Method A

Episode Grouper for Medicare (EGM)

Design Report
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Executive Summary

Medicare and other third-party payers maintain very detailed records of reimbursements for individual services. In addition to their main purpose in payment, these records could represent a wealth of information about patterns in resource use, providing meaningful descriptions as well as information about opportunities for improvement. The conceptual framework presented here involves organizing administrative claims data into episodes-of-care, or simply episodes, which are "sets of services provided to care for an illness or injury during a defined period of time." The National Quality Forum endorsed this approach in its consensus report on a measurement framework for evaluating efficiency, [1] and wrote in its more recent report on evaluation of episode groupers:

In recent years, there has been a drive toward performance measurement based on the patient's episode of care in how to better understand the utilization and costs associated with certain conditions. Measurement based on an episode of care facilitates this by attributing care to condition-specific or procedure-specific episodes based on the relationship of the healthcare service to the care of a specific condition (i.e., all diabetes-related care is attributed to the diabetes episode of care)...

Episode grouper software tools are a generally accepted method for aggregating claims data into episodes to assess condition-specific utilization and costs. Using an episode grouper, healthcare services provided over a defined period of time can be analyzed and grouped by specific clinical conditions to generate an overall picture of the services used to manage that condition.

Thus, the Centers for Medicare & Medicaid Services (CMS) has developed a software application called the Episode Grouper for Medicare (EGM) for organizing administrative claims into information about resource use that can be used to support various program objectives. This document describes the tool with respect to its development and logical components. Potential uses could include accountability, where cost outcomes could be linked to other performance domains; and performance improvement, where cost and utilization patterns could identify opportunities to coordinate care, and provide more efficient healthcare for individuals or populations.

[1] National Quality Forum (NQF). Measurement Framework: Evaluating Efficiency Across Patient-Focused Episodes of Care. Washington, DC: NQF; 2009

i. What is the Episode Grouper for Medicare (EGM)?

EGM is a software application that is set up to read Medicare administrative claims data chronologically by beneficiary, and assign services and their associated Medicare payments to episodes of care. Episodes correspond to clinically meaningful topics such as a clinical condition defined by diagnosis codes (e.g., pneumonia), or in other cases, a particular type of treatment defined by procedure codes (e.g., pacemaker insertion).

EGM standardizes and automates the construction of resource use measures using clinically meaningful episodes to provide context from which to interpret the relevance of various services provided to patients over time. The goal is to be inclusive with respect to the services and costs that result from an episode including claims for non-specific diagnoses such as signs and symptoms, (relevant diagnoses); plausible procedure/service codes (relevant services); and aftereffects and secondary results of care (sequelae).

ii. Why build episodes?

One of the most basic objectives of EGM is to describe or account for Medicare cost and utilization using categories that make sense to clinicians and others who are responsible for patient care and healthcare systems. For example, how much does diabetes or ischemic heart disease cost Medicare in terms of routine care, acute exacerbations, and secondary conditions (sequelae) that emerge over time? What settings or types of providers are involved in the care of patients contemporaneously or sequentially?

A second objective is to estimate average Medicare payments for episodes, risk-adjusted according to patient-level information and other factors as appropriate. These risk-adjusted costs can serve as reference points for comparison, for example, to know the extent to which actual episode costs for specific patient cohorts (e.g., defined geographically or by attribution to providers) may deviate from the average cost for clinically similar patients.

Another objective is to frame spending patterns in ways that highlight opportunities for improvement. Some opportunities may reside within a physician practice (e.g., low-value or duplicative services), while others might be “downstream” consequences such as sequelae (e.g., hospital admissions for sepsis following surgery), or problems “upstream” (e.g., missed opportunities to avoid acute exacerbations, or to reduce the need for surgery). Layers of information can be produced for different aspects of decision-making, including individual practitioners or facilities, and the continuum of care in delivery systems or whole market areas.

iii. How does EGM incorporate clinical expertise?

Clinicians interpret patient information based on known relationships and probabilities. For example, clinicians understand that cough is a symptom of pneumonia, that sepsis is a possible sequela of pneumonia, and that a case of pneumonia rarely lasts more than a week or so. Each condition has its own time course and set of possible symptoms and sequelae with implicit time-dependent probabilities for each relationship. Clinicians also know which tests and treatments are used and likely effective for different conditions. EGM emulates this set of relationships and probabilities using administrative claims data.

EGM has been developed with input from physicians and other clinicians, including individuals at CMS and the Agency for Healthcare Research and Quality, support contractors, and experts

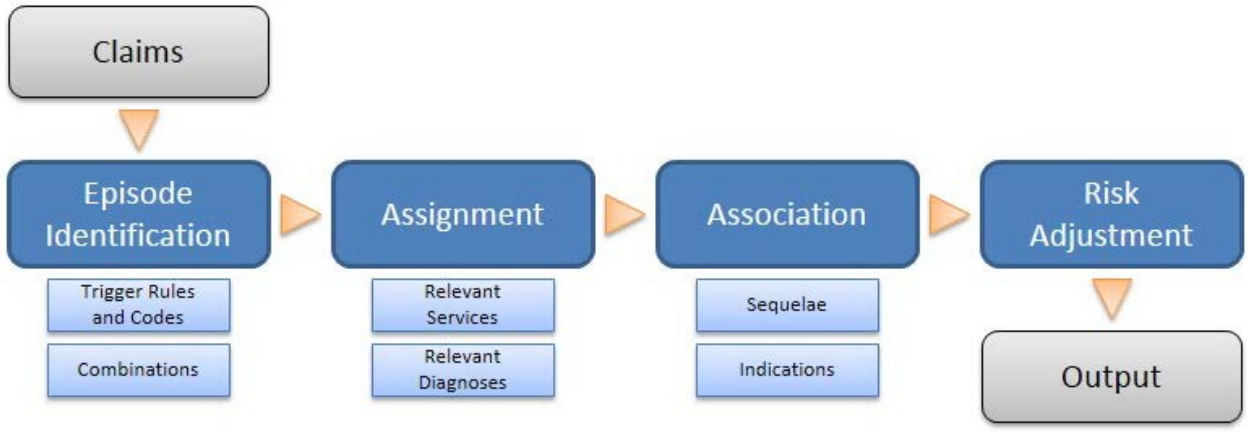
recruited through broad invitations. This led to the development of specifications for each episode, which are stored in tables that are accessed by the EGM software as it processes information on claims data. (Section 2 of this document discusses how episode specifications are derived.) Those tables are called the Episode Definition Data (EDD) and include clinical facts, such as possible symptoms, tests, treatments, and sequelae for each type of episode.

EGM software uses those tables along with patient-specific claims data, including date and place of service, type of provider, diagnosis, and procedure/service codes to construct episodes, and in effect, assemble an automated history for each patient. Just as an encrypted message may seem meaningless, so raw claims data might also seem, at first glance, to be a jumble of information. But, the actions of clinicians are purposeful, and a patient's claims can be deciphered into a meaningful history using clinical intelligence in the EDD as the key to unlock the code.

iv. How does EGM construct episodes?

EGM is a software application that reads Medicare administrative claims data and produces information organized by episode of care. EGM functions through interactions between the rules encoded in the software application and the clinical knowledge stored in the EDD tables. Figure ES-1 provides an overview of how EGM constructs episodes.

Figure ES-1: Overview of How EGM Constructs Episodes



Claims. EGM processes Medicare Part A and Part B claims data that are arranged in chronological order by beneficiary. The software first links pairs of service elements that are disjointed in FFS bills, such as the technical component of an image study along with the reading of the study, into more clinically-meaningful services. The result of this step is a database of services ready for episode identification.

Episode Identification. EGM reads the resulting set of services in chronological order to determine when a patient is involved in an episode of any given type.

Assignment. EGM reads the service data again to determine which services provided to the patient are relevant to each open episode.

Association. EGM determines the clinical relevance among episodes, such as an acute condition episode in its own right that also is an acute exacerbation of an underlying chronic condition episode, or is a sequela to a specific condition or treatment episode.

Risk Adjustment. EGM determines drivers of episode costs such as case-mix, severity, and recent clinical events. These result in cost estimates that adjust for these factors and enable comparisons across groups of patients with clinically similar episodes.

Output. The last segment of Figure ES-1 shows that EGM produces output data sets, which include the automated history for each patient expressed in terms of the contents and interrelationships among episodes, and related measures of resource use.

Subsequent sections of this executive summary consider each of the major steps in more detail.

v. How is an episode triggered?

EGM examines claims data in chronological order by patient and compares the information to specified criteria needed to trigger any given episode. To trigger an episode for acute myocardial infarction (AMI), for example, there must be one of the specified diagnosis trigger codes for that condition (e.g., Acute myocardial infarction of anterolateral wall, initial episode of care) conforming to the trigger rule for that condition (i.e., Trigger code in principal position on IP facility claim).

For each episode there is a corresponding set of trigger codes and one or more trigger rules. Condition episodes are defined in terms of diagnosis codes (what the patient has), whereas treatment episodes are defined in terms of procedure codes (what the physician does).

Trigger codes are used in conjunction with trigger rules to identify each instance of an episode. EGM supports a number of rules that reflect information available from different types of providers (e.g., hospital versus physician claims) and how that information can be used to trigger an episode. A trigger code for a particular condition may have to be observed only once on an inpatient claim, or more than once on outpatient claims. Similarly a trigger code for a treatment episode may have to be observed on a facility claim, a professional claim, or both. For example, a principal diagnosis of heart failure on a hospital claim can trigger acute (and chronic) heart failure episodes, whereas more than one professional evaluation and management services for heart failure can trigger a chronic heart failure episode. Section 4.1 describes the identification of episodes from claims data.

Triggering a chronic condition episode is not necessarily the same thing as identifying when the patient's illness began, or even when it became diagnosed for the first time. However, it is important to use the information when it becomes available, including the presence of an episode of care for the chronic condition. This allows EGM to track services and costs related to that condition, and to use information about the presence of the condition to set cost expectations related to that condition as well as likely other conditions that may be caused or exacerbated by the underlying condition.

vi. How is an episode closed?

Episode specifications indicate when an episode will close. EGM is optimized currently for episodes to close after a predetermined fixed-length interval. Episodes defined by acute conditions typically close 90 days after the date on which they were triggered. Similarly,

treatment episodes defined by a specific procedure will close 30 days after the trigger date. Episodes defined by chronic conditions may last for as long as the patient is covered by original Medicare. For any given type of episode, exceptions to the default rules are specified in the EDD.

A second approach also is available by which the duration of an episode can be determined by service patterns instead of a fixed length. Using this approach, an episode will close after a predetermined time interval in which the patient does not receive services indicating continued care for that episode. This variable-length approach to closing episodes can support analyses of variability in service utilization patterns. Section 4.2 describes closing rules for episodes.

vii. Can more than one episode be open at the same time?

Under most circumstances a patient can have more than one episode at a time representing different conditions or treatments. For example, a patient can have multiple concurrent chronic condition episodes open, perhaps overlapping in time with acute condition episodes or treatment episodes of various types. EGM permits such overlapping or concurrent episodes, even while recognizing that clinical treatment patterns and resource use can be affected by interactions between conditions, and between conditions and treatments. For example, the occurrence of pneumonia can influence clinical management and resource use for concurrent conditions such as COPD or heart failure. Section 4.3 describes how EGM combines condition episodes that cannot co-exist; Section 4.5 discusses overlapping treatment episodes.

Exceptions exist to the general rule that multiple episodes can be open at the same time. One such circumstance relates to observing in the claims data what could appear to be more than one condition episode (sufficient to trigger each one, respectively), but more likely represents uncertainty among providers about what is the patient's true underlying condition. EGM applies rules that also clarify which episodes to build, and which episode(s) to merge, subsume, and otherwise essentially discard. For example, an episode of community-acquired pneumonia may be triggered by outpatient evaluation and management (E&M) services with corresponding trigger codes; but followed shortly by a hospital admission for aspiration pneumonia. Given such a pair of episodes triggered closely in time, EGM would interpret the aspiration pneumonia as primary and would merge with (and discard) the community-acquired pneumonia episode. Services and costs that would have been assigned to community-acquired pneumonia would instead be assigned to aspiration pneumonia.

viii. How are services assigned to an episode?

A major aspect of building an episode is determining which services that a patient receives ought to be assigned to that episode. EGM does not build one episode at a time, reading all the data each time as it builds each episode in succession. Instead, EGM passes through the claims data to assign each service to one episode that is open on the date of the service, to more than one episode, or to no defined episode at all (e.g., a single service for a non-specific diagnosis that is not relevant to any open episode).

EGM uses a hierarchical set of rules for service assignment that allow the best evidence available to determine the assignment. The rules are summarized in the next several sections. The governing principle is that a service should be assigned to the episode(s) for which it is most relevant, taking into account procedure codes, diagnosis codes, and timing. Generally, codes that

identify an episode (i.e., trigger codes) are highly relevant and likely to be assigned to the episode. Commonly used services with potential clinical benefit, or commonly observed or treated symptoms also can be assigned to an episode. Assignment can be affected by timing as well. For example, an ambulance service may be assigned to the same episode as the emergency department or dialysis center claim that follows. Section 5 describes the service assignment rules, and how circumstances that can affect assignment.

ix. What are an episode's relevant services?

Each episode specification has a set of procedure codes, called **relevant services**, which are considered to have a plausible clinical purpose related to that episode. A bronchodilator, for example, is a relevant service for asthma but not for osteoarthritis. A patient may receive a bronchodilator while episodes for asthma and osteoarthritis are both open. Suppose the code was on an outpatient department claim, for which the billing format allows multiple diagnoses but does not align specific diagnosis codes with specific procedure codes. The fact that bronchodilator is a relevant service for asthma but not for osteoarthritis means that the service is likely to be assigned only to asthma.

However, it is common for beneficiaries to have many episodes open when a given service is provided, which might be relevant to more than one episode. Furthermore, the mere fact that a procedure code is listed as relevant to an episode does not mean that the service automatically will be assigned to that episode. For example, a certain type of lab test may be relevant to any of several open episodes, but the diagnosis code on the claim may indicate a specific episode.

The list of relevant services for each type of episode was developed using a two-stage process. First, a representative Medicare claims database was examined for services that included one or more trigger codes for the episode of interest. The procedure codes from those claims were used to produce a candidate list of relevant services, i.e., procedure codes that might be clinically relevant to that episode. Such a culling also could include other procedure codes that co-occurred with the trigger codes, but for reasons other than plausible clinical relevance to the type of episode defined by those trigger codes. The candidate list was then limited to the services that contributed most to the costs attributed to that type of episode.

Second, clinicians reviewed the candidate list, and removed all service codes for which clinical relevance to that episode was not clinically plausible. Note, the criteria applied here were looser than strict clinical appropriateness or treatments recommended by the development team; rather, the attempt was to capture the most impactful procedures that were provided to beneficiaries in relation to that type of episode.

x. What are an episode's relevant diagnoses?

Each episode has a set of diagnosis codes, called **relevant diagnoses**, which are considered to be plausible findings, symptoms, and various presentations that often occur in relation to a given episode. Suppose a patient has episodes open for hypertension and pneumonia, and has an E&M office visit or an emergency department visit with a diagnosis code indicating treatment for cough symptoms. Following from the clinical fact that cough could arise from pneumonia but not hypertension, the service would be assigned only to the pneumonia episode and not the hypertension episode. Including relevant diagnoses for each episode helps to capture the range of services and costs that are related to an episode even when more specific diagnoses are not

included on the claim. This has the additional advantage of judging the efficiency of providers more fairly by including services and costs that reflect non-specific diagnoses, which may partly be a reflection of variation in coding practices.

The list of relevant diagnoses for each episode was developed following a two-stage process similar to the one used for relevant services. First, a representative Medicare claims database was examined for all diagnosis codes that appeared on service claims during the same time intervals as service claims with trigger codes for that type of episode. In other words, during the time in which an episode would be open based on the pattern of trigger codes, what other services occurred with what diagnosis codes? A threshold of statistical likelihood or association was applied. To be considered further, the diagnosis codes must occur significantly more often when the episode is open than when it is not. This produced a candidate list of relevant diagnoses that might be clinically relevant to that episode, but still could include other diagnosis codes that occurred contemporaneously by coincidence. This list was trimmed to include only those codes associated with significant contributions to episode cost.

Second, clinicians reviewed the candidate list, and deleted all diagnosis codes for which clinical relevance to that episode was not clinically plausible. Listing a relevant diagnosis does not automatically mean assignment of a service to that episode. Indeed, the presence of a relevant diagnosis by itself (not paired with an affirmed relevant service) is considered weak evidence for assignment.[4]

xi. What other criteria can affect service assignment?

In addition to clinical assertions in the EDD regarding relevant services and relevant diagnoses, there are other episode construction rules that can affect service assignment. This generally occurs when diagnosis codes do not provide enough information. For example, an ambulance service may have a provisional or general code that does not directly connect to any open episode. In this situation the ambulance service is assigned to the same episode to which a facility claim that is submitted on the same day is assigned, such as a hospital emergency department, or a kidney dialysis center. In other words, the assignment process is not one of examining the data elements on the ambulance claim for clinical details, but using pragmatic logic that those two events on the same day (temporal proximity) is sufficient to make a plausible assignment of the ambulance service to the same episode as the facility service. This is determined by the clinical relevance of the facility claim to open episodes.

xii. What is the hierarchy of information used to assign a service to one or more than one episode?

EGM assesses if a service is relevant to each episode that is open for a patient and is eligible to receive service assignments. The relevance is neither a simple dichotomy of yes or no, nor a continuous scale. Rather, relevance is determined by a hierarchical set of categories: trigger code, combination of relevant service and relative diagnosis, and then either a relevant service or relevant diagnosis.

[4] As with relevant services, the relevant diagnoses captured in the EDD is not exhaustive, but optimized for analysis and profiling purposes. Future versions of the EDD can refresh, update, and add to the lists of relevant services and diagnoses.

Once a service has been assigned to one or more episodes based on the hierarchy, EGM does not proceed to consider any other categories (lower) in the hierarchy. EGM will assign the service to only one episode, using additional tie-breaking rules, *if the user selects single-assignment*.

xiii. What options affect service assignment rules?

The default option in EGM is to assign services according to the rules and hierarchy described in the previous sections. EGM provides an alternative option that assigns all services delivered to a beneficiary during a hospital stay to the same episode to which the hospital stay is assigned. Choosing this option overrides the examination of clinical evidence based on relationships between diagnosis codes, procedure codes, and any other open episode.

Similarly, EGM provides the option to assign post-acute services to the same episode to which a recent hospital stay is assigned without any further consideration regarding clinical relevance to other open episodes. This allows a user to integrate the acute and post-acute segments of care into a single episode for analysis. This also reflects Medicare benefit rules whereby coverage for a skilled nursing facility admission is contingent on a qualifying hospital admission.

xiv. How are costs allocated to episodes?

Allocation of costs to episodes follows directly from service assignment. In the simplest case where a service is assigned to a single episode, then Medicare payments for that service will be allocated fully and only to that episode.

In the case in which a service is assigned to more than one episode, the user has two options. The first option is called “apportioned cost,” and allocates the Medicare payment amount in equal shares to each episode to which the service is assigned. For example, if an E&M service for which Medicare paid $100 is assigned to two episodes, then half of the observed Medicare payment amount, $50, is allocated to each episode, respectively. The second option is called “full cost,” and allocates the entire Medicare payment amount to each episode to which the service is assigned. For each of the two episodes, $100 would be allocated for the E&M service for which Medicare paid $100. In other words, the full-cost option double counts dollars across episodes.

The apportioned-cost option helps to explain the likely reasons that Medicare made certain payments. In the example, Medicare paid $100 for an E&M visit, which served two episodes for which the same resources were shared. In other words, both episodes shared the single visit. The full-cost option could describe spending for an episode more intuitively, and what the episode likely would have cost without interactions with other episodes involving shared resources and joint production.

xvi. Does EGM recognize associations among episodes?

The steps described previously refer to direct assignment of services on claims to one or more episodes. Direct assignment of a service to one or more episodes reflects the best explanation as to why that service was provided in the first instance: that service was "part of" or "done for" that episode. EGM recognizes that, once formed, certain episodes (and other limited episodes) can be clinically related in various ways. A treatment episode occurs in order to treat a particular condition. EGM produces the treatment episode for analysis and reporting, and includes the treatment episode services and costs as part of the condition episode. At the same time, the condition for which a treatment episode occurs can be very important to the services and resources used for that episode. Stated in a different way, the **indication** can be a very important attribute of the treatment episode; for example, distinguishing colon surgery that occurs to treat an obstruction versus to treat cancer.

EGM recognizes another type of association among episodes and other limited episodes, namely sequelae, which refer to aftereffects or secondary results from a condition or its treatment. For example, a patient may acquire an infection following surgery. Another patient may experience sepsis or respiratory failure following treatment for pneumonia. A third patient with chronic COPD may be admitted to the hospital for an acute exacerbation of the COPD. The services and costs for these sequelae, including office visits, emergency visits, and hospital (re)admissions are associated and linked to their primary (causal) episodes.

The individual services may be directly assigned to specific episodes such as the infection or acute exacerbation, but nevertheless, those conditions are sequelae. Accordingly, performance evaluations centered on the primary episode can consider these sequelae and their costs, which presumably could be lower in frequency or cost for "high performers," versus more frequent or costly for "low performing" providers. In other words, evaluating efficiency and value with regard to a given primary episode of interest includes clinical consequences observed as sequelae and their costs.

EGM outputs include each episode and limited episode along with assigned services and costs; all condition episodes with their associated treatment episodes; all episodes with their associated sequelae; and all truly primary episodes (not occurring as a sequela) for each patient with their associated acute exacerbations, treatment episodes, and sequelae, where applicable.

xvii. Are episodes specified identically for every use case?

EGM allows users to customize construction of individual episodes though a stratification feature. This allows the attributes of episodes to be segmented into strata, which in turn, can be

used to select, segregate, or filter (exclude) cases with the particular attribute. For some types of analysis, important differences in efficiency may be observed in the tendency to use expensive treatment options more than necessary, such as inpatient hospital. For example, a user may wish to analyze the resource implications of differential hospitalization rates for pneumonia, which would involve analyzing pneumonia episodes regardless of setting.

A different use case, or a different focus of efficiency analysis may call for stratifying pneumonia episodes by setting, choosing only episodes that involved hospitalization, or only those that were treated in ambulatory settings. Profiling hospitalists, for example, would naturally be restricted to patients who were hospitalized. Similarly, inpatient episodes can be stratified by MS-DRG, and the user can retain cases based on one or more MS-DRGs, combine cases into specified groupings of MS-DRGs, and exclude some cases such as rare or idiosyncratic MS-DRGs.

xviii. Does EGM risk-adjust episode costs for valid comparisons?

Any given patient or episode, and any given provider's patients, can be different from average in terms of expected resource use for reasons to do with the patient's comorbidity burden or severity of illness. Thus, comparing average resource use for one provider's patients to another provider's patients, or to a simple unadjusted average of all other providers' patients, can bias an analysis or inference about relative performance.

EGM attempts to remove such bias by calculating expected costs for each episode using information about the patient's medical history.

Specifically, EGM uses a patient's constellation of episodes (including limited episodes) as factors in risk adjustment:

- At the start of each estimation period for expected costs, which is the beginning of any episode, or again every 90 days for chronic conditions, EGM looks at past and present episodes that may affect the expected cost for the episode of interest.
- Any that are already open at the beginning of the estimation period are considered potential risk factors. For example, when updating the expected cost estimates for a chronic COPD episode, a patient in the midst of a pneumonia episode could have higher expected cost for COPD in the near future (the next 90 days).
- Any episodes for the patient that may have closed within the past six months also are considered as potential risk factors. For example, when updating the expected cost estimates for a chronic heart failure episode, a patient who experienced a recent AMI may have higher expected cost for heart failure as a result. Similarly, recent implantation of a pacemaker could affect the expected costs of arrhythmia.
- Episodes that closed more than six months before the period of interest are considered are also used a potential risk factors.

EGM calculates expected costs for all episodes using EGM's own identification rules to trigger episodes, which are used as risk factors. This standardizes their definitions and pinpoints their time parameters (e.g., recent versus older). EGM calculates the risk factors using the identical choices made by the user in stratifying episodes according to their attributes. Similarly, the actual and observed costs included in EGM outputs reflect the user's choice of actual Medicare payment amounts versus payment amounts that have been standardized to remove differences attributable to regional or other pricing variation.

1. Introduction

The Episode Grouper for Medicare (EGM) is a software application that organizes Medicare administrative data into clinically meaningful **episodes of care**, or simply episodes, which are sets of services provided to care for an illness or injury during a defined period of time. EGM is part of a broad set of efforts to help improve care by describing how Medicare dollars are spent and providing comparative performance data on the costs and consequences of medical care delivered to clinically similar patients.[5]

An episode grouper bundles all care for a condition or a treatment into a single unit of analysis that is intended to serve as the basis for cost comparisons. For the comparisons to be useful and actionable, costs must be complete, and the groupings clinically valid and statistically reliable. For clinicians to improve care, they need to understand processes of care, not just in the abstract, but for their own patients. Opportunities to improve care can be overlooked despite the best of intentions. Such opportunities are hard to see because heath care often involves many providers and is dispersed over time and place, and because adjustment for comorbidities and other risk factors is usually needed for valid conclusions. Thus, formal analytics are needed to support clinical judgment.

Given the number of different conditions and services involved, any strategy to develop analytics must address issues of scale, scope, and consistency. The key to analysis is standardization, which may seem inconsistent with the complexity and individuality of illness and health care. However, a person's medical history can be summarized by a small number of clinical data tables. Thus, a first step is to develop the data tables that, taken together, represent the course of illness, diagnosis, and treatment at the patient level. A second step involves the processing of claims by algorithms that map claims into these data tables. The resulting tables can then be queried to produce a wide range of metrics to measure performance and identify opportunities for improvement.

This report describes how EGM works in terms of its logical components and processes: how the clinical data tables are organized, and how the software constructs episodes from claims data that are sorted chronologically and by beneficiary. The following section discusses the definitions and specifications of the types of episodes supported by EGM (i.e., the types of health conditions and treatments). Subsequent sections describe the process by which EGM constructs episodes and related information from the claims data.

2. Episode Definitions and Specifications

EGM forms episodes generally belonging to two classes:

- Conditions for which services are provided. Patients receive services for clinical reasons — that is, to detect or treat specific conditions (illnesses and injuries). EGM supports a large number of **condition episodes**, such as ischemic heart disease and pneumonia, which cumulatively account for a large proportion of total Medicare expenditures for the

[5]See §131 (c) of the Medicare Improvements for Patients and Providers Act of 2008 and §§3003, 3007 of the Affordable Care Act of 2010; Medicare Access and CHIP Reauthorization Act of 2015. For information on the CMS Quality Strategy, see: http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/QualityInitiativesGenInfo/CMS-Quality-Strategy.html

beneficiary population. A condition episode includes services for a particular condition over time, and across settings and providers.

- Treatments that have been provided. Some types of treatment can be costly in their own right, and represent opportunities for improvement in efficiency. EGM supports many **treatment episodes**, such as hip replacement and coronary artery bypass grafting (CABG). Treatment episodes are more narrowly focused on major procedures, along with accompanying or ancillary services.

These two classes of episodes recognize the utility of different perspectives on resource use. Condition episodes allow for analysis of cost variation driven partly by differences in treatment patterns, such as medical management versus surgical intervention, or greater versus lesser use of institutional services (e.g., hospitals versus outpatient treatment, or skilled nursing facility versus home health). Treatment episodes allow for a similar analysis of cost variation after the defining treatment has been provided, such as major surgery.

2.1. Defining Condition Episodes

A guiding principle for EGM is to use clinical concepts and terminology in ways that are familiar to clinicians generally, and not invent new terms for existing concepts, or use familiar terms in ways that are inconsistent with common conventions. At the same time, episodes and other concepts used in EGM must rely on operational definitions of billing codes because episodes ultimately are constructed from administrative claims data.

Moreover, defining conditions and episodes is not simply a matter of putting conventional labels on sets of codes; episodes are clinical and statistical constructs that must fulfill applicable criteria for performance measures, including scientific acceptability and usability.[6] Development of episodes is an optimization problem involving trade-offs in construction and corresponding results. One part of the challenge involves optimizing the degree of heterogeneity ("lumping concepts and codes into larger aggregations") versus homogeneity ("splitting concepts and code sets into smaller units"). Generally, larger aggregations allow more sources of variation affecting cost outcomes, larger patient volumes (sample sizes) per episode, and more providers meeting minimum thresholds set for inclusion in comparisons. Narrower specifications rule out some sources of variation affecting cost outcomes, making episodes more comparable; but reduce patient volumes and provider participation, and could be more susceptible to variation in coding practices.

This leads to another guiding principle for EGM, namely to avoid ruling out options that CMS or other users may need in order to fulfill purposes for EGM. Addressing this principle occurs in this context by defining episodes to be maximally heterogeneous subject to a consistent set of specifications (See Section 2.3); and allowing users to "configure," stratify or risk-adjust episodes to be more homogeneous as appropriate for the intended purpose.[7]

2.1.1 Conditions

For the purpose of defining a condition episode, a condition is:

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[6] National Quality Forum (NQF). Evaluating Episode Groupers: A Report from the National Quality Forum. Washington, DC: NQF; 2014

[7] Section 4.6 describes the episode stratification feature in EGM, and Section 7 describes risk adjustment.

- A single, distinct disease process (or injury), or
- A set of closely related disease processes (or injuries/incidents) having characteristics that are similar within the set (i.e., consistent specifications),[8] and distinct from other diseases (or injuries).

Furthermore, a condition is characterized by the existence of one or more clinically accepted approaches to diagnosis, treatment, and management. A condition episode is intended to reflect elements of diagnosis, treatment, and management for each condition relying upon information captured through the standard code sets used for Medicare billing.

Out of the universe of available diagnosis codes, the EGM development team constructed a diagnosis taxonomy of clinical concepts or topics consisting of over a thousand conditions, and hundreds of other diagnosis concepts representing non-specific clinical states, symptoms, or clinical presentations (see Section 9.1). Each clinical condition concept is evaluated for candidacy as the basis of one or more condition episodes.

2.1.2. Condition Episodes for Reporting and Analysis

The approach to developing episodes for analysis and inference is founded upon a desire to build episodes to measure resource utilization of clinically meaningful and well-defined diseases and illnesses that make-up a significant percentage of spend by Medicare. The EGM development team used a decision tree to identify and consider sources of resource variation in order to help focus on variation related more to differences in providers' discretionary practice patterns.

The evaluation process to determine suitability for analysis considers the extent to which the clinical concept/topic in question represents a condition defined by a clinically accepted approach(es) to diagnosis, treatment and management that are present and distinguishable using the standard coding systems available to EGM.

The process aims to determine whether the clinical topic can be specified adequately for development as a condition episode that can function as the subject of analysis. While there are many conditions that are satisfactory for this purpose, there are others that are not. For problematic clinical topics, the question becomes, "Can the clinical concept/topic be split or divided in a meaningful way so that one or more of the resulting clinical topics are suited to be the subject of analysis?" For example, treatment and management of chronic kidney disease (CKD) is predicated on the stage of the illness. If CKD could be "split" so that each stage of the disease were treated as its own condition episode, those new CKD condition sub-categories might function satisfactorily as condition episodes.

Still, many conditions face a challenge because codes defining those conditions represent a heterogeneous mix of clinical conditions that are not sufficiently distinguishable in claims data alone. A common example of this problem is many cancers, the treatment for which can depend greatly on the stage of illness. In such cases, the codes do not allow for EGM specifications to assert a consistent set of treatment approaches for the heterogeneous clinical concept. Such a heterogeneous specification would implicitly mix resource variation due to case-mix differences (i.e., different patients with different clinical conditions). A mitigating strategy for some conditions is to eliminate a source of resource variation by excluding selected codes from the

[8] Here, specifications refer to relevant services, relevant diagnoses, and sequela assertions. These are described in Section 2.3.

definition of the condition episode (i.e., exclude some "types" of the condition and focus more narrowly on other types).

2.1.3. Limited Episodes

Using methods described later in this report, EGM can identify the presence of each condition episode according to the claims data for a given patient population. In other words, the software application triggers episodes based on the trigger codes and rules applicable to each (Section 4), assigns services using a consistent set of rules (Section 5), applies closing rules, and associates clinically related episodes as appropriate (Section 6).

However, not all condition episodes are intended to function as the subject of resource use measures for analysis and reporting. EGM distinguishes between episodes intended for that purpose from "limited episodes," which can still serve other functions, which are:

1) To enhance the validity of service assignment. If the diagnosis code for a service is a trigger code for a given condition, then specifying that condition in the EDD helps to steer services to the most appropriate episode, and away from plausible but less valid alternatives. It also lowers the amount of spend by Medicare for which there is "no apparent explanation."
2) To be available to function as sequelae, as determined by clinical logic, to capture the full cost of an episode of interest. If a certain condition is asserted to be a plausible sequela of a given episode that is the subject of analysis, then specifying that condition in the EDD, and determining its cost when applicable for a patient, can help to determine the full cost of the (causal) episode of interest.
3) To serve as risk factors; i.e., to signify the presence of conditions that could be significant comorbidities that affect resource use for various episodes.

2.2. Defining Treatment Episodes

This section addresses issues in deciding which types of treatments, such as major procedures and therapies, should be considered in EGM as their own episodes. Selection criteria allow high cost and high frequency treatment episodes to be identified and defined separately from, but within the context of, the associated condition episode(s); i.e., the indications for the treatment episode. Similar to selected condition episodes, selected treatment episodes can be the subject of reporting and analysis for policy purposes. Limited episodes can serve other functions such as clarifying service assignment, documenting significant clinical events for the sake of risk-adjusting the expected costs of episodes, and identifying "treatment combinations" that can affect resource use.[9] Supporting more types of treatment episodes allows EGM to explain the resource use attributable to more providers, and more of each provider's practice, so that their contributions to Medicare can be evaluated more robustly across their body of work.

The definition of a particular treatment episode must be clinically meaningful such that all instances of the episode should share common treatment or diagnostic goals, should require

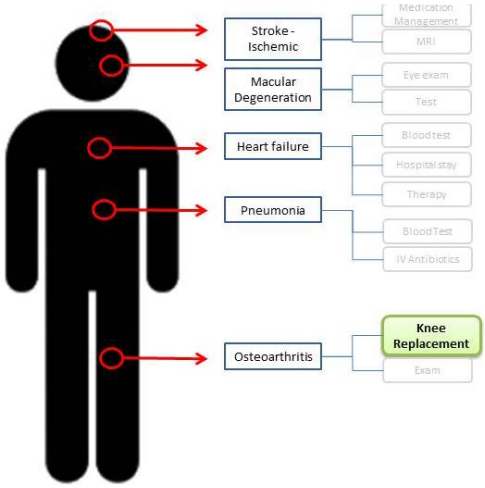
[9] Treatment combinations are instances of more than one treatment episode occurring for a patient during overlapping time intervals. Such instances may reflect particularly complex clinical circumstances, or situations involving joint production and shared resources, such as two operations provided in tandem.

similar supportive environments, and have similar expected sequelae and aftercare.[10] The specifications for a treatment episode, including relevant services, relevant diagnoses, and sequelae, should be consistent in terms of their clinical plausibility and applicability to the treatment episode type, considering the specific nature or approach taken in the treatment. The intent is to be inclusive within the episode type with respect to possible discretionary aspects of the treatment signifying relative efficiency, while minimizing incorrect assignment of services (false positives) that may occur if the patient has some other concurrent condition or other treatment episode overlapping in time that may explain services within the specifications of the given treatment episode of interest.

2.2.1. Selecting Treatment Episodes

EGM takes a stepwise approach to identifying treatment episodes from among all the service codes (procedure codes or claim lines) that may be found on a claim that is submitted to Medicare for payment. Service codes are mapped onto a list of service concepts, created by the EGM team, which articulate and describe clinically coherent groupings of service codes with common purposes and modalities routinely used in clinical communication by health care providers in actual practice settings (see Section 9.1). Then, from within the list of all service concepts, the EGM team identified the candidate treatment episodes. To be eligible for consideration as a treatment episode, a service concept must have prominence according to criteria that are clinical or related to utilization and performance.

Figure 1: Example Treatment Episode



Clinical Criteria

A treatment episode is defined by a primary procedure delivered towards a therapeutic, diagnostic, rehabilitative or palliative goal for specific condition(s), and should be considered substantial and direct towards this goal rather than ancillary. Thus, hip replacement surgery is a substantial service towards treatment of osteoarthritis, while the anesthesia is ancillary to the surgery. Coronary artery bypass grafting is a direct and substantial service, while the vein harvesting procedure is ancillary. To qualify as a treatment episode a service concept, such as a major surgical procedure, should:

- Have a direct impact on the patient, with benefits and harms to the patient clearly attributable to the intervention.
- Include a specific time frame anticipated for the course of treatment. This could be a single one-time encounter, episodic encounters, or ongoing treatment depending on the type of the service.

EGM is designed to go beyond routine care expected from the surgical or treatment team in order to capture potential subsequent resource use related to the treatment of interest, such as post-

[10] Regardless of the location or setting, a treatment episode should imply having similar supportive environments. For example, PCI in the hospital or in an outpatient setting still needs the same advanced imaging, advanced life support equipment, and cardiac surgery back-up.

acute care, home health versus skilled nursing facility (SNF), ED visits, readmissions, and sequelae. Thus, the timeframes used for treatment episodes in EGM are different and distinct from those used in Medicare's global surgery payment policy.

The EGM developers evaluated service concepts as potential treatment episodes as part of the clinical criteria and selected concepts to become treatment episodes according to these standards:

- Service concepts that provide direct and primary treatment to cure or resolve the associated condition (e.g. cholecystectomy, cataract surgery)
- Service concepts that are intended to change the course or prognosis of the associated condition (e.g. chemotherapy for cancer, critical care services)
- Service concepts that provide important diagnostic information about the associated condition (e.g. colonoscopy with biopsy, cardiac catheterization)
- Service concepts that serve a major rehabilitative or palliative role for the patient with the associated condition (e.g. rehabilitation after hip fracture, hospice care)

Utilization Criteria

Among the service concepts matching the clinical criteria, preference in development is given to those with high cost or high frequency among CMS beneficiaries. By prioritizing treatment episodes with high utilization, CMS would focus attention on opportunities for greater potential impact. The EGM development team used data on claims costs and volume to inform the selection of treatment episodes.

Performance Criteria

A useful treatment episode is for an intervention for which there are meaningful and discernable performance differences between providers and provider groups, or performance improvements to be made. Treatment episodes can have important implications for the creation of bundled payment programs, provider accountability, and provider buy-in for the EGM profiling functions. The development priority for treatment episodes reflects the intention to detect inefficiency in health care delivery and variation in cost and resource use beyond what is explained by variation in patient characteristics.

2.2.2. Development of Treatment Episodes from Service Concepts

The EGM developers further refined service concepts that were deemed appropriate to be raised to the level of treatment episode, and specified the boundaries between candidate treatment episodes based on similarities or differences in indications, anatomy, techniques or expected sequelae. The challenge is to define episodes to be distinct from others (concerning the variations in definitions between current coding systems and variations in coding practices), yet to avoid defining episodes so narrowly as to preclude useful contrasts in provider performance.

The process of defining episodes involves choosing a service type and sub type from the EGM taxonomy, and then individually examining each service concept within the sub type, along with all of the procedure codes related to that service concept. Procedure codes are then classified as either belonging to the treatment episode, not applicable to the treatment episode, or an ancillary service to the treatment episode.

In some cases, a treatment episode can be identical to the original service concept. Procedure codes are then mapped onto the treatment episode. In other cases, a service concept contains

more than one potential treatment episode. In such cases, procedure codes are mapped selectively to each of the treatment episodes within that service concept.

In general, procedure codes are combined into treatment episodes that are broadly construed. For example, surgical procedure codes are grouped into a single treatment episode when they represent the same treatment concept, even when they are applied to differing anatomies or use different operative approaches (e.g., laparoscopic versus open colectomy, or endovascular versus open femoral artery repair).

In other cases, a single treatment concept (e.g., aortic repair) is split into two or more separate treatment episodes based upon more profound differences in operative anatomy or surgical approach that mandate different providers or technologies (cardiac surgeons and cardiopulmonary bypass for thoracic aortic repair versus vascular surgeons and no cardiopulmonary bypass for abdominal aortic repair).

Once candidate treatment episodes are identified, the EGM development team further defined the boundaries of a treatment episode with regard to:

i) The indications for the treatment episode (i.e., the underlying conditions leading to the decision to initiate treatment). Each treatment episode will have a clearly defined and limited number of condition episodes that are listed as indications for that treatment episode

ii) The expected sequelae from the treatment episode, which also are chosen from among condition episodes

iii) The time parameters, which define the length of the entire episode including a time window in which sequelae are plausible and a look-back period (i.e., days before the procedure during which clinically relevant services may occur).

As with condition episodes, treatment episodes are intended to be defined such that they are homogeneous with respect to these specifications. In other words, the specifications are clinically plausible for all instances of a given episode. For example, if plausible sequelae vary by indication, then the treatment episode is defined to be homogeneous with regard to indication.

For every type of episode supported in EGM, it is necessary to identify plausible relevant services, relevant diagnoses, and sequelae (See Section 2.3). For example, a patient with the condition Ischemic Heart Disease (IHD) may have the treatment Percutaneous Coronary Intervention (PCI), both of which are episodes supported in EGM. While the services identifying PCI can be noted and considered as relevant services for an IHD episode, there are other services done ancillary to the PCI that also must be identified if PCI is to be viewed as a treatment episode. A properly constructed treatment episode will capture the full cost of the care that is associated with the primary procedure, e.g., the PCI, as well as the costs of sequelae. The specifications of a treatment episode are intended to reflect the clinical menu of services from which providers draw to manage patients for the primary procedure of interest. The actual combination of services drawn from the menu that are used to manage an individual patient's condition may vary in type and units.

2.3. Relevancy

The previous sections have described how condition episodes and treatment episodes can be defined from the universe of diagnosis codes and procedure codes, respectively. The code sets that constitute the operational definition of an episode are "relevant" to an episode when it comes to assigning individual services. In addition, an open episode is populated from those services in the claim stream that are determined to be relevant to the episode, although these services are less definite than the services that trigger the onset of the episode.

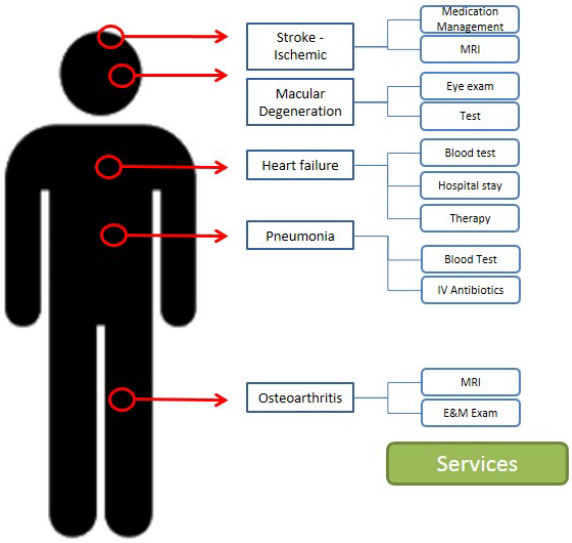
- A patient with pneumonia may receive services to treat a symptom such as coughing, or a patient undergoing surgery may receive services to treat pain. These diagnoses are considered relevant for those specific episodes, meaning they represent clinical factors, such as signs and symptoms that are likely alternative expressions of the condition or treatment episode.
- A patient with asthma may receive a nebulizer for treatment of his or her condition. This is an example of a relevant service; one that has potential benefit for the condition or treatment episode. Relevant services may include procedures, imaging, lab tests, etc.

Each service provided for a patient was ostensibly determined by the ordering clinician to have possible diagnostic or therapeutic benefit for one or more conditions. Any particular service may be relevant to some open conditions or episodes, but not to others. EGM defines for each type of episode its relevant services, as well as relevant diagnoses and sequelae. Those specifications of clinical relevancy (and their temporal parameters) are used to query the patient's claims and assign services to the appropriate episode among those that are open for the patient.[11]

Relevant services. The process for developing the specifications for relevant services is iterative and combines clinical judgment with empirical data from claims.[12]

In the first of two stages, a representative Medicare claims database is queried for all instances of services that occur in conjunction with a given condition or treatment. This was examined by analyzing all services that carry diagnosis codes that are trigger codes for the given condition or treatment. The result is a candidate list of procedure/service codes that co-occur with those trigger codes. These codes are candidates to be specified as relevant services in the Episode Definition Data (EDD). [13] In the

Figure 2: Example Services



[11] The EDD specifies trigger codes for limited episodes, but may contain few or even no relevant services, relevant diagnoses, or sequela assertions.

[12] A particular procedure or diagnosis may be relevant to more than one episode. Section 5 addresses the assignment of services, including situations of relevance to multiple open episodes for a patient.

[13] All services were ranked by the share of total payments for services having a trigger code for the condition as the line diagnosis (or principal diagnosis on Outpatient Department claims). Services were retained that had an odds ratio greater than 1, meaning they were significantly more likely to occur when the episode would be open than

second stage of the process, the candidate list is reviewed by clinical experts who delete (reject) any service codes for which there is no plausible diagnostic or therapeutic benefit in relation to the episode of interest.

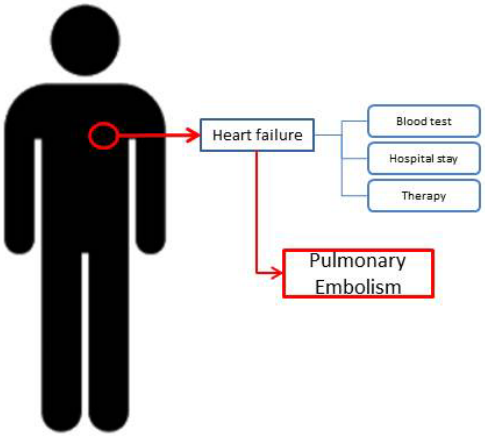
It is not the purpose of the clinical review to pare the list to include only services that "should be" provided ideally. Rather, the intent is to define a realistic set of services that are frequently provided with plausible clinical intent in the management of the episode.

Relevant diagnoses. The claims data also were used to generate lists of diagnoses that occurred on service claims other than the preselected trigger codes used to define a condition episode. These diagnostic codes are candidate alternative clinical descriptors of the condition being triggered and can include alternative coding, such as for symptoms and findings that are needed to fully capture the care (and costs) for the episode.

These candidate codes were reviewed by clinical experts, and those without plausible clinical relationship to the condition of interest were removed. For instance, cough symptoms are plausibly related to pneumonia, so those codes would be retained in the EDD as relevant diagnoses for pneumonia. The intent is to remove from the candidate list any diagnoses that co-occur because of spurious correlations, such as symptoms that are clinically related to other conditions that happen to co-occur in patients with pneumonia.

Sequelae. A sequela episode is a condition episode that occurs secondary to (or in consequence of) a pre-existing episode. Sequela episodes can follow both condition episodes and treatment episodes. Each full-specification episode in EGM contains parameters that define its pertinent sequela episodes. Sequela episodes may be acute exacerbations of a chronic condition or secondary events, such as complications, readmissions or other consequences of the index condition episode or treatment episode. Potential sequelae are identified using a two-stage process analogous to the process used to identify relevant diagnoses:[14]

Figure 3: Example Sequela



In the first stage, a claims database is used to identify condition episodes that occur contemporaneously with the open primary episode.[15] A statistical correlation test (odds ratio) is applied to determine which of those condition episodes occurred with significantly and substantially greater frequency in the presence of the open episode of interest compared to circumstances in which the primary episode of interest was not open. For example, surgical wound infections occur in patients with

otherwise. Ranked from highest to lowest contribution to total episode cost, services were retained that accounted for a cumulative 95 percent of episode cost.

[14] Sequela is a concept analogous to relevant diagnosis. Whereas relevant diagnoses include signs, symptoms, and findings that arise in the context of the primary episode, sequelae are other diagnosed conditions that are identified as contemporaneous or pursuant episodes, and clinically related to the primary episode.

[15] This process would not identify a sequela that arose after a substantial gap in time after the primary, causal episode has closed, such as transfusion-associated graft-versus-host disease in immunocompromised patients that becomes evident after six weeks. In future versions the EDD could be made more complete by expanding parameters and inclusion criteria (or relaxing exclusion criteria).

an open treatment episode for CABG significantly more frequently than patients who do not have an open CABG episode.[16]

In the second stage of the process, clinical experts review the candidate list for clinical relevancy to the primary (causal) episode of interest. As with other specifications, there must be a plausible clinical explanation for how the candidates for sequelae can be "caused by" the primary episode. Clinicians review the candidate sequelae for each primary episode and reject those assertions for which a plausible explanation is lacking. The EDD includes assertions about the sequelae for every episode that is intended to be the subject of analysis and reporting.[17]

When evaluating assertions about sequelae arising during inpatient hospital stays, EGM considers whether a given sequela was present on admission (POA). EGM requires that, in order to be interpreted as a sequela, a condition must be triggered at least one day after the trigger date of the presumed primary (causal) episode. By default, the sequela condition must begin within 10 days of the admission date for a hospital stay. Sequelae to chronic condition episodes can occur at any time.

3. Building Episodes: A Summary of the Process

This section is a summary or preview of the remaining sections of the design report. It provides a quick tour of the major steps involved in processing claims data into identified episodes of care and the services assigned to them. The major steps are depicted in Figure 4.

Claims

Building episodes begins with administrative claims data that contain information on date and place of service, diagnosis and procedure codes, provider, and more. EGM begins by building units of service called ***interventions***. An intervention is a combination of the individual components of a clinically meaningful service, the components of which may reside across multiple claims. The components, such as vaccines (supplies) and the administration of the vaccine (professional services), or the administering and reading of an imaging test, are so closely related that they are functionally a single unit. The large majority of services on claims are not combined with any others and are simply carried forward at this stage as their own "interventions."[18] The process of building interventions is driven by a set of data tables that provide information about how to handle particular combinations of service codes.

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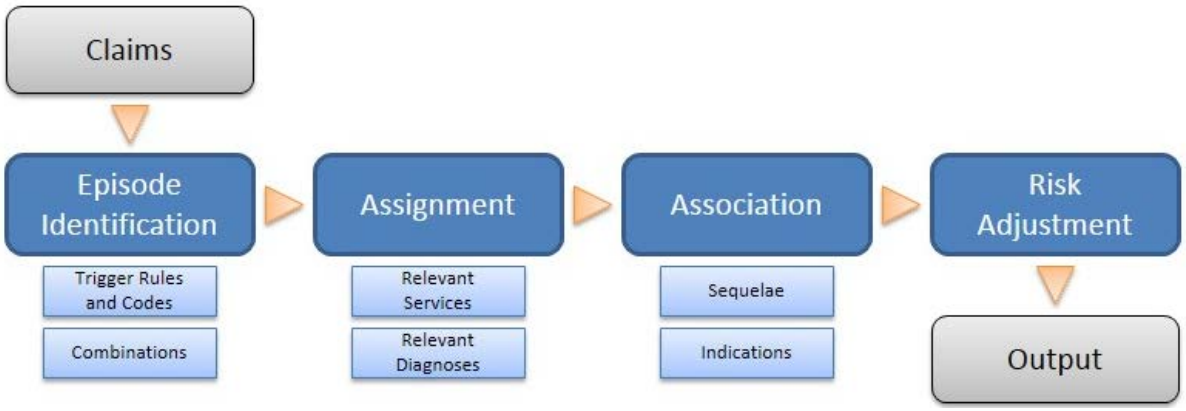
[16] As can be seen in this example, some conditions may be candidates for sequelae for many different primary episodes, as surgical infection may be a sequela for many different surgeries. EGM links the sequela condition episode to each of the open (causal) episodes for which it is asserted to be a sequela.

[17] The combined criteria do not lead to an exhaustive list that includes all theoretical or rare sequelae. This conforms to the anticipated purposes of EGM, which are statistical profiling of general tendencies that can affect average resource use and systematic factors leading to divergence from the average. It is also more pragmatic for development to base assertions on reliable findings from representative data, rather than speculating about events that may occur rarely or idiosyncratically even if their occurrence would substantially affect the "average" cost for patient cohorts attributed to a particular provider entity.

[18] For ease of communication, the terms interventions and services are used interchangeably except when context requires technical precision.

Figure 4: Episode Construction Process



Episode Identification

The episode grouping process begins with episode identification, which answers the questions: "What types of episodes does the patient experience; and when does each episode begin and end?" When specified criteria are met in the patient's claims history, an episode is said to "trigger," which means it is eligible for service assignment for as long as the episode remains open. As part of this process, EGM uses trigger logic, made up of trigger codes and trigger rules to indicate the presence of an episode of care. Trigger codes are diagnostic or procedure codes that are generally unique to a particular condition or treatment, such as pneumonia or CABG.[19] Additional criteria related to trigger codes, such as frequency of occurrence, presence on certain types of claims, or care setting, may be considered by EGM in determining when to trigger an episode. Together, these different types of information constitute *episode identification rules* for triggering an episode (see Section 4.1).

Once an episode has been preliminarily identified, it is called an episode shell and is assigned a set of attributes such as its type (for example, pneumonia or CABG), and time parameters (such as start date). EGM can identify relevant services that occur prior to the episode start date by defining a "look-back period," which is specified in the EDD for each episode. This feature helps to identify the total cost of care for the episode, such as to capture pre-operative services, and the signs, symptoms and preliminary diagnoses that may precede the diagnosis or service that triggers the opening of the episode.

An end date is assigned based on the *episode closing rule* (see Section 4.2). Closing rules vary by episode type. Chronic condition episodes, for example, can remain open as long as the patient is participating in Medicare, or until services for that condition are not observed for a specified duration, such as a year). Acute condition episodes have a default fixed length of 90 days following an outpatient triggering event (such as confirmed pneumonia) or discharge from a triggering inpatient hospital stay. Treatment episodes also have fixed lengths, which vary based on clinical consideration. Additionally, EGM supports closing rules resulting in patient-specific, variable-length episodes.

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[19] Trigger codes can be shared by episodes that reflect the same condition, such as chronic heart failure and acute heart failure. EGM allows users to analyze the acute condition in its own right, but integrates the acute condition as a segment of the underlying chronic condition episode.

During a given time period, a patient could have several chronic conditions, one or more acute conditions, and one or more major treatments. EGM allows for multiple simultaneous open episodes for a patient. As episode shells are formed for a patient, EGM tracks those that overlap in time and evaluates whether to confirm their existence, or to combine them into a single episode if they are not permitted to coexist as separate episodes (see Section 4.3). This can happen for overlapping conditions, such as episodes for aspiration pneumonia and community-acquired pneumonia, which must be merged if they trigger within days of each other.

This combination process can also take place with treatment episodes that have identical or nearly identical start dates, such as when two procedures are performed during the same hospital stay or outpatient visit. Some treatment episodes can occur as discrete events, while others will be combined if they occur in conjunction with another treatment episode (see Section 4.3).

Assignment

At this stage, the episode shell is complete and ready for services to be assigned. Relevant services and relevant diagnoses are identified and linked to the episode for assignment. EGM has a hierarchical set of service assignment rules that gauge the appropriateness of assignment to an episode using information about diagnosis and procedure codes on the intervention, as well as timing and setting (see Section 5). Each service for a patient is evaluated chronologically, with all open episodes being eligible candidates for assignment. The clinical and temporal information is used to inform whether a given service is assigned to one episode based on the strength of evidence, more than one episode based on equally good evidence, or to no open episodes because of lack of sufficient evidence.

Trigger codes for a specific episode are always considered relevant to that type of episode. Other relevant services for every type of episode are stored in the EDD (See Section 2.3). In the hierarchy of information, EGM gives great weight to trigger codes in the assignment of a service. For treatment episodes, the trigger code is definitive. Other services can be assigned based on their relevance. Similarly for condition episodes, the strongest evidence for assignment occurs for a service that has a procedure code that is a relevant service, combined with a diagnosis code that is a trigger code for that condition episode. Lesser evidence exists for a relevant service without a trigger code or other relevant diagnosis; or a relevant diagnosis for a service that is not listed as relevant.[20] EGM supports both single and multiple assignment of interventions to episodes.[21] Assignment rules are discussed in Section 5.

Association

Once services have been assigned directly to episodes, the next step in the process is identifying the logical associations that exist among the episodes. ***Direct assignments*** of services are made to episodes in their most basic and narrow form. However, useful descriptions of resource use often require appropriate combinations of individual episodes that provide more clinical and economic meaning.

There are two major categories of association. First, treatment episodes are linked to the condition episodes for which the primary treatment is indicated, thus providing a more complete

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[20] Currently in EGM, a relevant diagnosis alone without a relevant service code is considered below the evidence threshold for assignment.

[21] In multiple assignment mode, EGM will assign a service to more than one episode that meets the best available evidence for assignment. In single-assignment mode, EGM employs tie-breaker rules in order to make the "best" possible assignment for each intervention.

picture of the condition episodes. Second, condition episodes deemed to be sequelae of primary condition or treatment episodes are linked to their primary (causal) episodes, providing a more comprehensive, patient-centered construct that can be used to describe or analyze the totality of care related to a given condition.

Risk Adjustment

The final step in the process is determining risk-adjusted expected costs for each type of treatment and condition episode. The risk-adjusted cost is based on multivariable regression models that include information about patient demographic characteristics, as well as diagnostic and episode-based flags that describe the beneficiary's clinical history up to the start of the episode or cost-estimation period. The expected and actual costs for each type of episode are calculated at the patient level, which can be aggregated to higher levels for purposes defined by the user, such as comparing actual resource use to expected resource use for groups of similar patients.

4. Episode Shells

Medicare beneficiaries utilize health care services for many different reasons, including prevention, screening, evaluating symptoms, and diagnosing, managing, and treating chronic and acute conditions. All of these encounters with the delivery system generate claims with a wide array of procedure and diagnostic codes. Episode identification is the process of scanning all of the claims for a beneficiary in chronological order to identify the episodes of care that account for the services received.

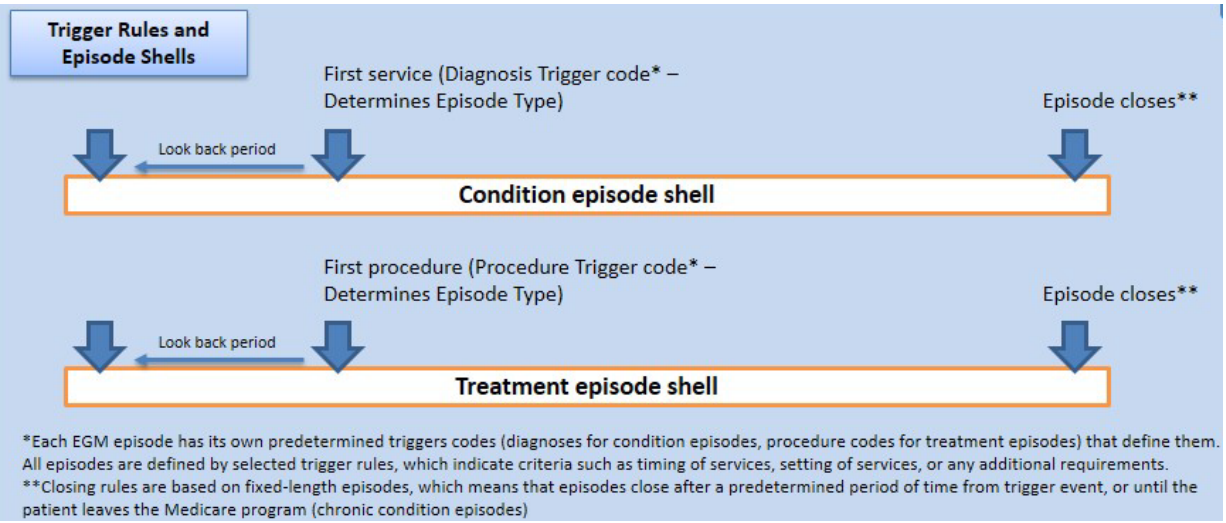
The first step in the process uses trigger logic – trigger codes and trigger rules – to produce the outline of an episode, which is called the ***episode shell***. See Figure 5. The episode shell includes three basic attributes:

- Start date: the calendar date when services provided to that patient can first be assigned to that episode. The start date is determined from the trigger date and the look-back period (Section 5.4). The trigger date corresponds to when the "trigger event" occurs for a patient, formally causing the episode to be open. The trigger event is the service that causes the trigger rule for an episode to be invoked, such as the primary procedure defining a treatment episode or the first of two requisite E&M visits to trigger a condition episode. EGM adds a look-back period prior to the trigger date in order to capture clinically relevant services occurring prior to the triggering event.
- End date: the calendar date when the patient's episode closes and services can no longer be assigned directly to that episode
- Episode type: the condition or treatment that defines the episode (e.g., pneumonia or CABG)

EGM supports two major classes of episodes: condition episodes and treatment episodes (see Section 2). Condition episodes are triggered according to the condition a patient has (that is, by diagnosis trigger codes). Treatment episodes are triggered according to the action taken by a clinician (by procedure trigger codes). For example, suppose a patient visited an ambulatory surgery center for percutaneous coronary intervention; the episode shell includes the episode type (PCI), the trigger date of the episode (the day of the procedure), the start date when services can first be assigned, and the end date, which is a specified number of days after the date of the

procedure.[22] The type of episode — the specific condition or treatment defining the episode — determines the relevant services and diagnoses that can be assigned to the episode, as well as associations with other episodes such as treatment indications[23] and sequelae.

Figure 5: Trigger Rules and Episode Shells



4.1. Episode Identification

A possible condition episode might be identified simply by one or more ICD diagnoses codes on claims that correspond to the condition. For example, any claim with a reported diagnosis code of 493.XX could identify a possible asthma episode. However, not all possible episodes are necessarily "real." There could be possible errors in reporting or diagnosis, or the clinician could be using a working diagnosis or seeking to rule out the diagnosis with further testing.

EGM sets standard criteria using information from the chronology of claims to infer whether a patient has the condition. The criteria for identifying condition episodes varies by type of condition. For instance, severe life-threatening conditions that cannot be safely treated in an ambulatory setting (e.g., acute myocardial infarction, or AMI) must include a hospital admission to be confirmed. For less serious conditions, observing some form of treatment may be required if treatment is mandatory and can be reliably identified from claims data. Therefore, evidence of treatment might be required for most fractures. In contrast, treatment cannot be required to confirm hypertension because treatment cannot be reliably identified without outpatient prescription claims, which are currently unavailable. In addition, no specific treatment can be required to confirm ischemic heart disease because conservative treatment often is appropriate.

In some cases, an episode may be confirmed by a test that is used to diagnose the condition, provided that it is followed by a post-test evaluation and management (E&M) service that affirms that the condition was actually present. For example, prostate cancer can be confirmed by a biopsy followed by an E&M service on a subsequent date with prostate cancer listed as a

[22] The duration of treatment episodes can vary. Major surgery episodes may remain open for 90 days, for example. Episodes for simpler procedures may be considerably shorter, for example, 10 or 30 days. For episodes for which the triggering intervention is a hospital inpatient stay, the end date is computed from the discharge date of that hospital stay.

[23] An indication is the associated condition episode for which an intervention or treatment episode occurred.

diagnosis. Other conditions can be confirmed by a specific number of E&M services with corresponding trigger codes. Finally, for minor conditions that typically require just a single encounter (e.g., acute pharyngitis), criteria must be further relaxed to perhaps a single service carrying a trigger code for the condition.

The table below summarizes characteristics of conditions and the corresponding criteria for identifying episodes.

Table 1: Characteristics of Condition

Characteristics of Condition	Minimum Confirmatory Service Criteria
Condition cannot be safely treated on an ambulatory basis	Acute inpatient admission
Treatment generally is required and can be identified by claims	One or more treatment(s) specific for condition
Condition typically requires more than 1 visit and needs test for diagnosis	Test followed on subsequent date by 1 or more E&M(s)
Condition typically requires more than 1 visit and does not need test for diagnosis	2 or more E&Ms
Minor condition typically requires 1 visit and needs test for diagnosis	1 E&M with test on same date
Minor condition typically requires 1 visit and does not need test for diagnosis	One E&M only

EGM has standardized criteria necessary to trigger an episode which are detailed as a set of trigger rules in the software that reflect the service criteria described above in Table 4. Used in conjunction with trigger codes for each respective type of episode, these form the ***trigger logic*** that answers the question, "When do we know that a particular type of episode is occurring for a patient?" In other words, for each type of episode, the trigger logic defines the threshold of evidence required to create an episode shell. As EGM reads each service claim in chronological order for each patient, the software examines information on the claim. This information is compared to the trigger logic for every type of episode that is defined in the EDD.

Every type of episode supported by EGM has corresponding information in the EDD that is particularly relevant to identifying an episode:

- ***Trigger codes*** are the predetermined diagnosis codes that define each type of condition episode, or the predetermined procedure codes that define each type of treatment episode.

- ***Trigger rules*** are the predetermined rules for each type of episode, which are used in conjunction with its trigger codes. For example, triggering an episode for AMI requires that EGM includes a designated trigger code as the first (principal) diagnosis on an inpatient hospital claim. Trigger rules for many types of episodes use combinations of services, such as more than one E&M service spaced apart in time or active treatment of a diagnosed condition (for example, neoplasms).

Table 2 lists trigger rules that are available in EGM for identifying condition episodes. For each of the six rules, the table shows the trigger event and, where applicable, a confirming intervention, such as an appendectomy for appendicitis. Generally, individual services that satisfy one or more episode identification rules are called ***qualifying interventions***.

Table 2: Trigger Rules for Identifying Condition Episodes

Rule	Trigger	Confirming Service	Illustrative Characteristics of Condition Targeted by the Rule
1	Inpatient facility claim with condition as the *principal or secondary* diagnosis	None required	Condition arises while patient cannot be treated safely on an ambulatory basis
2	E&M with condition as the principal or secondary diagnosis*	One or more subsequent E&Ms with condition listed in the first or secondary position on a claim within interval specified for that episode	Condition typically requires more than 1 visit but does not need (billed) test for diagnosis
3	E&M with condition as the principal or secondary diagnosis*	Diagnostic test for condition preceding the trigger within specified interval	Condition typically requires more than 1 visit and needs (billed) test for diagnosis
4	E&M with condition as the principal or secondary diagnosis*	Treatment for condition preceding or following the trigger within specified interval	Treatment generally is required and can be identified by claims
5	Inpatient facility claim with condition as the principal diagnosis	None required	Condition cannot be treated safely on an ambulatory basis
6	Treatment for condition with condition as the principal or secondary diagnosis*	None required	Minor condition typically requires 1 visit and does not need test for diagnosis

*Note: Principal and secondary diagnoses for professional services refer to “line diagnosis” (the diagnosis listed on the same line as a procedure code), and “header diagnosis” (other diagnoses listed on a claim but not necessarily on any line accompanying a procedure code). For hospital facility claims, principal diagnosis refers to the first diagnosis on the claim and conveys which occasioned the admission to the hospital.
*Note: The trigger event, which determines the trigger date, is determined by the date of the qualifying intervention listed in the table as Trigger, not the confirming service; for example, the hospital admission date or the first of two E&M visit dates.

The rules listed in Table 5 include a range of different triggering options. Two of the rules (1 and 5) involve the use of inpatient hospital stays with a trigger code for the condition listed as the principal diagnosis (Rule 5) or either the principal or secondary diagnosis (Rule 1). The principal diagnosis is the condition established at discharge to be chiefly responsible for the admission. It indicates the attending physician’s judgment about the condition that originally led to the inpatient admission. EGM considers the principal diagnosis on a hospital claim to be strong

evidence for triggering a condition episode when that condition episode is not already open for that patient.

Rule 1 relaxes the requirement that the trigger code be the principal diagnosis for the hospital stay, and would trigger the condition episode even if a trigger code were listed as a secondary diagnosis. These other diagnoses represent all conditions that coexist at the time of admission, that develop subsequently, or that affect the treatment received and/or the length of stay. Hence, a secondary diagnosis could be a preexisting comorbidity (not yet documented or triggered), an emerging comorbidity (not present on admission), or a sequela.

Such conditions could resolve during the hospital stay or continue after discharge. Conditions associated with secondary diagnoses during hospital stays may be important clinically, and they may implicitly affect observed Medicare costs. However, because of the DRG payment system, it is generally not possible to isolate and measure all costs during the inpatient stay that are attributable to comorbidities or sequelae.[24] For this reason, such condition episodes are not comparable in terms of observed costs to episodes for the same conditions that are treated in other settings. Users can distinguish these instances of a condition episode using stratification criteria (See Section 4.6). Episodes that are triggered based on a secondary diagnosis may be informative for purposes of tracking sequelae and for risk-adjustment of episodes for analysis.

The other episode identification rules focus on professional services. Other conditions can be identified by E&M services affirming (documenting) their presence.[25] E&M services are specified because they reflect patient encounters, which are most likely to reflect professional appraisal and intent with respect to a condition, in contrast to tests or ancillary services, which may reflect imprecise or tentative diagnoses.

Rule 2 specifically uses an E&M service with a trigger code along with a subsequent E&M service, also with a trigger code for the condition, to trigger a condition episode. The requirement for a second service is to provide specificity, and not to trigger the condition episode simply on the basis of a single service with a trigger code. This rule is often applied to chronic conditions for which services are expected over long periods of time. Specifically for those conditions, Rule 2 is frequently applied with time parameters indicating that the services used for triggering the episode must be at least 30 days apart, but not more than one year apart. The rationale for the minimum time interval between qualifying interventions (30 days apart) is to avoid inordinate sensitivity to documentation occurring around a short time interval, such as diagnostic work-up and consideration of differential diagnoses. The rationale for the maximum time interval between qualifying interventions (1 year) is to avoid inordinate sensitivity to isolated events, such as similar diagnostic work-ups occurring for a patient in the course of time.

In other cases, the presence of a condition may be confirmed by a test that is specific for the condition, provided that it is followed by a post-test E&M service that lists the condition (trigger code) and thereby affirms that the condition was present (Rule 3). For example, a malignancy can be identified by a biopsy followed by an E&M service on a subsequent date with cancer

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[24] Medicare payments for the institutional services are generally tied to the MS-DRG, which could correspond to the principal diagnosis, a sequela (e.g., respiratory failure), or a procedure (e.g., use of a mechanical ventilator).
[25] Certain billable procedure codes involve evaluation and management services. See http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/eval_mgmt_serv_guide-ICN006764.pdf

listed as a diagnosis.[26] Also, some conditions may be identified in part through confirming services; for example, lymph node excision may confirm a breast cancer episode (Rule 4).

A combination of rules may be specified for each type of episode. For example, heart failure can be identified through ambulatory encounters, which can trigger the chronic condition episode, or an inpatient hospital admission, which can trigger an acute heart failure episode as well as the underlying chronic condition episode. The date of service on the first qualifying intervention determines the start date of a condition episode, the date of hospital admission, or the first of the ambulatory qualifying interventions.[27]

The simplest rule supported in EGM (Rule 6) requires only one service with a trigger code in any position on an E&M service, such as some viral upper respiratory infections. Although most episode types triggered only by Rule 6 may not be analyzed typically for cost variation or relative provider performance, they could serve to document prevalence rates for such conditions, describe how Medicare dollars are spent comprehensively, and may signify potentially important clinical events for patients that could interact with care patterns for other episodes.

4.2. Closing Rules

The end date of an episode is determined by the ***closing rule*** and the application of ***closing-rule parameters***. EGM supports closing rules based on fixed-length, where the episode closes after a predetermined period of time. For example, a surgical treatment episode might have a defined length (closing-rule parameter) of 30 days following the date of the surgery or, for inpatient surgery, the date of hospital discharge. Similarly, acute condition episodes, such as pneumonia, will close 90 days after the episode was triggered. Closing rules based on a fixed length hold the time window constant for every patient with the same type of episode.

The fixed-length closing rules are as follows:

- **Fixed number of days.** The episode ends after a specified number of days. The end date of the episode is the trigger date plus the specified length in days. For episodes for which the triggering intervention is a hospital inpatient stay, the end date is computed from the discharge date of that hospital stay. This closing rule is applicable to acute condition episodes and treatment episodes.
- **No end.** The episode does not end until the date the patient leaves the original Medicare program. This closing rule is applicable to chronic condition episodes.
- **Clear period**. An episode remains open until a specified time interval occurs with no activity (the “clear period”), i.e., no qualifying interventions for that episode. This closing rule can be applied to acute or chronic condition episodes. For acute condition episodes, it permits analysis of varying durations of care. For chronic condition episodes, it helps to end episodes with no activity, which may have been triggered inadvertently, or may reflect changes in clinical status (e.g., lifestyle modification, or organ transplant).

[26] In the example in the text, without any post-test mention of cancer, it is likely that the biopsy was negative.
[27] Services may be assigned to an episode even before this start date via a look-back period recognizing that some relevant services and relevant diagnoses may occur before a bona fide condition is documented sufficiently. See Section 5.6.

4.3. Combining Condition Episode Shells

A “true” episode can be mistakenly split into two episode shells because trigger criteria were met for two different condition episodes. A patient could have services for two conditions that are very different, but can present with similar symptoms or findings. One condition might correspond to an incorrect working diagnosis that was abandoned in favor of a subsequently identified correct final diagnosis. In this case, the episode that corresponds to the working diagnosis should be combined with (merged into) the final diagnosis episode.

Combining episode shells is a manifestation of an EGM concept known as condition pairs or sibling relationships among episodes, where combining condition episodes reflects their clinical similarity. Once episode shells for a patient are identified, EGM compares each pair to see whether any two episodes should be combined into a single episode. EGM compares each condition episode shell with every other condition episode shell for the beneficiary.

Two episode shells representing two different types of conditions are combined if:

- They occur near each other in time (either they overlap or the interval between the end of one and the start of another is less than a specified time), and
- They correspond to a pair of conditions listed in the EDD indicating a specific clinical relationship stemming from similarity of the underlying conditions.

In these scenarios, EGM combines the two episode shells into a single condition episode, with start and end dates derived from the episode shell for the primary condition in the pair. Determining which condition in the pair is the ‘winning’ or primary condition can depend on:

- **Predetermination.** In some cases, there is a clinical predetermination as to which condition would be primary, such as the more specific or severe form of a condition; for example:
  - Hemorrhagic stroke is primary in relation to “Other cerebrovascular disease”
  - Cardiac arrest is primary in relation to atrial fibrillation/flutter (acute)
  - Acute shock is primary in relation to shock NOS
- The pairs of conditions for which the sibling relationship is predetermined are recorded in the EDD and used by EGM to adjudicate such pairs when they occur for a patient.
- **Patient-specific patterns.** If the EDD indicates that two conditions should be combined but does not specify a predetermination as to which condition is primary, EGM makes a determination based on timing. Currently in EGM, primacy is given to the episode that triggers later in time. For example:
  - If transient ischemic attack (TIA) triggers first, followed by stroke, EGM interprets this to mean that initial suspicion and testing for TIA confirmed a stroke.
  - However, if stroke triggers first, followed by TIA, EGM interprets this to mean that a patient may have presented with a deficit, which resolved, leading to a final diagnosis of TIA.

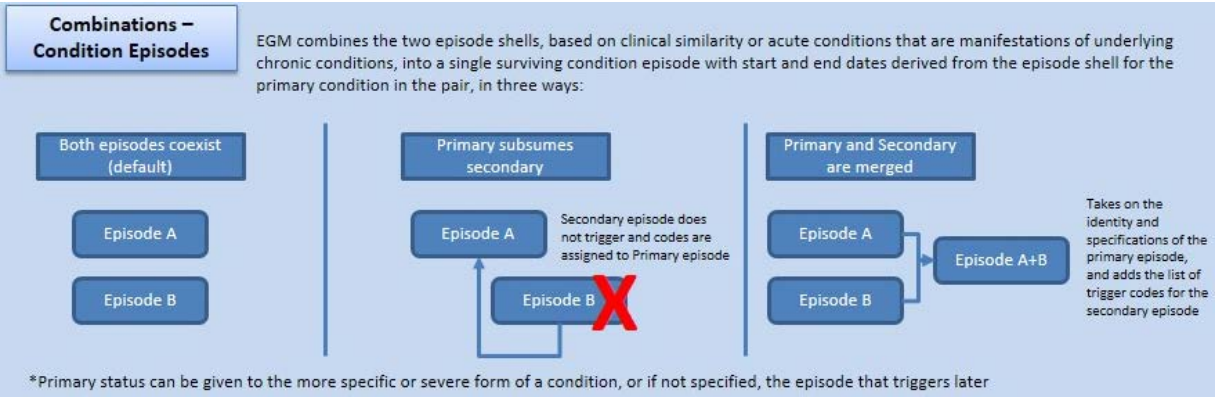
Generally, the discussion above has focused on how EGM handles condition episodes that trigger near to each other in time, which results in **merging** the two episode shells into a single episode for that patient. A variation on that scenario is when one condition episode is already open and established and trigger criteria for the other condition episode in the pair appear subsequently. In this latter scenario, the open condition episode can block the establishment of

the second condition episode, or the second condition episode replaces the existing condition episode. This results in one episode absorbing or **subsuming** the other.

Figure 6 below illustrates the default in EGM that allows condition episodes to co-exist, and the alternative scenarios represents exceptions to the rule. These two scenarios are logically similar, and involve the following:

- **The primary and secondary episodes are *merged*.** For some pairs of conditions, an episode for the secondary condition in the pair is allowed to trigger and remain open:
  - Unless an episode for the primary condition triggers around the same time, in which case the two episode shells are merged. The resulting merged episode shell takes on the identity of the primary condition episode, retains the specifications for the primary condition episode, and adds the list of trigger codes for the secondary condition to the list of relevant diagnoses for the (merged) primary condition episode. Any services with trigger codes for the secondary condition are eligible to be assigned to the merged episode for as long as the episode for the secondary condition would have been open; that is, between the start and end dates for the secondary condition episode shell.
- **The primary episode *subsumes* the secondary episode.** For some pairs of conditions, one of the two is allowed to trigger a corresponding condition episode and remain open:
  - Unless another episode that is primary in the relationship is already open for a patient. In other words, the condition episode that is considered primary remains open, and a condition episode that is considered secondary cannot be triggered but instead is subsumed by the open primary episode.
  - Until another episode triggers corresponding to the primary condition in the pair. An episode for the secondary condition can be triggered and remain open until an episode for the primary condition is triggered, at which time the primary episode subsumes the secondary episode, which ceases to exist as its own episode.
  - In either case, when a secondary condition episode is subsumed, its trigger codes are added to the list of relevant diagnoses for the primary condition episode, and services with those trigger codes are eligible to be assigned to the primary condition episode for the duration specified in the episode shell for the secondary condition; that is, between the start and end dates for episode that was subsumed.

Figure 6: Combining Condition Episode Shells



For example, a community-acquired pneumonia may be triggered in outpatient settings, followed two days later by the triggering of an inpatient aspiration pneumonia episode. Instead of allowing

the outpatient pneumonia to continue throughout its fixed duration (90 days), competing for services with the overlapping inpatient pneumonia episode, the two conditions are combined into a single condition episode representing the primary episode in the condition pair, i.e., the aspiration pneumonia.

4.4. Acute and Chronic Episodes for the Same Condition

Another type of sibling relationship relates to acute conditions that are manifestations of underlying chronic conditions. Acute exacerbations of chronic conditions may be defined as short-term, time-limited changes in a condition. During the acute event, the patient may be unstable, have severe symptoms, or be at increased risk for sequelae. Afterwards, the patient may return to his or her pre-exacerbation baseline. For example, a patient with heart failure may decompensate and be admitted to the hospital. The hospitalization will trigger an acute condition episode and will also trigger the chronic condition episode if the patient did not previously have the chronic condition episode open.

EGM recognizes acute episodes separately and recognizes that they are clinically related to an underlying chronic condition. This process of recognizing each episode distinguishes the acute condition from the chronic condition and permits analysis and reporting of episodes reflecting either the acute or the chronic aspect of the patient's total experience. Meanwhile, analysis and reporting of the episode for the chronic condition incorporates such acute events in order to convey the total picture for the patient in relation to that particular condition.

4.5. Combining Treatment Episode Shells

By default, a new treatment episode is triggered every time its respective trigger criteria are met. However, EGM links episodes that are part of a single treatment or where the episodes overlap in time as the services and costs of each cannot be separated for analysis. An intervention could be part of a larger intervention, as in the following cases:

- Two interventions are provided at the same time as part of combined treatment for increased effect
- The first intervention is performed as a preventive measure to reduce risk associated with the second intervention, such as a carotid endarterectomy performed to reduce stroke risk prior to a major cardiac procedure
- The second intervention is part of a staged procedure, as in a staged angioplasty for multi-vessel disease
- The second intervention is a retreatment after an initial treatment failure, as in a repeat angioplasty
- The second intervention is provided to treat a sequela of the first intervention, as in a procedure to stop post-operative hemorrhage

In these cases, the interventions can be thought of as constituting a single treatment and can be linked to permit analysis of costs and outcomes on a combined basis.

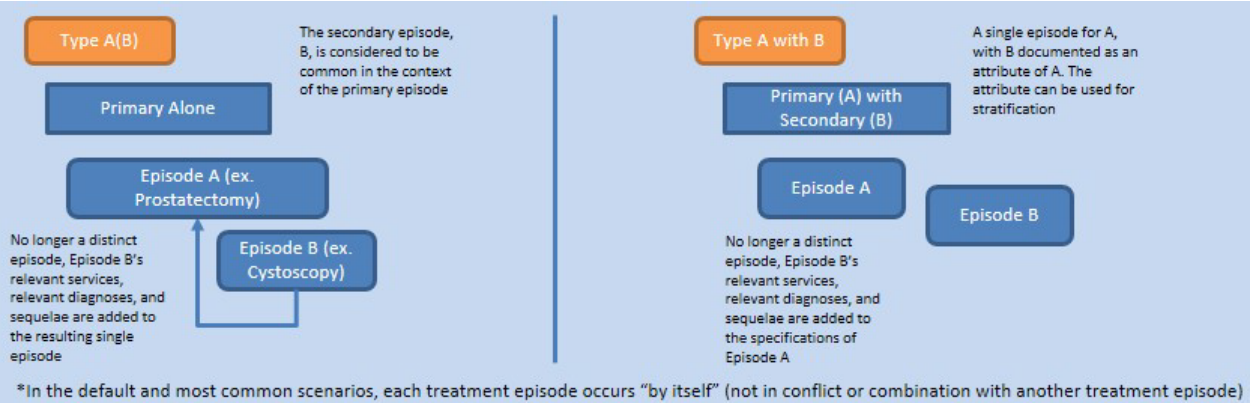
In other cases that do not fall into one of the categories listed above, the two interventions may be clinically distinct, but not analytically separable if performed at the same time. For example, the costs and risks of two surgical procedures may not be fully separable if performed during the same surgery or same inpatient stay.

Linking or combining treatment episodes has drawbacks. Because each combination could be a new episode type, the total number of analytic categories may increase substantially and many of the resulting combinations may have too few observations for meaningful analysis. Hence, EGM can identify when such treatments occur at the same time for the same patient and combine them into a single treatment episode. EGM applies temporal and clinical criteria for such pairs of treatment episodes observed for a patient. In appropriate instances, the treatment episodes are combined into a single treatment episode.

When EGM combines individual treatment episodes, the resulting combined episode is classified as one of the following types; see Figure 7:

- ***Type A(B): (Primary Alone)****:* The primary episode in the pair is specified in the EDD and defines the treatment episode without qualification. Here, the occurrence of the secondary treatment episode, B, is considered to be common and even routine in the context of the primary treatment episode, A. For example, a procedure that could be primary and corresponds to its own treatment episode (B), such as cystoscopy, could be a secondary procedure when its function is complementary to a more major procedure, such as a prostatectomy (A). In this type of combination, EGM would only retain a treatment episode for prostatectomy. The cystoscopy episode no longer remains as a distinct treatment episode; its relevant services, relevant diagnoses, and sequelae are added to the specifications of the resulting single treatment episode.
- ***Type A with B: (Primary with Secondary)****:* The resulting combined treatment episode is classified according to the episode that is determined to be primary within the pair. The episode type (A) is modified in that instance as occurring *with* the secondary treatment episode (B). For example, a combination of two respective treatment episodes would be classified as "heart valve repair with pacemaker insertion." EGM would produce a single treatment episode for heart valve repair, but the insertion of a pacemaker would be documented as an attribute of the valve repair. The attribute can be used for stratification of the primary episode for purposes of reporting and adjusting expected costs (see Section 4.6). After combination, the pacemaker episode no longer remains as a distinct treatment episode; its relevant services, relevant diagnoses, and sequelae are added to the specifications of the valve repair in the resulting treatment episode combination.

Figure 7: Combining Treatment Episode Shells



Generally, all instances of an episode should reflect similar specifications — the same lists (assertions) of relevant services, relevant diagnoses, and sequelae. In the default and most common scenarios, each treatment episode occurs "by itself" (not in conflict or combination with another treatment episode) and is constructed according to its own specifications stored in the EDD. Combined treatment episodes deviate from that principle because the specifications for the resulting combined episode reflect the union of the specifications for the treatment episode pair.

In Type A(B) combinations (Primary Alone), all instances of the primary episode are considered to be clinically similar and appropriate for pooled analyses without regard to whether it had been combined with an episode shell triggered by a complementary procedure. However, Type A with B combinations (Primary with Secondary) result in instances of the primary episode that are sufficiently different to warrant identification for analysis and reporting. The co-occurrence of the secondary episode and the addition of its relevant services, diagnoses, and sequela can alter the characteristics of the primary episode and its resource use.

4.6. Stratification of Episodes

The trigger logic for an episode type establishes, in effect, inclusion criteria for patient cohorts; patients who trigger a given type of episode are included in the cohort of patients who experience that type of episode. EGM provides exclusion criteria whereby certain attributes of an episode can be used to define more homogeneous subgroups — those that separate or exclude certain patients in order to conduct more focused analysis and reporting. Thus, stratification divides an episode type into mutually exclusive categories based on one or more attributes. The resulting categories can be used to filter instances of a particular episode type.

To illustrate, EGM supports stratification on the basis of Medicare Severity Diagnosis Related Groups (MS-DRGs) assigned to a patient's episode. Episodes involving an inpatient hospital claim will have the corresponding MS-DRG available for stratification. Episodes without an inpatient hospital claim or MS-DRG could constitute one stratum (i.e., outpatient or ambulatory settings), while other cases can be stratified separately (by unique MS-DRG), or using combinations of MS-DRGs as defined by the user. For example, a user analyzing pneumonia episodes might select cases involving MS-DRGs representing the condition (pneumonia), and exclude cases involving MS-DRGs for other conditions (such as sepsis) or procedures (mechanical ventilation). EGM produces episodes for cases separately by stratum, including their actual and expected costs, conditional on having sufficient case volumes to produce reliable cost statistics.

Treatment episodes also can be stratified, for example by MS-DRG or by a laterality modifier (e.g., cataract surgery in the right eye) observed on qualifying interventions (i.e., facility and professional claims).[28] Episode types for which laterality is relevant, such as hip replacement and cataract surgery, can be stratified as:

- Cases involving the treatment only for one side
- Cases involving the treatment for both sides at the same time
- Cases involving the treatment for both sides in temporal proximity (overlapping episodes) but not at the same time

[28] In addition to the laterality modifier, EGM looks for evidence of services on one side versus the other side.

Treatment episodes also can be stratified by attributes related to treatment combinations (see Section 4.5). For example, users could stratify CABG episodes as follows:

- CABG episodes with no combinations, along with CABG episodes (Primary Only)
- CABG episodes with open valve procedure
- CABG episodes with PCI
- CABG episodes with carotid endarterectomy
- CABG episodes with insertion of automatic implantable cardioverter defibrillator
- CABG episodes with pacemaker insertion
- CABG episodes with lung resection

If the co-occurrence of a primary episode such as CABG with a particular secondary treatment episode is common, then the combined episode may be useful for reporting. However, if the co-occurrence is uncommon, then that stratum might serve to exclude (filter) those instances of the primary episode for reporting.

Users can use episodes created by EGM in combination with other episodes to form composite measures. For example, a user who wanted to analyze all treatment episodes for open valve procedures, including those combined with CABG, could combine episodes for CABG with open valve procedure (cases within the appropriate stratum for CABG episodes) with some or all treatment episodes for open valve procedure.[29]

Finally, condition episodes can be stratified according to the occurrence of relevant treatment episodes. For example, AMI could be stratified as follows:

- AMI alone
- AMI with PCI
- AMI with CABG

As shown in these examples, EGM supports stratification by DRG, laterality, co-occurring condition or treatment. Episode sub-category is another option, meaning narrower specifications of a given episode based on additional clinical criteria. EGM allows users to stratify the episodes in order to focus analyses on more narrowly defined or attributed cases.

5. Assignment of Services to Episodes

Assigning services to conditions is complicated by the varying formats of Medicare claims. Facility claims identify principal and secondary diagnoses for admissions or visits paid in bundles (MS-DRGs and Hospital Outpatient Prospective Payment), but do not link different diagnoses with individual services. This differs from practitioner claims, which identify diagnoses for each service provided. Some ambiguities remain even with practitioner claims because the diagnostic information sometimes appears to be incomplete or inaccurate.

By constructing a logic table that classifies services as relevant for a condition, the additional information can supplement or compensate for ambiguities in claims data. For example, if an outpatient hospital claim lists hypertension as a primary diagnosis and diabetes as a secondary diagnosis, such classification can be used to assign an insulin injection to the patient's diabetes

[29] The actual and expected costs would be calculated as weighted averages for all combined episode types.

episode. Or, if a practitioner claim lists hypertension as the diagnosis for insulin injection, relevancy could be used to identify an alternate open episode (e.g., diabetes) for service assignment. This section describes how EGM assigns services directly to episodes.

Services can be provided to prevent, diagnose or treat a condition or to screen for possible sequelae and are "relevant" for the condition, and thus eligible for assignment to an episode for that condition. Care for a sequela (other than initial screening) should not be classified as part of routine care for the condition, and should instead be assigned to an episode for the sequela. For example, costs for treatment of deep venous thrombosis (DVT) complicating an episode of hip fracture should be included in a DVT episode, not in the fracture episode. Still, the costs of such sequelae are clinically relevant to the fracture episode and need to be recognized as affecting the relative performance of the primary (fracture) episode. See Section 6 on how clinical relationships among episodes are used to accomplish this objective.

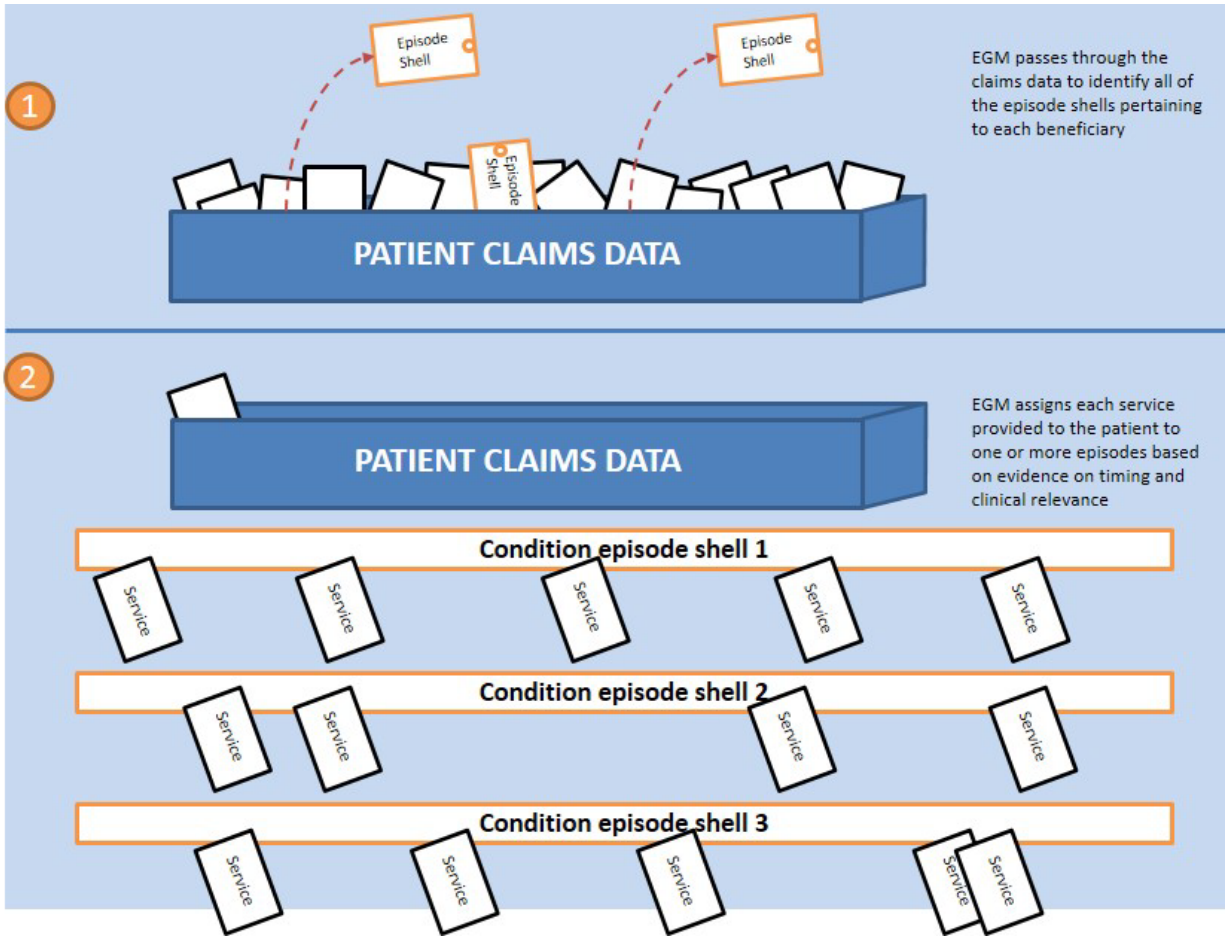
5.1. Overview of the Logical Steps in Assignment

After EGM has identified episode shells, it then assigns services directly to each open episode. Assignment occurs in the following way, as shown in Figure 8:

- EGM passes through the claims data to identify all of the episode shells pertaining to each beneficiary.
- With the knowledge of what episode types were open for a patient at any given time, EGM passes through the claims data once again in chronological order to assign each service provided to the patient to one or more episodes based on the best available evidence on timing and clinical relevance.[30]

[30] The user can select among options that are available for some service assignments (see Section 5.5).

Figure 8: Assignment of Services to Episodes



The assignment process uses timing, procedure, and diagnostic information from each service to reconstruct the care delivery process for any given episode. Since health care is complex and patients may have multiple episodes open at a time, EGM attempts to find the best assignment for a service given the available information. EGM proceeds as follows:

- To assign a service directly, EGM first considers each and every episode that is eligible to receive any services at the time that the particular service of interest was provided.
- For each eligible episode, EGM considers whether the particular service has relevance based on the procedure and diagnosis codes. In each instance in which there is relevance, that service is linked to the episode.
- Once initial linkages are made, EGM uses a set of hierarchical criteria to determine the basis for the linkage to each episode. EGM considers the strongest evidence for relevance before moving to lesser evidence. EGM continues down the list of criteria until an assignment is made or the service remains unassigned.

Claims for many services are reported using diagnosis codes for symptoms, findings, or other "non-specific" diagnoses. Suppose that a claim for a chest x-ray has cough as its only diagnosis

with no mention of any potential cause. Now consider three alternative scenarios:

- *Scenario 1* – The patient has no condition episodes close in time that could have resulted in cough. In this case, it is reasonable to conclude that the cough was an isolated occurrence not part of any diagnosed condition.
- *Scenario 2* – The patient also has a pneumonia episode close in time to the x-ray with no other possible cause for the cough. In this case, it would be reasonable to assume that the cough was due to pneumonia, and the chest x-ray and its costs should be included in the patient's pneumonia episode.
- *Scenario 3* – Same as scenario 2, but the patient also has chronic bronchitis. In this case, the cough could have been caused by pneumonia, chronic bronchitis, or both.

EGM includes logic tables that identify symptom, sign, and other non-specific diagnoses related to each condition; these are called relevant diagnoses. Timing could be included in the logic table, as well. For instance, cough might precede the trigger date for the pneumonia episode by only a few days,[31] but might persist for several weeks after the trigger date. Thus, the clinical information for each episode, including pneumonia, should specify the maximum time before the trigger date (i.e., the look-back period). EGM searches for all condition episodes that can match with a claim for a particular non-specific diagnosis given the time intervals involved. The result is a set of one or more condition episodes that link to the claim.

Separately, it is important to note that claims for some non-specific diagnoses also might be assigned to a treatment or treatment episode and not to a condition episode. For example, claims with a diagnosis of acute post-operative pain (ICD 338.18) should be linked directly to a surgical treatment episode. Similarly, a claim with a diagnosis of nausea may be more appropriately linked to a chemotherapy treatment episode rather than to a condition episode for which the chemotherapy was provided.

The remainder of this section considers more specific criteria that are applied in order to link and assign services to episodes. The criteria can differ by type of service. Section 6 addresses how episodes are linked and associated with each other using a similar approach.

5.2. Direct Assignment of Services by Type of Service

The informational content of services varies because of differences in both the structure of claims and the practices of the providers (or coders) preparing them. Thus, different algorithms are used for different types or places of service. As described above, each algorithm consists of a hierarchy of rank-ordered criteria for determining service assignment. An important aspect of each hierarchy is that the algorithm proceeds step-by-step looking for the most relevant links, and then ends (stops looking any further) once the criterion is met. Hence, within a given step EGM can find multiple, equally strong matches for a given service. These matches are retained for users selecting the option to retain multiple assignments of a service to more than one episode.

[31] A claim for cough might precede the first claim for pneumonia in cases where pneumonia was not initially diagnosed. Because of the time course of pneumonia, it is unlikely that a claim for cough could be related to an episode of pneumonia if the encounter for cough precedes the diagnosis of pneumonia by more than a few days.

The hierarchy of rules for type of claim are shown in Table 3. The algorithm for each type of claim is described briefly in the subsections that follow.

Table 3: Hierarchy of Rules for Service Assignment

Claim Type	Criteria	Assign to Episode Class	
		Treatment	Condition
Inpatient	1) Any procedure is a trigger for a treatment episode	X	
	2) Principal diagnosis is a trigger for a condition episode		X
	3) Principal diagnosis is relevant or principal diagnosis is a trigger for a condition episode that a treatment episode treats	X	X
E&M	1) Principal diagnosis is a trigger for condition episode or condition episode a treatment episode treats	X	X
	2) Principal diagnosis is relevant	X	X
All Other Part B and DME	1) Procedure is a trigger for treatment episode	X	
	2) Procedure is relevant and principal diagnosis is a trigger for condition episode a treatment episode treats	X	
	3) Procedure is relevant and principal diagnosis is relevant	X	
	4) Procedure is relevant	X	
	5) Procedure is relevant and principal diagnosis is a trigger for condition episode		X
	6) Procedure is relevant and principal diagnosis is relevant		X
	7) Principal diagnosis is a trigger for condition episode or condition episode a treatment episode treats	X	X
	8) Principal diagnosis is relevant	X	X
All Other Outpatient Department	1) Procedure is a trigger for treatment episode	X	
	2) Procedure is relevant and any diagnosis is a trigger for condition episode a treatment episode treats	X	
	3) Procedure is relevant and any diagnosis is relevant	X	
	4) Procedure is relevant	X	
	5) Procedure is relevant and principal diagnosis is a trigger for condition episode		X
	6) Procedure is relevant and principal diagnosis is relevant		X
	7) Procedure is relevant and secondary diagnosis is a trigger for condition episode		X
	8) Procedure is relevant and secondary diagnosis is relevant		X
Home Health	1) Procedure is a trigger for treatment episode	X	
	2) Procedure is relevant and any diagnosis is a trigger for condition episode a treatment episode treats	X	
	3) Procedure is relevant and any diagnosis is relevant	X	
	4) Procedure is relevant and any diagnosis is a trigger for condition episode		X
	5) Procedure is relevant and any diagnosis is relevant		X
	6) Principal diagnosis is a trigger for condition episode or condition episode a treatment episode treats	X	X
	7) Principal diagnosis is relevant	X	X

Claim Type	Criteria	Assign to Episode Class	
		Treatment	Condition
Skilled Nursing Facility	1) Principal diagnosis is a trigger for condition episode or condition episode a treatment episode treats	X	X
	2) Principal diagnosis is relevant	X	X

5.2.1. Acute Hospital Inpatient Services

The criteria for acute inpatient hospital facility claims are designed to make the optimal assignment(s) for each inpatient service and are shown in the first panel of Table 6. EGM examines the procedure codes that were listed on the hospital claim and determines whether any of those procedure codes are triggers for treatment episodes.[32] If one of the procedure codes is a trigger for a treatment episode, then the hospital claim will be assigned to that treatment episode (Criterion 1).[33] If not, EGM examines the principal diagnosis code on the hospital claim and checks to see whether it is a trigger code for a condition episode. If such is the case, the hospital claim will be assigned to that condition episode (Criterion 2).

If neither of those first two criteria is met, EGM determines whether the principal diagnosis is relevant to any open condition episode, or is a trigger code for a condition episode that is an indication for a treatment episode, and if so, it will assign the hospital claim to that (or those) episode(s) (Criterion 3). If none of these criteria are met, the hospital claim will remain unassigned to any episode.

5.2.2. Assignment of Evaluation and Management Services

In the process of having face-to-face encounters with patients, physicians and other clinicians can diagnose or treat one or more conditions. Most of this activity is captured on claims with evaluation and management (E&M) procedure codes. Accordingly, EGM handles E&M procedure codes as relevant to all supported episode types; assignment of E&M services therefore is guided by diagnosis codes that are observed on the claim. The second panel in Table 6 shows the hierarchical criteria used to assign E&M services to episodes. If the primary diagnosis (listed on the claim alongside the service (E&M code) is a trigger code for a condition, then the service will be assigned to the condition episode (Criterion 1). If it is not a trigger code, then the principal diagnosis listed on the claim will be examined for its relevance to any one or more open episodes. EGM will assign the service to the episode(s) for which relevance is asserted in the EDD (Criterion 2), or else the service will be unassigned.

The second panel in Table 6 shows the hierarchical criteria used to assign to episodes other Medicare Part B professional and supplier services, as well as durable medical equipment (DME). Because other professional and supplier services do not have universal relevance to all

[32] For some types of treatment episodes (e.g., PCI and CABG), certain MS-DRGs correspond to the defining procedure and can serve as trigger codes.
[33] If more than one episode shell had been triggered by the hospital claim, then the episode combination logic will determine the episode type opened for the patient (see Section 4.5).

types of episodes, the assignment rules examine the procedure codes defining the service for relevance to episodes, along with the documented diagnosis codes.

The first four criteria relate to assignment to treatment episodes; where the procedure is a trigger code (Criterion 1); the diagnosis code is a trigger for a condition episode that is an indication for an open treatment episode (Criterion 2); the procedure and diagnosis codes are relevant to an open treatment episode (Criterion 3); or the procedure code is relevant to an open treatment episode (Criterion 4).

The next two criteria relate to assignment to condition episodes; where the procedure is relevant and the diagnosis code is a trigger for a condition episode (Criterion 5); or the procedure and diagnosis codes are relevant to an open condition episode (Criterion 6).[34]

The last two criteria in this panel relate to diagnosis codes and assignment to either treatment episodes or condition episodes; where the diagnosis code is a trigger for a condition episode or a treatment episode's indication (Criterion 7); or the diagnosis code is relevant to an open episode (Criterion 8).[35]

The criteria used to assign durable medical equipment (DME) services to episodes are the same as the criteria for professional and supplier services. EGM tracks these separately given differences in the record layouts and data elements in the respective data sources.

5.2.3. Assignment of Outpatient Department and Other Services

Logic for assigning outpatient department and other services is similar to those already described. However, outpatient departments and other facility or agency claims are not as detailed as provider or Part B bills.[36] Thus, there can be multiple services occurring in the same setting and around the same time, but the connection between those individual services and particular conditions (diagnoses) is less clear than with professional services billed to Part B. Nevertheless, the aim is to assign the individual interventions to individual episodes, and not to assign all services during an outpatient visit as a unit.

5.2.4. Assignment of Home Health or Skilled Nursing Facility Services

Logic for assigning Home Health services is similar to those already described (see Section 5.3 for options available for post-acute services). Skilled Nursing Facility services are considered relevant to any type of condition episode; hence, service assignment is guided by whether the principal diagnosis code is a trigger code (Criterion 1), or a relevant diagnosis (Criterion 2).

5.3. Alternatives for Acute and Post-acute Services

Users may override (toggle) the assignment rules described above in special circumstances, namely during acute inpatient hospital stays and in the post-acute period following discharge

[34] Comparing criteria 3 and 6, for example, illustrate priority given to treatment episodes over condition episodes in the particular use of EGM for Medicare Quality and Resource Use reports (QRUR). The choice of rules and their order are a matter of optimizing for a particular use case. EGM stores these in data tables are easily modified.
[35] Criterion 8 is illustrated here although it was not implemented for QRUR.
[36] More specifically, these claims lack line-level diagnoses corresponding to specific procedure codes.

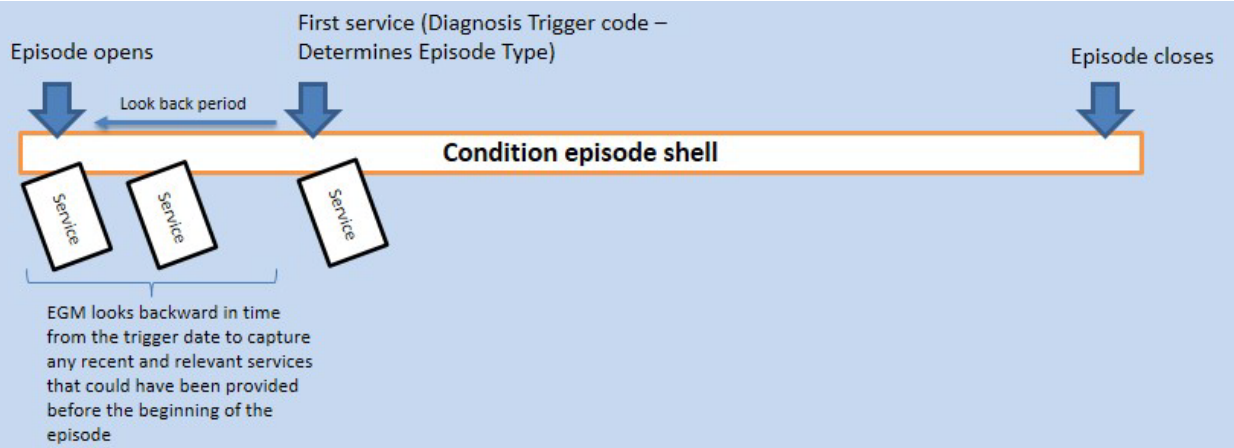
from an acute hospital stay. Specifically, interventions that occur during these respective periods can be assigned as a group to the same episode as the inpatient hospital claim itself.

- **Inpatient toggle:** All covered services with dates of service that coincide with an acute hospital inpatient stay will be assigned to the same episode as the inpatient hospital claim itself. This includes all professional services by physicians visiting the hospitalized patient for any reason.
- **Post-acute toggle:** Certain post-acute services are assigned in the same way that the preceding acute hospital stay is assigned. These include sub-acute hospital, skilled nursing facility (SNF), and home health services that are part of an uninterrupted "chain" of services that begins with institutional placement within 30 days (or home health within 20 days) following discharge from the acute hospital stay.

5.4. Look-Back Periods

In addition to clinical criteria, much of the relevance of the service to one or more episodes must be interpreted in light of temporal sequence and circumstances. Thus, for the most part services are considered relevant (temporally) when the date of service corresponds to a time interval during which the candidate episode is open for a patient. However, for determining assignment of services, the time window can start prior to the service date of the episode's trigger event. The interval of time that is added prior to the trigger event is called a ***look-back period*** because EGM looks backward in time from the trigger date to capture relevant services that could have been provided before the beginning of the episode. For example, symptoms due to pneumonia might predate the first claim for the pneumonia by a few days if pneumonia is not diagnosed upon initial presentation. Similarly, preoperative visits and testing may precede the date of a surgery. The duration of the look-back period (in days) is specific for each type of episode and captured in the EDD. Figure 9 illustrates the role of look-back periods.

Figure 9: Look-Back Periods



5.5. Allocating Service Costs to Episodes

As services are assigned to respective episodes, EGM accounts for the costs (Medicare-allowed amounts) that correspond to those services. EGM supports three basic options for cost accounting, which are illustrated in Figure 10. If a given service is assigned to only one episode,

its costs are as well ***(full cost)***. Alternatively, if a service is assigned to more than one episode, EGM provides for either ***"full cost"*** or ***"apportioned cost."*** [37]

There is also a method that combines multiple assignment of services to episodes, along with full cost accounting. Under this option, EGM applies the full cost of each service to each assigned episode. This involves double-counting of dollars across all episodes to which the service was assigned. For example, a physician visit costing $100 that is assigned to two concurrent episodes would each be allocated the "full" $100. In other words, analyzing both episodes involves consideration of the same $100. If the same visit was assigned to three different episodes, the $100 would be allocated to each of the three episodes.

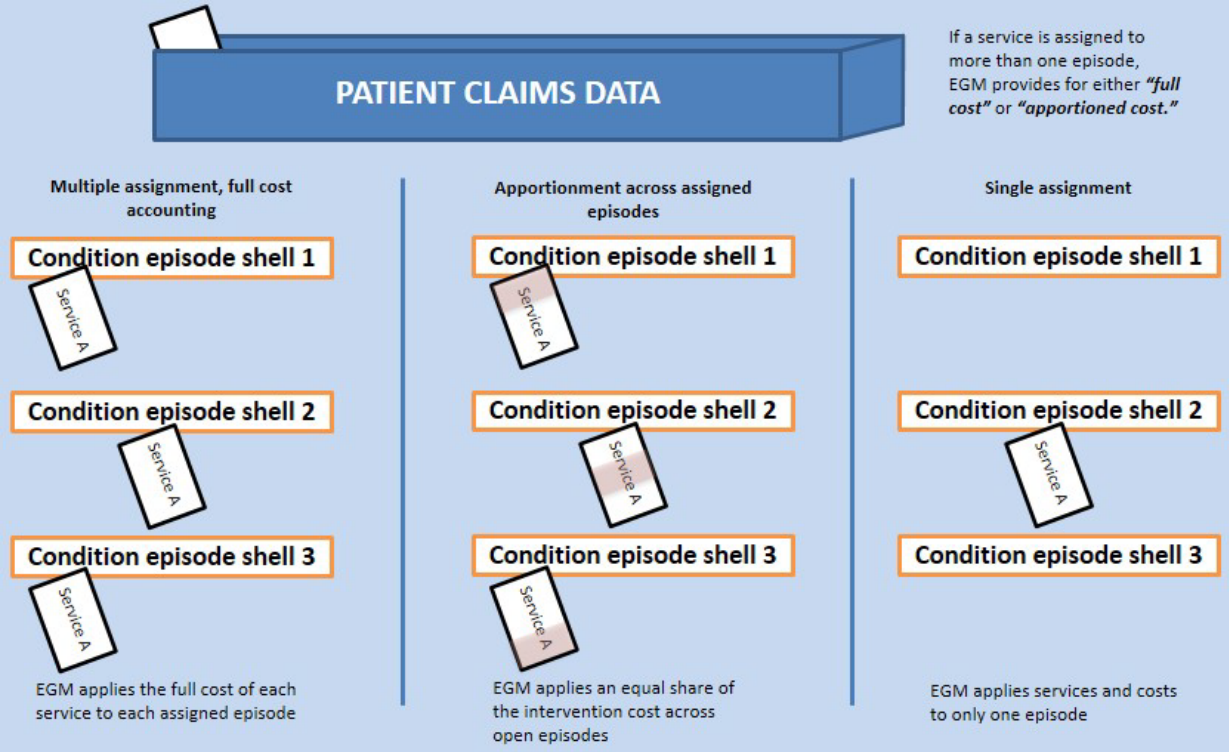
As an alternative to the full-cost option, EGM supports apportionment of dollars across assigned episodes. The process of assigning an intervention to more than one episode determines the proportions of the payment amount for the intervention allocated to each episode. The proportion of each dollar allocated to each episode is called its ***apportionment weight***. The apportionment weight algorithm supported in EGM is *equal shares* — each assigned episode gets an equal weight [38] – so that if a $100 service has been assigned to two episodes, $50 will be allocated to each of the two episodes.

If a user selects the single-assignment option in EGM, meaning that all service assignments are limited to only one episode, all dollars are allocated to the assigned episode, which results in a representation of full cost for each episode without double-counting dollars across episodes. For example, if a $100 physician visit could have been assigned to two different episodes but was instead assigned to one, then the $100 would be allocated to the one (assigned) episode, and $0 would be allocated to the other (not assigned) episode.

[37] EGM mirrors whichever allocation method the user selects when calculating risk-adjusted expected costs for episodes. In other words, the framing of the actual costs for an episode is replicated in the methods for calculating expected costs for the same episode.

[38] Apportionment can be carried out using different formulas, so this option can be specified in various ways.

Figure 10: Allocating Service Costs to Episodes



6. Associations among Episodes

At this point in the construction process, the system has identified episodes and assigned services directly to basic episodes, including the relevant services (procedure codes) and relevant diagnoses (symptoms and findings). See Section 2.3 regarding relevancy, and Section 5.2 for logic steps in direct service assignment.

In order to support analysis and reporting purposes, episodes must be sufficiently complete. A complete episode generally includes all relevant services, relevant diagnoses, and sequelae. This section describes how episodes supported by EGM are made complete by way of appropriate associations and aggregation into complete episodes for reporting and analysis.

Episodes are building blocks that can be combined to fulfill various purposes for the user. Additional steps are needed to associate those building blocks identified for a patient in ways that are suitable for reporting and analysis:

- In their most basic form, episodes include only services that are assigned directly. These are included in EGM outputs as "Level 0" episodes, and generally are considered the building blocks for episodes meant for analysis and reporting.
- Treatment episodes are associated with their respective indications (condition episodes for which the treatments were performed). This supplies the condition episodes with relevant services that were initially defined as treatment episodes; it also supplies treatment episodes with important clinical context. These are included in EGM outputs as "Level 1" episodes, and like Level 2, are generally are considered the building blocks for episodes

meant for analysis and reporting.

- Treatment and condition episodes are associated with their respective sequelae (condition episodes). Sequelae are important consequences with implications for relative performance and accountability. These are included in EGM outputs as "Level 2" episodes, and generally are considered appropriate for analysis and reporting.[39]
- Acute exacerbations are acute condition episodes that are associated with chronic condition episodes for the same illness. Level 2 episodes include the acute exacerbations separately; and the underlying chronic condition episodes with their constituent acute exacerbations. This supplies chronic condition episodes with relevant services and costs that were initially defined as acute condition episodes.
- For each patient, each condition episode is identified that was NOT deemed to be a sequela; i.e., caused by a prior episode. These are included in EGM outputs as "Level 3" episodes, and generally are considered appropriate for analysis and reporting. These include constituent treatment episodes and acute exacerbations, along with their sequelae, and condition episodes that were sequelae to the Level 3 episode itself. Thus, Level 3 episodes provide clinically coherent episodes without double-counting of dollars across different episodes for the same patient.

These associations provide for alternative representations of how services and costs occur for patients, particularly how individual episodes relate to and affect each other.

6.1. Episodes and Their Sequelae

EGM identifies potential associations among condition and treatment episodes in relation to their sequelae, which are condition episodes that arise as aftereffects or secondary results of a condition episode or a treatment episode. The basic requirements for identifying and linking sequelae are similar to requirements for linking signs or symptoms to episodes.

- First, clinical experts must agree that a particular condition or treatment can result in a particular sequela. These are recorded as sequela assertions in the EDD, indicating what primary (causal) episodes can lead to which sequelae.
- Second, timing must be taken into account. The cause of a sequela (the trigger date for condition or treatment episode) should predate the sequela. Potential sequelae episodes revealed through secondary diagnoses on a hospital claim and which were present on admission can be negated, and not considered sequelae related to the acute hospital stay. Also, a sequela episode will not be linked to a condition or treatment if its onset is beyond a maximum time interval.[40] If these requirements are met, sequelae as episodes will be linked and assigned to one or more causative condition or treatment episodes.
- Third, EGM examines all condition episodes for consideration as potential sequelae episodes. That is, for each open condition or treatment episode, EGM looks for the appearance of the condition episodes that are listed as potential sequela conditions for

[39] Treatment episodes with their sequelae are included in Level 2a. Condition episodes are included in Level 2c. Level 2b is a latent capacity in EGM to designate other phases of an episode besides acute exacerbations such as stages of progression.

[40] This means that the onset (start date) of a sequela (condition episode) must occur within a specified time interval in relation to the primary (causal) episode to which it is linked.

that episode and that occur within the specified time parameters for the sequela relationship. In each affirmative case, the sequela condition episode linked to the primary episode as a sequela.

- Fourth, each condition episode that is linked to a primary episode as a sequela has its services assigned indirectly to that primary episode, and its costs are allocated to the primary episode as sequela costs.[41]
- Fifth, a condition can be associated as a sequela with more than one episode that is open for a patient. In other words, more than one primary episode can be associated with the same sequela condition. Generally, EGM proceeds with hierarchical criteria to identify the primary assignment of sequela, as follows:
    - Priority is given to a treatment episode over a condition episode.
    - A condition episode of more recent onset (no more than 30 days) before the trigger date of the sequela episode.
    - The episode with the fewest days between its start date and the earliest service that is assigned to the sequela.

The EDD are limited to assertions about direct (first-order) sequelae relationships. Higher-order linkages can be derived from the first-order linkages by tracking multiple linkages (or chains) in succession. In other words, the application constructs chains of sequelae whereby one episode can lead to another as a sequela, which in turn can lead to another condition as a sequela, and so on. By default rule, only the first-order sequelae (and their costs) are assigned back to primary causative episodes.[42]

6.2. Treatment Episodes and Their Indications

A treatment episode is triggered when the claims data for a patient satisfy the trigger logic, which generally consists of one or more procedure codes, sometimes paired with other factors such as setting of care. In some cases, triggering a particular treatment episode will automatically trigger a particular condition episode. For example, a PCI treatment episode can automatically trigger an ischemic heart disease condition episode. This only happens in cases where a treatment is so specific that its occurrence alone is enough to trigger the condition episode. However, in most cases, EGM must determine the indication for the treatment episode — the patient's condition for which the treatment was performed or, more specifically, the patient's condition episode of which the treatment episode ought to be a component.[43] For EGM, this means associating the treatment episode with the appropriate condition episode. In order to

[41] This assignment is called indirect because it comes about through associations among episodes, rather than the original direct assignment of services to the basic episodes, e.g., the primary (causal) condition or treatment episode and the condition episode that is determined to be a sequela for a given patient.

[42] Higher-order linkages can be made implicitly, such as when a treatment episode (and its sequela) is linked back to its indication, or when an acute condition episode is linked to its "parent" chronic condition episode (e.g., heart failure).

[43] Recall that treatment episodes are an expansion of the concept of relevant services. A procedure could be listed as a relevant service for a condition episode. Alternatively, an entire treatment episode could be defined for that procedure, with its own relevant (complementary) services, relevant diagnoses, and sequela. When a procedure or a treatment episode is provided it was provided as a component of the care provided for a condition, which in turn is defined as the indication for that treatment.

complete the condition/indication episode, the services from the treatment episode are assigned indirectly to the condition episode.

Treatment episodes include information that identifies the condition for which the treatment is being performed. EGM assigns a treatment episode to the condition episode for which the treatment is relevant. In the case of a surgery, a single trigger intervention is used to guide the process.[44] For example, association of a knee-replacement treatment episode is guided by diagnoses included on the surgery itself (such as injury or osteoarthritis).[45]

It some cases there may be ambiguity about the indication for a treatment. For example, a colorectal procedure episode may occur in the context of diverticulitis, ulcerative colitis, or colon cancer, with one or more of those conditions documented on the services related to the colectomy. Logic for linking and assigning treatment episodes is the same as that used for linking and assigning services to episodes: priority is given to an open condition episode for which the treatment episode's principal diagnosis is a trigger code; otherwise, one or more links are made to open condition episodes for which the principal diagnosis is relevant. These associations permit analysis of condition episodes with respect to the incidence rates and costs related to treatment episodes supported in EGM.

6.3. Acute and Chronic Condition Episodes for the Same Illness

EGM can identify and construct episodes for acute and chronic manifestations of the same illness. Some patients might have an episode for a chronic illness such as COPD and never have an acute exacerbation sufficient to trigger its own episode. Other patients with chronic COPD may have one or more acute exacerbations sufficient to become their own episodes; EGM considers the acute exacerbation to be a sequela of the chronic condition episode. For some patients, COPD may first manifest as an acute illness represented by an acute condition episode for COPD, after which there remains open an episode for chronic COPD.

During the process of assigning services directly to episodes, services that are relevant to both acute and chronic episodes for the same condition are assigned to the acute condition episode. This allows a complete accounting and attribution of the services and costs for COPD during the acute exacerbation, which EGM includes in the output files. Meanwhile, a complete accounting of COPD in its entirety requires that the acute manifestations be associated with the underlying chronic illness, and the services directly assigned to the acute condition episode be assigned indirectly to the chronic condition episode. EGM also includes the (complete) chronic condition episode inclusive of services occurring during any acute exacerbations.

7. Determining Expected Costs

The final task for EGM is to determine the expected costs for episodes produced by the system. The term "expected cost" is used here with its technical meaning of statistical estimates of cost

[44] A therapy episode may have a more than one trigger intervention that is repeated periodically. The diagnoses for these trigger interventions can be considered collectively.

[45] EGM examines diagnosis codes on claims for the primary service and not on diagnoses reported for ancillary or supporting services that happen to be assigned to the treatment episode.

after risk adjustment, not in a normative sense about what is clinically appropriate, economically optimal, or what somebody should expect ideally. Analysis can quantify and illuminate divergence in care patterns and relative cost performance across market areas or other attributed entities. A major approach in such analyses is to compare observed episode costs with expected costs.

Costs per episode can be highly variable across patients, even for treatment of the same conditions. The mean and distribution of costs can reflect a number of factors related to the patient, to provider characteristics, and to more systemic characteristics. In performance evaluations, an important concern is the potential for confounding health care efficiency measures with differences in patient clinical characteristics. Accordingly, EGM adjusts expected costs per episode according to each patient's history of conditions and treatments.

7.1. Risk Adjustment

EGM constructs episodes according to the taxonomy reflected in the EDD as customized by the user's choices regarding stratification (Section 4.6). EGM calculates expected cost per patient within each type of episode, conforming exactly to the specifications used to determine the actual cost per patient. EGM includes a risk-adjustment module that consists of several statistical models, the purpose of which is to determine the average expected cost per episode for all patients in the cohort. The statistical models determine and adjust the expectation according to characteristics of the patient that are observed to affect costs on average. For example, if statistical models find that female patients cost more than male patients on average for a given episode, then the predicted cost for each female patient will be higher than for a male patient corresponding to the average cost difference observed between the two subgroups. If females are more likely to have a particular morbidity than male patients and that accounts for some of the observed difference by gender, then the statistical model will adjust each patient's expected cost in relation to that person's combination of gender and the presence or absence of the comorbidity. The relevance of gender, that comorbidity, and all other factors is determined for each episode separately.

7.1.1. Time Periods for Estimation

In order to make use of updated information, the risk adjustment module in EGM divides chronic episodes into time periods. The episode costs during each time period are then estimated separately based on information known at the beginning of the time period. The length of the time period of episodes is user-specified with values conceivably ranging from as short as 1 month to as long as a year. By default, EGM uses a period length of 91 days (i.e., a quarter-year) because this duration is sufficiently short to make meaningful updates of clinical events and service patterns, yet sufficiently long for the large majority of patients to accumulate some services and costs and thereby avoid too many cases with no services and zero costs. For other episodes, such as acute conditions and treatments, the quarter-year is considered long enough to represent the episode's appropriate duration for comparisons and accountability. For this reason, acute and treatment episodes are not divided into sequential time periods but have their costs modeled as a single time period.

The expected costs per quarter for a chronic condition episode can be added together, allowing the user to calculate totals for longer time intervals, such as for a given fiscal or calendar year.[46] This approach allows the user to estimate expected costs for specific policy applications.

7.1.2. Risk Factors

The risk factors, or explanatory variables in the risk adjustment model, are situated in several categories: demographics, health conditions (comorbidities), prior treatments, episode-specific severity, and selected concurrent risk factors. The demographic variables include age, sex, and whether the patient recently became eligible for Medicare (within six months of the beginning of the observation period).[47] Recent eligibility is included because the medical histories observed in claims for recently enrolled patients are likely to be incomplete. Claims-based indicators of costs (diagnoses and other episodes) paid by payers other than Medicare are not observable, which can understate factors that predict expected cost. As a result, unhealthy patients would appear to be relatively healthy for lack of their medical claims histories, and their expected costs would be biased downward.

To adjust for the presence of other health conditions, EGM includes episodes currently supported in the EDD as risk adjusters. If a patient had triggered a condition episode prior to the period being estimated for the episode of interest, then its presence is used to adjust the expected cost for the upcoming period. It is the existence of the episode, though not its costs, that is used to estimate expected costs for the episode of interest. This logic is applied using several types of characteristics, including conditions and treatments. Patients who are being treated for one condition may, at the same time, have other conditions (comorbidities) that are important in their own right but that also may affect expectations for the condition or treatment episode being evaluated. Multiple co-occurring episode types can interact with each other in the entire experience of the patient. One episode type (such as heart failure) may be exacerbated and be more costly because of the presence of another episode type (such as pneumonia).

EGM distinguishes between other episodes that are open at the time the expected costs for an episode are being calculated and episodes that have recently closed. For example, when determining the expected cost for a heart failure episode, the program considers whether the patient has COPD as well. The program also determines whether the patient has concurrent comorbidities such as pneumonia, or has resolved a recent bout with an illness such as pneumonia, or has recently concluded a treatment episode such as CABG.

EGM uses the timing of episodes in relation to risk factors. More specifically, the software distinguishes between episodes open at the beginning of the episode or the time period for which expected costs are being estimated and those that have already closed. The four time periods of interest are:

- **Open episodes.** These are other episodes that are open at the beginning of the episode or

[46] Still, the results reflect the time-ordered structure of the comparisons between actual and expected costs by quarter, with (future) expected costs estimated using only information available at the beginning of the estimation period. This is different from estimating an entire year at once, for example, with all clinical events occurring even late in the year "explaining" all costs occurring even early in the year, which is commonly known as concurrent risk adjustment.

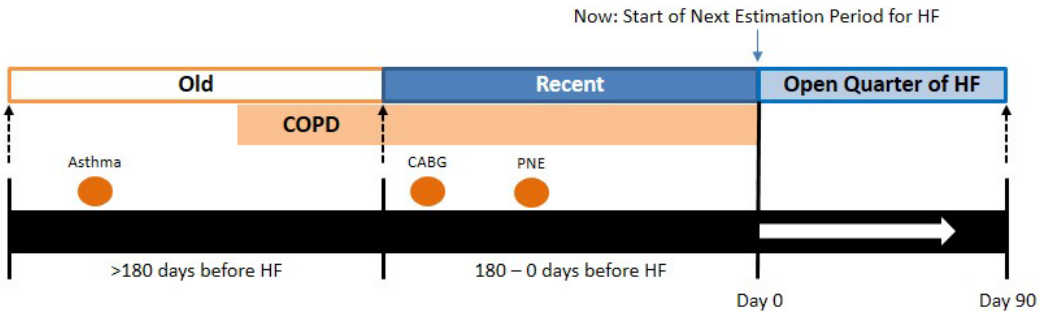
[47] This time period can be specified by the user based on the availability of data to determine information for expected cost (e.g., 6 months, 1 year, 18 months etc.).

chronic episode period being estimated.

- **Recent episodes.** These are episodes that have recently closed — within the last 180 days as of the beginning of the episode or time period for which expected costs are being estimated.
- **Old episodes.** These are episodes that had closed more than 180 days prior the beginning of the episode or time period for which expected costs are being estimated.
- **Concurrent events.** These are episode-specific events that are observed only after an episode has been open, such as specialized devices or procedures occurring during a surgical treatment episode that signify relative health status (severity) of a patient during the episode.

Figure 11 shows how different episodes relate temporally to the example of heart failure (HF). EGM has been configured to support episodes open in each of the three time frames described — concurrent or open, recent, or old — in relationship to the episode or 90-day period of interest. In the example, when determining the expected cost for a period of a heart failure episode, the program would determine that the patient has an open COPD episode, a recently resolved episode of pneumonia, a treatment episode for CABG recently closed, and placement of a cardiac pacemaker even more distantly in the past. EGM uses the logic of the grouper to validate the occurrence of condition and treatment episodes, as well as the timing of events in relation to the episode and time period of interest.

Figure 11: Example of Risk-Adjusting Heart Failure Using Patient's Episode Profile



End of Life. Anticipating that patients may be nearing end of life can have significant effects on treatment decisions and cost variation. Degrading health or spiraling circumstances may provoke greater volume and intensity of services, leading to higher costs. This or other effects could differ significantly by type of episode: EGM calculates relative likelihood of death in 90 days globally for each patient and then allows that probability to adjust expected cost individually for each open episode for which the effect is statistically significant.

Additional details on episode costs, including the statistical modeling approach and variables used, are included in the Technical Note: Risk Adjustment.

8. Glossary

Accounting period: The period of time for which episode costs are accounted. This can vary based on available data, an arbitrary period, such as a calendar year, or some other criteria.

Acute exacerbation: An acute condition episode that also is a time-limited portion of a chronic condition episode marked by a hospitalization or other event signifying a period of more intensive treatment.

Apportionment weights: When multiple assignment is selected, this is the proportion of the payment amount for the *intervention* (service) that is allocated to each of the respective episodes. The apportionment weights add to 1 over all assignments.

Apportioned Cost: When multiple assignment is selected the cost of an *intervention* can be split between multiple episodes. The apportioned cost is the amount allocated to each episode.

Association: Linking two episodes according to their clinical and temporal relationship, including a treatment episode with the condition episode for which it is indicated, and a condition deemed to be a sequela in relation to a primary (causal) episode.

Chronic Condition: A long lasting or persistent illness that can remain stable, improve, or deteriorate over time. Some chronic conditions have intermittent periods of stability and acute exacerbation.

Clear Period logic: A closing rule that allows an episode to remain open until a specified time interval has elapsed during which no services with trigger codes are observed.

Combination: A pair of condition or treatment episodes of the same type that cannot co-exist for the same patient at the same time. When such a pair of closely related episodes are triggered during an overlapping period of time, only one episode in the pair will be retained

Complication: A potentially avoidable *sequela*; a *sequela* that can be reduced in probability or cost during the current performance period.

Complementary services: Related services that are grouped by date of service, rather than by diagnosis or procedure so that more accurate linkages can be made. Example: an anesthesiologist claim is grouped with the associated surgery.

Condition: An illness, injury, or status that defines a type of episode.

Condition episode: One of a class of episodes that represents all services provided during a period of time for an acute or chronic illness, injury or clinical status. The underlying condition can be either a single, distinct disease process (or injury) or a set of closely related disease processes (or injuries/incidents).

Closing rule: Rule that determines when an episode ends, such as a fixed length time period, or variable length according to clear period logic.

Closing rule parameters: Specific time interval or other information specific to an episode type that is used in conjunction with a closing rule; e.g., the episode closes 90 days after the trigger date.

Direct assignment: An *intervention* that is assigned to an episode because the intervention has a trigger code, relevant service or diagnosis for that episode.

Episode or episode-of-care: A set of services provided to care for an illness or injury or associated with a treatment during a defined period of time.

Episode construction logic: Information and rules that determine when episodes open and close, and the assignment of services and cost to each episode.

Episode Definition Data (EDD): A set of tables that define the clinical details of an episode including trigger rules, closing rules, trigger codes, relevant services codes, relevant diagnosis codes, combinations, indications, and sequelae.

Episode identification rules: Part of the episode construction logic that contains the criteria for forming episode shells.

Episode shell: An outline of an episode that is created when the episode identification rules have been applied. The shell includes a start date, an end date (for fixed length closing rule situations), and diagnosis or procedure information that is used to identify and construct episodes.

Event: An encounter with a physician in a particular location at a particular point in time, such as a hospital admission, emergency room (ER) visit, or office visit.

Expected cost: Statistical estimates or predictions of normative costs for an episode.

Fixed-length: A specified number of days after a trigger event that an episode.

Full cost: In situations of multiple assignment, this method allocates the entire payment amount of the *intervention* to each episode to which the intervention is assigned.

Indication: The associated condition episode for which a treatment episode was provided. For example, ischemic heart disease is an indication for coronary artery bypass graft surgery.

Indirect Assignment: Inclusion of services in an episode through linkage and association to another episode. Examples are treatment episode to condition episode, or sequela to primary episode. In both cases the associated episode brings its services and costs to the new, linked pair.

Inpatient toggle: An option to group all services occurring during the hospital stay with the same episode as the hospital claim.

Intervention: A unit of care formed by grouping data elements within or across claim records, such as the technical and profession components of an imaging test. Once they are created, these units are used in the rest of the application for episode identification and service assignment. Although a minority of services are grouped in this way, most *interventions* are individual

services. For ease of communication, *intervention* and service are terms used interchangeably unless the context requires precise usage.

Level: A specific aspect provided among the outputs of EGM: episodes consisting only of services assigned directly (Level 0); condition episodes with integrated treatment episodes (Level 1); treatment and condition episodes with associated sequelae (Level 2); primary episodes (not identified as sequela) with integrated treatment episodes and respective sequelae (Level 3).

Limited Specification Episodes: Condition episodes or treatment episodes that are not built or intended for analysis or inference regarding cost variation, often have fewer specifications asserted in the EDD, and do not have expected costs included in EGM outputs. These episodes are identified and assigned services, can serve as risk factors for other episodes, and can serve as indications or *sequelae*.

Look-back period: A number of days specified prior to the triggering intervention in which some diagnoses (e.g., symptoms) or relevant services (e.g., diagnostic tests) can occur before an episode is opened.

Multiple assignment: An episode construction rule that allows *interventions* to be assigned directly to more than one open episode for which they are relevant. See *single assignment*.

Post-acute toggle: This option requires the assignment of services for skilled nursing facilities and home-health care occurring in the aftermath of a hospitalization be assigned to the same episode as the prior hospital stay.

Primary episode: An episode to which another condition episode, a treatment episode or a sequel is assigned. This can be the focal point for reporting.

Primary service: The main service that is used to define a treatment episode. It could be for therapeutic, rehabilitative, or palliative care. Examples include complex, singular events such as cardiac surgery, or sequences of repeating interventions, such as chemotherapy.

Qualifying intervention: An intervention that potentially triggers or confirms an episode; used with the episode identification rules.

Relevant diagnoses: Specific diagnosis code categories to represent clinical factors important in the care of a condition or treatment episode. These include signs, symptoms, and selected "service" diagnosis codes. All trigger codes are relevant to a condition episode.

Relevant services: Services that are determined by clinicians to possibly offer benefit in relation to the care of a condition or treatment episode. Such interventions include procedures, imaging, and lab tests.

Risk factor: Information that is used in statistical models to adjust the expected cost of an episode.

Risk adjustment: A statistical process that establishes expected costs for an episode that account for variation attributable to selected risk factors, providing a more accurate assessment of outcomes related to other factors (e.g., provider discretion).

Sequela: Aftereffect or secondary results of care in the form of a new condition episode that is caused by an open condition or treatment episode.

Severity: Variants of a condition or treatment episode that are expected to be correlated with symptoms, prognosis and average cost.

Service concept: Specific sets of medical services with common purposes and modalities routinely used in clinical communication by health care providers in actual practice settings. As with diagnostic concepts, some service concepts may be called out as treatment episodes. Otherwise, service concepts are useful for organizing and displaying relevant services for EGM assignment tables and logic in support of the comprehensive set of condition episodes as described above.

Single assignment: An episode construction rule that assigns *interventions* to only a single open episode based on the "best match" available evidence. Also see *multiple assignment*.

Specific: High degree of relevance or correspondence of an *intervention* to an episode; used in the service assignment rules.

Stratification: Division of episodes, prior to grouping, into categories based on characteristics or circumstances pertaining to the patient or episode.

Treatment episode: One of a class of episodes that represents all services provided during a period of time for the treatment of a condition. These episodes allow the end user to focus specifically on all services necessary for the particular treatment or diagnostic intervention, and services incurred to treat sequelae of the particular intervention.

Trigger codes: ICD-9/10 or CPT codes that are used in combination with Trigger Rules to identify the start of an episode.

Trigger event: An *intervention* that defines the beginning of an episode when the trigger rules for a supported episode have been met. See definition of *intervention* above.

Trigger logic: The combination of trigger rules and trigger codes that must be satisfied for an episode to be opened.

Trigger rule: The episode construction logic used in conjunction with trigger codes to define the evidence required to open an episode.

9. Appendix A: Design Report Technical Notes/Reports

9.1. Technical Note: EDD Structure: Chapters and Types

The EGM taxonomy is designed as a stable base from which service and diagnostic codes can be used to define and specify episodes. Furthermore, the entire structure is premised on being able to consistently and unambiguously place a clinical concept into a chapter (body system) for purposes of answering the basic question of what human anatomic area or functional system is involved or targeted for the clinical problem or intervention. Simultaneously, the EGM taxonomy articulates two additional descriptive categories for clinical concepts: types of conditions or other diagnoses, and types of services or treatments.

The EGM taxonomy includes 16 ***Chapters*** that are used in both diagnostic and service taxonomies (see full list below). This is important because it allows condition and treatment episodes to come together under a single, unifying concept, in this case body area or system. The chapters also correspond to medical specialties, which allows EGM to be directly relevant to the way medicine is practiced.

Table 4: EGM Chapters

Chapter
Behavioral
Cardiovascular
Chest (respiratory)
Dermatologic
Ear, Nose, Throat, Dental
Endocrine Metabolic
Eye
Female Genital (includes breast)
Gastrointestinal
General, systemic, unspecified
Hematologic, Lymphatic
Male Genital (includes prostate)
Musculoskeletal
Neurological
Pregnancy
Urinary (includes gender neutral genital items)

Next, EGM parses diagnostic concepts into ***Diagnostic Types*** representing natural kinds of pathophysiologic processes that can manifest as overt disease. This allows a user to shift from a body system orientation to pathophysiology orientation to consider clinical concepts such as cancers or infections as group, regardless of location. EGM Diagnostic Types are outlined in the table below.

Table 5: EGM Diagnostic Types

Diagnostic Type within chapters
Congenital and hereditary

Diagnostic Type within chapters
Infection
Neoplasm
Injury Poisoning Toxins
Signs. Symptoms, clinical states
Degenerative
Immune, Inflammatory
Nutrition, metabolic
Other, general
Status, Screening, service

At the same time, EGM articulates ***Service Types***, which classify services (procedure codes) into clinically meaningful categories. EGM Service Types are outlined in the table below.

Table 6: EGM Service Types

Service type within chapters
Anesthesia
Supplies, equipment, devices
Drugs, contrast, etc.
Evaluate, manage (specific to chapter)
Facility (IP, OP, ER, etc.)
Infusion, dialysis, pharesis, radiation tx
Other, general
Definitive (major) procedure
Supporting (minor) procedure
Tests, labs, imaging
Professional treatment, therapy
Transport

9.1.1. Diagnostic Concepts

Within a given pair of Chapter and Diagnostic Type, there are a number of diagnostic concepts. These serve to articulate specific and unambiguous diagnostic entities recognizable to and routinely used in clinical communication by health care providers in practice, policymakers or even beneficiaries seeking care. These common ideas, like arrhythmia, need more careful thinking to become an episode. In the case of arrhythmia, for example, it is expressed as two episodes differentiating an acute condition episode from a chronic condition episode (see Section 2.1).

9.1.2. Diagnostic Families

In some cases, there is a large number of diagnostic concepts with a single chapter > type grouping, for which an additional layer of categories between chapter > type and the individual diagnostic concept are useful. There are two reasons why this additional layer, called the diagnostic family, can be useful. First, the layer provides an organizing structure to make clinically meaningful groupings within chapter > type. Second, it can help to identify diagnostic

concepts that are related in such a way that corresponding episodes may also be related. In some cases, they may be considered for combination during the episode construction process (see Section 4.3).

9.1.3. Condition Episode

These are episodes articulated during the episode identification stage of the EGM process. Each episode has a unique entry in the table of EDD and further has a specific set of episode identification rules as well as designations of acute versus chronic, look-back period, and duration or length of episode.

9.1.4. Taxonomy: Service Concepts

As with diagnostic concepts, service concepts fall within specific chapter and service type categories. They articulate and describe specific sets of medical services with common target organs or systems and similar purposes and modalities. As with diagnostic concepts, some service concepts may be defined as a treatment episode. This is done when there are specific and compelling policy imperatives to do so (see Section 2.2). Otherwise, service concepts are used for organizing and displaying relevant services for EGM assignment tables, and logic in support of a comprehensive set of condition episodes (a strict subset of the diagnostic concepts described above).

9.1.5. Taxonomy: Service Families

As with diagnostic concepts, service families are an additional layer of categorization that are interposed between service chapter > type and the individual service concepts. If the particular use case or service chapter > type domain does not require the additional family categorization, the family is identical to the concept.

9.1.6. Taxonomy: Treatment Episodes

Selected service concepts are defined as treatment episodes. Such episodes are triggered independently of condition episodes and accumulate services preferentially during the assignment step of the EGM process (Section 5). The cost of treatment episodes is tied back to condition episodes by means of indication assertions.

9.2. Technical Note: Cost Accounting Options

This appendix focuses on accounting period, which are often tied to a 12-month calendar or fiscal year as opposed to a patient's episode experiences, which can start or end on any given calendar day, and last for several years or otherwise span the boundaries of a calendar year. For example, an acute condition episode may begin for a patient on November 1 and continue until January 31 of the following year. Or, a chronic condition episode could begin on November 1 and continue indefinitely.

It could be problematic if an episode were to be truncated, meaning artificially ended on December 31 without careful attention to implications for accounting and inference. For example, the average resources used per month for a patient with IHD just prior to a CABG treatment episode are different than an average that includes the resource used for the CABG. Similarly, if the accounting period ends just before the CABG, or in the middle of the CABG

treatment episode, then the results and apparent performance could be impacted by the end-point for accounting, which is arbitrary from the perspective of the patient's unfolding clinical history.

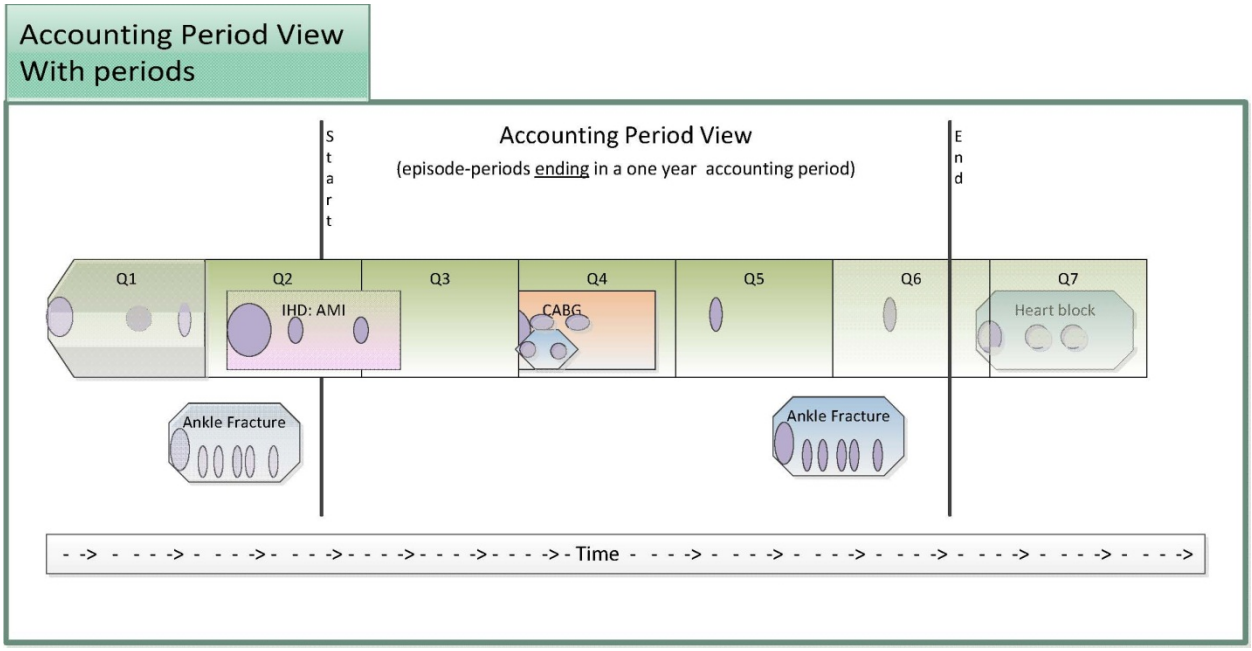
Although the empirical results that occur as a result of that arbitrariness also would occur for other physicians and other episodes used for comparison, over a large pool of patients and providers, the effects could cancel out. That is, arbitrary cut-points would occur in a distribution that included various fractions of a CABG episode, or similarly, a probability distribution of whether a given patient's CABG episode was or was not included during the accounting period, in part or in full. However, while that is true in the aggregate, it might not be true for an individual physician or other unit of analysis.

As such, EGM creates an expected cost of an episode based on a patient's clinical picture at the beginning of the episode, or at each periodic update of chronic condition episodes. This is done for acute condition episodes and treatment episodes, i.e., for episodes lasting up to 90 days, and for each successive calendar quarter within an episode that lasts more than about 90 days (including all chronic condition episodes). Thus, the actual and expected cost results for the entire episode or period are available for analysis.

Users have a choice of a) including entire episodes (and periods) that end during an accounting period; b) that begin during an accounting period; or, c) proration of entire episodes (and periods) across accounting periods. These options provide useful ways of mitigating the effects of calendar breaks because the user has a summary of actual and expected cost for every episode in its entirety, or every (quarterly) update period, from which to draw analytical conclusions.

These time periods of analysis and inference are referred to as "performance period summations," and are illustrated in Figure 14. An EGM user may choose to have included in a performance period summation all episode-periods beginning in the performance period (such as the CABG and second ankle fracture episodes in the illustration, but not the AMI), those ending in the performance period (such as the AMI, the CABG, and the second ankle fracture), or those either beginning or ending in the performance period. In the latter instance, actual and expected costs during episode-periods that are not fully within the performance period are apportioned.

Figure 12: Accounting Periods Selected from a Patient's Episode Experiences



9.3. Technical Note: Risk Adjustment

This technical note describes the risk adjustment component of the Episode Grouper for Medicare (EGM). The EGM risk-adjustment component generates risk-adjusted costs for each episode using linear regression models with risk factors as covariates. The risk factors in these models can include exogenous health circumstances of the subject derived from claims data (e.g., past or initial comorbidities), demographic factors (e.g., age, sex, and race) and socio-economic circumstances (e.g., median local income). However, factors generally not included are health circumstances that arise during the episode as a consequence of the patient's care management (e.g., sequelae such as infections or treatments for those complications).

The EGM software program provides separate risk-adjusted and actual costs for each episode (and period)[48] identified in the EDD (i.e., the episode_risk data table). The results provide the expected and actual costs of each episode/period for each patient. Users of EGM can group the patients into cohorts suitable for the particular purpose in mind, such as episodes attributed to particular provider organizations.

9.3.1. Use of Statistical Modeling to Determine Expected Episode Costs

In general, risk-adjustment methods employ statistical models that use a patient's demographics, comorbidities and severity to adjust estimation of the patient's episode cost compared with the overall average cost of treatment. Risk adjustment is a method to account for components of a patient's health care cost that are appropriate for determining the starting point from which cost outcomes can be evaluated, and modifying performance expectations. Cost variation after risk

[48] A "period" represents the entire duration of acute condition episodes and most treatment episodes, as well as each 90-day time interval into which the entire duration of a chronic condition episode is partitioned.

adjustment is meant to reveal modifiable resource use by provider, practice, delivery system, market area, or other considered entity.

The risk adjustment approach must specify the frequency of updating risk factors and estimated cost (e.g., monthly, quarterly, annually). A simple procedure may use a single time period per episode and quantify diagnosis and procedure risk factors as 0/1 based on a single fixed period beforehand (e.g., within one year of the start of the episode). More sophisticated risk adjustment procedures might make greater use of the date and current status of patients' medical conditions. The EGM approach falls in this latter category.

Acute conditions and surgical treatment episodes are short enough to have their total costs estimated once based on risk factor values as of the episode start. Longer episodes, on the other hand, are subject to periodic updating of risk factors to reflect better the information available to providers in managing care, and to anticipate changes in attributed providers over time. Thus, the dependent variables in models for chronic condition episodes are costs aggregated over evenly spaced periods, such as quarterly, and the risk factors are based on a fixed date near the start of each period being estimated.

EGM includes a user-set parameter to indicate the number of days a risk factor is allowed after period start. All risk factors are based on the parameter value of −1, indicating that the information must be known at the start of the time period being estimated.

9.3.2. Use of episodes as risk adjusters

EGM uses risk information from other episodes to help estimate the cost of a selected episode. For example, in estimating the cost of a patient's episode of heart failure, the risk adjustment model would include information that the patient had episodes of pneumonia and/or ischemic heart disease. Using episodes takes advantage of the trigger logic to specify conditions and treatments, and provides specific information on their status and timing, for example, whether something is ongoing or has ended.

An important advantage of an episode-based risk factor is that the episode exists over some time period, while an ICD-9 diagnosis is observed at a single moment in time. As such, an episode-based factor may be open at the start of the period being cost estimated, it may have recently closed (for example, within 182 days prior to the period), or it may have closed in some earlier time period (for example, between 365 and 183 days prior). These three situations are used in EGM Version 3 to create three distinct risk factors —open, recent, or old —for each episode employed for risk adjustment.

9.3.3. Specific Approaches

EGM uses a modular approach to processing health care information. Episodes, the basic building blocks of EGM, are the collective units for service utilization, which in turn, lie within a logical framework that preserves and utilizes associations with respect to other episodes, concurrently and sequentially. The final module of EGM, risk adjustment, estimates expected costs per episode after accounting for patient-level complexity under *ceteris paribus* conditions, i.e., standard care as observed for average providers in average markets. As noted previously, default EGM risk adjustment is based on patient factors only, not for geographical or provider differences. If desired by a user, adjustments for geographical and provider variables can be included.

In order to make use of updated information, the risk adjustment module in EGM may divide episodes into time periods. The episode costs during each time period are then estimated separately based on information known at the beginning of the time period. The length of the time period of episodes is user-specified with values conceivably ranging from as short as one month to as long as a year. By default, EGM uses a period length of 91 days (i.e., a quarter-year) because this duration is sufficiently short to make meaningful use of clinical events and service patterns, yet sufficiently long for the large majority of patients to accumulate some services and costs and thereby avoid too many cases with no services and zero costs. For other episodes, such as acute conditions and treatments, the quarter-year is considered long enough to represent the episode's appropriate duration for comparisons and accountability. For this reason, acute and treatment episodes are not divided into sequential time periods but have their costs modeled as a single time period.

The expected costs per quarter for a chronic condition episode can be added together, allowing the user to calculate totals for longer time intervals, such as for a given fiscal or calendar year.[49] This approach allows the user to estimate expected costs for specific policy applications, and provides a basis for measuring performance, determining financial incentives, or establishing prospective payment rates or targets.

9.3.4. Risk Factors

The explanatory variables selected for EGM are situated in three categories: demographic, health conditions, and prior treatment. The demographic variables include age, sex and whether the patient recently became eligible for Medicare (i.e., within six months of the beginning of the observation period).[50] Recent eligibility is included for a practical reason. The medical histories observed in claims for recently enrolled patients are likely to be incomplete and claims-based indicators of costs (diagnoses and other episodes) paid by payers other than Medicare are not observable, which can understate factors that would predict expected cost more accurately. As a result, unhealthy patients would appear to be relatively healthy for lack of their medical claims histories, and their expected costs would be biased downward.[51]

To adjust for the presence of other health conditions, EGM includes episodes as risk adjusters. If a patient had triggered a condition episode prior to the period being estimated for the episode of interest, then the presence and experience of that is used to adjust the expected cost for the period. For example, when estimating the expected cost of IHD for the next quarter, treatments and even sequelae related to IHD can be used as risk factors. In effect, this updating of risk-adjustment information attempts to reflect how a physician must function, continually monitoring a patient's situation, choosing services and using resources based on a patient's history and current status.

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[49] Still, the results reflect the time-ordered structure of the comparisons between actual and expected costs by quarter, with (future) expected costs estimated using only information available at the beginning of the estimation period. This is quite different from estimating an entire year at once, for example, with all clinical events during the year "explaining" all costs during the year, which is commonly known as concurrent risk adjustment.

[50] This time period can be specified by the user based on the availability of data to determine information for expected cost (e.g., six months, one year, eighteen months etc.).

[51] This bias would be offset by a smaller average bias in the other direction for other patients.

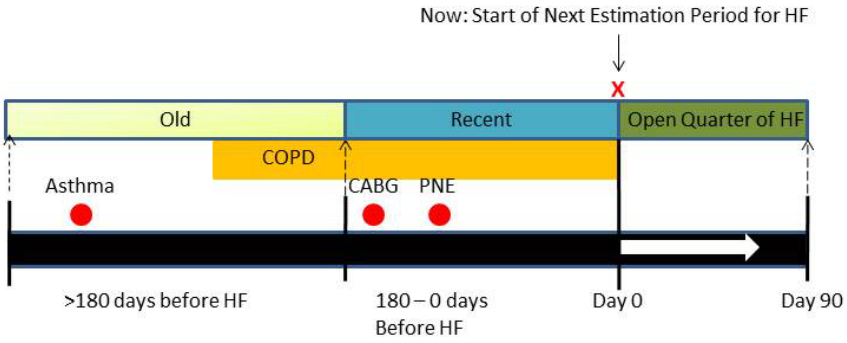
EGM distinguishes between episodes as risk factors according to time parameters in relation to the beginning of the episode or time period for which expected costs are being estimated:

- Open episodes. These are episodes that are still open at the beginning of the period being estimated. The fact of their existence is used to estimate expected costs for the episode of interest, although costs and consequences of the other open episodes are not; in other words, the risk-adjustment approach is prospective, not concurrent.
- Recent episodes. These are episodes that have recently closed, i.e., within the last 180 days as of the beginning of the episode or time period for which expected costs are being estimated.
- Old episodes. These are episodes that had closed more than 180 days prior the beginning of the episode or time period for which expected costs are being estimated.

For example, when determining the expected cost for a period of a heart failure episode, the program could determine that the patient has an open COPD episode, a recently resolved episode of pneumonia, a treatment episode for CABG recently closed, and placement of a cardiac pacemaker even more distantly in the past. Thus, EGM uses the logic of the grouper to validate the occurrence of condition and treatment episodes, as well as the timing of events in relation to the episode and time period of interest.

Figure 14 below shows how these different episodes relate temporally to the example of heart failure (HF). EGM has been configured to support episodes open in each of the three time frames described —concurrent or open, recent, or old — in relationship to the episode or 90-day period of interest.

Figure 13: Example of Risk-Adjusting Heart Failure Using Patient's Episode Profile



9.3.5. Statistical Modeling Approach

EGM implements the determination of expected costs using a multi-step statistical modeling approach, crafted in accordance with assumptions about the underlying distributions of the variables as applied to various types of episodes. The modeling approach has two or three steps depending on the user's choice:

- Construction and inclusion of an indicator for "potential end of life" status – user option,
- Estimation of the likelihood of the beneficiary having positive episode costs,
- Corresponding estimated magnitude of episode costs, condition on this cost being positive.

The service costs per time period consist of costs assigned directly or indirectly to the episode. Based on an application of Chebychev's equation, the logistic and linear regression estimates must be multiplied together to determine a patient's final expected cost for an episode:

$$E(Y|X1,X2,….Xn) = E(Y|X1,X2,…..Xn,Y>0)*P(Y>0|X1,X2,……Xn),$$

where the left hand side is the expected episode cost (Y) within the time period given risk adjusters X1,X2,…..Xn, the first factor on the right is the expected episode cost from the regression model using X1,X2,…..Xn, and limited to cases with positive cost (Y>0), and the second factor is the transformed value of the predicted outcome of the logistic model for the likelihood of episode cost being greater than zero:

$$P(Y>0|X1,X2,…..Xn) = 1/(1+exp(-logit(Y>0|X1,X2,….Xn)).$$

9.3.6. Modeling Quarterly Expenditures

Starting from the trigger date and continuing for the duration of the episode, expected costs are estimated for increments of approximately 91 days (i.e., a quarter-year). For chronic episodes, the quarter-year is the specified time interval for predicting costs incrementally, but many successive increments are predicted. The 91-day interval is sufficiently short to update and include recent clinical events and service patterns for accurate predictions, yet sufficiently long for the large majority of patients to accumulate services and costs, i.e., to avoid observing too many cases with no services and zero costs. For other episodes, such as many acute and treatment episodes, the 91-day period is considered long enough to represent the episode's full duration.

EGM provides the capability to add together episode costs over a user-defined duration, thereby producing totals for some fixed time period, such as a given fiscal or calendar year. A calendar year estimate, for example, would be based on all episodes contained within the year, as well as either episodes that overlap with the beginning or the end of the year. This approach allows the user to estimate expected costs for specific policy applications.

9.3.7. Modeling Potential End-of-Life Status

Providers may allocate resources differently to patients facing potential end-of-life prognoses. These prognoses may lead to higher costs, if the resources represent extreme measures to prolong life, or conversely they may lead to lower costs, if treatment is changed to palliative care and hospice. The statistical estimation models for expected costs in EGM may, at the user's option, include a probability of death as an additional risk factor. This factor is a probability based on a logit model. It is intended to reflect how providers treat patients facing potential end-of-life prognoses. It is not intended to adjust retrospectively for the "fact" of a patient's death.

As a practical issue, when the end-of-life probability is included as a risk factor, it may be more significant and have higher magnitude for some episodes (e.g., AMI) compared with others (e.g., Asthma). In addition, while patients with higher probabilities of death commonly have higher cost estimates for most episodes, for some episodes the higher likelihood of death actually predicts lower estimated costs. As noted earlier, users of EGM have the option to not include the potential end-of-life variable. In this case, the derived expected costs will depend solely on the direct effects of the other demographic and medical history variables in the models.

User Options

The EGM risk adjustment module makes default choices concerning the risk factors, how risk factors are further categorized as open, recent, or old, and the time periods of these categories, but an EGM user has the option to alter these default choices. The means for choosing other risk factors and/or associated time periods involve the alternative specification of values in three tables that accompany the risk adjustment module. A description of these three tables and possible alternative specifications is provided below:

The Risk Parameters table: This specification table identifies each combination of risk set (e.g., condition episodes, treatment episodes, global risk factors) and time period (open, recent, and old) used for risk adjustment and by way of the variables, before_days and after_days, indicates the time span distinguishing recent episodes from old episodes. A common value of (before_days, after_days) for recent episodes might be (182,-1) indicating recent episodes must end within a half year of the time period being risk adjusted. A common value of (before_days, after_days) for old episodes might be (365,-183) indicating old episodes must end within the half year previous to the time period for recent episodes.

The Risk Sets table: The risk sets specification table identifies the collection of risk factors that belong to each risk set.

The Episode Risk table: The episode risk table links episodes with the risk sets which will be used for their risk adjustment.

9.4. Technical Note: Clinical Vignette in Detail

The following vignette represents a 76-year-old female with a history of Diabetes, Hypertension, Ischemic Heart Disease (IHD) & Gastroesophageal Reflux Disease (GERD). The patient presents with chest pain to the Emergency Room (ER) and is hospitalized for Acute Coronary Syndrome (ACS). Within 3 days of discharge, she is re-admitted with a Urinary Tract Infection (UTI). The following illustrates how the EGM would handle this patient's claims for the acute episode of ACS.

Table 7: Admission

Code	ICD9PX/ CPT/ HCPCS Label	ICD9 Label	CV - ACS
3120F	12-Lead ECG Performed (EM)	Precordial pain	X
71010	Radiologic examination, chest; single view, frontal	Chest pain NOS	X
93010	Electrocardiogram, routine ECG with at least 12 leads; interpretation and report only	Chest pain NOS	X
99285	Emergency department visit for the evaluation and management of a patient	Precordial pain	X
MSDRG282	ACUTE MYOCARDIAL INFARCTION, DISCHARGED ALIVE W/O CC/MCC	Subendo infarct, initial	X

- Patient presents with chest pain to the Emergency Room (ER) and is hospitalized for Acute Coronary Syndrome (ACS)
  - An ICD-9 code Subendocardial Infarction in the principal position of the inpatient (IP) claim triggers (opens) an episode for ACS
- While the ACS episode is triggered based upon an inpatient hospitalization, the grouper ensures that any services deemed *relevant* to the management and treatment of the patient's ACS leading up to the admission are assigned to the ACS episode

- Example: ER visit the day before the admission (and its component services) get assigned to the open ACS episode

Table 8: Hospital Course

Thru Date	ICD9Px/ CPT/ HCPCS Cod	ICD9PX/ CPT/ HCPCS Label	ICD9 Label	CV - ACS
4/7/08	71020	Radiologic examination, chest, 2 views, frontal and lateral;	Chest pain NOS	X
	99223	Initial hospital care, per day, for the evaluation and managem	Intermed coronary synd	X
	71020	Radiologic examination, chest, 2 views, frontal and lateral;	Chest pain NOS	X
	93510	Left heart catheterization, retrograde, from the brachial artery	Crnry athrscl natve vssl	X
	99232	Subsequent hospital care, per day, for the evaluation and ma	Intermed coronary synd	X

- EGM is designed to ensure that ALL services during an inpatient stay are assigned to the episode that prompted the hospital stay
- In this case, the claims reveal that the patient underwent a cardiac catheterization during the April 2008 hospital stay. Since the hospitalization was prompted by the patient's ACS diagnosis ALL the cardiac catheterization services are assigned to the open ACS episode

Table 9: Sequelae

Thru Date	Code	Label	ICD9 Label	CV - ACS
04/11/08	93010	Electrocardiogram, routine ECG with at least 12 leads; interpret	Urin tract infection NOS	X
	71010	Radiologic examination, chest; single view, frontal	Altered mental status	X
	99285	Emergency department visit for the evaluation and managemen	Altered mental status	X
	A0427	Ambulance service, advanced life support, emergency transpor	Fever	X
04/11/08	70450	Computed tomography, head or brain; without contrast material	Altered mental status	X
04/14/08	MSDRG689	KIDNEY & URINARY TRACT INFECTIONS W MCC	Urin tract infection NOS	X

- EGM is designed to capture sequela (aftereffects or secondary results) from a condition or treatment episode.
- 3 days following discharge the patient develops altered mental status and a fever. She is brought by ambulance to the ER and re-admitted due to a urinary tract infection (UTI)
- EGM assigns the services from this hospitalization to an inpatient UTI episode. Since UTI is recognized as sequelae of ACS, EGM then links the UTI episode to the ACS episode as a sequela

Table 10: Post - Discharge Follow-up

From Date	Thru Date	ICD9Px/ CPT/ HCPC	ICD9PX/ CPT/ HCPCS Label	ICD9 Label	CV - ACS
4/16/08	4/16/08	99214	Office or other outpatient visit for the evaluation and manager	Precordial pain	X

- EGM is designed to ensure that relevant diagnoses are assigned to the open ACS episode
- Two days following discharge the patient is seen for a follow-up office visit. Since "precordial pain" is listed as a relevant diagnosis for the ACS episode, the EGM assigns the corresponding office visit to the open ACS episode