Challenges in the Risk Adjustment of Episode Costs

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EXECUTIVE SUMMARY

To stem the tide of rising Medicare costs, the Centers for Medicare and Medicaid Services (CMS) has been exploring an array of value-based purchasing initiatives aimed at enhancing the quality of care while avoiding unnecessary costs. A method commonly proposed for improving efficiency involves evaluating physicians' relative resource utilization. A potential mechanism for accomplishing this task consists of adapting episode grouping software to create measures of resource use and expenditures for the treatment of different medical conditions. In principle, groupers organize Medicare claims into clinically coherent and comparable episodes of care reflecting courses of treatment for health events. After the construction of episodes and their attribution to providers, risk adjustment must be performed to purge episode costs of factors beyond a physician's control to provide a basis for policymakers to compare physicians' relative resource utilization.

This report investigates the issues encountered in risk adjusting the costs of episodes built by two prominent commercial groupers using Medicare claims data: Ingenix's Symmetry Episode Treatment Groups (ETG) and the Thomson Reuters' Medstat Medical Episode Grouper (MEG). With the aim of using risk-adjusted costs to score physician efficiency, the analysis explores the use of several regression approaches to risk adjust episode costs controlling for beneficiary demographics, the specialties of attributed physicians, and beneficiary health conditions. Further, these methods account for the impacts of patient health conditions in two ways: beneficiary-level risk adjustment, which uses scores computed from beneficiary annual capitation rates under Medicare Part C, and episode-level risk adjustment, which measures the effects of hierarchical condition categories (HCCs) on episode costs separately for each individual ETG and MEG episode type.

All the risk adjustment specifications considered in this report reduce the dispersion of episode costs according to familiar measures, with episode-level risk adjustment achieving the largest reductions. However, unexpectedly, the use of episode-level risk adjustment sharply increases the severity of high-cost outliers for several episode types. We track the reasons underlying this outcome to the construction of episode sequences by the groupers which raises issues about their appropriateness for describing complete treatment profiles. The occurrence of this phenomenon uncovers disconcerting questions about the creation of Medicare episodes of care produced by both the ETG and MEG groupers.

High Variability in Costs within Episode Types

The ETG and MEG groupers assign claims into episodes of treatment based primarily on diagnosis codes, with procedure codes sometimes used in a variety of circumstances to resolve ambiguity in diagnoses or to determine the starts and ends of episodes. After aggregating claims into episodes, the grouping software classifies care as chronic, acute, or preventive. As neither grouper assigns costs to episodes, this analysis aggregates the payment on the claims assigned to each episode to calculate episode costs, with a claim's expense composed of its Medicare payments. In the case of the MEG, where each claim is assigned to only one episode, this exercise is straightforward. In contrast, the ETG algorithm can link the services inputs from a single Medicare institutional claim to different episodes. When this occurs, our analysis allocates the cost of the claim to the episode assigned the plurality of the claim's service-level input records.

The data analyzed in this report consists of episodes created by the ETG and MEG groupers using 2002-2004 Medicare claims for all beneficiaries residing in Oregon who were continuously enrolled in the fee-for-service (FFS) Parts A and B programs while alive. To formulate a representative population of episodes, our sample includes all complete episodes that ended in 2003. An additional sample analyzed in this report consists of those episodes in the 2003 complete sample that can be attributed to providers based on the highest Part B costs. The findings presented in this report focus on those acute and chronic episode types produced by the ETG and MEG groupers with the highest aggregate total expenses.

The cost distributions for the top-aggregate-expense acute and chronic episode types exhibit considerable variability. Specifically, unadjusted cost distributions display the following features:

- For the majority of episode types, costs at the 90^{th} percentile of the distribution exceed costs at the 10^{th} percentile by over 100 times.
- These distributions are also highly skewed. For most episode types, the top five percentiles of the distribution capture a larger proportion of total costs than the bottom 50 percentiles.

- These findings about the large variability in cost distributions do not change when one instead considers samples consisting of only those episodes that can be attributed to a physician or only those for patients who remain alive throughout the observation period.

The question arises about how much of this sizeable dispersion in episode costs can be allotted to physician efficiency and how much reflects factors beyond the physician's control. The purpose of risk adjustment is to neutralize episode costs for these latter factors.

Three Models of Risk Adjustment

This report applies regression methods to risk adjust episode costs, controlling for beneficiary demographics, specialties of attributed physicians, and beneficiary pre-existing health conditions. In particular, the analysis estimates three specifications of a risk adjustment regression model:

- *Model 1*: The first model incorporates measures of a patient's age and gender, and the specialty of the physician attributed to the episode.
- *Model 2*: The second model adds beneficiary-level risk scores that predict the total prospective annual costs for a patient for all types of health care starting with the onset of the episode; scores of the sort used by CMS in its setting of premiums for the Medicare Advantage program.
- *Model 3*: The third model replaces beneficiary-level risk scores with episode-level scores constructed to predict the costs of episodes within individual types using information on patients' demographic characteristics and pre-existing health conditions measured by CMS's HCC indicators.

Comparison of risk-adjusted cost distributions provides the basis for evaluating the effectiveness of these different models in neutralizing episode costs for varying pre-existing circumstances of patients.

Risk Adjustment Reduces Dispersion But Exacerbates Outliers

Table 1 summarizes the effects of risk adjustment on episode cost distributions using two measures: the ratio of costs at the 90th percentile to the 10th percentile and the fraction of total episode costs in the top five percentiles. The 90/10 ratio is a familiar measure of dispersion. The first column in this table shows the average change of this ratio in the cost distributions achieved by risk adjustment using only patient age/gender and physician specialty as regression controls (Model 1). The second column reports the average change in the 90/10 ratio when risk adjustment controls for patient age/gender, physician specialty, grouper-assigned disease severities, and beneficiary-level health risk scores (Model 2). The third column gives the average change when controlling for the same factors, but replacing beneficiary-level scores with episode-level risk scores computed individually for each episode type (Model 3). Paralleling the structure of the 90/10 analysis, the next three columns show the impact of the same specifications on the fraction of cost captured by the top five percentiles of the episode cost distributions.

Inspection of Table 1 reveals the following findings:

- All risk adjustment regression specifications lead to large reductions in dispersion of costs for all episode types as measured by the 90/10 ratio. Not surprisingly, episode-level risk adjustment (Model 3) produces the greatest declines, shrinking the average 90/10 ratio by 34% for ETG and by 48% for MEG.
- Unexpectedly, however, episode-level risk adjustment (Model 3) sharply increases the severity of high-cost outliers for several episode types. Such risk adjustment specifications increase the fraction of cost captured in top five percentiles by an average of 24% for ETG and 17% for MEG. In contrast, other specifications have little impact on the percent of cost in the top five percentiles.

Table 1: Effects of Risk Adjustment on Episode Cost Distributions for Top-Aggregate-Cost ETGs and MEGs

	90/10 Ratio			Percent of Cost in Top Five Percentiles		
Impact of Risk Adjustment	Model 1: Age/Gender & Physician Specialty	Model 2: Beneficiary-Level	Model 3: Episode-Level	Model 1: Age/Gender & Physician Specialty	Model 2: Beneficiary-Level	Model 3: Episode-Level
Average Change for ETGs	-20%	-21%	-34%	-3%	-1%	24%
Average Change for MEGs	-25%	-40%	-48%	-2%	1%	17%

Note: A positive (negative) number indicates risk adjustment increased (decreased) the measure compared to the unadjusted distribution.

The sharp increase in the magnitude of high-cost outliers induced by risk adjustment is particularly striking in the case of hip fracture episodes, one of the episode types summarized in the average statistics reported in Table 1. Use of episode-level risk adjustment for hip fracture episodes (Model 3) increases the fraction of costs captured by the top five percentiles of the cost distribution by over 200%.

Table 2 elaborates on the impacts of risk adjustment for ETG and MEG constructions of hip fracture episodes. The rows report statistics describing properties of episode cost distributions, with costs normalized by the mean of the distribution. The top row in each set presents statistics for unadjusted costs and the bottom row reports statistics for episode costs after adjusting for beneficiary age and gender, physician specialty, and episode-level health risk scores (Model 3). Normalized costs at the 90th percentile fall with risk adjustment by about one-third. The normalized values of the 95th percentiles, however, increase by more than 25% after risk adjustment. The standard deviation also expands by a factor of about three. Most notable, risk adjustment increases the magnitude of outliers dramatically: the share of costs accounted for by the top five percentiles rises to half of all cost, compared to 15% prior to risk adjustment.

Table 2: Normalized Unadjusted and Risk Adjusted Costs for Hip Fracture Episodes

Hip Fracture Episode	Cost Adjustment	Summary Statistics: 10%	50%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
ETG	Unadjusted	0.01	0.96	1.98	2.36	1.00	0.81	17%	15%
	Risk Adjusted	0.04	0.46	1.31	3.61	1.00	2.51	10%	50%
MEG	Unadjusted	0.01	0.94	2.01	2.38	1.00	0.82	19%	15%
	Risk Adjusted	0.05	0.49	1.45	3.05	1.00	2.40	11%	48%

Costs are risk adjusted using Model 3.

Issues in the Construction of Episodes

Whereas the original motivation for this report aimed to assess the impact of risk adjusting the costs of Medicare episodes of care created by the ETG and MEG groupers, the findings presented here instead highlight questions about the construction of episodes by each grouper. Investigation of the sources underlying the creation of extreme outliers produces critical insights into aspects of the construction of episodes by both groupers.

Exploring data for hip fracture episodes reveals that the ETG and MEG groupers each build a pattern of episodes resembling "follow-on" care rather than a full course of treatment for a hip fracture. Our analysis distinguishes hip fracture episodes according to whether they include some institutional or only non-institutional claims. On average, the costs of institutional hip fracture episodes exceed their non-institutional counterparts by over 40 times. The problematic patterns of care primarily come in two forms: high-cost institutional episodes followed by inexpensive non-institutional episodes and high-cost institutional episodes followed by another high-cost institutional episode. Because the former pattern predominates, the regression model predicts low costs for the second episode. When the second hip fracture episode is a high-cost institutional episode, risk adjustment magnifies the episode's costs to create an extreme outlier.

These findings raise questions about the construction of episodes and whether episode costs, even after risk adjustment, constitute reliable measures of physician resource use. If risk-adjusted costs were used to evaluate physician efficiency, then a physician assigned just one of the outlier institutional episodes described above would likely be rated as inefficient. Under the "follow-on" scenario, succeeding non-institutional episodes typically do not represent full courses of care whereas the outlier institutional episodes do. Consequently, the physician deemed inefficient is penalized for treating an actual serious second hip fracture. This problem cannot easily be remedied by modifying the risk adjustment model.

A resolution of the issue might be possible through an alternative construction of hip fracture episodes. Currently, physical therapy for hip injuries that takes places months later would be considered separate hip fracture episodes because the claims take place after the clean period of the initial injury has elapsed. The phenomena described above would subside if follow-on non-institutional episodes were considered continuations of the predecessor institutional episodes. Under these circumstances, sequences would now primarily consist of successive institutional episodes as the follow-on non-institutional episodes would be attached to the preceding institutional episode. To the extent that second fractures cost more than first fractures, a risk adjustment model would discount rather than inflate costs. This discount factor would in turn make these later episodes less likely to be outliers. Although restructuring outputs from the ETG and MEG groupers offers a possible solution to this particular problem, it also brings along the unattractive side effect of requiring a retooling of the groupers.

Hip fractures are not the only episode type showing problematic patterns of episode sequences and an increase in the portion of costs in the top percentiles after risk adjustment. In the case of the ETG grouper, one sees these problematic sequence patterns for such episode types as acute pancreatitis and joint degeneration of the knee and lower leg. For the MEG grouper, these patterns come about for femur and tibia fractures, and pancreatitis. Moreover, many of the top-aggregate-expense episodes analyzed in this report continue to exhibit increased high-cost outliers after risk adjustment. Preliminary evidence suggests that these episode types may also be comprised of events that are not fundamentally comparable (e.g., including institutional episodes that constitute full courses of care and non-institutional episodes that represent only follow-on, pre-procedure, or diagnostic care under the same episode type). As several issues with episode construction and composition may be present in a variety of episode types, further investigations are warranted into the Medicare episodes of care created by the groupers before such episodes can be used as a basis for developing physician rankings.

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1 INTRODUCTION

Implementing a pay-for-performance system for Medicare aims to increase physician cost efficiency, saving money without decreasing quality of care. Episode grouping software has recently been discussed in the policy and health care communities as a technological solution that offers a framework for developing such a system. This software allots healthcare claims into "episodes of care" in order to identify service patterns and their associated costs, which can then be used to create provider efficiency assessments. However, using the raw costs attached to these episodes of care would also include the cost impact of factors influencing resource use levels that are beyond the physician's control.

Using any grouping software as the basis for physician evaluation and ranking without adjusting for these factors outside of physicians' control could unfairly penalize physicians who treat unhealthier patients. An unadjusted high-cost outlier episode could be because of a very ill patient with numerous co-morbidities but, without a reliable risk adjustment, the physician responsible for this episode could be rated as inefficient. Similarly, physicians who are not efficient could be rewarded for treating healthier patients if unadjusted episode costs were used to rate physicians. Separating cost variation due to physician efficiency from cost variation due to factors such as patient case mix or treatment patterns within specialty is the role of risk adjustment. With a risk adjustment model that accounts for all such factors outside of physician efficiency, any variation in the costs of comparable episodes would result from differences in the physicians' choice of treatments and quality of care.

Devising a risk adjustment model that purges the expenses associated with factors beyond a physician's influence from episode costs is a substantial challenge. This report explores the use of a regression-based risk adjustment framework that controls for the impact of beneficiary characteristics and physician specialty. The analysis examines a variety of specifications to assess how each factor affects cost distributions for episode types created by two commercially available software packages using Medicare claims data: Ingenix's Symmetry Episode Treatment Groups (ETG) and the Thomson Reuters' Medstat Medical Episode Grouper (MEG). Comparing unadjusted and adjusted cost distributions provides information on how much of the dispersion in episode costs stems from patient and physician factors controlled for by risk adjustment, as well as whether these factors explain high-cost outliers.

Of the factors incorporated in the risk adjustment models, a patient's pre-existing health conditions are likely to have the most substantial impact on costs. A question arises in how to measure a patient's health level. CMS uses HCC health indicators in conjunction with a patient's demographic attributes to predict annual beneficiary costs under Medicare Part C. CMS-HCC risk scores reflect the influence of prior health events and patient demographics on prospective annual beneficiary costs. Clearly, individual CMS-HCC health indicators are likely to predict different cost impacts across different episode types (e.g., a prior vertebral fracture is likely a better predictor of costs for a subsequent back injury compared to a future cataract). Recognizing this issue, our analysis introduces episode-level risk adjustment. Unlike beneficiary-level risk scores, episode-level risk regressions permit each variable to have a distinct impact depending on the episode type under consideration. This empirical specification allows the HCC variables most closely related to a given episode type to exert a larger predictive power on that episode's cost.

Section 2 of this report presents an overview of how Medicare claims are used by the ETG and MEG groupers to create episodes and to compute costs of care. Section 3 explores the cost distributions of those ETG and MEG episode types comprising the highest aggregate expenses, considering several sample configurations. Section 4 introduces a regression methodology for risk adjustment and demonstrates the impacts of different specifications on the cost distributions of episode types. Section 5 narrows the focus to a specific episode type, hip fractures, and explores how and why risk adjustment creates and exacerbates high-cost outliers for these episodes, an unexpected outcome. Finally, Section 6 concludes with discussion of the main findings and important lessons learned.

2 ADAPTING GROUPERS TO MEDICARE DATA

Episode grouping software is one type of technology that offers a potential basis for the development of a pay-for-performance system. The grouping of medically-related claims into clinically coherent episodes of care that reflect the treatment of health conditions creates the foundation for a common measure of physician resource utilization and expenditures. Physician ranking involves comparing healthcare providers responsible for comparable episodes of care along resource use. A major issue in episode grouping is assigning the costs of claims to episodes of care so that the episodes' costs reflect the actual costs of treating individual health conditions. This challenge is complicated by the fact that patients may experience several conditions simultaneously.

There are several steps involved in grouping episodes and creating efficiency scores for providers. First, groupers organize administrative medical claims into episodes of treatment for specific categories of illnesses. After claims have been aggregated into episodes, the second step is determining the costs of these episodes. Next, episodes must be attributed to providers so that provider resource use can be calculated and compared. Challenges arise in attributing episodes and costs to providers given that patients may encounter multiple providers during a course of treatment. Episode costs must then be risk adjusted so that cost differences better reflect provider efficiency as opposed to patient risk factors. Finally, physicians are given resource utilization scores based on the risk-adjusted costs of the episodes they have been attributed as compared to other physicians treating similar episodes.

To build episodes from claims, this study relies on the Symmetry ETG and Medstat MEG groupers. Section 2.1 provides background on the data structures in Medicare claims and ETG and MEG groupers. This section describes features of the groupers and implementation steps that are important to running each grouper with Medicare claims data. Section 2.2 describes a framework for presenting the results produced by the two groupers using a common measure of episode costs. Section 2.3 explains approaches for assigning episodes and costs to Medicare providers.

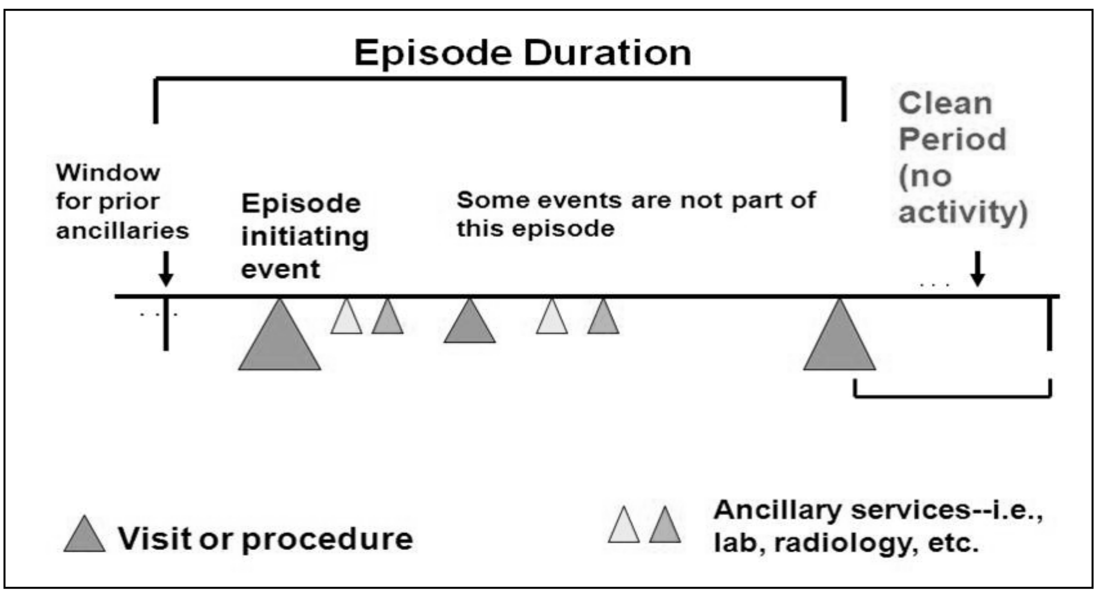
2.1 Overview of Medicare Claims Data and the ETG and MEG Groupers

The ETG and MEG groupers are proprietary software packages designed to assign raw medical claims into sets of clinically coherent episodes that capture courses of treatment for particular health conditions. In principle, episodes should be units of analysis comparable across providers. Episodes should ideally be constructed so that after controlling for patient and physician characteristics that influence cost, they exhibit cost differences sensitive only to the decisions made by the providers deemed responsible for the care. Section 2.1.1 introduces how groupers use claims data to create episodes of care and Section 2.1.2 provides a breakdown of Medicare claims data by type. Sections 2.1.3 and 2.1.4 discuss in greater detail the application of the ETG and MEG groupers, respectively, to Medicare data.

2.1.1 General Characteristics of Groupers

Groupers build episodes of care based on Medicare claims as depicted in Figure 2.1. Episodes are "opened" by an initiating event (specific groupers have different rules about what type of claim can open an episode). Claims are then aggregated into episodes within an opaque component in the groupers. An episode is "closed" when a sufficient period of time has passed (the length of this period depends on the type of episode and specific grouper used) without any related claims.

Figure 2.1: Construction & Timeline of an Episode



The groupers' algorithms that construct episodes of care extract specific data items from claims, including: diagnosis codes, procedure and/or revenue center codes, start and end dates, and patient characteristics. Diagnosis codes on claims primarily drive the grouping process, with procedure codes also used in a variety of circumstances. The output produced by groupers depends on users' decisions regarding the claim types included in the processing and the information on the claims selected for input.

2.1.2 Overview of Medicare Claims Data

This analysis uses Medicare claims data as the input for the groupers to create episodes of care. Medicare Parts A and B claims, the only claims this analysis considers, consist of "institutional" and "non-institutional" claims. Medicare's definition of institutional claims includes the following types: hospital inpatient (IP), outpatient facility (OP), skilled nursing facility (SNF), home health (HH), and hospice (HS). Non-institutional claims consist of Part B services (PB) and durable medical equipment (DME).

The distinction between institutional and non-institutional claims is of consequence in the use of diagnosis and procedure codes, which groupers use to build episodes of care. Principal diagnoses are of particular interest because groupers generally use them as the base to build episodes. Institutional claims have up to 10 diagnosis codes. Among these, the first diagnosis code always corresponds to the principal one for that claim. For IP and SNF claims, there is also a diagnosis code designated as the admitting diagnosis. This code often (but not necessarily) corresponds with the first (principal) diagnosis. All institutional claims also report a set of service items identified by revenue center codes

Non-institutional claims have only procedure codes and do not have revenue center codes. Each claim contains a group of individual line items and a header section with up to four diagnosis codes. Each line item has a single diagnosis and a single HCPCS or CPT code. The header codes on a claim tend to come from the line items making up the claim.

2.1.3 Application of the ETG Grouper to Medicare Data

The following section describes the design features and implementation steps involved in running the ETG grouper (Version 7.0.1) with Medicare data. There are a total of 524 base ETG classes, of which 68 are categorized as "ungroupable." ETG also divides a subset of the base ETGs into up to four severity levels. For the purpose of attributing episodes to healthcare providers using the current version of its software, Symmetry recommends using base ETGs plus their assessed severity level as the episode categories for comparing cost outcomes. Consequently, when this report mentions ETG episodes, this refers to a base ETG plus an associated severity level.

All episodes are also categorized as being chronic, acute, or preventative. Although acute and preventative episodes invariably have clearly defined start and end dates, chronic episodes typically do not. They often reflect health conditions that began before the study period, became progressively worse, and continued afterwards. It is possible for patients to experience more than one type of episode at the same time, usually due to the presence of co-morbidities.

For each claim, the ETG grouper reviews the diagnosis code(s), procedure code(s), revenue center code(s), provider category, and type of service to determine the classification of the claim. The ETG grouper only allows claims representing clinical interactions (e.g., an office visit, surgery, or admission to a hospital or SNF) to open an episode; these are called "anchor records." An episode is typically opened by the earliest record that qualifies as an anchor record for an episode. The episode ends when a sufficiently long "clean period"—a time span with no related claims activity for the beneficiary—follows the last claim assigned to the episode. Clean periods depend on the episode type, with acute episode types having shorter required clean periods and chronic episode types requiring longer ones.

The ETG software inputs each claim as a set of service-level records based on the revenue center and procedure codes on the claim. For institutional claims, each input record consists of a single revenue center code identifying a form of service, an accompanying procedure code if available, and the diagnoses listed on the parent claim. An institutional claim has as many input records as it has revenue center codes. Since ETG allows a maximum of four diagnosis codes per input record, the user must choose which four codes to use. The ETG grouper can and often does assign separate input records from a parent institutional claim to different episodes. Such assignments can result in institutional claims being linked to more than one episode.

For non-institutional services, Medicare's PB and DME claims are separated into line items associated with individual HCPCS or CPT codes that identify the procedures performed; these claim types have no revenue center codes. Each input record constructed from a PB or

DME claim consists of a single procedure code and its corresponding line item diagnosis. The ETG grouper allocates each PB and DME line item to only one episode.

2.1.4 Application of the MEG Grouper to Medicare Data

Although some steps involved in running the ETG grouper are also applicable to the MEG grouper, others are unique to MEG. When creating episodes, the MEG grouper (version 7.1) assigns each episode to one of 560 base MEG disease classifications. In addition, MEG can allot up to four "disease stages" to a base MEG episode, with stage 1 representing the lowest level of health complication and stage 4 being death. Distinguishing base MEGs by their disease stages implies thousands of classifications. Though this analysis defines ETGs at the severity level, it uses base disease classifications for MEGs. As with ETGs, MEGs are classified as one of acute, chronic, or preventative.

In initiating episodes, MEG uses physician services (visits and procedures), hospitalizations (IP), skilled nursing facility stays (SNF), and hospice services (HS). If a claim is flagged as an x-ray or lab procedure, it cannot begin an episode.[1] Similar to the ETG software, the grouper ends an episode when a clean period follows the last claim assigned to the episode.

The MEG grouping process inputs each institutional claim as a single record, relying primarily on diagnosis information in its assignments to episodes. Crucially, the MEG grouper does not allow an institutional claim to be treated as an aggregate of services that could potentially be linked to more than one episode. However, for the non-institutional PB and DME claims, MEG, like ETG, considers each line item to be a separate input record.

An input record distinguishes IP and PB claims from other types of Medicare claims, but it does not differentiate among the other distinct types of Medicare claims as the source of diagnoses. Switching from one of these claim types to another results in no change in constructed episodes. However, an input record contains data on procedure codes appearing on the claim. The groupers use this procedure information to determine whether a claim represents a lab event, which cannot start an episode, and in some instances to interpret secondary diagnoses on the

[1] Medstat supplies a recommended list of procedure codes for setting the x-ray/lab flag. In assigning x-ray/lab flags, the analysis in this paper generally follows Medstat's recommendation; it uses procedure codes to identify claims as x-ray/lab, with the exception of IP claims.

claim. Medicare institutional claims allow for up to nine secondary diagnoses, and MEG allows for all these to be included on input records. Typically only the primary diagnosis is used in the grouping process, although the secondary diagnoses can affect the assignment to disease stages.

2.2 Assigning Costs to Episodes

After the groupers have assigned claims to episodes, the next step involves calculating costs of these episodes. Neither grouper offers guidelines on how to calculate episode costs. This analysis aggregates the costs of the institutional claims and non-institutional line items assigned to the episode, with a claim or line item's expense consisting of its Medicare payments.[2] For the MEG grouper, this analysis simply aggregates the cost of institutional claims and non-institutional line items assigned to the episode. As the ETG grouper assigns some institutional claims to multiple episodes, the costs of institutional claims are allocated to the episode assigned the plurality of the claim's service-level input records.[3]

2.3 Attributing Episode Costs to Providers

After episodes have been created, the next step is to attribute episodes to providers. As a beneficiary may encounter multiple physicians during an episode, attribution can sometimes prove to be a challenging task. In about 75% of episodes, only one physician is listed on the PB line items assigned to that episode.[4] This physician is automatically attributed the episode and its associated costs. However, these episodes account for only about 25% of all episode costs, demonstrating the need for rules that attribute costs for episodes with PB claims that contain multiple providers to a single physician.

This analysis assigns responsibility for episodes with multiple physicians to the provider with the highest total Part B costs (PBmax). If there are no positive costs on PB line items assigned to an episode, then the episode is not attributed to a provider. In a case where the payments from PB line items are equal for two or more providers, the episode is attributed to the provider with the highest costs from Evaluation and Management (E&M) items. The analysis in

[2] For IP claims, this excludes the capital payment portion.
[3] In the case of a tie, the parent institutional claim's cost is distributed equally among episodes tied with the highest assignments. See MaCurdy et al. (2008a) for additional details.
[4] This analysis identifies providers based on Tax IDs. Providers can also be identified via their Universal Physician Identification Numbers (UPINs), but many claims do not list UPINs or list them incorrectly. We have thus opted to identify the candidate pool of providers using the Medicare Physician Identification and Eligibility Registry, MPIER, which tracks providers' Tax IDs, their specialties, and the settings in which they practice.

MaCurdy et al. (2008b) found that, under the PBmax attribution rule, both groupers attributed roughly 80% of Oregon Medicare episodes ending in 2003 and 90% of associated episode costs to 90% of Oregon providers.

Beyond the steps described in this section, episode costs require risk adjustment before they can be used as the basis for physician resource utilization comparisons. Risk adjustment fulfills the need to take into account risk factors beyond the physician's control. The following sections examine the cost distributions of the top-aggregate-cost acute and chronic episodes types as grouped by the ETG and MEG groupers and explore the results of risk adjustment for the costs of these episode types.

3 DISTRIBUTIONS OF EPISODE COSTS

This section presents the unadjusted cost distributions of episodes grouped by the ETG and MEG groupers, demonstrating that these distributions are highly skewed and variable. The focus of these distributions is the acute and chronic episode types with the highest aggregate costs. To show that the distributional features are inherent in the data rather than a product of sampling specifications, several restrictions of the sample are tested and the results compared. The findings suggest that changing sampling restrictions does not change the distributional features of high dispersion and right-skewness.

Section 3.1 defines the full sample of episodes that comprise the distributions. Sections 3.2 and 3.3 discuss the results for ETG and MEG episodes, respectively, following a parallel structure. Each subsection initially describes properties of the unadjusted cost distributions for the sample of all episodes. The discussion later considers cost distributions for the sample of attributed episodes.

3.1 Sample of 2003 Oregon Medicare Episodes

The data on episodes analyzed in the subsequent discussion consists of all complete episodes ending in 2003 of Medicare beneficiaries residing in Oregon. Requiring that episodes be complete for a fixed period of time creates a sample of episodes that is representative. Beneficiaries must have been continuously enrolled in Medicare fee-for-service (FFS) Parts A and B while alive during the 2002-04 time period.[5] Claims for this time frame were input into the grouper software to build episodes.[6] Our analysis determines providers' medical specialties using information supplied by the MPIER. The principal data used in the risk-adjustment analysis below consists of the sample of attributed episodes, which necessarily have positive Part B costs.

[5] This sample includes beneficiaries who died before the end of the time period (December 31, 2004) as long as they were continuously enrolled in Medicare Parts A and B while alive. To prevent termination of claims flows in our evaluation of the functionality of groupers, our previous reports (MaCurdy et al., 2008a and MaCurdy et al., 2008b) excluded beneficiaries who died before the end of the study from the sample. This exclusion does not have an appreciable effect on any of the analysis done in this paper or our previous work.
[6] MaCurdy et al. (2008a) describes the precise settings and options selected in running the ETG and MEG groupers.

3.2 Most Expensive ETG Episode Types

This section compares the distributions of all episodes and attributed episodes for the ETG grouper. As the data show, applying the attribution rule does not change distributional features. The first section, 3.2.1, studies the full sample of all ETG episodes, while Section 3.2.2 examines the effects of requiring that episodes be attributable to a provider.

3.2.1 Distributions of All ETG Episode Costs

This segment of the discussion examines the distributions of the top 10 acute and top five chronic ETG episode types for the full sample, including ones that cannot be attributed to a physician. It then presents a sub-sample that excludes episodes from any beneficiaries who died during the study period. Almost all of the episode types in both categories show extreme right-skewness, with the share of costs in the top 5% exceeding the share in the bottom 50% and the mean usually being at least twice the median. All distributions also show high dispersion; the 90th percentile is frequently several hundred times greater than the 10th percentile.

The tables displaying these statistics adhere to the following uniform structure throughout all subsequent sections. Episode types are divided into acute and chronic, with the rows showing the episode types with the highest aggregate costs. The columns identify the total number of episodes for each type, the aggregate costs, and the cost per episode for six different percentiles of the distribution: the 10th, 25th, 50th, 75th, 90th, and 95th. The mean and standard deviation are displayed alongside the percentiles, followed by the shares of costs in the bottom 50% and the top 5% of the distribution, which serve to illustrate skewness.

Table 3.1 contains the cost distributions of the costliest ETGs for the full sample. It shows that all of the top 10 acute and top five chronic episode types have right-skewed distributions with large dispersion. The 95th percentile for acute episodes ranges from $1,523 to $36,798, while the 10th percentile ranges from $53 to $601. The enormous ranges seen for all episode types often lack consistency, for example, the existence of $67 episodes for *Spinal Trauma, SL* 3 juxtaposed with $19,604 episodes of the same type. The chronic episodes are no different, with *Ischemic heart disease, SL 1*, for example, containing both $38 and $11,708 episodes.

The second most costly acute ETG episode type, *Bacterial lung infections, SL 4* displays a high level of right-skewness typical to the episode types displayed in Table 3.1. To illustrate, the fraction of costs captured by the top five percentiles for this type accounts for several times the share of costs captured by the bottom fifty percentiles, the 95th percentile is several hundred times greater than the 10th percentile, and the mean is almost double the median. This level of skewness is common to episode types in all sub-sampling categories. The most extreme example is *Spinal trauma, SL 3*, where the mean is around six times the median and the share of costs in the top five percentiles is 13 times the share in the bottom half. In the vast majority of cases, the 95th percentile is at least 100 times greater than the 10th percentile.

Table 3.2 shows the same statistics as Table 3.1 but for a sample limited to only those alive during the entire study period. This restriction does decrease the sample size, but does not appreciably alter the distributions. For each of the episodes in this table, the fraction of costs captured in the bottom half of the distribution and the top five percentiles remains roughly the same. The largest change is seen in *Non-malignant neoplasm of intestines & abdomen, SL 1* episodes, where the top 5% of episodes moves from comprising 43% of the total costs for the unrestricted sample to 39% in the restricted sample. The majority of the other episode types see changes no larger than two percentage points in the fraction of costs captured in the bottom 50% and top 5%. Sample sizes, however, drop by as much as 55%, such as in the cases of *Septicemia, SL 2* and *Bacterial Lung Infections, SL 4.*

3.2.2 Distributions of Attributed ETG Episode Costs

Whereas the tables in the previous section did not require episodes to be attributed to a physician, this section presents statistics that characterize the distributions of costs for only those episodes attributable under the PBmax rule. Table 3.3 shows that with the constraint of the attribution rule, the rankings remain identical for the most costly acute and chronic episode types. The number of episodes drops by a small factor, the largest change being roughly 20%. The skewness remains equally extreme, with the share of costs in the top five percentiles consistently being several times higher than the bottom half, and top percentiles exhibiting costs several hundred times greater than the 10th percentile.

In Table 3.4, an additional limitation is imposed according to the *10-10* cell size rule, which requires that attributed physicians be members of a peer group of comparable physicians consisting of at least 10 providers of the same specialty that are each attributed a minimum of 10 episodes of that type. Under this restriction, the number of episodes drops by a large factor, in general by almost a half. Rankings also change with the cell size rule. However, cost levels do not change meaningfully; the distributions still remain strongly right-skewed and dispersion remains high.

These results demonstrate that the requirement of the attribution rule for selection in the sample does not change costs or their distributions appreciably for ETG. They also demonstrate that the *10-10* cell size restriction decreases sample size by a large amount but does not affect overall results, thereby motivating the choice not to impose it for the analyses in Sections 4 and 5.

Table 3.1: Episode Costs for Top-Aggregate-Cost ETGs

#	ETG: Description	# of Episodes	Total Cost	Summary Statistics: 10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,789	$21,574,695	$91	$2,019	$11,542	$18,552	$24,362	$28,913	$12,060	$9,976	17%	15%
2	Bacterial lung infections, SL 4	4,083	$18,204,268	$78	$254	$2,485	$5,619	$10,527	$16,946	$4,459	$6,962	5%	29%
3	Septicemia, SL 2	1,731	$8,366,935	$99	$258	$2,745	$7,634	$9,712	$15,757	$4,834	$5,717	5%	23%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	456	$7,215,345	$601	$7,044	$15,181	$22,214	$30,536	$36,798	$15,823	$11,881	21%	15%
5	Bacterial lung infections, SL 3	2,808	$6,944,071	$53	$138	$552	$4,521	$5,661	$8,663	$2,473	$3,449	4%	27%
6	Bowel obstruction, SL 1	1,867	$6,912,190	$68	$211	$1,055	$4,314	$9,179	$16,682	$3,702	$7,463	4%	36%
7	Spinal trauma, SL 3	1,476	$6,907,401	$67	$193	$820	$5,431	$12,927	$19,604	$4,680	$10,001	3%	39%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	863	$6,537,679	$69	$413	$4,712	$13,354	$18,632	$22,904	$7,576	$8,089	6%	19%
9	Cholelithiasis, SL 2	1,510	$6,360,405	$163	$513	$2,338	$6,329	$10,721	$13,177	$4,212	$5,103	9%	21%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	6,525	$6,296,804	$213	$443	$606	$756	$1,063	$1,523	$965	$2,866	20%	43%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	10,755	$40,318,806	$56	$164	$638	$2,578	$11,099	$21,646	$3,749	$8,494	3%	47%
2	Ischemic heart disease, SL 1	16,178	$31,519,876	$38	$86	$266	$1,056	$4,041	$11,708	$1,948	$5,327	3%	56%
3	Cerebral vascular accident, SL 2	10,086	$31,151,029	$52	$146	$531	$3,489	$8,532	$14,482	$3,089	$6,477	3%	40%
4	Ischemic heart disease, SL 3	2,733	$30,091,522	$189	$899	$6,835	$15,589	$29,118	$36,501	$11,010	$15,120	8%	26%
5	Ischemic heart disease, SL 4	1,696	$26,545,025	$675	$4,941	$9,981	$21,375	$36,380	$46,855	$15,652	$16,826	15%	21%

Table 3.2: Episode Costs for Top-Aggregate-Cost ETGs for Individuals who Remain Alive

#	ETG: Description	# of Episodes	Total Cost	10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
				Summary Statistics									
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,122	$13,161,079	$67	$756	$11,279	$18,555	$24,174	$28,913	$11,730	$10,154	14%	15%
2	Bacterial lung infections, SL 4	1,871	$7,319,739	$71	$213	$2,094	$5,382	$8,453	$13,876	$3,912	$6,038	5%	29%
3	Non-malignant neoplasm of intestines & abdomen, SL 1	6,162	$5,541,078	$213	$445	$605	$749	$1,025	$1,345	$899	$2,721	21%	39%
4	Cholelithiasis, SL 2	1,238	$5,264,157	$178	$672	$2,430	$6,843	$10,719	$13,071	$4,252	$4,524	11%	19%
5	Bowel obstruction, SL 1	1,275	$4,482,114	$75	$219	$1,081	$4,166	$9,340	$16,320	$3,515	$6,792	4%	34%
6	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	585	$4,257,290	$62	$337	$3,613	$13,179	$18,107	$22,229	$7,277	$7,828	5%	18%
7	Spinal trauma, SL 3	1,032	$4,237,318	$65	$170	$720	$4,700	$12,007	$18,520	$4,106	$7,968	3%	38%
8	Septicemia, SL 2	765	$4,054,690	$99	$257	$4,663	$7,595	$11,121	$16,947	$5,300	$7,534	6%	25%
9	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	253	$4,024,212	$426	$6,426	$15,119	$22,210	$30,876	$35,740	$15,906	$12,409	21%	15%
10	Bacterial lung infections, SL 3	1,729	$3,981,303	$53	$131	$470	$4,457	$5,367	$7,255	$2,303	$3,217	3%	26%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	8,579	$32,789,226	$59	$164	$607	$2,437	$11,477	$24,346	$3,822	$8,740	3%	47%
2	Ischemic heart disease, SL 1	15,145	$29,391,413	$38	$85	$263	$1,046	$3,916	$11,739	$1,941	$5,339	3%	57%
3	Cataract, SL 1	44,972	$23,441,359	$38	$62	$74	$522	$1,658	$2,848	$521	$918	5%	30%
4	Ischemic heart disease, SL 3	1,761	$21,836,440	$209	$1,125	$7,922	$18,380	$31,755	$39,196	$12,400	$15,231	8%	23%
5	Cerebral vascular accident, SL 2	7,570	$20,817,867	$52	$139	$468	$2,481	$7,757	$12,650	$2,750	$6,186	3%	43%

Table 3.3: Episode Costs for Top-Aggregate-Cost Attributed ETGs

				Summary Statistics									
#	**ETG: Description**	**# of Episodes**	**Total Cost**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**Mean**	**Std Dev**	**Fraction of Cost in Bottom 50% of Episodes**	**Fraction of Cost in Top 5% of Episodes**
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,670	$20,524,551	$103	$2,737	$11,836	$18,685	$24,309	$28,987	$12,290	$9,950	17%	15%
2	Bacterial lung infections, SL 4	3,767	$16,708,793	$79	$254	$2,589	$5,615	$10,527	$16,836	$4,436	$6,804	5%	29%
3	Septicemia, SL 2	1,499	$7,312,042	$98	$249	$2,876	$7,662	$10,224	$16,021	$4,878	$5,790	4%	22%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	429	$6,695,637	$638	$7,228	$15,163	$21,722	$30,010	$35,740	$15,608	$11,625	22%	15%
5	Bacterial lung infections, SL 3	2,566	$6,372,136	$56	$142	$576	$4,542	$5,661	$8,663	$2,483	$3,396	4%	26%
6	Bowel obstruction, SL 1	1,670	$6,371,316	$71	$220	$1,181	$4,371	$9,753	$16,877	$3,815	$7,597	4%	35%
7	Spinal trauma, SL 3	1,309	$6,363,256	$71	$213	$898	$5,700	$13,110	$19,960	$4,861	$10,162	3%	38%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	783	$6,247,548	$81	$500	$5,482	$13,888	$19,161	$23,149	$7,979	$8,186	8%	18%
9	Cholelithiasis, SL 2	1,382	$5,855,648	$176	$533	$2,359	$6,329	$10,497	$13,110	$4,237	$5,134	10%	21%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	5,570	$5,529,368	$205	$432	$603	$758	$1,099	$1,603	$993	$3,023	19%	44%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	8,933	$35,629,929	$65	$193	$704	$2,875	$11,811	$23,961	$3,989	$8,756	3%	45%
2	Ischemic heart disease, SL 1	13,246	$27,910,647	$40	$97	$300	$1,164	$4,751	$12,431	$2,107	$5,570	3%	54%
3	Cerebral vascular accident, SL 2	8,076	$27,296,026	$65	$176	$639	$4,109	$9,212	$15,449	$3,380	$6,802	3%	38%
4	Ischemic heart disease, SL 3	2,428	$27,093,265	$217	$1,084	$7,111	$15,602	$28,917	$36,501	$11,159	$15,012	9%	25%
5	Ischemic heart disease, SL 4	1,563	$24,393,738	$682	$5,141	$10,065	$21,185	$36,057	$45,945	$15,607	$16,595	15%	21%

Table 3.4: Episode Costs for Top-Aggregate-Cost Attributed ETGs Fulfilling 10-10 Cell-Size Classification

#	ETG: Description	# of Episodes	Total Cost	Summary Statistics 10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	926	$13,301,293	$120	$8,239	$14,521	$20,444	$26,198	$30,861	$14,364	$9,962	23%	13%
2	Bacterial lung infections, SL 4	1,844	$8,819,553	$114	$310	$3,911	$5,927	$11,421	$17,634	$4,783	$7,302	7%	28%
3	Non-malignant neoplasm of intestines & abdomen, SL 1	4,302	$3,425,305	$231	$465	$606	$734	$969	$1,271	$796	$1,703	25%	32%
4	Cholelithiasis, SL 2	551	$2,760,592	$332	$1,012	$2,759	$8,614	$11,985	$13,743	$5,010	$4,933	13%	18%
5	Infection of lower genitourinary system, not sexually transmitted, SL 3	2,855	$2,215,138	$38	$60	$124	$363	$3,409	$4,273	$776	$1,818	4%	43%
6	Bacterial lung infections, SL 3	772	$2,080,854	$64	$146	$699	$4,792	$5,861	$9,319	$2,695	$3,499	4%	25%
7	Other hematologic diseases, SL 1	2,252	$2,073,504	$33	$61	$126	$372	$1,782	$4,956	$921	$2,917	3%	61%
8	Gastroenterology diseases signs & symptoms, SL 1	5,708	$2,040,984	$38	$47	$98	$232	$533	$849	$358	$1,981	7%	58%
9	Inflammatory eye disease, SL 1	9,354	$1,907,091	$30	$46	$69	$136	$392	$919	$204	$457	13%	47%
10	Other diseases of female genital tract, SL 1	1,835	$1,721,462	$29	$41	$112	$369	$4,343	$5,042	$938	$1,849	3%	34%
	Top 5 Chronic ETGs by Cost												
1	Cataract, SL 1	42,715	$21,131,914	$40	$62	$72	$376	$1,625	$2,803	$495	$890	6%	32%
2	Ischemic heart disease, SL 2	5,935	$20,547,710	$71	$223	$787	$3,012	$10,975	$16,602	$3,462	$6,946	4%	40%
3	Ischemic heart disease, SL 1	10,136	$18,112,611	$43	$104	$326	$1,238	$4,503	$11,297	$1,787	$4,190	3%	47%
4	Cerebral vascular accident, SL 2	4,644	$14,166,672	$64	$174	$630	$3,870	$8,424	$13,929	$3,051	$5,534	4%	36%
5	Ischemic heart disease, SL 3	1,281	$14,128,157	$387	$1,786	$8,778	$16,714	$22,745	$29,923	$11,029	$10,949	13%	19%

3.3 Most Expensive MEG Episode Types

This section looks at the most expensive MEG episode types for the same sub-sampling specifications as in the previous section. Paralleling the previous section's structure, Section 3.3.1 looks at a sample of all episodes, while Section 3.3.2 looks only at attributable episodes. Consistent with the findings in the previous section, all of the distributions show the same extreme skewness and dispersion, and do not meaningfully change under the different sub-sampling specifications.

3.3.1 Distributions of All MEG Episode Costs

This section examines the distributions of the top 10 acute and top five chronic MEG episode types for the full sample, including ones that are not attributable to a physician. Table 3.5 shows that all episode types display large standard deviations, with all but one being larger than their means, and the largest, *Chronic Hypertension*, being over three times its mean. Right-skewness is high as well. Generally, the share of costs in the top five percentiles accounts for double the share in the bottom 50%, with the most extreme case, *Cerebrovascular Disease with Stroke*, having the cost in the top five percentiles exceed its bottom half by a factor of over 25.

Restricting the sample to only beneficiaries alive for the entire period, Table 3.6 illustrates the continued persistence of right-skewness and dispersion. As was the case with ETG, the number of episodes drops considerably when beneficiaries who died during the study period are removed. The number of episodes for *Cerebrovascular Disease with Stroke*, for example, decreases by around one-third and the number for *Fracture: Femur, Head or Neck* by roughly 40%. However, cost levels remain roughly equivalent. Comparing Table 3.6 to Table 3.5, the distributions and cost levels are not considerably different, and their results are analogous to those of the ETG episodes in Section 3.2.1.

3.3.2 Distribution of Attributed MEG Episode Costs

This sub-section further restricts episodes to only those attributable to a physician. With the addition of this restriction, there is a rearrangement of rankings in the top 10 acute types. Table 3.7 shows that distributions remain skewed, with the share in the top 5% being at least 2.5 times the bottom half in all but three cases for the acute episode types and in all cases for the chronic types. The 90th percentile is over 75 times greater than the 10th for all but two episode types.

The requirement that all episodes be attributed only to physicians who satisfy the *10-10* cell size rule does have noticeable effects on the rankings, as displayed in Table 3.8, with all of the acute and two of the chronic ranks changing. Despite changes in rankings, however, the cost distributions retain high degrees of right-skewness and dispersion. Sample size decreases a considerable amount with the addition of the *10-10* cell size restriction, to a greater extent than the change seen when the sample was limited to attributable episodes.

These results serve as a basis for comparison in the analysis of the effects of risk adjustment that follows. They also serve to demonstrate that the sampling refinement posed in the following analysis is representative of the overall sample, which exhibits striking degrees of dispersion and skewness. The remainder of the paper looks at the effects of risk adjusting these distributions to account for factors exogenous to physicians' decisions. Risk adjustment should, in principle, mitigate the dispersion and skewness seen here by removing such factors, which can bias a physician's sample of episodes and thereby affect his or her rating. The unadjusted cost distributions in this section thus provide a point of reference for evaluating the results of the risk adjustment presented in the subsequent portion of the paper.

Table 3.5: Episode Costs for Top-Aggregate-Cost MEGs

#	MEG: Description	# of Episodes	Total Cost	Summary Statistics: 10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute MEGs by Cost												
1	Acute Myocardial Infarction	3,956	$42,298,039	$209	$2,213	$7,451	$14,820	$26,148	$32,039	$10,692	$11,866	14%	21%
2	Pneumonia: Bacterial	11,454	$41,728,983	$41	$91	$520	$4,817	$9,235	$15,201	$3,643	$6,698	2%	34%
3	Cerebrovascular Disease with Stroke	8,624	$37,988,500	$38	$77	$452	$5,349	$13,021	$21,753	$4,405	$9,465	1%	40%
4	Fracture: Femur, Head or Neck	2,558	$29,025,913	$77	$1,640	$10,659	$17,401	$23,533	$27,472	$11,347	$9,677	17%	15%
5	Complications of Surgical and Medical Care	6,064	$25,990,797	$50	$117	$640	$5,172	$11,872	$18,371	$4,286	$9,105	2%	38%
6	Cataract	50,999	$24,518,390	$38	$60	$74	$581	$1,480	$2,125	$481	$794	6%	30%
7	Arrhythmias	22,915	$22,716,514	$36	$60	$159	$571	$2,322	$4,918	$991	$2,740	3%	55%
8	Urinary Tract Infections	14,701	$12,213,571	$31	$46	$94	$339	$2,530	$4,656	$831	$2,364	3%	55%
9	Diverticular Disease	7,814	$11,631,790	$58	$162	$405	$630	$3,511	$5,960	$1,489	$4,386	6%	57%
10	Cholecystitis and Cholelithiasis	2,158	$10,783,445	$124	$553	$2,457	$8,213	$12,318	$16,440	$4,997	$6,406	9%	24%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	26,586	$57,193,928	$47	$105	$313	$1,120	$10,056	$12,843	$2,151	$4,804	3%	43%
2	Angina Pectoris, Chronic Maintenance	23,128	$51,477,727	$46	$95	$258	$1,323	$5,313	$12,535	$2,226	$5,885	2%	53%
3	Chronic Obstructive Pulmonary Disease	13,168	$27,570,454	$43	$105	$418	$2,393	$5,458	$8,763	$2,094	$4,217	3%	39%
4	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	2,097	$22,153,051	$190	$865	$6,865	$17,086	$27,393	$34,357	$10,564	$11,795	9%	20%
5	Essential Hypertension, Chronic Maintenance	66,244	$21,908,869	$38	$65	$120	$219	$408	$717	$331	$1,280	10%	57%

Table 3.6: Episode Costs for Top-Aggregate-Cost MEGs for Individuals who Remain Alive

#	MEG: Description	# of Episodes	Total Cost	Summary Statistics: 10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute MEGs by Cost												
1	Acute Myocardial Infarction	2,390	$27,471,714	$174	$1,832	$7,897	$16,480	$27,883	$33,989	$11,494	$12,456	13%	20%
2	Cataract	48,083	$22,949,719	$38	$60	$74	$568	$1,478	$2,132	$477	$795	6%	30%
3	Cerebrovascular Disease with Stroke	5,719	$20,585,666	$38	$63	$265	$3,301	$10,190	$20,384	$3,600	$8,465	1%	46%
4	Complications of Surgical and Medical Care	4,788	$18,803,352	$46	$106	$540	$4,869	$11,452	$17,867	$3,927	$8,171	2%	37%
5	Pneumonia: Bacterial	7,270	$18,204,112	$38	$73	$261	$4,285	$6,564	$9,968	$2,504	$4,944	2%	36%
6	Fracture: Femur, Head or Neck	1,587	$17,631,630	$62	$776	$10,645	$17,401	$23,519	$27,422	$11,110	$9,487	16%	15%
7	Arrhythmias	18,304	$16,708,141	$35	$57	$143	$504	$2,028	$4,467	$913	$2,573	3%	56%
8	Diverticular Disease	7,203	$9,026,194	$57	$156	$400	$598	$2,323	$4,743	$1,253	$3,793	7%	57%
9	Other Spinal and Back Disorders	14,660	$8,636,069	$38	$42	$98	$369	$867	$1,786	$589	$2,166	4%	63%
10	Cholecystitis and Cholelithiasis	1,760	$8,477,492	$124	$596	$2,494	$8,079	$11,821	$15,089	$4,817	$5,774	10%	22%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	24,833	$54,118,631	$48	$106	$314	$1,130	$10,295	$12,972	$2,179	$4,825	3%	42%
2	Angina Pectoris, Chronic Maintenance	19,965	$43,109,909	$44	$93	$241	$1,198	$5,027	$12,582	$2,159	$5,836	2%	54%
3	Encounter for Preventive Health Services	113,452	$16,658,076	$15	$17	$43	$104	$198	$372	$147	$709	6%	58%
4	Essential Hypertension, Chronic Maintenance	61,113	$16,503,494	$38	$65	$120	$213	$379	$596	$270	$956	12%	49%
5	Chronic Obstructive Pulmonary Disease	9,884	$14,956,685	$39	$89	$291	$1,955	$4,262	$6,311	$1,513	$3,069	4%	38%

Table 3.7: Episode Costs for Top-Aggregate-Cost Attributed MEGs

#	MEG: Description	# of Episodes	Total Cost	Summary Statistics 10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute MEGs by Cost												
1	Pneumonia: Bacterial	10,219	$37,149,075	$41	$89	$533	$4,844	$9,247	$15,180	$3,635	$6,533	2%	33%
2	Cerebrovascular Disease with Stroke	7,065	$33,050,071	$38	$69	$435	$5,697	$14,245	$22,747	$4,678	$9,964	1%	40%
3	Acute Myocardial Infarction	3,034	$32,949,660	$172	$2,618	$7,646	$14,923	$25,467	$31,647	$10,860	$11,847	15%	21%
4	Fracture: Femur, Head or Neck	2,299	$26,934,252	$77	$2,911	$11,030	$17,667	$23,579	$27,900	$11,716	$9,551	19%	15%
5	Cataract	48,440	$23,722,537	$38	$60	$74	$593	$1,485	$2,233	$490	$800	6%	30%
6	Complications of Surgical and Medical Care	4,951	$21,243,490	$47	$110	$539	$5,175	$12,105	$18,626	$4,291	$9,214	2%	38%
7	Arrhythmias	20,484	$20,588,453	$36	$60	$158	$572	$2,392	$5,032	$1,005	$2,765	3%	55%
8	Diverticular Disease	6,460	$10,617,019	$43	$154	$432	$665	$3,989	$7,096	$1,644	$4,729	6%	57%
9	Urinary Tract Infections	12,685	$10,573,603	$32	$45	$93	$348	$2,545	$4,660	$834	$2,359	3%	55%
10	Cholecystitis and Cholelithiasis	1,959	$9,898,237	$133	$591	$2,474	$8,247	$12,318	$16,452	$5,053	$6,482	9%	24%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	24,076	$51,878,524	$47	$106	$316	$1,130	$10,176	$12,807	$2,155	$4,772	3%	42%
2	Angina Pectoris, Chronic Maintenance	20,511	$44,777,039	$45	$94	$251	$1,275	$5,176	$12,425	$2,183	$5,774	2%	53%
3	Chronic Obstructive Pulmonary Disease	11,707	$24,600,725	$41	$105	$424	$2,426	$5,505	$8,768	$2,101	$4,192	3%	39%
4	Renal Failure	3,751	$19,954,097	$86	$240	$943	$6,619	$19,514	$24,702	$5,320	$8,450	3%	29%
5	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	1,841	$19,556,716	$190	$819	$6,873	$17,353	$27,697	$34,394	$10,623	$11,636	8%	20%

Table 3.8: Episode Costs for Top-Aggregate-Cost Attributed MEGs Fulfilling 10-10 Cell-Size Classification

#	MEG: Description	# of Episodes	Total Cost	Summary Statistics								Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
				10%	25%	50%	75%	90%	95%	Mean	Std Dev		
	Top 10 Acute MEGs by Cost												
1	Pneumonia: Bacterial	7,297	$27,547,533	$41	$98	$688	$4,964	$9,544	$15,454	$3,775	$6,548	2%	32%
2	Acute Myocardial Infarction	1,863	$21,275,773	$217	$3,008	$8,024	$15,928	$26,148	$32,800	$11,420	$11,610	15%	20%
3	Cataract	45,799	$20,616,905	$38	$60	$69	$509	$1,453	$1,944	$450	$770	6%	31%
4	Fracture: Femur, Head or Neck	1,478	$19,810,915	$114	$8,491	$12,436	$18,525	$24,305	$28,873	$13,404	$9,387	24%	13%
5	Arrhythmias	17,290	$17,021,078	$36	$60	$156	$563	$2,290	$5,041	$984	$2,624	3%	55%
6	Cerebrovascular Disease with Stroke	4,109	$15,748,449	$38	$65	$331	$5,321	$11,206	$19,120	$3,833	$7,481	1%	38%
7	Complications of Surgical and Medical Care	1,866	$8,249,496	$45	$91	$518	$6,060	$12,643	$18,544	$4,421	$8,082	2%	35%
8	Urinary Tract Infections	9,372	$7,805,978	$32	$46	$97	$364	$2,599	$4,732	$833	$2,280	3%	54%
9	Other Spinal and Back Disorders	10,023	$6,616,072	$38	$41	$93	$370	$898	$2,267	$660	$2,432	4%	66%
10	Other Arthropathies, Bone and Joint Disorders	27,897	$5,669,761	$25	$38	$67	$156	$406	$691	$203	$820	9%	47%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	19,082	$46,627,246	$48	$104	$325	$1,276	$11,018	$13,622	$2,444	$5,119	3%	39%
2	Angina Pectoris, Chronic Maintenance	16,702	$27,486,067	$44	$89	$231	$1,119	$4,177	$10,226	$1,646	$4,035	3%	50%
3	Chronic Obstructive Pulmonary Disease	8,621	$18,298,799	$42	$102	$408	$2,446	$5,589	$9,024	$2,123	$4,280	3%	39%
4	Renal Failure	2,196	$15,462,713	$127	$316	$1,486	$10,468	$23,023	$27,081	$7,041	$9,912	3%	24%
5	Essential Hypertension, Chronic Maintenance	53,503	$14,657,622	$38	$63	$117	$207	$365	$573	$274	$1,010	12%	51%

4 RISK ADJUSTMENT OF EPISODE COSTS

Analysts consider a wide variety of factors intended to compensate for cost-related conditions outside the physician's control. Relevant factors include patient demographics, physician attributes, and patient health conditions. Patient demographics, such as age and gender, are likely to affect episode costs. For example, an episode linked to an older beneficiary is likely to cost more than one performed for a young patient. Controlling for physician specialty provides additional predictive information concerning episode cost. A patient who experiences an acute myocardial infarction, for example, may receive surgical care from a cardiothoracic surgeon and subsequent care from a cardiologist. Cardiothoracic surgeons tend to have higher costs than cardiologists due to specializing in surgery, but these higher costs are typical for his specialty.

Additionally, a patient's prior health conditions constitute influential factors determining the costs of many types of episodes, which providers can only partially mitigate. A patient suffering from serious chronic obstructive pulmonary disease at the onset of an acute myocardial infarction, for example, can be expected to require more services in treatment than a non-ill counterpart regardless of an individual physician's skills. Risk adjustment should account for all such factors to create reliable assessments of physicians' relative efficiencies in utilizing resources. The analysis in this section finds that the risk adjustment method used—whether at the beneficiary-level or episode-level—makes a large impact on the validity of the resulting physician scores.

To understand the effectiveness of a variety of risk adjustment methods, this section examines the changes in the episode cost distribution before and after risk adjustment. To provide a benchmark for judging the efficacy of risk adjustment, Section 4.1 presents the normalized distributions of unadjusted costs. These distributions highlight the large cost dispersion demonstrated in the previous section for the most expensive ETG and MEG episode types. Section 4.2 outlines a regression-based framework for risk adjusting episode costs, describing the effects of three different risk adjustment specifications on the dispersion of episode costs. Section 4.3 presents findings using basic information on beneficiary demographics and physician specialty to perform risk adjustment. Section 4.4 expands these characteristics to include health risk scores at the beneficiary level. Section 4.5 risk adjusts at the episode level using HCC flags.

4.1 Depicting Dispersion of Episode Costs and Outlier Severity

Normalizing episode costs produces a convenient setting for comparing the dispersion of distributions among different episode types. A normalized cost distribution divides all episode costs by the average cost of that episode type. Normalization controls for the magnitude of episode costs and allows for a simple comparison of cost distributions across episode types.

Tables 4.1 and 4.2 show the normalized distributions of episode costs for the highest cost acute and chronic episode types for ETG and MEG episodes. The data for these tables come from all attributed episodes ending in 2003. Since the distributions are normalized, each value in the distribution is a fraction or multiple of the mean, which is set to 1. This implies that an episode with a normalized cost of 1.2 is 20% more expensive than the average cost of that episode type; an episode with a normalized cost of 0.8 is 20% less expensive than the average cost of that episode type.

To describe the normalized cost distributions, the tables present two key metrics: the ratio of the 90th percentile episode cost compared to the 10th percentile (the "90/10 ratio") and the fraction of costs in top five percentiles of the distribution. The 90/10 ratio measures the overall dispersion of episode costs. The wider the spread of the distribution, the larger the 90/10 ratio is. For instance, Table 4.2 indicates that there is significantly more cost dispersion in the treatment of *Acute Myocardial Infarctions* than *Cataracts*. Typically, the standard deviation measures the dispersion in a distribution. However, because episode cost distributions are highly skewed towards high-cost outliers, the 90/10 ratio provides a more thorough characterization of the general level of dispersion in the data.

The second key metric is the fraction of total costs in the top five percentiles of the distribution. Even if the 90/10 ratio is small for any given episode type, there may be a number of extremely costly outliers above the 90th percentile which skew the distribution. For instance, in Table 4.1, *Bacterial lung infections, SL 4* episodes likely have more extreme high-cost outliers than *Closed fracture or dislocation - thigh, hip & pelvis, SL 2* episodes, since 29% of costs for lung infections are located in the top five episode cost percentiles, whereas the hip fracture episodes have only 15%. The higher fraction of costs in the extreme upper range is a result of more high-cost outliers or high-cost outliers of larger relative magnitudes.

4.2 Regression Framework for Risk Adjustment

A regression analysis provides a flexible and commonly-used method to adjust for factors outside of the physician's control in evaluating episode costs. This framework calculates the extent to which patient characteristics and other attributes influence episode expenses. An appropriately specified regression purges episode cost of differences affected by factors other than the provider's efficiency.

The regression relationship implemented in this analysis describes the log of the cost of the i^{th} episode for the k^{th} physician by the equation:

$$\ln(EpisodeCost_{ik}) = \mu\delta_k + \beta X_{ik} + \theta Z_{ik} + \varepsilon_{ik} \quad (4.1)$$

where

δ_k	=	indicator of physician specialty for the *(i,k)*th episode;
X_{ik}	=	a vector of age/gender variables associated with the patient experiencing the *(i,k)*th episode;
Z_{ik}	=	measures of the patient's health conditions;
ε_{ik}	=	error term for the *(i,k)*th episode.

Observations in this regression consist of all episodes of the type under consideration attributed to a designated set of providers; each regression is run for a common type of episodes. The coefficients μ measure the cost differentials linked to the attribution of episodes to different specialties. The parameters β capture the influence of a patient's demographic characteristics on episode costs and the coefficients θ adjust episode expenses for a patient's health condition and possible measures of episode severity.

To calculate the expected value of the *level* of episode cost under the log regression framework, this report adopts a "logs-to-levels" transformation. The expected value of the *level* of episode cost takes the form:

$$E[EpisodeCost_{ik}] = E[\exp(\mu\delta_k + \beta X_{ik} + \theta Z_{ik}) \bullet \exp(\varepsilon_{ik})] \quad (4.2)$$

Assuming the errors ε in (4.1) are distributed independently of both X and Z, but may possibly depend on physician specialty δ, Appendix A proves that (4.2) simplifies to

$$E\,[EpisodeCost_{ik}] = \alpha_k \bullet \exp(\mu\delta_k + \beta X_{ik} + \theta Z_{ik}) \quad (4.3)$$

The term α_k represents the logs-to-levels adjustment factor. Because of the non-linearity of the exponential function, the distribution of the residual will affect the expected value of the *level* of episode costs. For instance, if the error in (4.1) happened to be normally distributed—implying ε is log normal—then the variance of this error (σ_ε^2) would affect the expected value of the level of episode costs even though the expected value of the residual is zero.[7]

Further, the variance of the residual may also change depending on the manner in which the patient receives treatment. Although the methodology assumes that the variance of this error (σ_ε^2) is

[7] For example, if $\varepsilon \sim N(0, I)$, then $E[\exp(\varepsilon)] = 0.5 * \varepsilon'\varepsilon / (n-k)$.

unrelated to all patient-based characteristics X and Z, it does allow the variance to depend on physician specialty. Thus, fluctuations in episode costs could be systematically higher (or lower) when patients were treated by cardiologists than by general practitioners. Appendix A further shows how to estimate all the parameters appearing in (4.3), which, in turn provides inputs for calculating the fitted value:

(4.4) $$\hat{E}[EpisodeCost_{ik}] = \hat{\alpha}_k \bullet \exp(\hat{\mu}\delta_k + \hat{\beta}X_{ik} + \hat{\theta}Z_{ik}) \quad .$$

The subsequent analysis uses this quantity to predict the expected level of the cost of the $(i,k)^{th}$ episode.

The implied risk-adjusted value of episode costs takes the form:

(4.5) $$\frac{EpisodeCost_{ik}}{\hat{E}[EpisodeCost_{ik}]} \quad .$$

For the log regression specification (4.1), Appendix A demonstrates that this normalized cost measures equals:

(4.6) $$\frac{EpisodeCost_{ik}}{\hat{E}[EpisodeCost_{ik}]} = \frac{\exp\{\hat{\varepsilon}_{ik}\}}{\hat{\alpha}_k} \quad .$$

The average of these normalized variables equals one and their distributional properties depict the risk-adjusted features of episode costs.

4.3 Adjusting Costs for Physician Specialty and Beneficiary Demographics

The analysis initially considers risk adjustment of episode costs accounting for primarily two factors: (i) beneficiary demographics and (ii) specialty of the attributed physician. This segment of the analysis excludes patient health characteristics from the risk adjustment. Such factors are added in the subsequent segment of the analysis. In the case of beneficiary demographics, regression specifications in X include the set of age-gender variables making up the demographic risk factors incorporated in CMS's HCC risk adjustment models. To determine an attributed[8] physician's specialty, this analysis refers to the MPIER (Medicare Physician Identification and Eligibility Registry) for the years covered by our sample.

4.3.1 Reduction in Dispersion of ETG Cost Distributions

The following discussion evaluates the distributional changes arising from risk adjustment using two main criteria: the overall spread of the data and the likelihood of outliers. Two metrics

[8] As described in Section 2, this analysis relies on the PBmax rule to attribute episodes to providers. See MaCurdy et al. (2008b) for more details concerning the implications of this attribution rule.

summarizing these measures are: the ratio of costs at the 90th percentile compared to the 10th percentile and the fraction of total episode costs in the top five percentiles. The first metric evaluates how risk adjustment changes the general dispersion of an episode type's cost distribution and the second metric evaluates how risk adjustment affects the severity of outliers.

To compare episode cost distributions before and after adjustment for beneficiary demographics and physician specialty, Table 4.3 displays the percentage changes for each of the two stated metrics.[9] The first column of Table 4.3 shows that the simplified risk adjustment substantially decreases the 90/10 ratio. Of the fifteen episode types considered, eleven experience a decrease in the 90/10 ratio of more than 10%. Risk adjustment decreases the 90/10 ratio more for chronic ETGs (-38%) than for acute (-12%). The average change in the 90/10 ratio is -20% across all fifteen episode types.

The magnitude of the outliers, measured by the fraction of total episode costs in the top five percentiles, displays low levels of change. Four of the 15 episode types see the fraction of costs in the top five percentiles increase by more than 10% compared to seven of the fifteen episode types where the magnitude of the outliers decreases by more than 10%. On average, the fraction of the total cost in the top five percentiles decreases by 3%. As outlier magnitude changes little overall and the 90/10 ratio tends to decrease noticeably, risk adjustment based merely on patient age and gender and physician specialty can be concluded to appreciably decrease the cost dispersion in ETG episode types.

4.3.2 Reduction in Dispersion of MEG Cost Distributions

Table 4.4 compares the changes in the two metrics before and after risk adjustment for the top-aggregate-cost MEG episode types. Just as with ETG episodes, the simple age/gender and physician specialty risk adjustment considerably reduces the 90/10 ratio. The average magnitude of this effect is even larger for MEGs (-25%) than ETGs (-20%). The fraction of cost in the top five percentiles also changes in a similar fashion to that of ETGs. On average, the proportion of total cost in the top five percentiles decreases by 2% for MEGs after risk adjustment. Based on this data, risk adjustment using patient age/gender and physician specialty generally decreases episode cost dispersion as measured by the 90/10 ratio and has a small effect on the proportion of total cost accounted for by the top five percentiles.

[9] The full distributions for this specification and all subsequent risk adjustment specifications are in Appendix B.

4.4 Adjusting Costs for Beneficiary-Level Health Risks

The following discussion expands factors in the risk adjustment analysis to include scores measuring the health condition of the patient. These beneficiary-level risk scores are based on hierarchical condition categories (HCC) and beneficiary characteristics.[10] HCCs divide beneficiaries into groups with similar health risks according to ICD-9 diagnosis codes. An HCC “flag” turns on when a patient’s claims report the relevant diagnosis codes within the twelve months prior to the start of the episode. Conceptually, the HCC score predicts a beneficiary’s prospective annual cost relative to the cost of an average Medicare beneficiary, beginning in the month in which an episode occurs. A risk score greater than 1.0 implies that an individual will experience a higher-than-average predicted cost. The value of the risk score for a given beneficiary remains constant across all episode-level regressions for episodes starting in the same month. The regression specification enters the value of risk scores in Z in (4.1) as bracketed variables distinguishing eight ranges of values.[11] The results described in this section change little if one were instead to enter risk scores in Z as a single continuous variable with no brackets.

To place episodes constructed by the MEG and ETG groupers on a comparable foundation when accounting for health risk factors, this analysis also includes severity indicators assigned by MEG as elements of Z in (4.1) when risk adjusting MEG episode costs. In addition to allocating each episode to a MEG (disease classification), Medstat's grouper also assigns detailed disease stages. Medstat recommends classifying episodes into MEGs as the relevant categories for attributing incidents of care to providers, but further suggests using disease stages to adjust episode costs within MEGs for risk factors. The subsequent presentation of findings therefore employs these recommendations. Severity variables for ETG episodes are not employed as risk adjusters, however, because the classification of episodes in this analysis already incorporates a base ETG and severity level to define an episode type. Therefore, the classification by episode type for ETG regressions inherently controls for severity level. [12]

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[10] CMS uses these HCC scores to predict average beneficiary cost in order to calculate reimbursement for Medicare Part C (i.e. Medicare Advantage).
[11] These groups are: less than 0.3, 0.3 to 0.6, 0.6 to 0.9, 0.9 to 1.1, 1.1 to 1.4, 1.4 to 1.7, 1.7 to 2.0, and greater than 2.0.
[12] This classification scheme follows the prescriptions of the ETG vendor. For the purpose of attributing episodes to health care providers using the current version of its software, ETG recommends utilizing the base ETG plus its assessed severity level as the episode categories for comparing cost outcomes.

4.4.1 Small Effects on ETG Cost Distributions

To evaluate the additional effect of including beneficiary-level risk scores on reducing the dispersion of ETG episode costs, return to Table 4.3. The second column shows that the 90/10 ratio decreases considerably compared to unadjusted costs with the beneficiary-level risk score included, but the change is roughly equal to the change from adjusting merely by age/gender and physician specialty. In 11 of the 15 episode types, the 90/10 ratio decreases by more than 10% compared to only one case where it increases by 10%. On average, including patient health condition decreases the 90/10 ratio by 21%. Controlling for patient health status improves risk adjustment, but this improvement is small. On the other hand, average changes in the total cost accounted for by outliers decreases by 1% compared to the unadjusted distribution. Risk adjustment which includes patient health condition based on risk scores offers a small decrease in dispersion for ETG episode costs compared to the case of simply using patient age/gender and physician specialty.

4.4.2 Larger Effects on MEG Cost Distributions

The second column of Table 4.4 reveals that including beneficiary-level risk scores noticeably decreases the dispersion of costs for many of the highest-cost MEG episode types. The 90/10 ratio decreases on average by 40% for these fifteen MEG episode types. In the case of *Angina Pectoris* and *Diverticular Disease* episode types, the 90/10 ratio decreases by 70% or more. On the other hand, the effect on the fraction of costs in the top five percentiles is somewhat mixed. Whereas the proportion of total cost captured by the top five percentiles of episodes increases by 26% for *Fracture: Femur, Head or Neck* episodes, it decreases by 24% for *Diverticular Disease* episodes. In many instances the proportion of total costs accounted for by outliers does not change materially.

4.5 Adjusting Costs for Episode-Level Health Risks

Since a patient's previous health condition may have heterogeneous effects across episode types, this section explores the effects of conducting risk adjustment at the episode level. In this framework, the vector *Z* includes a list of dummy variables indicating the presence of a hierarchical condition category (HCC). [13] This follows the methods established by Pope et al. (2004). However, the coefficients on all variables in the regression are calculated separately for each episode type. Although beneficiary-level risk adjustment uses CMS-calculated weights to construct a single risk score that does not vary across episode types, episode-level risk adjustment allows the coefficients on HCC flags to vary across episode types. In principle, episode-level risk adjustment should more

[13] As in our use of the CMS HHC risk model, variables are defined by the twelve month period ending in the month just prior to the start of the episode.

closely predict how previous ICD-9 diagnoses affect the cost of any given episode, as these flags are tailored to do so.

To better elucidate the meaning of episode-level risk adjustment, consider the case of a Medicare beneficiary who suffered a vertebral fracture within a year prior to current experiences. The beneficiary's medical care claim will include an ICD-9 diagnosis code for a vertebral fracture which will turn on an HCC flag for a "prior vertebral fracture" for all episodes in the current period. Suppose this beneficiary experiences two episodes of care: *Other Spinal and Back Disorders* (MEG 391) and *Cataract* (MEG 92). At the beneficiary level, risk scores are the same for any beneficiary across all observations in the risk adjustment regressions from equation (4.1).[14] However, a prior vertebral fracture more precisely predicts the cost of treating *Other Spinal and Back Disorders* compared to the cost of treating a *Cataract*. Thus, when calculating episode-level health condition, the impact of the "prior vertebral fracture" flag is allowed to vary by episode type for each beneficiary. This is because under episode-level risk adjustment, the coefficients on the HCCs are calculated separately for each episode type (i.e., each ETG or MEG). In this episode-level example, the value of the coefficient on the flag for a prior vertebral fracture will be higher for *Spinal and Back Disorders* episodes than for *Cataract* episodes because a previous vertebral fracture will more accurately predict high cost for the former episode type compared to the latter. Episode-level risk adjustment should more precisely characterize how prior health conditions predict future episode costs.

4.5.1 Decreased Dispersion with Increased Outlier Magnitude for ETG Episodes

Table 4.3 compares the changes in episode cost distributions between the risk-adjusted costs at the episode-level and the unadjusted costs. The decrease in the 90/10 ratio tends to be larger than in the prior specifications. The general dispersion of the episode cost distributions drops by 34% on average. This is an improvement over both prior risk adjustment specifications and lends some credibility to the notion that constructing episode-level risk adjustment provides a better measure of how prior health level affects different episode cost distributions.

A more unexpected result involves how episode-level risk adjustment affects high-cost outliers. For the three ETG episode types related to hip fractures, the percentage of total costs in the

[14] In the beneficiary-level specification, we use the CMS derived coefficients to weight the impact of each HCC category flag. In reality, the HCC patient prior health score is also based on the patient's age and gender as well as their community status.

top five percentiles increases dramatically. For the *SL 2* hip fractures, the proportion of total cost increases by 243% after risk adjustment. For the *SL 1* and *SL 3* fracture varieties, these figures are both over 75%. On average, the top five percentiles account for 24% more costs than was the case in the unadjusted distributions. Even as episode-level risk adjustment decreases general dispersion for ETG episodes, it tends to increase the magnitude of the high-cost outliers.

4.5.2 Decreased Dispersion with Increased Outlier Magnitude for MEG Episodes

Table 4.4 presents comparisons between risk adjustment at the episode level and the unadjusted distribution for MEGs. As was the case for ETG episodes, episode-level risk adjustment noticeably decreases overall dispersion. The 90/10 ratio decreases on average by 48% compared to the unadjusted episode cost distributions. This is a larger decrease in dispersion than seen with the previous two risk adjustment specifications. Just as was the case for ETGs, episode-level risk adjustment holds the promise of more accurate risk adjustment.

Despite its improved ability to reduce dispersion, episode-level risk adjustment again tends to increase the magnitude of the high-cost outliers in the distribution, substantially so in several instances. The skewness of the distribution increases dramatically, with the proportion of total cost accounted for by the top five percentiles expanding by 17% on average compared to the unadjusted distribution. This average increase in outlier severity is driven by the results for the MEG episode type *Fracture: Femur, Head or Neck*. The proportion of total costs in the top five percentiles more than doubles for this episode type..

The fact that episode-level risk adjustment decreases overall dispersion but increases the magnitude of high-cost outliers is puzzling. Calculating the coefficients on the HCCs flags separately for each episode should in principle be superior to the broader beneficiary-level risk adjustment because episode-level risk adjustment allows patient health conditions to affect the predicted episode cost for conditions related to the episode under evaluation more than for unrelated conditions. Empirically, although episode-level risk adjustment looks promising due to its impact on the overall distribution's dispersion, the fact that it inflates the proportion of total cost attributed to outliers detracts from its positive effects.

Table 4.1: **Normalized Episode Costs for Top-Aggregate-Cost ETGs**

#	ETG: Description	# of Episodes	Summary Statistics 10%	25%	50%	75%	90%	95%	Mean	Std Dev	90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,670	0.01	0.22	0.96	1.52	1.98	2.36	1.00	0.81	236.4	17%	15%
2	Bacterial lung infections, SL 4	3,767	0.02	0.06	0.58	1.27	2.37	3.80	1.00	1.53	133.74	5%	29%
3	Septicemia, SL 2	1,499	0.02	0.05	0.59	1.57	2.10	3.28	1.00	1.19	104.50	4%	22%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	429	0.04	0.46	0.97	1.39	1.92	2.29	1.00	0.74	47.02	22%	15%
5	Bacterial lung infections, SL 3	2,566	0.02	0.06	0.23	1.83	2.28	3.49	1.00	1.37	101.79	4%	26%
6	Bowel obstruction, SL 1	1,670	0.02	0.06	0.31	1.15	2.56	4.42	1.00	1.99	136.60	4%	35%
7	Spinal trauma, SL 3	1,309	0.01	0.04	0.18	1.17	2.70	4.11	1.00	2.09	183.67	3%	38%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	783	0.01	0.06	0.69	1.74	2.40	2.90	1.00	1.03	236.50	8%	18%
9	Cholelithiasis, SL 2	1,382	0.04	0.13	0.56	1.49	2.48	3.09	1.00	1.21	59.72	10%	21%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	5,570	0.21	0.44	0.61	0.76	1.11	1.62	1.00	3.05	5.35	19%	44%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	8,933	0.02	0.05	0.18	0.72	2.96	6.01	1.00	2.20	182.97	3%	45%
2	Ischemic heart disease, SL 1	13,246	0.02	0.05	0.14	0.55	2.25	5.90	1.00	2.64	118.79	3%	54%
3	Cerebral vascular accident, SL 2	8,076	0.02	0.05	0.19	1.22	2.73	4.57	1.00	2.01	142.71	3%	38%
4	Ischemic heart disease, SL 3	2,428	0.02	0.10	0.64	1.40	2.59	3.27	1.00	1.35	133.31	9%	25%
5	Ischemic heart disease, SL 4	1,563	0.04	0.33	0.64	1.36	2.31	2.94	1.00	1.06	52.90	15%	21%

Table 4.2: Normalized Episode Costs for Top-Aggregate-Cost MEGs

#	MEG: Description	# of Episodes	Summary Statistics: 10%	25%	50%	75%	90%	95%	Mean	Std Dev	90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute MEGs by Cost												
1	Pneumonia: Bacterial	10,219	0.01	0.02	0.15	1.33	2.54	4.18	1.00	1.80	227.4	2%	33%
2	Cerebrovascular Disease with Stroke	7,065	0.01	0.01	0.09	1.22	3.05	4.86	1.00	2.13	372.1	1%	40%
3	Acute Myocardial Infarction	3,034	0.02	0.24	0.70	1.37	2.35	2.91	1.00	1.09	147.8	15%	21%
4	Fracture: Femur, Head or Neck	2,299	0.01	0.25	0.94	1.51	2.01	2.38	1.00	0.82	308.0	19%	15%
5	Cataract	48,440	0.08	0.12	0.15	1.21	3.03	4.56	1.00	1.63	38.8	6%	30%
6	Complications of Surgical and Medical Care	4,951	0.01	0.03	0.13	1.21	2.82	4.34	1.00	2.15	256.8	2%	38%
7	Arrhythmias	20,484	0.04	0.06	0.16	0.57	2.38	5.01	1.00	2.75	66.5	3%	55%
8	Diverticular Disease	6,460	0.03	0.09	0.26	0.40	2.43	4.32	1.00	2.88	92.8	6%	57%
9	Urinary Tract Infections	12,685	0.04	0.05	0.11	0.42	3.05	5.59	1.00	2.83	80.7	3%	55%
10	Cholecystitis and Cholelithiasis	1,959	0.03	0.12	0.49	1.63	2.44	3.26	1.00	1.28	92.7	9%	24%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	24,076	0.02	0.05	0.15	0.52	4.72	5.94	1.00	2.21	218.0	3%	42%
2	Angina Pectoris, Chronic Maintenance	20,511	0.02	0.04	0.11	0.58	2.37	5.69	1.00	2.64	114.6	2%	53%
3	Chronic Obstructive Pulmonary Disease	11,707	0.02	0.05	0.20	1.15	2.62	4.17	1.00	1.99	133.2	3%	39%
4	Renal Failure	3,751	0.02	0.05	0.18	1.24	3.67	4.64	1.00	1.59	225.8	3%	29%
5	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	1,841	0.02	0.08	0.65	1.63	2.61	3.24	1.00	1.10	145.8	8%	20%

Table 4.3: Effects of Risk Adjustment on Episode Cost Distributions for ETGs

#	ETG: Description	Change in 90/10 Ratio			Percent of Cost in top five percentiles		
		Age/Sex, Physician Specialty Only	Beneficiary-Level	Episode-Level	Age/Sex, Physician Specialty Only	Beneficiary-Level	Episode-Level
	Top 10 Acute ETGs by Cost						
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	-22%	-24%	-84%	20%	27%	243%
2	Bacterial lung infections, SL 4	-9%	-8%	-13%	-2%	-3%	-2%
3	Septicemia, SL 2	14%	9%	9%	13%	14%	23%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	-14%	-18%	-48%	14%	13%	78%
5	Bacterial lung infections, SL 3	5%	6%	-1%	6%	6%	10%
6	Bowel obstruction, SL 1	-34%	-36%	-42%	-13%	-12%	-10%
7	Spinal trauma, SL 3	-15%	-17%	-36%	-15%	-15%	-13%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	-45%	-45%	-76%	13%	32%	85%
9	Cholelithiasis, SL 2	-27%	-26%	-37%	4%	5%	11%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	29%	30%	28%	-23%	-24%	-25%
	Top 5 Chronic ETGs by Cost						
1	Ischemic heart disease, SL 2	-47%	-47%	-53%	-12%	-12%	-9%
2	Ischemic heart disease, SL 1	-36%	-38%	-41%	-20%	-21%	-21%
3	Cerebral vascular accident, SL 2	-14%	-15%	-17%	-7%	-7%	-4%
4	Ischemic heart disease, SL 3	-48%	-47%	-54%	-13%	-11%	-3%
5	Ischemic heart disease, SL 4	-42%	-39%	-43%	-10%	-8%	-8%
	AVERAGE	**-20%**	**-21%**	**-34%**	**-3%**	**-1%**	**24%**

Note: A positive number indicates risk adjustment increased the measure compared to the unadjusted distribution. A negative number indicates that risk adjustment decreased the measure compared to the unadjusted distribution.

Table 4.4: Effects of Risk Adjustment on Episode Cost Distributions for MEGs

#	MEG: Description	Change in 90/10 ratio: Age/Sex, Physician Specialty Only	Change in 90/10 ratio: Beneficiary-Level	Change in 90/10 ratio: Episode-Level	Percent of Cost in top five percentiles: Age/Sex, Physician Specialty Only	Percent of Cost in top five percentiles: Beneficiary-Level	Percent of Cost in top five percentiles: Episode-Level
	Top 10 Acute MEGs by Cost						
1	Pneumonia: Bacterial	-17%	-43%	-44%	2%	16%	15%
2	Cerebrovascular Disease with Stroke	-31%	-31%	-30%	-2%	-2%	3%
3	Acute Myocardial Infarction	-19%	-19%	-26%	-7%	-7%	-6%
4	Fracture: Femur, Head or Neck	-37%	-40%	-90%	23%	26%	232%
5	Cataract	-15%	-15%	-13%	-6%	-5%	-4%
6	Complications of Surgical and Medical Care	5%	-1%	-4%	-6%	-10%	-11%
7	Arrhythmias	-5%	-15%	-22%	-4%	-5%	-5%
8	Diverticular Disease	-31%	-70%	-71%	-22%	-24%	-26%
9	Urinary Tract Infections	-21%	-53%	-54%	-1%	3%	0%
10	Cholecystitis and Cholelithiasis	-22%	-48%	-53%	8%	12%	7%
	Top 5 Chronic MEGs by Cost						
1	Osteoarthritis	-58%	-58%	-58%	-7%	-8%	-9%
2	Angina Pectoris, Chronic Maintenance	-40%	-75%	-75%	-14%	-15%	-15%
3	Chronic Obstructive Pulmonary Disease	-16%	-35%	-49%	-1%	-1%	1%
4	Renal Failure	-47%	-47%	-71%	2%	9%	33%
5	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	-26%	-42%	-54%	7%	33%	43%
	AVERAGE	**-25%**	**-40%**	**-48%**	**-2%**	**1%**	**17%**

Note: A positive number indicates risk adjustment increased the measure compared to the unadjusted distribution. A negative number indicates that risk adjustment decreased the measure compared to the unadjusted distribution.

5 ISSUES IN THE CONSTRUCTION OF EPISODES

The performance of risk adjustment that incorporates episode-specific health risk factors points to the need for further exploration into the reasons underlying this phenomenon. Episode-level risk adjustment can greatly increase the magnitude of the high-cost outliers for some episode types, regardless of whether one considers ETG and MEG constructions. This is especially prominent for the cost distributions of hip fractures.

Section 5.1 reexamines the distributions of raw and risk-adjusted ETG and MEG hip fracture costs and presents evidence that high-cost outliers are associated with prior hip fractures. It is the presence of prior hip fractures in the episode-level risk adjustment that accounts for the increase in outlier magnitude in the risk-adjusted distributions. Section 5.2 explains how the sequences of hip fracture episodes and their composition of institutional and non-institutional claims complicate risk adjustment and lead to the creation of extreme high-cost outliers.

5.1 Understanding Why Risk Adjustment Exacerbates Outliers

Although the distributions of raw costs for ETG and MEG hip fracture episodes display high levels of dispersion, episode-level risk adjustment reduces the overall spread while also creating new high-cost outliers. Section 5.1.1 explores the distributions of unadjusted ETG and MEG costs for hip fracture episodes. Section 5.1.2 elaborates on how risk adjustment reduces dispersion while dramatically inflating costs in the top percentiles of the episode cost distribution. Finally, Section 5.1.3 presents evidence that the majority of these high-cost outlier episodes follow an earlier hip fracture diagnosis.

5.1.1 Distributions of Unadjusted Costs for Hip Fracture Episodes

Sections 3 and 4 establish that hip fractures are among the costliest acute ETGs and MEGs and that attributed ETG and MEG hip fractures show unadjusted cost distributions with high levels of dispersion. The ETG grouper refines the classification of the base hip fracture ETG (*Closed fracture or dislocation—thigh, hip & pelvis*) into three severity levels, where *SL 1* is the least severe and *SL3* the most severe. This analysis considers ETG hip fracture episodes to be only *Closed fracture or dislocation—thigh, hip & pelvis* episodes classified as *SL 2* (ETG

7131032).[15] For the MEG grouper, this analysis defines hip fracture episodes as only the type *Fracture: Femur, Head, or Neck* (MEG 348). A hip fracture episode can open with either an institutional or non-institutional claim. A beneficiary can experience more than one such episode if this person has claims linked to hip fractures separated by a clean period, which is 90 days for ETG and 60 days for MEG. Consequently, if a beneficiary experiences follow-on care (such as an office visit) long enough after the last treatment performed on an initial hip fracture, then this care is sometimes allocated to a new episode with low cost.[16]

Table 5.1 illustrates the high levels of dispersion in unadjusted costs for hip fracture episodes. The first row in Table 5.1 shows the unadjusted cost distribution for attributed 2003 ETG hip fracture episodes for all beneficiaries and the second row shows the unadjusted cost distribution for attributed 2003 ETG hip fracture episodes for only those beneficiaries that were alive through the end of 2004. Rows 3 and 4 provide analogous cost distributions for the MEG grouper. This particular comparison is examined because a considerable number of Medicare hip fracture patients with 2003 episodes died before the end of 2004 and patients who died during this time frame may have routinely incurred higher or lower costs than other beneficiaries.

For ETG, dispersion in unadjusted costs for hip fracture episodes for all beneficiaries is extremely high; 90th percentile costs exceed 10th percentile costs by over 200 times. The distribution of episode costs for beneficiaries who were alive through the end of 2004 resembles the cost distribution of episodes for all beneficiaries. Tenth percentile costs for beneficiaries alive from 2002-2004 are about two-thirds of the 10th percentile cost for all beneficiaries and 25th percentile costs are less than half of those for all beneficiaries. However, for both cohorts, these values are extremely small compared to costs at the upper end of the distribution. Costs at the median and the 90th percentiles are almost the same for the two cohorts. The top of the cost distribution is the same for both groups, with the 95th percentile values and fraction of costs

[15] This severity level constitutes the majority of complete ETG hip fracture episodes ending in 2003 and is the #1 top-aggregate-cost acute ETG.

[16] For the MEG grouper, claims related to complications of medical care or surgery for a hip fracture (e.g., postoperative shock) can open a new episode of the type *Complications of Surgical or Medical Care*. Of the 2,558 complete 2003 hip fracture episodes for MEG, 12% had a *Complications of Surgical or Medical Care* episode at any time in 2003-2004 after the start date of the hip fracture episode, and less than 6% had a 2003-2004 *Complications of Surgical or Medical Care* episode starting more than 60 days (the clean period for hip fractures) after the end of the hip fracture episode. These *Complications of Surgical or Medical Care* episodes may be due to complications from hip fracture treatments or care for other medical conditions.

captured by the top five percentiles being identical. Comparing the number of episodes and total cost for the two cohorts of beneficiaries shows that a large number of beneficiaries with 2003 episodes died before the end of 2004; about 60% of hip fracture episodes and just below 60% of episode costs were for beneficiaries who were alive through the end of 2004.

Like ETG episodes, MEG episodes show high levels of cost dispersion. Cost distributions are similar for all beneficiaries and beneficiaries alive from 2002-2004. Although 25th percentile costs are lower for beneficiaries alive from 2002-2004, the 90th and 10th percentile values are similar for both cohorts. Unadjusted 90th percentile costs exceed 10th percentile costs by over 300 times in both groups. The 95th percentile values for the two cohorts are exactly the same and the fraction of cost in the top five percentiles is also identical for both cohorts. As with ETG, roughly 60% of hip fracture episodes and 60% of episode costs are for individuals who remained alive through the end of 2004.

Table 5.1: Unadjusted ETG and MEG Attributed Hip Fractures by Cohort

				Summary Statistics									
Episode Description	**Cohort**	**# of Episodes**	**Total Cost**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**Mean**	**Std Dev**	**Fraction of Cost in Bottom 50% of Episodes**	**Fraction of Cost in Top 5% of Episodes**
Closed fracture or dislocation - thigh, hip & pelvis, SL2 (ETG 7131032)	All Beneficiaries	1,670	$20,524,551	$103	$2,737	$11,836	$18,685	$24,309	$28,987	$12,290	$9,950	17%	15%
	Beneficiaries Alive From 2002 - 2004	1,047	$12,515,834	$68	$952	$11,574	$18,729	$24,253	$28,987	$11,954	$10,112	15%	15%
Fracture: Femur, Head or Neck (MEG 348)	All Beneficiaries	2,299	$26,934,252	$77	$2,911	$11,030	$17,667	$23,579	$27,900	$11,716	$9,551	19%	15%
	Beneficiaries Alive From 2002 - 2004	1,421	$16,259,658	$62	$1,140	$10,931	$17,608	$23,583	$27,900	$11,442	$9,388	17%	15%

5.1.2 Distributions of Risk-Adjusted Costs for Hip Fracture Episodes

Table 5.2 illustrates that risk adjustment creates high-cost outliers for ETG and MEG hip fracture episodes. This analysis relies on the sample of attributed 2003 hip fracture episodes for all beneficiaries. The first row of Table 5.2 shows raw ETG episode costs normalized to the mean unadjusted ETG hip fracture cost. The next row shows ETG costs adjusted for beneficiary age and gender, physician specialty, and HCC flags, normalized to the mean adjusted episode cost. As expected, normalized costs at the 90th percentile fall with risk adjustment and the 90/10 ratio decreases by a factor of over five, indicating that dispersion drops. However, the normalized level of adjusted costs at the 95th percentile increases from 2.36 to 3.61 with risk adjustment. Risk adjustment increases the magnitude of outliers dramatically and results in the top five percentiles of episodes representing half of adjusted costs, compared to about 15% of unadjusted costs. The standard deviation also expands by a factor of about three.

Table 5.2: Normalized Unadjusted and Risk Adjusted ETG and MEG Hip Fractures

Episode Description	Cost Adjustment	Summary Statistics 10%	25%	50%	75%	90%	95%	Mean	Std Dev	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
Closed fracture or dislocation - thigh, hip & pelvis, SL2 (ETG 7131032)	Unadjusted	0.01	0.22	0.96	1.52	1.98	2.36	1.00	0.81	17%	15%
	Risk Adjusted	0.04	0.20	0.46	0.76	1.31	3.61	1.00	2.51	10%	50%
Fracture: Femur, Head or Neck (MEG 348)	Unadjusted	0.01	0.25	0.94	1.51	2.01	2.38	1.00	0.82	19%	15%
	Risk Adjusted	0.05	0.22	0.49	0.83	1.45	3.05	1.00	2.40	11%	48%

The bottom two rows of Table 5.2 present analogous normalized cost distributions for unadjusted and risk-adjusted MEG episodes. As with ETGs, risk adjustment raises normalized 10th percentile costs and reduces normalized 90th percentile costs. The 90/10 shrinks by a factor of almost 10. Risk adjustment, however, exacerbates MEG outliers. Adjusting costs moves the 95th percentile normalized cost from 2.38 to 3.05 and dramatically expands the cost of episodes above the 95th percentile. These high-cost outliers in the distribution of adjusted episode costs increase the fraction of costs captured by the top 5% costliest episodes from about 15% for unadjusted episodes to almost half for risk-adjusted episodes. As with ETGs, the standard deviation of the cost distribution increases by almost three times with risk adjustment.

5.1.3 Episodes with Prior Hip Fractures Explain Aggravated Cost Outliers

Close inspection of risk-adjusted hip fracture episodes reveals that a segment of the high-cost episodes is associated with low expected costs and receives large upward cost adjustments, causing these high-cost episodes to become extreme outliers. Careful examination of these outliers shows that a large majority share two characteristics: (i) they have a "flag" turned on indicating the beneficiary had an earlier hip fracture diagnosis (recall that an HCC score translates "flags" for prior health events along with beneficiary characteristics into a measure of predicted costs); and (ii) they include high-cost institutional claims. The discussion here examines the implications of characteristic (i), and the subsequent section addresses the contributions of characteristic (ii) to the poor performance of risk adjustment.

The flag alluded to in characteristic (i) indicates the presence of HCC 158. HCC 158 is activated when the beneficiary has a hip fracture diagnosis within the 12 months before the start of the episode. Further examination of the episode-level risk adjustment shows that coefficient on the prior hip fractures HCC flag is significant and negative. This means that having a prior hip fracture actually predicts a lower cost hip fracture episode in the future. This is surprising, as one would expect that a hip fracture patient with a prior hip fracture would be more likely to experience costly complications.

A low risk score predicts low costs. Under such a scenario, risk adjustment would bring the below-average cost episodes closer to the mean, but also considerably inflate the cost of the few episodes with a low risk score and a higher-than-average raw cost.

5.2 Sequences of Episodes Explain Ineffectiveness of Risk Adjustment

As noted previously, in addition to being associated with the presence of a prior diagnosis consistent with the presence of HCC 158, a second characteristic linked to outlier risk-adjusted hip fracture episodes involves their makeup of institutional verses non-institutional Medicare claims. Most hip fracture episodes with preceding fractures are inexpensive non-institutional episodes, leading to the scenario described above, in which a preceding hip fracture predicts a low-cost episode. High-cost institutional episodes for beneficiaries with prior hip fractures then become outliers due to upward risk adjustment.

Section 5.2.1 documents the cost differences between the two varieties of hip fracture episodes: institutional and non-institutional. Institutional episodes are several times more expensive than non-institutional and there is little overlap in the cost distributions for these two varieties of hip fracture events. Section 5.2.2 decomposes the sequences of institutional and non-institutional hip fracture episodes, finding that the majority of episodes that have a prior hip fracture are low-cost non-institutional episodes. These episodes are also likely to be preceded by an institutional episode, suggesting that the non-institutional episode captures only follow-on care for an earlier fracture. Finally, Section 5.2.3 explains how this sequence pattern underlies the unexpected results of risk adjustment.

5.2.1 Different Cost Distributions for Institutional vs. Non-Institutional Episodes

The sharp cost difference between episodes with institutional claims and episodes without institutional claims underlies both the previously discussed high levels of dispersion in unadjusted costs and the complications resulting from risk adjustment. In this analysis of hip fracture episode costs, institutional claims include inpatient (IP), skilled nursing facility (SNF), hospice (HS), and home health (HH) claims, along with outpatient (OP) ambulance and emergency room claims. Non-institutional claims refer to Part B (PB) and durable medical equipment (DME) claims, as well as outpatient (OP) claims outside of those requiring an ambulance or emergency room entrance. For example, a visit to a physician's office for a check-up would be classified as non-institutional.

Table 5.3 shows the cost distributions for ETG and MEG hip fracture episodes by the inclusion of institutional claims. As episodes that are preceded by other hip fractures are of particular interest, the sample in these distributions includes both 2003 hip fracture episodes as well as any hip fracture episodes in our 2002-2004 data window that precede them for the same beneficiaries. This analysis refers to these earlier episodes as "preceding hip fracture episodes." For each grouper, the table compares costs for episodes with one or more institutional claims to those without institutional claims.

A stark contrast exists between the distributions of institutional episode costs and that of non-institutional episode costs. The first three rows of Table 5.3 show the distributions of costs for ETG hip fracture episodes and the bottom three rows show the same for MEG hip fracture episodes. For both ETG and MEG, around 80% of episodes include at least one institutional claim. For both groupers, the average cost of an institutional hip fracture episode is over 40 times higher than that of the average non-institutional hip fracture episode. This contrast is stronger in MEG hip fracture episodes, where the institutional average is over 45 times higher than the non-institutional average. It is not surprising that episodes with institutional claims are associated with higher costs, as they represent serious events that cannot be treated through a visit to a physician's office alone. There is little to no overlap between the cost distributions of institutional episodes and non-institutional episodes for either grouper. In ETG episodes, even at the 90th percentile, the cost of a non-institutional episode is only $757, compared to over $4,000 for the 10th percentile cost of an institutional hip fracture episode. For MEG, the corresponding values are $1,046 and over $6,000.

Table 5.3: Cost Distributions of 2002 - 2003 ETG and MEG Hip Fractures

Cohort: Beneficiaries with a Hip Fracture Ending in 2003

2003 Complete Episode	Composition of Episode by Claim Type	# of Episodes	% of All Episodes	Summary Statistics								Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
				10%	25%	50%	75%	90%	95%	Mean	Std Dev		
Closed fracture or dislocation - thigh, hip & pelvis, SL2 (ETG 7131032)	Episodes Containing Any Institutional Claims	1,515	79%	$4,168	$9,823	$14,775	$20,429	$25,932	$30,517	$15,343	$8,747	28%	12%
	Episodes without Institutional Claims	305	21%	$35	$55	$110	$330	$757	$1,129	$349	$1,296	8%	43%
	All 2002-2003 Hip Fractures	1,820	100%	$99	$2,067	$11,678	$18,657	$24,103	$28,816	$12,130	$9,916	17%	15%
Fracture: Femur, Head or Neck (MEG 348)	Episodes Containing Any Institutional Claims	1,975	77%	$6,136	$9,670	$13,350	$19,288	$24,869	$29,064	$14,785	$8,356	29%	12%
	Episodes without Institutional Claims	587	23%	$31	$51	$87	$304	$1,046	$1,298	$315	$530	8%	33%
	All 2002-2003 Hip Fractures	2,562	100%	$73	$2,199	$10,850	$17,504	$23,436	$27,422	$11,469	$9,533	18%	15%

5.2.2 Non-Institutional Episodes Often Follow Institutional Episodes

Understanding the source of the risk adjustment mechanism responsible for inducing high cost outliers requires documenting patterns of episodes consistent with this phenomenon. Although slightly over a quarter of attributed and preceding hip fracture episodes are non-institutional and low-cost, the treatment of a hip fracture often necessitates surgery. One possible explanation for the inexpensive non-institutional episodes is that they represent follow-on care for a preceding institutional episode. Under this follow-on scenario, beneficiaries with these non-institutional episodes should have a flag for a prior hip fracture diagnosis and show an earlier institutional hip fracture episode. If inexpensive non-institutional episodes typically follow institutional episodes, then the risk adjustment model will forecast low costs for these episodes. Under such circumstances, the risk model creates upward adjustments to these follow-on episodes to reflect their typical low-cost character. If some beneficiaries experience two actual hip fractures,[17] then the risk adjustment would result in exaggerating this expense even further. As shown below, this story strongly contributes to an explanation of the findings discovered in the previous analysis.

An attributed hip fracture episode ending in 2003 and a preceding hip fracture episode together constitute a sequence of episodes. Table 5.4 presents the relationship between attributed ETG hip fracture episodes and preceding episodes by the presence of an institutional claim. The sequences captured by this table are for all beneficiaries with a 2003 attributed hip fracture episode and a flag for a prior hip fracture diagnosis (HCC 158). The columns are separated by the presence of an institutional claim in the second episode in the sequence. The two rows show whether the preceding hip fracture diagnosis was an assigned hip fracture episode or another event that activated the HCC 158 flag. Observations in the third row labeled "Other Hip Fracture Event" are individuals who have the flag for a prior hip fracture diagnosis but do not have a previous hip fracture episode. The majority of these cases are individuals who had an earlier "related episode" of another episode type that is associated with the presence of the prior hip fracture diagnosis flag.[18] The remainder of the sequences captured by the "Other Hip Fracture Event" row represent cases where the attributed episodes show a prior hip fracture

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[17] Recall that the groupers can only open a second episode of a given type after there is a clean period (90 days for ETG hip fractures and 60 days for MEG hip fractures) with no related claims activity following the first episode.

[18] An individual receives a hip fracture diagnosis flag if they had previously been assigned any hip fracture episode of any severity level as well as closely related conditions such as a sprain or dislocation of the hip.

diagnosis but the claim with this diagnosis was either grouped to a non-hip fracture, non-related episode or fell outside the scope of our 2002-2004 Medicare claims data.

Table 5.4 shows that two-thirds of ETG hip fracture episodes with the HCC 158 flag for a prior hip fracture diagnosis do not include an institutional claim. Furthermore, an attributed episode is less likely to include an institutional claim if the preceding hip fracture or related episode includes an institutional claim. The most common sequence of hip fractures, representing nearly half (47%) of attributed episodes with a flag for an earlier hip fracture diagnosis, is an institutional hip fracture followed by a non-institutional hip fracture episode. The prevalence of this sequence lends strong support to the follow-on argument. The next most common sequence, representing about 17% of cases, is for an institutional hip fracture episode to precede an institutional hip fracture episode. These two sequences capture nearly two-thirds of all episode sequences. Although not shown in the table, for hip fracture episodes preceded by a hip fracture-related episode (this represents 17% of all sequences, or the majority of sequences in the "Other Hip Fracture Event" row), the most common sequence is an institutional related episode followed by a non-institutional hip fracture episode. A slightly smaller number of cases involve an institutional related episode followed by an institutional hip fracture episode. However, the fact that almost half of the sequences with HCC 158 are captured by the institutional-non-institutional sequence corroborates highly with the explanation of post-acute follow-on care episodes accounting for the creation of high-cost outliers post-risk adjustment.

Table 5.4: Sequences of ETG Hip Fractures for Beneficiaries with Previous Hip Fracture Diagnosis

		Subsequent Hip Fracture (ETG 7131032)		**Total**
Preceding Event	**Type of Episode**	**with Inst. Claims**	**without Inst. Claims**	
Hip Fracture Episode (ETG 7131032)	**with Inst. Claims**	17%	47%	64%
	without Inst. Claims	3%	8%	11%
Other Hip Fracture Event	**All**	13%	11%	25%
Total		33%	67%	100% # = 314

Table 5.5 shows similar sequences for MEG episodes and can be read in the same manner as Table 5.4. As with ETG episodes, over two-thirds of subsequent or attributed episodes do not include institutional claims. The most common sequence of episodes, capturing just over half (51%) of all MEG sequences with the HCC 158 flag, is a non-institutional hip fracture episode preceded by an institutional hip fracture episode. Such episodes outnumber institutional hip fracture-institutional hip fracture sequences by more than a factor of four. For sequences where the first episode is a hip fracture-related episode (these sequences represent slightly over a tenth of all sequences), institutional-institutional sequences are roughly as common as institutional-non-institutional sequences.

Table 5.5: Sequences of MEG Hip Fractures for Beneficiaries with Previous Hip Fracture Diagnosis

		Subsequent Hip Fracture (MEG 348)		**Total**
Preceding Event	**Type of Episode**	**with Inst. Claims**	**without Inst. Claims**	
Hip Fracture Episode (MEG 348)	**with Inst. Claims**	12%	51%	61%
	without Inst. Claims	5%	10%	13%
Other Hip Fracture Event	**All**	11%	10%	26%
Total		28%	72%	100% # = 422

The fact that the majority or plurality of sequences with HCC 158 consists of an institutional followed by non-institutional episode strongly supports the follow-on care explanation for ETG and MEG hip fractures. The hip fracture episodes showing a fracture diagnosis in the previous year are usually preceded by a hip fracture or related episode with an institutional claim. It is likely that these non-institutional hip fracture episodes are follow-on care in a physician's office for a fracture or related event whose institutional care is grouped into an earlier episode. The second most common sequence, an institutional episode followed by another institutional episode, however, is likely to represent two distinct occurrences of actual hip fractures.

another institutional episode, however, is likely to represent two distinct occurrences of actual hip fractures.

One might suspect that the problems with unattached follow-on care could be remedied by extending the length of clean periods. Setting long enough clean periods would link the follow-on care with the earlier episode. However, this approach raises new problems as it could also group two distinct fractures into one episode. In this scenario, only one physician would be attributed that episode even though the fractures may have been treated by different physicians.

5.2.3 Sequence Patterns Explain Increased Outlier Severity

In the case of two distinct hip fractures, each requiring a full course of care, one would expect risk adjustment to predict a high-cost second episode because of the possibility of greater complications. Instead, risk adjustment predicts an inexpensive second episode, as most sequences of hip fracture episodes consist of an institutional episode followed by an inexpensive non-institutional one. To illustrate, assume an average-cost non-institutional episode for one beneficiary (costing less than $1,000) and an average-cost institutional episode (costing around $15,000) for another beneficiary, where both beneficiaries have each had a previous hip fracture. As Section 5.1 suggests, under such a scenario, the non-institutional episode does not become an outlier and moves toward the mean for all episodes. However, the institutional episode's cost, which is already 40 times that of the non-institutional episode's cost, would be pushed to an extremely high level.

Table 5.6 provides the distributions of ETG and MEG costs for unadjusted and adjusted institutional and non-institutional episodes with a prior hip fracture. All unadjusted costs are normalized to the mean unadjusted cost for all sequences, and all adjusted costs are normalized to the mean adjusted cost for all sequences. For ETG, the first two rows provide the unadjusted and episode-level risk-adjusted cost distributions for all sequences. The next two rows show the unadjusted and adjusted costs for institutional sequences preceded by institutional sequences. These are followed by rows showing the unadjusted and adjusted costs for non-institutional sequences preceded by institutional sequences. The bottom half of the table follows the same pattern for MEG.

Comparing the third and fourth rows for ETG and MEG (unadjusted and adjusted cost distributions for institutional episodes preceded by institutional episodes) shows that risk adjustment dramatically increases costs for institutional episodes preceded by other institutional episodes, consistent with the scenario described in the above paragraph. The mean cost for adjusted institutional episodes preceded by institutional episodes is about eight times the mean cost for all adjusted episodes, while the mean unadjusted institutional cost is close to the mean for all unadjusted episodes. For both ETG and MEG, the highest cost institutional episodes that are preceded by other institutional episodes receive particularly large upward adjustments; the normalized costs at the 95th percentile expand dramatically from about 2 to over 20 for ETG and from 2.8 to over 17 for MEG. On the other hand, even though non-institutional episodes also receive an upward cost adjustment for both ETG and MEG, they do not become outliers and move toward the mean for all episodes. Risk adjustment is therefore complicated by the mix of institutional and non-institutional episodes created by the groupers, which may not be comparable due to fundamentally different underlying events.

5.3 Other Episode Types Exhibit Similar Patterns in Episode Sequencing

The problems described above are not limited to just hip fracture episodes, implying analogous complications with risk adjustment for these other episode types. The key feature in the patterns detailed above involves the predominance of low-cost non-institutional episodes following prior hip fracture episodes. This sequencing leads to risk adjustment inflating the cost of follow-on episodes. When expensive institutional episodes instead follow, the risk adjustment inflation factor can induce the creation of large outlier costs.

This same pattern shows up for several other episode types constructed by both the ETG and MEG groupers. Appendix C presents variants of Table 5.4 for these episode types, displaying the sequences of institutional and non-institutional episodes following prior episodes of the same variety. The tables in this appendix for the ETGs *Acute Pancreatitis, SL1, Joint Degeneration, Localized-Knee and Lower Leg, SL3,* and *Closed Fracture or Dislocation of Lower Extremity-Knee & Lower Leg, SL1* all show that, for beneficiaries with two of these episodes, the second episode is non-institutional the majority of the time. The same is true of the MEG episode types *Pancreatitis, Fracture: Femur, Except Head or Neck, Fracture: Tibia*, and *Fracture: Craniocerebral.* Like hip fractures, a prior episode of the same type principally predicts occurrence of a low-cost non-institutional episode. The use of episode-level risk adjustment will lead to inflation of the adjusted cost for subsequent episodes. A subsequent institutional episode will receive an inflated risk-adjusted cost. An episode-based efficiency scoring system would likely identify physicians treating these episodes as inefficient, but it is unclear whether these high-cost outliers represent actual inefficiency or problems with episode construction. Further investigation into the composition of episodes and, specifically, the services represented in episodes, is necessary before the adoption of any episode-based pay-for-performance system.

Table 5.6: Normalized Unadjusted and Adjusted Cost Distributions for Sequences of Hip Fractures
Cohort: Beneficiaries with a Hip Fracture Ending in 2003

Episode Description	Cost Adjustment	Sequence of Episodes	# of Sequences	Summary Statistics							
				10%	25%	50%	75%	90%	95%	Mean	Std Dev
7131032: Closed fracture or dislocation - thigh, hip & pelvis, SL2	Unadjusted	All Sequences	1,670	0.01	0.22	0.96	1.52	1.98	2.36	1.00	0.81
	Risk Adjusted	All Sequences	1,670	0.04	0.20	0.46	0.76	1.31	3.61	1.00	2.51
	Unadjusted	Institutional followed by Institutional	54	0.09	0.46	0.91	1.35	1.76	1.99	0.97	0.65
	Risk Adjusted	Institutional followed by Institutional	54	0.83	3.30	7.22	11.02	15.77	20.28	8.02	5.78
	Unadjusted	Institutional followed by Non-Institutional	147	0.00	0.00	0.01	0.01	0.04	0.06	0.02	0.03
	Risk Adjusted	Institutional followed by Non-Institutional	147	0.02	0.03	0.06	0.15	0.44	0.89	0.19	0.40
348: Fracture: Femur, Head or Neck	Unadjusted	All Sequences	2,299	0.01	0.25	0.94	1.51	2.01	2.38	1.00	0.82
	Risk Adjusted	All Sequences	2,299	0.05	0.22	0.49	0.83	1.45	3.05	1.00	2.40
	Unadjusted	Institutional followed by Institutional	52	0.09	0.63	1.04	1.34	2.29	2.77	1.10	0.80
	Risk Adjusted	Institutional followed by Institutional	52	1.67	4.22	7.94	12.81	14.93	17.14	8.68	5.90
	Unadjusted	Institutional followed by Non-Institutional	217	0.00	0.00	0.01	0.01	0.03	0.08	0.02	0.04
	Risk Adjusted	Institutional followed by Non-Institutional	217	0.03	0.04	0.07	0.14	0.53	1.39	0.23	0.51

6 CONCLUDING DISCUSSION

Whereas the original motivation for this report aimed to assess the impact of risk adjusting the costs of Medicare episodes of care created by the ETG and MEG groupers, the findings presented here additionally highlight questions about the construction of episodes by each grouper. This analysis applies regression methods to risk adjust episode costs, controlling for beneficiary demographics, specialty of attributed physicians, and beneficiary health conditions. Further, these methods explore the impacts of patient health conditions in two ways: beneficiary-level risk adjustment, which uses scores computed from beneficiary annual capitation rates under Medicare Part C, and episode-level risk adjustment, which measure the effect of hierarchical condition categories (HCCs) on episode cost separately for each individual ETG and MEG episode type. All of these risk adjustment specifications reduce the dispersion of episode costs as measured by the ratio of the 90th percentile cost to the 10th percentile cost. Not surprisingly, episode-level risk adjustment achieves the largest reduction in the 90/10 ratio. Unexpectedly, however, risk adjustment at the episode level sharply increases the severity of high-cost outliers for several episode types. This effect is particularly striking in the case of hip fracture episodes: the fraction of costs captured by the top five percentiles of the cost distribution increases by over 200%.

Investigation of the sources underlying the creation of these extreme outliers produces critical insights into aspects of the construction of episodes by both groupers. Exploring data for hip fracture episodes reveals that the ETG and MEG groupers each build a pattern of episodes resembling follow-on care rather than full courses of care. Whereas a full course of care typically involves medical services from institutional providers, follow-on care primarily consists of relatively inexpensive non-institutional services. To illustrate how such patterns affect risk adjustment, consider two scenarios. In Scenario 1, a sequence of two episodes occurs with each requiring a full course of treatment for two actual hip fractures experienced by a beneficiary. Given their severity, both fractures require medical services from providers involving payments of high-cost institutional claims (i.e., inpatient, emergency, or long-term care). In Scenario 2, a sequence of two hip fracture episodes occurs with the second representing follow-on care for the earlier hip fracture event. In this instance, the second episode involves relatively inexpensive non-institutional care. In a world where Scenario 2 is the predominate pattern, risk adjustment would assign an inflation factor to prior hip fracture events to reflect the relatively low expected costs of second episodes. When the occasional Scenario 1 occurs in such a world, risk scores still inflate costs of the second episodes. Second episodes are expensive in Scenario 1, and their inflation by risk adjustment makes them even more costly. If a prior hip fracture implies increased expenses for a second fracture, then risk adjustment exaggerates this increased cost even further. The resulting exaggeration of costs is more likely to create outliers: (i) as Scenario 2 becomes more common in the data, (ii) when the expected cost of second episodes in Scenario 2 drops further relative to typical episodes in the cost distribution, and (iii) when second episodes in Scenario 1 become more expensive relative to typical episodes in the cost distribution.

The results presented in this report reveal that all of these forces are at work in explaining the severity of high-cost outliers seen in the analysis. The evidence strongly supports the follow-on scenario. The risk adjustment factors linked to outlier episodes tend to have a diagnosis indicating a prior hip fracture event, with this factor inflating future costs. Further, these outlier episodes involve expensive institutional claims; on average, the costs of institutional episodes exceed non-institutional ones by over 40 times. The combination of inflation due to risk adjustment and the high actual expenses causes the risk-adjusted cost of the episode to become an outlier. The median episode fitting this description receives an upward cost adjustment that causes it to exceed the median adjusted cost for all episodes by a factor of about eight.

The findings do raise questions about the construction of episodes and whether episode costs, even after risk adjustment, constitute reliable measures of physician resource use. If risk adjusted costs were used to evaluate physician efficiency, then a physician assigned just one of the outlier institutional episodes described above would likely be rated as inefficient. Under the follow-on scenario, succeeding non-institutional episodes typically do not represent full courses of care whereas the outlier institutional episodes do. Consequently, the physician deemed as being inefficient would be penalized for treating an actual serious second hip fracture as opposed to providing more treatment akin to follow-on care. This problem cannot easily be remedied by modifying the risk adjustment model.

A resolution of the issue might be possible through an alternative construction of hip fracture episodes. In particular, the phenomena described above would recede if follow-on non-institutional episodes were considered continuations of the earlier institutional episodes. Under these circumstances, sequences would now primarily consist of successive institutional episodes. To the extent that second fractures cost more than first fractures, a risk adjustment model would discount rather than inflate costs. This discount factor would in turn make these later episodes less likely to be outliers. Although restructuring outputs from the ETG and MEG groupers offers a possible solution to this particular problem, it also brings along the unattractive side effect of requiring a retooling of the groupers.

Hip fractures are not the only episode types showing an increase in the portion of costs in the top percentiles after risk adjustment, and the problems in the patterns of episode sequences discovered for hip fractures underlying the creation of risk-adjusted cost outliers show up in other episode types as well. In the case of the ETG grouper, one sees these problematic sequence patterns for such episode types as acute pancreatitis and joint degeneration (and fractures) of the knee and lower leg. For the MEG grouper, these patterns come about for pancreatitis and femur and tibia fractures. Moreover, many of the top-aggregate-expense episodes analyzed in this report continue to exhibit increased high-cost outliers after risk adjustment. Preliminary evidence suggests that these episode types may also comprise episodes that are not fundamentally comparable (e.g., they include institutional episodes that constitute full courses of care and non-institutional episodes that represent only follow-on, pre-procedure or diagnostic care under the same episode type). As several issues with episode construction and composition may be present in a variety of episode types, further investigations into Medicare episodes of care created by the ETG and MEG groupers are warranted before such episodes can be used as a basis for developing physician rankings.

7 REFERENCES

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APPENDIX A SPECIFICATION OF REGRESSIONS USED TO COMPUTE ADJUSTED EPISODE COSTS

This appendix presents the regression methodology used to risk-adjust episode costs. Section A.1 describes the methodology for running the regressions. Sections A.2 and A.3 explain the specifications for the regressions as applied to the ETG and MEG groupers.

A.1 Regression Methodology

A formal representation of the regression specification used to impute "adjusted" episode costs takes the following form in vector notation:

(A.1) $$\omega_{ik} = \mu\delta_k + \beta X_{ik} + \theta Z_{ik} + \varepsilon_{ik}$$

where:

- ω_{ik} = $\ln(Y_{ik})$
- Y_{ik} = cost of the i-th episode for the k^{th} provider
- δ_k = vector of dummy variables identifying provider k's specialty associated with the $(i,k)^{th}$ episode
- X_{ik} = vector of demographic controls associated with the $(i,k)^{th}$ episode
- Z_{ik} = vector of severity and health factors associated with the $(i,k)^{th}$ episode
- ε_{ik} = error term for the $(i,k)^{th}$ episode
- μ = regression coefficients measuring cost differentials for the different provider specialties
- β = regression coefficients measuring the influence of the controls X
- θ = regression coefficients measuring the influence of the controls Z

This regression is run for a common type of episode, so only the providers vary in their specialties and the factors X_{ik} and Z_{ik} differ across beneficiaries within this episode type. Observations for this regression consist of all episodes of the type under consideration attributed to a designated set of providers.

To use the estimates of regression model (A.1) to create risk-adjusted measures of episode costs in levels, this analysis assumes that the errors ε_{ik} in (A.1) are distributed independently of both X_{ik} and Z_{ik}, but may depend physician specialty δ_k. More specifically, the analysis maintains that

$$E[\exp\{\varepsilon_{ik}\} \mid \delta, X, Z] = E[\exp\{\varepsilon_{ik}\} \mid \delta] .$$

With this property, one can rewrite (A.1) as:

(A.2) $$Y_{ik} = [\lambda_k \delta_k] \bullet \exp\{\beta X_{ik} + \theta Z_{ik}\} + \eta_{ik}.$$

where $E[\eta_{ik} \mid \delta, X, Z] = 0$ and the coefficients λ_k vary across provider specialties. Formally,

$$\lambda_k = \exp\{\mu_k\} \; E[\exp\{\varepsilon_{ik}\} \mid \delta_k = 1] \;.$$ [19]

One can consistently estimate the parameters λ_k using the following translation of regression relationship (A.2):

(A.3) $$\frac{Y_{ik}}{\exp\{\hat{\beta} X_{ik} + \hat{\theta} Z_{ik}\}} = \lambda_k \delta_k + \nu_{ik}.$$

The quantities $\hat{\beta}$ and $\hat{\theta}$ constitute values of the coefficients estimated from regression (A.1). The parameter λ_k represents the mean of episode costs for specialty *k* after adjusting for risk factors captured by beneficiary attributes X_{ik} and Z_{ik}. The error ν_{ik} is a simple translation of the disturbance η_{ik} in (A.2) and continues to have zero mean. Least squares estimation of (A.3) yields values for the coefficients $\hat{\lambda}_k$.

Finally, the risk-adjusted value of episode cost Y_{ik} takes the form

(A.4) $$\frac{Y_{ik}}{\hat{Y}_{ik}}$$

where

(A.5) $$\hat{Y}_{ik} = \hat{\lambda}_k \cdot \exp\{\hat{\beta} X_{ik} + \hat{\theta} Z_{ik}\} = \hat{\alpha}_k \cdot \exp\{\hat{\mu}_k + \hat{\beta} X_{ik} + \hat{\theta} Z_{ik}\}$$

with

(A.6) $$\hat{\alpha}_k = \hat{\lambda}_k \exp\{-\hat{\mu}_k\} \;.$$

For the log regression specification, the normalized cost measures equal

(A.7) $$Y_{ik}/\hat{Y}_{ik} = \exp\{\omega_{ik} - \hat{\mu}_k - \hat{\beta} X_{ik} - \hat{\theta} Z_{ik}\}/\hat{\alpha}_k = \exp\{\hat{\varepsilon}_{ik}\}/\hat{\alpha}_k.$$

The average of the normalized variables in (A.4) equals one and the distributional properties of these variables depict the risk adjusted features of episode costs. Equation (A.5) corresponds to relationship (4.4) in the report, and measure (A.4) corresponds to (4.5).

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[19] For a proof of this result and the translation of (A.1) to (A.2), take note of the following relationships:

$$\begin{aligned}
Y_{ik} = \exp\{\mu\delta + \beta X_{ik} + \theta Z_{ik} + \varepsilon_{ik}\} \\
&= E[\exp\{\mu\delta + \beta X_{ik} + \theta Z_{ik} + \varepsilon_{ik}\} \mid \delta, X, Z] + \eta_{ik} \\
&= \exp\{\mu\delta\} \bullet \exp\{\beta X_{ik} + \theta Z_{ik}\} \bullet E[\exp\{\varepsilon_{ik}\} \mid \delta, X, Z] + \eta_{ik} \\
&= \exp\{\mu\delta\} \bullet E[\exp\{\varepsilon_{ik}\} \mid \delta] \bullet \exp\{\beta X_{ik} + \theta Z_{ik}\} + \eta_{ik} \\
&= [\Sigma_\ell (\exp\{\mu_\ell\} \bullet E[\exp\{\varepsilon_{i\ell}\} \mid \delta_\ell = 1] \bullet \delta_\ell)] \bullet \exp\{\beta X_{ik} + \theta Z_{ik}\} + \eta_{ik} \\
&= [\Sigma_\ell \lambda_\ell \bullet \delta_\ell] \bullet \exp\{\beta X_{ik} + \theta Z_{ik}\} + \eta_{ik}. \\
&= [\lambda_k \delta_k] \bullet \exp\{\beta X_{ik} + \theta Z_{ik}\} + \eta_{ik}.
\end{aligned}$$

A.2 Regression Specification for ETGs

This section specifies the sample and explanatory variables used to adjust costs for Symmetry episodes.

A.2.1 Sample Used for ETG Regressions

The regressions are estimated separately for each ETG. For an episode to be included in this sample, it must:

- Qualify under the PBmax attribution rule for that ETG (irrespective of specialty).
- Be associated with a beneficiary with non-missing gender and date of birth variable.
- Have a cost greater than zero.

The analysis involves running one regression per ETG using observations making up this *10-10* PBmax sample.

A.2.2 Covariates Included in ETG Regressions

The ETG grouper does not produce measures of severity for individuals within the ETG categories used in this study, so we exclude severity measures as elements of Z from (A.1) when running the regression for ETG episodes. Following the recommendation of Symmetry, ETGs are defined as the combination of Base ETG and severity level, so there is no difference in levels within an ETG.

For elements of X, the model includes the set of age-gender variables comprising the demographic risk factors incorporated in CMS's HCC risk adjustment models. The HCC age-gender categories are: Male Age 0-34, Male Age 35-44, Male Age 45-54, Male Age 55-59, Male Age 60-64, Male Age 65-69, Male Age 70-74, Male Age 75-79, Male Age 80-84, Male Age 85-89, Male Age 90-94, Male Age 95+, Female Age 0-34, Female Age 35-44, Female Age 45-54, Female Age 55-59, Female Age 60-64, Female Age 65-69, Female Age 70-74, Female Age 75-79, Female Age 80-84, Female Age 85-89, and Female Age 90-94, Female Age 95+. The analysis excludes the Female 65-69 age-gender dummy from the regression as a conventional normalization—if Female Age 65-69 is missing, then the dropped dummy is the most common age-gender category that does appear.

A.3 Regression Specification for MEGs

This section specifies the sample and explanatory variables used to adjust costs for Medstat episodes.

A.3.1 Sample Used for MEG Regressions

The regressions are estimated separately for each MEG. For an episode to be included in this sample, it must:

- Qualify under the PBmax attribution rule for that MEG (irrespective of specialty).
- Be associated with a beneficiary with non-missing gender and date of birth variable.
- Have a valid disease stage assignment (one of Medstat's defined values).
- Have a cost greater than zero.

The analysis involves running one regression per MEG using observations making up this PBmax sample.

A.3.2 Covariates Included in MEG Regressions

The Medstat grouper stratifies episodes by "disease stages", and we include the dummy variables indicating the main disease stage (identified by first digit of the disease stage) as elements of Z_{ik} in (A.1) when running the regression for MEG episodes. As a conventional normalization, the model excludes the lowest disease stage assignment found in within each sample of episodes in a given MEG.

For elements of X, the model includes the set of age-gender variables making up the demographic risk factors incorporate in CMS's HCC risk adjustment models. The HCC age-gender categories are: Male Age 0-34, Male Age 35-44, Male Age 45-54, Male Age 55-59, Male Age 60-64, Male Age 65-69, Male Age 70-74, Male Age 75-79, Male Age 80-84, Male Age 85-89, Male Age 90-94, Male Age 95+, Female Age 0-34, Female Age 35-44, Female Age 45-54, Female Age 55-59, Female Age 60-64, Female Age 65-69, Female Age 70-74, Female Age 75-79, Female Age 80-84, Female Age 85-89, and Female Age 90-94, Female Age 95+. The model excludes the Female 65-69 age-gender dummy from the regression as a conventional normalization—if Female Age 65-69 is missing, then the dropped dummy is the most common age-gender category that does appear.

APPENDIX B RISK ADJUSTED COST DISTRIBUTIONS

Table B.1: Age-Gender and Specialty Risk Adjusted Episode Costs for Top-Aggregate-Cost ETGs

#	ETG: Description	# of Episodes	Summary Statistics 10%	25%	50%	75%	90%	95%	Mean	Std Dev	90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,670	0.01	0.28	0.92	1.42	1.96	2.50	1.00	0.87	183.9	18%	18%
2	Bacterial lung infections, SL 4	3,767	0.02	0.06	0.59	1.34	2.50	3.49	1.00	1.46	122.20	5%	28%
3	Septicemia, SL 2	1,499	0.02	0.06	0.68	1.48	2.27	3.24	1.00	1.34	119.22	5%	25%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	429	0.05	0.53	0.89	1.34	1.90	2.44	1.00	0.79	40.50	22%	17%
5	Bacterial lung infections, SL 3	2,566	0.02	0.06	0.26	1.66	2.43	3.59	1.00	1.44	107.02	4%	28%
6	Bowel obstruction, SL 1	1,670	0.03	0.09	0.40	1.36	2.47	3.45	1.00	1.66	90.13	6%	31%
7	Spinal trauma, SL 3	1,309	0.02	0.06	0.27	1.32	2.89	4.14	1.00	1.66	156.66	4%	32%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	783	0.02	0.14	0.80	1.45	2.31	2.72	1.00	1.06	130.12	13%	20%
9	Cholelithiasis, SL 2	1,382	0.05	0.16	0.54	1.56	2.36	2.92	1.00	1.24	43.70	11%	22%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	5,570	0.20	0.37	0.75	1.01	1.36	1.90	1.00	2.05	6.87	19%	34%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	8,933	0.03	0.08	0.27	1.02	2.66	4.20	1.00	2.12	96.48	5%	40%
2	Ischemic heart disease, SL 1	13,246	0.04	0.09	0.26	0.82	2.73	4.56	1.00	2.41	76.28	5%	43%
3	Cerebral vascular accident, SL 2	8,076	0.02	0.06	0.25	1.28	2.75	4.20	1.00	1.83	122.15	4%	36%
4	Ischemic heart disease, SL 3	2,428	0.03	0.15	0.78	1.44	2.18	3.03	1.00	1.12	68.98	12%	22%
5	Ischemic heart disease, SL 4	1,563	0.06	0.38	0.85	1.33	1.98	2.52	1.00	0.96	30.78	19%	19%

Table B.2: Age-Gender and Specialty Risk Adjusted Episode Costs for Top-Aggregate-Cost MEGs

#	MEG: Description	# of Episodes	Summary Statistics 10%	25%	50%	75%	90%	95%	Mean	Std Dev	90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
	Top 10 Acute MEGs by Cost												
1	Pneumonia: Bacterial	10,219	0.01	0.03	0.17	1.38	2.57	3.90	1.00	1.80	189.74	2%	34%
2	Cerebrovascular Dis with Stroke	7,065	0.01	0.02	0.11	1.29	2.77	4.72	1.00	1.97	257.82	2%	39%
3	Acute Myocardial Infarction	3,034	0.02	0.26	0.85	1.34	2.23	2.75	1.00	0.99	120.18	16%	20%
4	Fracture: Femur, Head or Neck	2,299	0.01	0.36	0.90	1.38	1.99	2.47	1.00	0.93	194.74	18%	18%
5	Cataract	48,440	0.08	0.12	0.28	1.14	2.75	3.56	1.00	1.55	33.03	6%	28%
6	Complications of Surgical and Medical Care	4,951	0.01	0.03	0.15	1.34	2.90	4.30	1.00	1.89	226.93	2%	36%
7	Arrhythmias	20,484	0.04	0.07	0.19	0.59	2.40	5.21	1.00	2.77	63.46	4%	53%
8	Diverticular Disease	6,460	0.04	0.11	0.35	0.75	2.59	4.75	1.00	2.36	64.43	6%	44%
9	Urinary Tract Infections	12,685	0.04	0.07	0.16	0.52	2.46	5.21	1.00	2.92	63.51	4%	54%
10	Cholecystitis and Cholelithiasis	1,959	0.03	0.14	0.48	1.49	2.36	3.27	1.00	1.39	72.69	10%	26%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	24,076	0.03	0.09	0.28	0.92	2.86	3.93	1.00	2.30	91.85	5%	39%
2	Angina Pectoris, Chronic Maintenance	20,511	0.04	0.09	0.22	0.67	2.77	4.98	1.00	2.48	68.50	5%	46%
3	Chronic Obstructive Pulmonary Disease	11,707	0.02	0.05	0.21	1.17	2.66	4.25	1.00	1.95	112.55	3%	38%
4	Renal Failure	3,751	0.02	0.05	0.23	1.53	2.88	3.94	1.00	1.55	119.30	4%	30%
5	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	1,841	0.02	0.11	0.67	1.49	2.43	3.15	1.00	1.12	107.82	10%	21%

Table B.3: Beneficiary-Level Risk Adjusted Episode Costs for Top-Aggregate-Cost ETGs

#	ETG: Description	# of Episodes	10%	25%	50%	75%	90%	95%	Mean	Std Dev	90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
			Summary Statistics										
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,670	0.01	0.26	0.83	1.42	2.20	2.76	1.00	0.95	180.0	16%	19%
2	Bacterial lung infections, SL 4	3,767	0.02	0.06	0.57	1.33	2.54	3.59	1.00	1.46	122.9	5%	28%
3	Septicemia, SL 2	1,499	0.02	0.06	0.64	1.51	2.28	3.11	1.00	1.34	114.1	5%	26%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	429	0.05	0.44	0.81	1.39	2.06	2.49	1.00	0.86	38.7	20%	17%
5	Bacterial lung infections, SL 3	2,566	0.02	0.06	0.27	1.65	2.49	3.65	1.00	1.44	107.5	4%	28%
6	Bowel obstruction, SL 1	1,670	0.03	0.09	0.41	1.39	2.43	3.49	1.00	1.70	87.2	6%	31%
7	Spinal trauma, SL 3	1,309	0.02	0.06	0.26	1.33	2.89	4.17	1.00	1.67	152.5	4%	32%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	783	0.02	0.14	0.73	1.39	2.35	3.06	1.00	1.16	130.7	12%	24%
9	Cholelithiasis, SL 2	1,382	0.05	0.16	0.54	1.56	2.38	2.99	1.00	1.26	44.1	11%	22%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	5,570	0.20	0.37	0.75	1.01	1.38	1.91	1.00	2.00	7.0	19%	34%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	8,933	0.03	0.08	0.27	1.02	2.64	4.20	1.00	2.12	96.2	5%	40%
2	Ischemic heart disease, SL 1	13,246	0.04	0.10	0.27	0.82	2.69	4.65	1.00	2.37	73.8	5%	43%
3	Cerebral vascular accident, SL 2	8,076	0.02	0.06	0.24	1.26	2.73	4.22	1.00	1.82	120.8	4%	35%
4	Ischemic heart disease, SL 3	2,428	0.03	0.15	0.73	1.38	2.32	2.98	1.00	1.18	70.3	12%	23%
5	Ischemic heart disease, SL 4	1,563	0.06	0.38	0.84	1.33	2.03	2.56	1.00	0.99	32.1	19%	19%

Table B.4: Beneficiary-Level Risk Adjusted Episode Costs for Top-Aggregate-Cost MEGs

#	MEG: Description	# of Episodes	Summary Statistics								90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
			10%	25%	50%	75%	90%	95%	Mean	Std Dev			
	Top 10 Acute MEGs by Cost												
1	Pneumonia: Bacterial	10,219	0.02	0.05	0.18	1.11	2.98	4.33	1.00	2.06	127.6	3%	38%
2	Cerebrovascular Dis with Stroke	7,065	0.01	0.02	0.11	1.23	2.83	4.60	1.00	2.00	264.9	2%	39%
3	Acute Myocardial Infarction	3,034	0.02	0.25	0.83	1.33	2.16	2.82	1.00	1.03	115.9	16%	20%
4	Fracture: Femur, Head or Neck	2,299	0.01	0.26	0.76	1.38	2.26	3.01	1.00	1.02	173.6	15%	20%
5	Cataract	48,440	0.08	0.13	0.28	1.14	2.80	3.63	1.00	1.58	33.1	6%	28%
6	Complications of Surgical and Medical Care	4,951	0.01	0.04	0.17	1.30	3.08	4.27	1.00	1.84	216.2	2%	34%
7	Arrhythmias	20,484	0.04	0.08	0.21	0.62	2.20	5.11	1.00	2.92	54.0	5%	52%
8	Diverticular Disease	6,460	0.06	0.17	0.48	0.99	1.67	3.62	1.00	2.26	27.0	9%	42%
9	Urinary Tract Infections	12,685	0.05	0.10	0.21	0.57	1.94	4.51	1.00	3.20	37.5	5%	56%
10	Cholecystitis and Cholelithiasis	1,959	0.05	0.18	0.63	1.24	2.29	3.31	1.00	1.46	48.6	11%	27%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	24,076	0.03	0.09	0.28	0.92	2.90	3.96	1.00	2.27	93.3	5%	39%
2	Angina Pectoris, Chronic Maintenance	20,511	0.07	0.14	0.35	0.92	1.96	3.51	1.00	2.70	29.3	8%	45%
3	Chronic Obstructive Pulmonary Disease	11,707	0.03	0.08	0.27	1.09	2.55	4.09	1.00	2.14	77.7	5%	39%
4	Renal Failure	3,751	0.03	0.06	0.26	1.43	2.78	3.83	1.00	1.66	99.3	4%	32%
5	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	1,841	0.04	0.14	0.47	1.28	2.64	3.61	1.00	1.41	73.4	8%	28%

Table B.5: Episode-Level HCC Risk-Adjusted Episode Costs for Top-Aggregate-Cost ETGs

#	ETG: Description	# of Episodes	Summary Statistics								90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
			10%	25%	50%	75%	90%	95%	Mean	Std Dev			
	Top 10 Acute ETGs by Cost												
1	Closed fracture or dislocation - thigh, hip & pelvis, SL 2	1,670	0.04	0.20	0.46	0.76	1.31	3.61	1.00	2.51	36.90	10%	50%
2	Bacterial lung infections, SL 4	3,767	0.02	0.06	0.56	1.36	2.52	3.55	1.00	1.46	117.02	6%	28%
3	Septicemia, SL 2	1,499	0.02	0.07	0.51	1.41	2.44	3.66	1.00	1.41	113.86	6%	28%
4	Closed fracture or dislocation - thigh, hip & pelvis, SL 3	429	0.09	0.37	0.64	1.08	2.25	3.44	1.00	1.34	24.28	17%	27%
5	Bacterial lung infections, SL 3	2,566	0.03	0.07	0.27	1.55	2.58	3.76	1.00	1.49	101.02	4%	29%
6	Bowel obstruction, SL 1	1,670	0.03	0.10	0.41	1.31	2.43	3.42	1.00	1.74	79.82	6%	32%
7	Spinal trauma, SL 3	1,309	0.02	0.07	0.30	1.27	2.80	4.54	1.00	1.66	118.09	5%	33%
8	Closed fracture or dislocation - thigh, hip & pelvis, SL 1	783	0.04	0.17	0.62	1.16	2.03	2.81	1.00	1.61	57.19	11%	33%
9	Cholelithiasis, SL 2	1,382	0.06	0.18	0.56	1.42	2.37	3.12	1.00	1.23	37.55	11%	24%
10	Non-malignant neoplasm of intestines & abdomen, SL 1	5,570	0.20	0.37	0.74	1.02	1.38	1.93	1.00	2.06	6.86	19%	33%
	Top 5 Chronic ETGs by Cost												
1	Ischemic heart disease, SL 2	8,933	0.03	0.08	0.27	0.95	2.57	4.16	1.00	2.24	86.34	5%	41%
2	Ischemic heart disease, SL 1	13,246	0.04	0.10	0.27	0.83	2.61	4.69	1.00	2.34	69.50	6%	43%
3	Cerebral vascular accident, SL 2	8,076	0.02	0.06	0.24	1.23	2.72	4.16	1.00	1.91	117.78	4%	37%
4	Ischemic heart disease, SL 3	2,428	0.04	0.16	0.71	1.33	2.24	3.08	1.00	1.30	61.49	12%	25%
5	Ischemic heart disease, SL 4	1,563	0.07	0.38	0.83	1.32	2.09	2.66	1.00	0.95	30.20	19%	19%

Table B.6: Episode-Level HCC Risk-Adjusted Episode Costs Top-Aggregate-Cost MEGs

#	MEG: Description	# of Episodes	Summary Statistics								90/10 Ratio	Fraction of Cost in Bottom 50% of Episodes	Fraction of Cost in Top 5% of Episodes
			10%	25%	50%	75%	90%	95%	Mean	Std Dev			
	Top 10 Acute MEGs by Cost												
1	Pneumonia: Bacterial	10,219	0.02	0.05	0.19	1.04	2.97	4.39	1.00	2.25	119.9	3%	39%
2	Cerebrovascular Dis with Stroke	7,065	0.01	0.03	0.12	1.05	2.83	4.62	1.00	2.18	249.8	2%	42%
3	Acute Myocardial Infarction	3,034	0.02	0.24	0.76	1.31	2.23	2.94	1.00	1.12	102.7	15%	22%
4	Fracture: Femur, Head or Neck	2,299	0.05	0.22	0.49	0.83	1.45	3.05	1.00	2.40	31.0	11%	48%
5	Cataract	48,440	0.08	0.13	0.28	1.15	2.87	3.62	1.00	1.59	33.9	6%	29%
6	Complications of Surgical and Medical Care	4,951	0.01	0.04	0.17	1.21	3.08	4.30	1.00	1.91	208.0	3%	36%
7	Arrhythmias	20,484	0.04	0.09	0.23	0.64	2.11	4.67	1.00	3.13	49.1	5%	52%
8	Diverticular Disease	6,460	0.07	0.17	0.48	1.00	1.69	3.64	1.00	2.22	25.9	10%	41%
9	Urinary Tract Infections	12,685	0.05	0.11	0.22	0.57	1.91	4.58	1.00	3.18	35.2	5%	56%
10	Cholecystitis and Cholelithiasis	1,959	0.05	0.19	0.63	1.27	2.39	3.30	1.00	1.36	46.5	11%	26%
	Top 5 Chronic MEGs by Cost												
1	Osteoarthritis	24,076	0.03	0.09	0.28	0.93	2.92	3.97	1.00	2.25	92.5	5%	38%
2	Angina Pectoris, Chronic Maintenance	20,511	0.07	0.14	0.36	0.92	1.97	3.52	1.00	2.67	29.1	8%	45%
3	Chronic Obstructive Pulmonary Disease	11,707	0.04	0.09	0.28	1.07	2.49	4.10	1.00	2.13	67.1	5%	40%
4	Renal Failure	3,751	0.04	0.09	0.29	1.05	2.58	4.32	1.00	1.89	63.3	5%	39%
5	Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum	1,841	0.04	0.15	0.46	1.16	2.43	3.61	1.00	1.57	59.2	9%	31%

APPENDIX C SEQUENCES OF OTHER EPISODE TYPES

The tables in this Appendix show sequences of episodes by the presence of institutional claims for selected episode types. A sequence consists of two episodes of the same ETG or MEG for a beneficiary. The first episode in the sequence can occur in 2002 or 2003, and may or may not be attributed. The second episode must be an attributed 2003 complete Oregon episode. The end of the first episode and the beginning of the second episode must be no less than 12 months apart.

Table C.1: ETG Sequences of Acute Pancreatitis, SL1

Total Sequences: 39

		Subsequent Episodes		Total
		w/ Inst. Claims	**w/o Inst. Claims**	
Preceding Episodes	**w/ Inst. Claims**	26%	49%	74%
	w/o Inst. Claims	10%	15%	26%
Total		36%	64%	100%

Table C.2: ETG Sequences of Joint Degeneration, Localized-Knee & Lower Leg, SL3

Total Sequences: 519

		Subsequent Episodes		Total
		w/ Inst. Claims	w/o Inst. Claims	
Preceding Episodes	w/ Inst. Claims	10%	25%	34%
	w/o Inst. Claims	22%	44%	66%
Total		32%	68%	100%

Table C.3: ETG Sequences of Closed Fracture or Dislocation of Lower Extremity - Knee & Lower Leg, SL1

Total Sequences: 50

		Subsequent Episodes		Total
		w/ Inst. Claims	w/o Inst. Claims	
Preceding Episodes	w/ Inst. Claims	10%	54%	64%
	w/o Inst. Claims	2%	34%	36%
Total		12%	88%	100%

Table C.4: MEG Sequences of Pancreatitis

Total Sequences: 73

		Subsequent Episodes		Total
		w/ Inst. Claims	w/o Inst. Claims	
Preceding Episodes	w/ Inst. Claims	22%	32%	53%
	w/o Inst. Claims	8%	38%	47%
Total		30%	70%	100%

Table C.5: MEG Sequences of Fracture: Femur, Except Head or Neck

Total Sequences: 89

		Subsequent Episodes		Total
		w/ Inst. Claims	w/o Inst. Claims	
Preceding Episodes	w/ Inst. Claims	7%	49%	56%
	w/o Inst. Claims	8%	36%	44%
Total		15%	85%	100%

Table C.6: MEG Sequences of Fracture: Tibia

Total Sequences: 48

		Subsequent Episodes w/ Inst. Claims	Subsequent Episodes w/o Inst. Claims	Total
Preceding Episodes	w/ Inst. Claims	4%	67%	71%
Preceding Episodes	w/o Inst. Claims	6%	23%	29%
Total		10%	90%	100%

Table C.7: MEG Sequences of Injury: Craniocerebral

Total Sequences: 59

		Subsequent Episodes w/ Inst. Claims	Subsequent Episodes w/o Inst. Claims	Total
Preceding Episodes	w/ Inst. Claims	25%	34%	59%
Preceding Episodes	w/o Inst. Claims	10%	31%	41%
Total		36%	64%	100%