NSITU	6,022	0.0	1.63	0
CMR_CANCER_SOLID	572,698	3.1	5.09	10
CMR_CBVD	869,087	4.8	4.99	5
CMR_HF	3,663,752	20.1	5.15	15

[23] The risk of in-hospital mortality index weights were updated in v2023.1.

Comorbidity Measure	Frequency in 2018 Development File		Observed in-hospital mortality rate	Risk of In-Hospital Mortality Index Weight, v2022.1[21]
	N	Percent of Total	Per 100 Discharges	
CMR_COAG	1,207,839	6.6	7.74	15
CMR_DEMENTIA	1,372,168	7.5	4.84	5
CMR_DEPRESS	2,514,683	13.8	1.80	-9
CMR_DIAB_CX	3,486,123	19.1	3.19	-2
CMR_DIAB_UNCX	2,072,198	11.4	2.23	0
CMR_DRUG	984,665	5.4	1.45	-7
CMR_HTN_CX	4,408,068	24.2	4.27	1
CMR_HTN_UNCX	6,693,892	36.8	1.75	0
CMR_LIVER_MLD	984,250	5.4	2.96	2
CMR_LIVER_SEV	320,444	1.8	8.83	17
CMR_LUNG_CHRONIC	4,220,599	23.2	3.23	2
CMR_NEURO_MOVT	521,554	2.9	2.78	-1
CMR_NEURO_OTH	1,255,224	6.9	9.34	23
CMR_NEURO_SEIZ	766,683	4.2	3.74	2
CMR_OBESE	3,353,551	18.4	1.80	-7
CMR_PARALYSIS	887,493	4.9	4.60	4
CMR_PERIVASC	1,154,879	6.3	4.00	3
CMR_PSYCHOSES	872,370	4.8	1.55	-9
CMR_PULMCIRC	787,555	4.3	5.07	4
CMR_RENLFL_MOD	2,199,795	12.1	3.85	3
CMR_RENLFL_SEV	1,253,340	6.9	4.90	8
CMR_THYROID_HYPO	2,605,975	14.3	2.60	-3
CMR_THYROID_OTH	219,882	1.2	1.82	-8
CMR_ULCER_PEPTIC	201,598	1.1	3.47	0
CMR_VALVE	1,381,191	7.6	4.03	0
CMR_WGHTLOSS	1,375,324	7.6	7.36	14

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2018, 44 States and the District of Columbia

Index for Risk of 30-Day, All-Cause Readmissions

The development of the 30-day, all-cause readmissions index used the 2018 HCUP Nationwide Readmissions Database (NRD). The 2018 NRD is drawn from 28 SID with reliable, verified patient linkage numbers that can be used to track the patient across hospitals within a State, while adhering to strict privacy guidelines. NRD records for Delaware and Wyoming were excluded because their 2018 data did not include indicators that the diagnosis was present on admission (POA). The discharges were limited to nonmaternal adults, aged 18 years and older

with non-missing information on the timing between discharges and a non-missing discharge disposition that did not indicate the patient left against medical advice.[24] In addition, discharges that failed the POA edits available on the 2018 SID were excluded from the analysis. To qualify as an index event the discharges must have occurred between January and November 2018, not have a principal diagnosis of rehabilitation, not have a discharge disposition of died, and have a nonmissing length of stay (needed to determine timing to the readmission). Each qualifying discharge was included as an index admission. Next, it was determined if each index event had a qualifying readmission within 30 days of discharge. The readmission could occur at any hospital in the same State.[25] If more than one readmission occurred during the 30 days, only the first, most immediate readmission was considered. If the readmission was for a procedure or diagnosis that is always planned (e.g., organ or bone marrow transplant, Cesarean section, vaginal delivery, maintenance chemotherapy, or other aftercare), then the index event was not marked as having a readmission.[26] If the readmission was for a procedure that was potentially planned *and* the principal diagnosis was not an acute condition, then again the index event was not marked as having a readmission.[20] For example, if the discharge included a procedure code indicating a coronary artery bypass graft and the principal diagnosis was not an acute condition such as acute myocardial infarction or cardiac arrest, then the discharge was not counted as a readmission.

The resulting 12.3 million index events had an overall 30-day readmission rate of 13.0 per 100 index events. The file was randomly split into a 75 percent development file and a 25 percent validation sample. The Elixhauser Comorbidity Software Refined for ICD-10-CM, v2022.1, was applied to the data using the POA indicators so all 38 comorbidities were assigned.

The development file was used to run 100 bootstrapped replications (each based on a 5 percent random sample) of backward stepwise logistic regression models with 30-day readmission as the dependent variable. Two comorbidities were excluded from consideration because they had a very low observed readmission rate and were highly correlated with another comorbidity measure (diabetes without chronic complications and uncomplicated hypertension). Six comorbidities that were retained in less than 20 percent of the bootstrapped replications were excluded from the final logistics model (solid tumor without metastasis, in situ; cerebrovascular disease; hypertension, complicated; hypothyroidism; other thyroid disorders; valvular disease). The final logistic regression model using maximum likelihood fit included the remaining 30

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[24] To eliminate this possibility of counting a transfer as a readmission, pairs of records in the NRD representing a transfer were collapsed into a single "combined" record during the development of the NRD.

[25] Readmissions that cross State boundaries could not be identified because the synthetic patient linkage numbers are State specific.

[26] The identification of planned and potentially planned readmissions was based on 2021 Center for Medicare & Medicaid Services (CMS) Hospital-Wide Readmission Measure code specifications, updated to use the Clinical Classifications Software Refined (CCSR) for ICD-10-CM/PCS.

comorbidity measures. The weights for risk of readmission were calculated from the final regression using the same methodology as the ICD-9-CM-based weights. The index weight for each comorbidity was calculated as the value of its regression coefficient divided by the absolute value of the regression coefficient for the comorbidity with the smallest absolute value, rounded to the nearest integer. Standardizing the weights in this manner means that a comorbidity with a weight of 5 has five times the weight of a comorbidity with a weight of 1. Some comorbidity weights carry a negative sign, reflecting a protective relationship with 30-day, all-cause readmissions in the context of the model. Table B.2 provides the frequency of the 38 comorbidity measures in the development files, and observed 30-day, all-cause readmission, and the index weight.

The derived weights were used to determine the index for the risk of 30-day, all-cause readmission for the 3.1 million discharges in the validation sample. The performance and goodness of fit was similar to the ICD-9-CM version of the index (*c*-Statistic of 0.634).

Table B.2. 30-Day, All-Cause Readmission Index Weights Based on the 38 Elixhauser Comorbidity Measures, v2022.1[27]

Comorbidity Measure	Frequency in 2018 Development File		Observed 30-Day, All-Cause Readmission Rate	Risk of 30-Day, All-Cause Readmission Index Weight, v2022.1[25]
	N	Percent of Total	Per 100 Index Events	
CMR_AIDS	55,256	0.6	18.53	5
CMR_ALCOHOL	559,414	6.0	15.88	3
CMR_ANEMDEF	1,713,010	18.5	19.25	5
CMR_AUTOIMMUNE	337,831	3.7	14.93	2
CMR_BLDLOSS	86,225	0.9	16.86	2
CMR_CANCER_LEUK	70,747	0.8	21.76	10
CMR_CANCER_LYMPH	102,693	1.1	19.48	7
CMR_CANCER_METS	312,836	3.4	21.06	11
CMR_CANCER_NSITU	3,265	0.0	12.07	0
CMR_CANCER_SOLID	287,868	3.1	18.72	7
CMR_CBVD	436,818	4.7	15.39	0
CMR_HF	1,813,770	19.6	19.81	7
CMR_COAG	585,644	6.3	19.66	3
CMR_DEMENTIA	701,788	7.6	14.94	1
CMR_DEPRESS	1,285,116	13.9	14.63	2
CMR_DIAB_CX	1,755,792	19.0	18.12	4

[27] The risk of 30-day, all-cause readmission index weights were updated in v2023.1.

Comorbidity Measure	Frequency in 2018 Development File		Observed 30-Day, All-Cause Readmission Rate	Risk of 30-Day, All-Cause Readmission Index Weight, v2022.1[25]
	N	Percent of Total	Per 100 Index Events	
CMR_DIAB_UNCX	1,060,923	11.5	12.57	0
CMR_DRUG	533,333	5.8	16.90	6
CMR_HTN_CX	2,204,127	23.8	18.03	0
CMR_HTN_UNCX	3,440,344	37.2	10.77	0
CMR_LIVER_MLD	502,689	5.4	16.72	3
CMR_LIVER_SEV	150,787	1.6	24.95	10
CMR_LUNG_CHRONIC	2,127,143	23.0	16.48	4
CMR_NEURO_MOVT	261,547	2.8	14.86	1
CMR_NEURO_OTH	596,652	6.4	16.69	2
CMR_NEURO_SEIZ	386,822	4.2	17.70	5
CMR_OBESE	1,693,675	18.3	12.46	-2
CMR_PARALYSIS	447,955	4.8	15.70	3
CMR_PERIVASC	612,356	6.6	15.91	1
CMR_PSYCHOSES	458,754	5.0	17.24	6
CMR_PULMCIRC	399,703	4.3	20.08	3
CMR_RENLFL_MOD	1,107,356	12.0	17.55	4
CMR_RENLFL_SEV	618,810	6.7	23.61	8
CMR_THYROID_HYPO	1,314,082	14.2	14.04	0
CMR_THYROID_OTH	117,069	1.3	12.74	0
CMR_ULCER_PEPTIC	104,162	1.1	16.62	2
CMR_VALVE	716,640	7.7	16.53	0
CMR_WGHTLOSS	671,890	7.3	20.12	6

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), Nationwide Readmissions Database (NRD), 2018, limited to 26 States and without the use of the discharge weights included in the NRD.

Limitations on Using the Elixhauser Comorbidity Indices Refined for ICD-10-CM

Consistent with the development of the ICD-9-CM version of the indices, the refinement process for ICD-10-CM focused on adult, nonmaternal inpatient stays. The development of the Elixhauser Comorbidity Software Refined for ICD-10-CM did not explicitly focus on pediatric hospitalizations or outpatient visits. Additional and/or different comorbidity measures may apply to those populations. In addition, no analysis has been performed to understand the impact of the COVID-19 pandemic on the weights for the indices.

The intended use of the weights to calculate the two comorbidity indices is specific to data that includes POA indicators. The indices depend on all 38 comorbidity measures being coded in the data.

APPENDIX C: DIAGNOSIS CODES THAT ARE INCLUDED IN MORE THAN ONE COMORBIDITY MEASURE

In v2027.1, there are 122 ICD-10-CM diagnosis codes (out of about 4,500 diagnosis codes in the software) that are included in more than one comorbidity measure:

- Two codes included in alcohol-related disorders and mild liver disease
- One code included in mild liver disease and other neurological disorders
- One code included in autoimmune conditions and valvular disease
- Forty-eight codes included in drug use disorders and psychoses
- Sixty-three codes included in cerebrovascular disease and paralysis
- Two codes included in heart failure and complicated hypertension
- Two codes included in complicated hypertension and severe renal (kidney) failure and disease
- One code included in heart failure, complicated hypertension, and severe renal (kidney) failure and disease
- One code included in other neurological disorders, and seizures and epilepsy
- One code included in mild liver disease and pulmonary circulation disease

The specific codes are detailed in the separate AHRQ HCUP Elixhauser Comorbidity Software Refined for ICD-10-CM Reference File (Excel format).