The Ability of Event-Based Episodes to Explain Variation in Charges and Medicare Payments for Various Post Acute Service Bundles

A report by staff from 3M Health Information Systems, Inc., for the Medicare Payment Advisory Commission

James Vertrees, PhD
Richard Averill, MS
Jon Eisenhandler, PhD
Anthony Quain, MA
James Switalski, BS
Dave Gannon, MS

3M Health Information Systems, Inc.

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MedPAC
425 Eye Street, NW
Suite 701
Washington, DC 20001
(202) 220-3700
Fax: (202) 220-3759
www.medpac.gov

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James Vertrees, Ph.D, Richard Averill, M.S., Jon Eisenhandler, Ph.D,

Anthony Quain, M.A., James Switalski, B.S. and Dave Gannon, M.S.

3M Health Information Systems, Inc

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1: Introduction and Purpose.

The successful implementation of the Medicare diagnosis related group (DRG) based inpatient prospective payment system (IPPS) in 1983 demonstrated that bundling payment for all inpatient services into a single per case payment amount could create an effective incentive for hospitals to use resources more efficiently. The all inclusive per case DRG payment bundle shifted the financial risk for use of bed days and diagnostic and therapeutic services during the hospital stay from Medicare to the hospital, thereby creating a strong financial incentive for efficiency. The incentive structure within IPPS could be readily extended to include broader bundles of service that encompass post acute (post inpatient hospital) care.

Clearly, bundling post acute care (PAC) could greatly increase the financial incentive to improve coordination of acute and post acute care and, thereby increase both efficiency and quality. This has been recognized by the Medicare Payment Advisory Commission (MedPAC). MedPAC noted that a bundled payment that includes all services rendered during an episode of care would create the incentive for providers to deliver "the right mix of services at the right time" (MedPAC, June 2008). Further, the Medicare Improvements for Patients and Providers Act of 2008 requires the Center for Medicare and Medicaid Services (CMS) to establish a physician feedback program in which physicians would receive confidential information on their resource use based on episodes of care (profiling). While there are many different ways to identify episodes of care, Section 3003 of the Patient Protection and Affordable Care Act (2010) supported the concept of person based episodes by requiring that "The Secretary shall develop an episode grouper that combines separate but clinically related items and services into an episode of care *for an individual*, as appropriate." For FY2014 CMS has proposed adding to the Hospital IQR Program an episode based measure of Medicare spending per beneficiary:

> "We are proposing an episode that runs from three days prior to an inpatient PPS hospital admission (the index admission) through 90 days post hospital discharge. We are proposing to include the time period 90 days post hospital discharge in order to emphasize the importance of care transitions and care coordination in improving patient care."
>
> *Federal Register*, May 5, 2011

Finally, CMS is developing a demonstration program for bundling post acute care (PAC). CMS has recognized that if PAC bundles became part of the payment system, this could create incentives for providers to provide acute and post acute care more efficiently – much as Medicare's PPS did in the early 1980's. CMS is providing a great deal of flexibility for bidders in the hope that a diversity of responses will assist CMS in identifying potentially fruitful alternatives.

The purpose of the analyses in this report is to test alternative ways to bundle hospital and post acute care. This includes an assessment of the utility of functional status measures in risk

adjustment for differences in the burden of chronic diseases. The comparisons are provided to assist in the evaluation of alternative risk adjustment methods and alternative service bundles.

2: Methods

There are five basic components of a payment bundle that is initiated by a hospital event and which is extended to include PAC services**:**

- *The Trigger Event*: This is the hospitalization that precipitates and defines the episode. The following analyses are based on MS-DRGs.
- *Episode Acuity:* The acuteness of the patient's conditions at the time of the episode trigger event (e.g., the severity of illness of the patient during the hospitalization). Patient acuity was defined using the severity subclasses within the MS-DRGs.
- *Chronic Disease Burden*: The extent of the patient's co-morbid chronic diseases at the beginning of the episode (at the time of discharge from the hospital). Chronic disease burden was measured using Clinical Risk Groups (CRGs). The CRGs were modified by aggregating the detailed CRG categories into 23 aggregate categories (ACRGs).
- *Episode Window*: The number of days post-discharge in which PAC services are included in the episode. For this study, post-hospitalization windows of 30 and 90 days were used.
- *Episode Services*: The services included during the window (e.g., institutional care, readmissions, etc). A wide range of different bundles of service were evaluated.

The MS-DRGs are composed of a base MS-DRG (e.g., heart failure) that may be further subdivided into severity levels based on the presence of complications and comorbidities. Each hospital episode was assigned to a single base MS-DRG that defines the reason for hospitalization (the trigger event). Each trigger event was assigned an acuity level based on the MS-DRG severity level. Acuity level 1 identifies episodes *without* a major complication or comorbid condition (MCC); Acuity level 2 includes episodes *with* a MCC. Each base MS-DRGs was split into the two acuity levels even if the standard MS-DRGs used by Medicare for payment was not differentiated by the presence of an MCC. This means that each base MS-DRG and acuity level represent a *different* trigger event (episode). Thus, an admission for emergency cardiac bypass surgery for a critically ill (i.e., high severity) patient and an admission for scheduled cardiac bypass surgery for a stable (i.e., low severity) patient are different acute trigger events. For example, all hospitalized patients assigned to base MS-DRG 235 (coronary bypass without cardiac catheterization) at acuity level 1 would constitute a different episode from patients assigned to base MS-DRG 235 at acuity level 2.

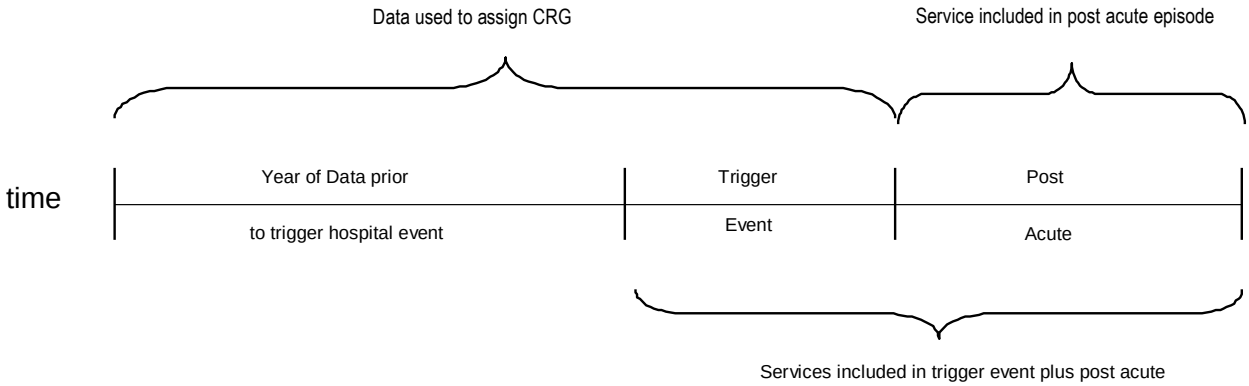
The MS-DRGs focus primarily on the time-limited treatment of acute illnesses (e.g., pneumonia) or acute deteriorations of chronic illnesses (e.g., acute exacerbations of heart failure). The MS-DRGs attach less significance to relatively serious but stable chronic conditions. However, during the post acute care period the patient's chronic illness burden is likely to be one of the primary determinants of resource use. For example, the use of services during the post acute care

period for a patient with multiple chronic diseases can be much different than a patient who is otherwise healthy or has only a single chronic disease. This is true for both medically complex cases as well as an elective surgery case such as a hip replacement.

The Clinical Risk Groups (CRGs) were used to define chronic illness burden (Hughes, 2004). CRGs are a categorical clinical model that uses a patient's claims history to assign patients to a single mutually exclusive category that reflects the chronic illness burden of the patient and predicts the level of expected future resource use (Hughes, 2004). Like MS-DRGs, each CRG is composed of a base CRG that describes the patient's most significant chronic conditions and a severity of illness level (e.g., a patient with diabetes and heart failure at severity level 3). There are 272 base CRGs which are subdivided into up to six severity of illness levels for a total of 1,080 CRGs. The 1080 CRGs are aggregated into three predefined CRG hierarchical consolidations into 416, 151 and 38 CRGs. The aggregated CRGs sacrifice some clinical precision but with only a slight loss of predictive performance. Because all the patients in the study required hospitalization, implying a minimum level severity of illness, the 38 CRG categories were further consolidated into 23 CRG categories. These 23 CRG categories are referred to as ACRGs and range from patients with no significant chronic disease to patients with multiple major chronic diseases at high severity. Additional information regarding CRGs is provided in Appendix A.

Since MS-DRGs and CRGs are independent categorical clinical models, each patient can be assigned to both an MS-DRG/acuity group and a CRG. This allows each MS-DRG/acuity group to be differentiated by the CRG category assigned to the patient. The assignment of the MS-DRG/acuity and the CRG to a patient are independent processes allowing the two assignments to be combined together for the purpose of predicting resource use within an episode. Essentially, the MS-DRG/acuity groups are used to identify the reason for hospitalization and the 23 ACRGs are used to differentiate patients in terms of their chronic disease burden.

As illustrated below, the CRG is assigned using the diagnoses and procedures present during the hospitalization plus any diagnosis and procedures that occurred one year prior to the date of hospital discharge. The resources that are included in the post acute care episode are those resources that were delivered during the episode window starting on the day following discharge.



The combination of the base MS-DRG (reason for hospitalization), MS-DRG severity level (acuity) and ACRG (chronic illness burden) define unique types of episodes (payment bundles) with each combination having a separate payment amount. The projected expenditures (payments or charges) in a bundle for a patient is computed as average expenditures in the MS-DRG/ACRG group to which the patient is assigned times a CRG relative weight and is computed as follows:

g = MS-DRG/acuity cell

c = CRG based on the 23 consolidated CRGs

A(g) = average expenditure for MS-DRG/acuity group g

W(c) = CRG expenditure weight for CRG c computed as the average relative expenditure for patients in CRG c across all MS-DRG/acuity groups

E(i,g,c) = Expected expenditures for ith patient assign to MS-DRG/acuity group g and CRG g

$E(i,g,c) = W(c)*A(g)$

The expected expenditures for an episode will also vary depending on the length of the episode window and comprehensiveness of the episode scope of services. Episode windows of 30 and 90 days and various combinations of the services included in the episode payment bundle were examined. The expected use of services for an episode with a short episode window and a limited service scope is likely to be determined primarily by the patient's acuity at the time of the episode trigger hospitalization. In contrast, for many conditions the extent of the post acute services in an episode for a long episode window and comprehensive service scope may be determined more by the patient's chronic illness burden at the time of the initiation of the episode – though this may be less true for cases such as elective surgery where the PAC patterns are well established. Thus, *both* the patient's acuity at the time of the episode trigger hospitalization and the chronic disease burden of the patient at the beginning of the episode window must be *simultaneously* taken into account in order to understand and predict the expected utilization of services incurred during the post acute episode.

Hospital readmissions that occurred during the post acute care window of a trigger hospitalization were included in the payment bundle of the trigger admission. However, readmissions can have a substantial impact on post acute costs. In order to avoid having post acute care cost dominated by a completely unrelated readmission (e.g., a subsequent admission for injuries incurred in a traffic accident), the Potentially Preventable Readmissions (PPRs) (Goldfield, 2008) were used to identify readmission that were related to the trigger hospitalization. If an unrelated readmission occurred during a post acute care window, the payment bundle for the trigger hospitalization was truncated and a new payment bundle based on the readmission was begun. For example, a patient initially treated for CHF is admitted for

injuries due to a car accident. The CHF episode is truncated. However, the admission for the injuries is allowed to be a trigger hospitalization and initiate a new episode related to the injuries. Payment bundles that included all cause readmissions and only related readmission (PPRs) were examined separately.

Those beneficiaries who died during the post acute care window or had an unrelated readmission occur during the post acute care window were excluded from the analysis. One of the objectives of the analysis is to evaluate the impact of post acute care windows of different lengths. As the length of the window increases, the number of patients experiencing a truncated payment bundles due to death or an unrelated readmission increases. In order to keep the number of patient's constant across windows of varying lengths, only patients whose payment bundle was not truncated for 90 days following the trigger hospitalization were included in the analysis.

Reduction in variance as measured by the R^2 statistic was used to measures the ability of the MS-DRG/Acuity/CRG groups to estimate accurately the expected expenditures for the bundles. In the context of a payment system this is important because it relates to the level of payment accuracy and provider financial risk. The ability to identify low and high severity patients is essential in order to prevent the financial incentive for hospitals to seek out or avoid specific types of patients. R^2 calculations are based on the difference between actual and expected expenditures for each episode. As the accuracy of the prediction increases, the difference between actual and expected becomes small and the value of R^2 approaches 1.0.

The coefficient of variation is the standard deviation divided by the mean and is reported in some of the analyses. This statistic measures the homogeneity of the categories. Though somewhat arbitrary, CV values less than one are generally considered acceptable. Higher values mean that there is considerable variation within the category. The weighted (by category volume) CV is a convenient summary statistic similar to the case mix index for DRGs.

The assignment of the CRGs is based on standard claims data and is focuses on the burden of chronic illnesses. In addition to chronic illness burden, a patient's functional status may also impact service use during the post acute care period. In a separate project, four domains of functional health status (self care, mobility, cognition and incontinence) were constructed from beneficiary assessment data. These domains were chosen because of their clinical importance and the availability of mappings for these domains across different functional status assessment instruments. Since the functional status data was collected using different assessment instruments (OASIS, MDS, IRF PAI)), each of the functional status measures from the different instruments was co-calibrated into a three level scale (high, moderate, low). The 81 possible combinations of the three levels in the four functional status domains were consolidated into a nine category composite categorization of limitations in functional ability that was exhaustive and mutually exclusive. That is, based on a beneficiary's level of functional status in each of the four domains, the beneficiary is assigned to one of the nine composite functional categories that represent the extent of overall beneficiary functional status impairment. The ACRGs can use

functional status information to affect the grouping – presumably increasing accuracy (R^2). The nine composite functional categories are summarized in Appendix C. As described in Appendix B functional status has a substantial impact on post acute care service use.

3: Data.

This section describes the data used for the analyses reported in subsequent chapters.

The initial file contained information for a 5% sample of Medicare beneficiaries who were continuously enrolled in Medicare from 1/1/2006 though 12/31/2008, or the date of their death if they died earlier than that, with no evidence of another primary payer during that time. Beneficiaries who did not have a hospitalization during 1/1/2006 though 12/31/2008 were excluded from the analysis. Finally, beneficiaries who had children's hospital inpatient claims were excluded. The total count of beneficiaries that met all these conditions was 714,019.

The data include claims for various types of services. These services and the number of claims for each are:

- Inpatient - 2,079,381
- Outpatient - 5,889,430
- Home health - 489,136
- Hospice - 135,828
- DME - 6,695,545
- Part B - 45,038,763

The inpatient claims were sub-classified as follows:

- PPS – 1,530,409
- SNF – 352,166
- CAH – 62,067
- Psychiatric – 63,869
- Rehabilitation – 52,845
- Long-term care – 18,025

The analysis began with 2,079,381 inpatient hospital claims. Not all of these claims would trigger episodes, and not all episodes were kept for the analysis file. The qualification of inpatient claims as trigger events involved three stages: (1) qualification of inpatient claims as separate events; (2) qualification of inpatient events as candidate episode trigger events; and (3) rejection of episode trigger event candidates due to classification of readmissions. After the qualification of trigger events, the resulting episodes were further pared to make comparisons between different types of payment scenarios.

The first stage of the qualification of inpatient claims as trigger events involves the qualification of claims as separate events. First, to strictly qualify as an inpatient event, an inpatient claim must be from a PPS, CAH, or psychiatric facility; SNF, inpatient rehabilitation, and long-term care facility claims did not qualify as an episode trigger event. Second, some inpatient claims are transfers to other hospitals; when transfers are involved, the two hospitalizations were joined together into a single claim to arrive at inpatient continuous event. Third, the inpatient event must have a start date that begins after the data collection period. Since the data is for years

2006, 2007 and 2008, events that start prior to January 1, 2006 are discarded. After making these three adjustments, the number of claims that remain as separate inpatient events is 1,597,223. The details of this attrition are shown in the following table:

From Inpatient Claims to Inpatient Events		
Inpatient claims		2,079,381
minus: Non-acute facility claims	-	423,036
Acute facility inpatient claims		1,656,345
minus: Transfers	-	49,544
Possible inpatient events		1,606,801
minus: Out of data date range	-	9,578
Inpatient events		1,597,223

The second stage of trigger event qualification determines which inpatient events qualify as candidate episode trigger events. There are four tests an inpatient event must pass to qualify as a candidate trigger. First, the patient must not have died during the inpatient event. Second, there must be no record of a hospice claim before the event. Third, the event's start date must fall within the analysis period defined as 1/1/2007 to 8/31/2008. The analysis period is more narrow than the data collection period to allow for sufficient prior history for a CRG to be assigned (the full year of 2006) and for the hospitalization and trailing window of episodes at the end of the analysis (the last four months of 2008). Fourth, each candidate trigger event must have a positive non-zero dollar amount, from all sources in total, of the resources being measured. Since it is possible that some claims will have zero payments while having positive submitted charges, and vice versa, the number of candidate trigger events will differ if payments (allowed charges) as opposed to submitted charges are analyzed. After qualifying inpatient events as candidate trigger events, the number of possible episodes is further reduced to 887,375 for analyses using payments and 882,948 for analyses using submitted charges.

The breakdown is provided next:

From Inpatient Events to Candidate Trigger Events				
		Payments		**Submitted Charges**
Inpatient events		1,597,223		1,597,223
minus: Deaths during event	-	43,957	-	43,957
Survived inpatient events		1,553,266		1,553,266
minus: post-hospice events	-	9,447	-	9,447
Survived inpatient events pre-hospice		1,543,819		1,543,819
minus: Outside analysis period	-	656,444	-	656,444
Analyzed inpatient events		887,375		887,375
minus: Zero-cost events	-	0	-	4,427
Candidate episode trigger events		887,375		882,948

The third stage of trigger event qualification assesses whether each admission is an independent trigger event or the readmission of a past trigger event. This assessment differs greatly depending on the trailing window length and the readmission rule (e.g., preventable readmissions versus all cause readmissions). A longer trailing window will result in more readmissions and less episodes. Using an all-cause readmission rule will also result in more readmissions and less episodes, compared to a restricted readmission rule (i.e., using PPRs). The number of readmits and the resulting number of episodes for all four scenarios, using both payments and submitted charges, are shown in the following table. Note that for payments, the readmits and episodes together add up to the total candidate episode trigger events from Table 2.2 (887,375), as they do for submitted charges (882,948).

From Candidate Trigger Events to Episodes				
	Payments		**Submitted Charges**	
Scenario	**Readmits**	**Episodes**	**Readmits**	**Episodes**
30 days, All-cause	136,626	750,749	135,047	747,901
30 days, PPR	87,966	799,409	86,795	796,153
90 days, All-cause	245,096	642,279	242,713	640,235
90 days, PPR	150,333	737,042	148,647	734,301

Finally, three adjustments were made after these episodes were populated. First, only those episodes that were created in both the 30 day and the 90 day trailing windows (i.e., with the same trigger event) for the same readmission rule and financial measure were kept. This ensured that for each scenario the same number of episodes could be used for both the 30 day and the 90 day window allowing the same episodes to be included in the 30 and 90 day results. Second, of these, only those episodes that completed the entire 90-day window were kept. (e.g., did not die in the community during the 90 days following discharge from the trigger hospitalization). Third, of these, only those episodes that had no hospice claims and no psychiatric inpatient claims were kept. The final counts of episodes for each scenario, after making these episode-specific adjustments, are listed.

Episodes for Scenario Comparison		
Scenario		**Episodes**
Readmit Rule	**Financial Measure**	
All-cause	Payments	572,332
All-cause	Submitted Charges	570,754
PPR	Payments	572,762
PPR	Submitted Charges	571,186

These inpatient episodes were each analyzed to determine which claims were allocated to each episode, the CRG risk level of the individual at the beginning of the episode, and the episode expenditures.

The data available to this project included two different methods of defining resources: providers' charges and Medicare payments. The charges submitted by the provider on the claim were used for the charge variable. The payment variable was standardized as shown in the following table.

Determination of the standardized payment variable*

Hospital	Amount paid with outlier payments, disproportionate share, indirect medical education, new technology add-on amount, and capital removed from hospital allowed payment but added back through a uniform increase in the payment amount (about 18%) *plus* beneficiary coinsurance payment *plus* beneficiary deductible payment. This removes sources of variation unrelated to patient care, making hospital payments similar for a given inpatient DRG. LTCH includes separate average for short stay outliers
Outpatient	Single national OP rate. This "average hospital" amount paid for service *plus* beneficiary coinsurance payment *plus* beneficiary deductible payment
SNF	National average per diem amount paid *plus* beneficiary coinsurance payment *plus* beneficiary deductible payment IRF average with adjustment for some rugs
Other part B	National average allowed payment
DME	Allowed payment
Home health	National average prospective amount paid for the prospective service mix.
Hospice	National average Amount paid (not included)

*All payments were standardized for differences in wages across geographic areas.

The standardization of payments captures total spending associated with add-ons but not the variation in service use across facilities. Each of these potential measures of resource use has advantages and disadvantages. Charges likely reflect with more accuracy the relative costliness of individual services. However, charges also include a mark-up factor that differs from provider to provider. Medicare payments reflect the cost of the service to the program as well as reflecting the outcome of political processes. However, Medicare payments for a given service have limited variation and this variation was further reduced in that hospital payments were standardized for differences in wages across geographic areas. Since neither is clearly "correct" for all circumstances, the following analyses were done once using charges as the dependent variable and then using Medicare payments as the dependent variable. Other than the dependent variable, the pairs of analyses are identical.

Analysis

The initial results are presented in a series of tables. These analyses were done for all MS-DRGs. However, for presentation purposes, it is useful to focus on a few common conditions. The conditions selected for this purpose were:

Selected MS-DRGs

MS DRG	Acuity	Description
064	1, 2	Intracranial hemorrhage or cerebral infarction
193	1, 2	Simple pneumonia & pleurisy
231	1, 2	Coronary bypass w PTCA
233	1, 2	Coronary bypass w cardiac cath
235	1, 2	Coronary bypass w/o cardiac cath
291	1, 2	Heart failure & shock
329	1, 2	Major small & large bowel procedures
469	1, 2	Major joint replacement or reattachment of lower extremity
480	1, 2	Hip & femur procedures except major joint
535	1, 2	Fractures of hip & pelvis
689	1, 2	Kidney & urinary tract infections
871	1, 2	Septicemia or severe sepsis w/o MV 96+ hours

For purposed of this report, acute and post acute care services were aggregated into various financial bundles. The following list defines these financial bundles:

1. Institutional PAC includes SNF, IRF, and LTCH use after a hospital stay. Does not include physician services furnished during the SNF, IRF, or LTCH stay.
2. HHA. Home Health Agency. Does not include physician services furnished during the HHA episode.
3. All PAC ("All") include both institutional and HHA (1+2)
4. PAC outpatient therapies including physician and ancillary services, outpatient services and therapies as defined by selected HCPC codes.
5. PAC MD. Physician services delivered during an institutional PAC stay or within the sixty-day period following the initiation of HHA services but not extending beyond the end of the episode window.
6. Post discharge services (PDS) = services furnished after hospital stay but excluding 1,2, 4 and 5. Includes MD post discharge services.
7. Total PAC and PDS (3+4+5+6)
8. Readmissions. Does not include physician services furnished during readmission
9. Physician services during readmissions
10. Total PAC, PDS and readmissions (7+8+9)
11. Trigger hospitalization. Does not include physician services furnished during trigger hospitalization
12. Physician services during trigger hospitalization
13. Entire Episode (10+11+12)
14. Entire episode less post discharge services (13-6)
15. PAC and PAC MD (3+4+5)
16. PAC and readmission (3+4+5+8+9)

In addition to having different bundles of service, the data was also subdivided into four subpopulations:

- All episodes ("All")
- Only episodes in which there was institutional PAC ("Inst PAC")
- Only episodes in which there was institutional PAC or home health services ("Any PAC")
- Only episodes in which there were no institutional PAC or home health services ("No PAC")

In addition to specifying the content of the payment bundle and the subpopulations of data, the reports will indicate the episode window (30 or 90) and the readmission logic used (all cause or PPRs). Acuity is indicated by a 1 or 2 where 1 means that no major complications or co-morbidities were present during the trigger hospitalization and a 2 means that a major complication or co-morbidity was present during the trigger hospitalization.

There were nine reports produced using the following parameters:

List of Parameters for the Reports

Report	Episode Window	Payment Charges	Patient Subpopulation	Report Level	Readmission
1	30/90	Payment	All	MS-DRG, Acuity	All Cause, PPR
2	30/90	Payment	All	MS-DRG, Acuity	All Cause, PPR
3	30/90	Both	All, Any PAC, Inst	MS-DRG	All Cause, PPR
4	30/90	Payment	All, Any PAC	MS-DRG, Acuity,	All Cause, PPR
5	30/90	Payment	All, Any PAC	MS-DRG, Acuity	All Cause, PPR
6	90	Payment	All, Any PAC	MS-DRG, Acuity	All Cause, PPR
7a	30/90	Payment	All, Any PAC, Inst	MS-DRG, Acuity	All Cause
7b	30/90	Payment	All, Any PAC, Inst	State	All Cause, PPR
7c	30/90	Payment	All	MSA	PPR
7d	30/90	Payment	All	Condition, MSA	PPR
8	30/90	Both	All, Any PAC, Inst	MS-DRG, CRG	All Cause, PPR
9	30/90	Payment	All, Any PAC	MS-DRG, Acuity,	All Cause, PPR
10	30/90	Payment	All	MS-DRG, Acuity,	All Cause

Report 1 focuses on average payments for various service bundles and on the probability that a particular service will be used. An extract from report 1 is on the following page. Report 1 contains separate Reports for 30 and 90 day windows and all cause and PPR readmissions; the extract is for a 90 day window with PPRs. The first column is the three digit MS-DRG number. Acuity is the MS-DRG severity level - 1 for no for minor complication or co-morbidity (CC); 2 for major CC. The next column is the MS-DRG description. Next is the number of cases in the analysis data for this MS-DRG/acuity. In the extract the MS-DRG is Intracranial hemorrhage or cerebral infarction, MS-DRG number 064 with the two acuity levels. Acuity 1 had 10740 cases; acuity 2 1989 cases.

In the report 1 extract, the 6th column (Average PAC + Readm) is the average institutional PAC, home health and readmission payments for the episode. The 7th column (Average Entire Episode minus Post D/C), adds the facility plus physician payments for the inpatient trigger event to the bundle. The 8th column (Average PAC Payment) is the institutional PAC and home health payments.

The next six columns present the percent of beneficiaries in an episode who use a particular service or set of services. Thus, from the report 1 excerpt, 63.7 percent of the individuals in MS-DRG 064 at acute 1 had a PAC service (SNF, IRF, or LTCH or HH). The percent using a PAC service in MS-DRG 64 but with acuity 2 is higher at 65.5%. LTCH is the least common first site of post discharge care. These institutions are common in some areas but rare in many others. Less than one percent of persons discharged with these DRGs used only outpatient therapies.

In the complete set of report 1s, the average payment and percent of episodes with PAC services are slightly higher for the longer (90 day) window. Eighty plus percent of patients with hip fractures used at least one of the PAC services; SNF in particular. This percent was less for major small and large bowel procedures where home health was used almost as often as SNF. Generally, about one half patients with coronary problems used PAC services; most commonly home health. The percent using SNF and home health increases slightly for the ninety day window, implying that the need is most often immediate upon discharge.

Patients who use SNFs tend to have had significant procedures while medical patients use fewer PAC services, but more home health. IRF is also more common for individuals who have had major procedures. LTCHs are not common so it is difficult to detect a pattern. Most individual who used PAC services also used other services post discharge.

Report 1: Payments by MS-DRG and Acuity by services included in 90 day episode bundle across all episodes, PPRs

								% Using PAC as First Site				
MS DRG	Acuity	Description	Cases	Average PAC + Readmit Payment	Average Trigger hosp + PAC + Readmit Payment*	Average PAC Payment	Pct Using any of the 4 PAC sites	SNF	HH	IRF	LTCH	Pct Using Only OP Therapy
064	1	Intracranial hemorrhage or cerebral infarction	10740	$14,641	$22,692	$12,995	63.7	26.1	14.1	22.8	0.7	0.60
064	2	Intracranial hemorrhage or cerebral infarction	1989	$18,222	$28,565	$15,539	65.5	34.8	10.5	18.0	2.1	0.40

* services not furnished during an inpatient hospital stay, institutional PAC stay or home health are excluded.

Report 2 is focused on differences between those who use PAC services or a particular type of PAC service first (Data Subset). An extract from report 2 is on the following page. Report 2 contains separate Reports for 30 and 90 day windows and all cause and PPR readmissions; the extract is for a 90 day window with PPRs. The 4th column begins with All Episodes. Subsequent rows contain only those who used some PAC service, then those whose first PAC service use was LTCH, then those whose first PAC service use was IRF and so on. The first four columns are the same as Report 1, but the rows are distinguished in terms of whether PAC services were used and which PAC service was used first. When LTCH and IRF are used first, the episode is often more expensive (higher payments); possibly reflecting the fact that these are relatively expensive sites of care. Readmissions are often $3000 or less, on average, the lower average payment reflecting that readmissions are relatively infrequent. PAC MD - physician services and outpatient therapy - are generally relatively inexpensive. The 90 day window results in slightly higher spending.

Patients who use only home health are less expensive than those who used some institutional PAC. However, though no PAC use of any kind is sometimes (but not always) less expensive, the difference is never large. LTCH is not always available in an area, but when this kind of hospital is used, expenses are high. Of course, individuals admitted to LTCHs should require additional services. When SNF is the first PAC, costs are similar to those for the "any institutional PAC". However, since SNF costs dominate this category, this is expected

Report 2: Payment by services included in 90 day episode bundle by data subset by MS-DRG and Acuity, PPRs

					Services							Readmission	
MS DRG	Acuity	Description	Data Subset	Episode Count	Hospital + PAC + Readmt	Trigger Hospital	Any PAC	PAC MD	Readmits	Outpatient Therapy	Other Post Discharge	Rate	Group
064	1	Intracranial hemorrhage or cerebral infarction	1. All Episodes	10740	$22,692	$8,051	$12,995	$95	$1,533	$18	$2,066	15.71	1. Total
064	1	Intracranial hemorrhage or cerebral infarction	1. All Episodes	1687	$38,078	$8,297	$19,834	$171	$9,760	$15	$2,774	100.00	2. With Readmission
064	1	Intracranial hemorrhage or cerebral infarction	1. All Episodes	9053	$19,824	$8,005	$11,721	$81	$0	$18	$1,934	0.00	3. No Readmission
064	1	Intracranial hemorrhage or cerebral infarction	2. PAC Used (all SNF,IRF, LTCH,HHA)	6838	$30,770	$8,150	$20,411	$149	$2,041	$20	$2,315	20.39	1. Total
064	1	Intracranial hemorrhage or cerebral infarction	2. PAC Used (all SNF,IRF, LTCH,HHA)	1394	$42,576	$8,338	$24,003	$207	$10,012	$16	$2,795	100.00	2. With Readmission
064	1	Intracranial hemorrhage or cerebral infarction	2. PAC Used (all SNF,IRF, LTCH,HHA)	5444	$27,747	$8,102	$19,491	$134	$0	$21	$2,192	0.00	3. No Readmission
064	1	Intracranial hemorrhage or cerebral infarction	3. PAC Institutional (SNF,IRF,LTCH)	5404	$35,394	$8,231	$24,721	$187	$2,231	$24	$2,450	21.74	1. Total
064	1	Intracranial hemorrhage or cerebral infarction	3. PAC Institutional (SNF,IRF,LTCH)	1175	$46,510	$8,392	$27,594	$246	$10,259	$19	$2,805	100.00	2. With Readmission
064	1	Intracranial hemorrhage or cerebral infarction	3. PAC Institutional (SNF,IRF,LTCH)	4229	$32,306	$8,187	$23,922	$171	$0	$26	$2,352	0.00	3. No Readmission
064	1	Intracranial hemorrhage or cerebral infarction	4. LTCH - FIRST PAC	74	$51,702	$9,271	$39,156	$206	$3,063	$6	$4,217	22.97	1. Total
064	1	Intracranial hemorrhage or cerebral infarction	4. LTCH - FIRST PAC	17	$70,606	$8,507	$48,488	$277	$13,334	$0	$4,839	100.00	2. With Readmission
064	1	Intracranial hemorrhage or cerebral infarction	4. LTCH - FIRST PAC	57	$46,064	$9,499	$36,373	$185	$0	$7	$4,031	0.00	3. No Readmission
064	1	Intracranial hemorrhage or cerebral infarction	5. IRF - FIRST PAC	2450	$39,049	$8,203	$28,651	$238	$1,913	$43	$3,402	19.27	1. Total
064	1	Intracranial hemorrhage or cerebral infarction	5. IRF - FIRST PAC	472	$52,009	$8,266	$33,457	$318	$9,931	$37	$3,875	100.00	2. With Readmission
064	1	Intracranial hemorrhage or cerebral infarction	5. IRF - FIRST PAC	1978	$35,957	$8,188	$27,505	$219	$0	$44	$3,289	0.00	3. No Readmission

In **Report 3** the percentile columns for each MS-DRG/acuity are a weighted average of the difference of the mean expenditures in a CRG/severity cell and the percentile value of the cell. The computation of the weighted average difference only included cells with at least 10 patients and was done as follows.

$$\frac{\sum_{g} (Pg-Ag)Ng}{\sum_{g} Ng}$$

g = CRG status/severity cell

Pg = Payment percentile value for CRG status/severity cell g

Ag = Average payment for CRG status/severity cell g

Ng = Number of patients in CRG status/severity cell g

From the report 3 extract on the next page, for the Intracranial hemorrhage or cerebral infarction, MS-DRG number 064 and considering the total of all services during the episode, the weighted average difference between the value of the 75th percentile and the average in each CRG/severity cell is $37,062. The computation of the weighted average difference includes cells with at least 10 patients. R^2 and CV include all patients. The report treats patients with different CRG status and severity as different episodes. Each service category (the rows) report the payment percentile differences then R^2, and then the coefficient of variation (CV). Results are provided for all, all PAC users, institutional PAC users, and HHA users.

The weighted average of the difference between the value of the percentile and the average in the CRG/severity cells gets larger as the percentile increases. This is consistent with a log-normal distribution; the expected distribution for financial variables like cost and payments. This is because neither cost nor payments can be less than zero, but they can be quite large. In other words, the log-normal distribution reflects the fact that a relatively few high cost individuals are responsible for a large share of Medicare spending.

The coefficient of variation is the standard deviation divided by the mean. This measures the homogeneity of the categories. Though somewhat arbitrary, CV values less than one are generally considered acceptable. Higher values mean that there is considerable variation within the category. The weighted (by episode volume) CV is a convenient summary statistic similar to the case mix index for DRGs.

The CV values are much less than 1.0 for the total and for the trigger event for all of the selected common conditions. This is to be expected as the calculation is based on payments and the trigger event payment (a significant part of the total) is based on MS-DRGs. The CV values are higher (generally more than 1.0) for the other payment categories. Note that the counts remain constant for each payment category.

The last column is Power. This is the number of cases needed to be within plus or minus 10% of the national average 90% of the time. The required number is related to the CV; as the CV gets larger, the number of cases needed to achieve a given level of precision increases. Thus, when the CV is 0.248, only 17 cases are needed, but when the CV is 1.339, 488 cases are needed to achieve the same level of precision.

The above results (with the exception of the trigger event) include real zero values, i.e., there are individuals who did not use the service in question.

Report 3: Payment showing statistics by services included in 90 day episode bundle, by MS-DRG, all episodes, PPR

					Difference in Percentile from mean							
DRG	Desc	Patient Group	Cases	Mean	p10	p25	p50	p75	p90	CV	STD	Power
064	Intracranial hemorrhage or cerebral infarction	01. Total	12729	25715	8399	10179	18512	37062	53689	0.746	19191.59	151.64
064	Intracranial hemorrhage or cerebral infarction	02. Trigger Event	12729	8409	6860	7461	8067	8756	10531	0.248	2088.97	16.80
064	Intracranial hemorrhage or cerebral infarction	03. Any PAC	12729	13393	0	0	5506	23486	38246	1.216	16280.87	402.34
064	Intracranial hemorrhage or cerebral infarction	04. PAC Facility	12729	11900	0	0	1789	20736	36008	1.339	15931.84	488.00
064	Intracranial hemorrhage or cerebral infarction	05. Home Health Only	12729	1493	0	0	0	2437	5157	1.717	2563.52	802.81
064	Intracranial hemorrhage or cerebral infarction	06. PAC Facility MD	12729	98	0	0	0	158	282	1.799	176.84	881.09
064	Intracranial hemorrhage or cerebral infarction	07. Readmission Facility & MD	12729	1693	0	0	0	0	6973	3.045	5155.19	2524.09
064	Intracranial hemorrhage or cerebral infarction	08. Outpatient Therapy	12729	16	0	0	0	0	0	11.512	186.56	36083.27
064	Intracranial hemorrhage or cerebral infarction	09. Other Post Discharge Services	12729	2106	354	702	1480	2724	4470	1.091	2296.37	323.80
064	Intracranial hemorrhage or cerebral infarction	10. Tot Less Oth Post Dis Services	12729	23609	7551	8394	16429	34163	51307	0.782	18452.16	166.30
064	Intracranial hemorrhage or cerebral infarction	11. PAC with MD and Readmits	12729	15200	0	0	8033	25711	42001	1.185	18008.24	382.13

Report 4 presents admission rates by condition, CRG status and CRG severity level. The total count for each condition is found in the sixth column. The next columns in the Report organize the readmission rates by the CRG severity level within the base MS-DRG/acuity/CRG status (which defines the episode). Each severity level is divided into two columns, count of episodes and the readmission rate. The results may not be stable at the level of an individual episode severity cell because readmission rates are sometimes based on relatively few episodes. It seems reasonable to expect that:

a) readmissions will be less common in low severity cells – which are usually well populated, while,

b) readmissions will be more common in high severity cells – cells which may be less populated.

However, these expectations are not clearly supported by the results. While it does appear that volume decreases as severity increases, this trend is not strong. There is no clear pattern in terms of medical versus surgical episodes in terms of readmission rates.

Most important, readmissions, while not rare, are not common. The rates are commonly in the five to twenty percent range. Readmissions are paid at the rate for MS-DRGs, which is high relative to other cost categories. Finally, individual readmissions are difficult to predict, even with a clinical model.

Report 4: Readmission rates by MS-DRG and Acuity by CRG status and severity, across all episodes, PPR

					Severity									
					Level 1		Level 2		Level 3		Level 4		Level 5	
MS DRG	Acuity	Description	CRG Status	Total Episodes	Episode Count	Rate Readmit	Episode Count	Rate Readmit	Episode Count	Rate Readmit	Episode Count	Rate Readmit	Episode Count	Rate Readmit
064	1	Intracranial hemorrhage or cerebral infarction	5	789	460	7.0	134	11.2	115	8.7	---	---	80	11.3
064	1	Intracranial hemorrhage or cerebral infarction	6	5769	836	10.4	1183	12.8	1088	13.5	1670	15.0	992	17.5
064	1	Intracranial hemorrhage or cerebral infarction	7	3735	305	11.1	548	14.8	1401	18.8	582	19.4	899	26.1
064	1	Intracranial hemorrhage or cerebral infarction	8	357	105	15.2	187	19.3	65	18.5				
064	1	Intracranial hemorrhage or cerebral infarction	9	90	38	15.8	36	22.2	16	37.5				
064	2	Intracranial hemorrhage or cerebral infarction	5	54	10	10.0	4	25.0	20	15.0	---	---	20	10.0
064	2	Intracranial hemorrhage or cerebral infarction	6	720	25	16.0	45	8.9	76	9.2	263	15.2	311	22.2
064	2	Intracranial hemorrhage or cerebral infarction	7	781	14	14.3	41	19.5	252	20.6	133	24.1	341	21.1
064	2	Intracranial hemorrhage or cerebral infarction	8	100	11	0.0	60	11.7	29	6.9				
064	2	Intracranial hemorrhage or cerebral infarction	9	334	21	19.0	127	24.4	186	34.4				

Report 5 presents the overall readmission rate (column 6) and then columns 7 - 9 present the timing of the readmission:

- Within 3 days of hospital discharge,
- During the use of SNF, IRF, LTCH or HHA services but excluding the first 3 days after hospital discharge
- After the PAC service ends (but within the episode window).

The full version includes separate Reports for:

- 30-day and 90 day windows,
- Potentially preventable readmissions (as distinct from all cause readmissions),
- Episodes where any PAC service was used - as distinct from all episodes.

One might expect readmissions to occur more often during the first three days from discharge. This is often, but not always true. For example, for individuals in Report 5 in DRG 064 (Intercranial hemorrhage or cerebral infarction, acuity 1) the rate for the first 3 days is 1.7% while the rate for the subsequent days is 10.8% for those readmitted during PAC services and 7.9% for those readmitted after the PAC services were completed but before the end of the 90 episode window. Readmissions longer than three days from discharge from the hospital are more common during PAC use than following PAC use. Note that the rates presented in the table do not overlap. Thus, one can sum readmissions for 3 days or less to the more than 3 days during PAC use and more than 3 days following PAC use. This total is 20.4% for DRG 064, acuity 1.

Report 5: Readmission for all episodes and episodes with PAC by time interval by MS-DRG and Acuity across all episodes, 90 day window

					Readmission Rate for Episodes with Any PAC			
MS DRG	Acuity	Description	Episode Count	Readmission Rate for all episodes	Overall	Within 3 days of Discharge	> 3 days during PAC	> 3 days after PAC ends but before end of episode window
064	1	Intracranial hemorrhage or cerebral infarction	10740	15.7	20.4	1.7	10.8	7.9
064	2	Intracranial hemorrhage or cerebral infarction	1989	20.4	26.5	2.1	16.9	7.5

Report 6. Report 6 is focused on two issues. The first is the percent of episode payments (all payments and PAC payments) for a 90 day window which occur in 30 days. The second is the readmission rate for the 90 day window and the percent of these readmissions which occur in 30 days. This information is provided for all episodes (i.e., episodes with and without PAC).

For the selected conditions at least two-thirds of the post acute care payments were made in the first 30 days. Readmissions are fairly common 20 – 30% for individuals in the selected conditions. Roughly two-thirds to one-half of readmissions occur in the first 30 days.

Report 6: Proportion of payments and readmissions for 90 day episodes occurring within 30 days by MS-DRG and Acuity for all episodes, PPRs

MS DRG	Acuity	Description	Cases	30 day percent of 90-day episode payments	30 day percent of 90-day Any PAC payments	Readmission rate for 90 day episodes	Percent of 90-day readmissions that occur within 30 days
064	1	Intracranial hemorrhage or cerebral infarction	10740	77.0	66.6	15.7	52.4
064	2	Intracranial hemorrhage or cerebral infarction	1989	72.6	58.6	20.4	57.3

Report 7a computes payments with and without trimming by MS-DRG and Acuity by services included. Trimming was done by removing top 10th percentile in spending within each cell (where the cell includes CRG-severity). These simple averages are a first step in considering the potential use of bundles of acute and PAC services for payment. Since "Trimmed" means that the most expensive ten percent of the cases have been removed from the data, trimming reduces the average of the payments. Restricting the sample to any PAC generally increases the average as does further restricting the sample to institutional PAC services. When the window is increased to 90 day the average payment is higher as the additional services provided in the additional 60 days are counted. However, as seen above, services are concentrated in the earlier part of the stay, so the increase is not large. Generally, higher acuity results in higher payments.

However, the most important observation from this report is that the trigger event itself represents a significant part of the payments. For example, for Intracranial hemorrhage or cerebral infarction, acuity 1 the average payment for the entire episode (untrimmed) is $ 26,306 while the trigger event (untrimmed) makes up 31% of the payment ($8044). This relationship is actually lower than is typical for most episode types.

Report 7a: Payments with and without trimming by MS-DRG and Acuity by services included in 90 day episode bundle across all episodes, PPRs

			Cases		Entire Episode		Trigger Hospital + MD		Trigger Hosp + MD + Readmits		Any PAC		Any PAC + Readmits		Any PAC + Readmits + Readmit MD		Any PAC + Readmits + Readmit MD + Other Post Discharge Services	
MS DRG	Acuity	Description	No Trim	Trim	No Trim	Trim	No Trim	Trim	No Trim	Trim	No Trim	Trim	No Trim	Trim	No Trim	Trim	No Trim	Trim
064	1	Intracranial hemorrhage or cerebral infarction	10511	9452	26306	21601	8044	7974	10807	9870	13209	9630	15652	11310	15972	11526	18262	13627
064	2	Intracranial hemorrhage or cerebral infarction	1751	1570	33988	28510	10402	10146	14650	12974	16693	13232	20415	15704	20940	16060	23586	18363

Report 7b, 7c, and 7d are based on the difference between actual and expected payments. This means that when actual payments are lower than expected, providers in the area are relatively efficient. This report was provided at various levels including State (7b), Metropolitan Statistical Area (MSA) (7c). A separate report was provided for the 10 MSAs and states with the highest and lowest difference between actual and expected episodes payments (30-day, 90-day, separate and combined bundles) by condition (7d). A national average was also included. There are three numbers in each cell: the State actual average, the expected risk adjusted average based on national average, and the difference. The expected average adjusts for patient mix using the based MS-DRG, acuity level and CRG. For example, in Report 7b, the first State, Louisiana, has the highest difference between actual and expected payments. In contrast, Alaska had lower than expected payments. Again, areas where expected payments are higher than actual are likely to do well under a system where post acute services are bundled.

Report 7c provides similar information for selected MSAs. For example, Medford Oregon is lower than expected by $604 per episode on average, while Grand Junction Colorado is higher than expected by $606 on average. These estimates assume that provider behavior would not change (i.e., become more efficient) under an episode-based payment system. They are also "budget neutral", meaning that total actual and expected payments total to the same overall amount. Report 7d provides more detail for selected episodes and contains the payment for the top (highest payments) and bottom (lowest payments) five percent of MSAs. For example, for Intracranial hemorrhage or cerebral infarctions the average payment for PAC services is $15,003 in the top MSAs which is $1,899 higher than expected and $10,902 in the bottom MSAs which is $2,033 lower than expected.

Report 7b: Actual and expected 90 day episode payments by services included in episode by state, all episodes, PPRs

			Trigger hosp+ PAC + Readmit			Trigger Hospital + MD			Trigger Hosp + MD + Readmits			Any PAC			Any PAC + Readmits			Any PAC + Readmits + Readmit MD			Any PAC + Readmits+ Readmit MD + Other Post Discharge Services		
State	Description	Count	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff
19	Louisiana	9840	18862	17481	1380	10434	10576	-141	12542	12702	-160	6278	4737	1540	8167	6621	1546	8385	6863	1521	10792	9209	1582
7	Connecticut	7759	18723	17501	1221	10321	10451	-131	12313	12426	-113	6352	5030	1321	8120	6780	1340	8344	7005	1339	10504	9296	1209
31	New Jersey	18720	18997	17802	1196	11067	10604	463	13573	12760	812	5360	4996	363	7475	6903	573	7865	7152	713	10271	9544	727
22	Massachusetts	14002	18024	16843	1181	9931	10079	-148	11830	11985	-155	6148	4815	1333	7860	6505	1355	8047	6721	1326	10388	8999	1389
45	Texas	38967	19515	18375	1140	11075	11159	-83	13155	13285	-129	6309	5045	1264	8150	6927	1222	8389	7171	1218	11060	9564	1496
29	Nevada	3168	19064	18199	865	11231	11233	-2	13172	13190	-18	5832	4964	867	7515	6697	818	7773	6922	851	10429	9243	1187
10	Florida	38456	18715	17902	813	11155	11001	154	13160	12995	164	5504	4863	641	7220	6628	592	7509	6857	652	10224	9189	1035
15	Indiana	14521	18722	18178	544	10870	11011	-141	12765	13047	-281	5908	5086	822	7608	6889	719	7804	7121	682	10058	9430	628
14	Illinois	27763	17579	17075	504	10217	10244	-28	12414	12195	218	5116	4836	280	7048	6565	483	7313	6787	526	9486	9076	410
30	New Hampshire	2550	18325	17945	380	10797	10810	-13	12587	12738	-151	5698	5161	537	7336	6874	462	7488	7089	399	9858	9352	506
24	Minnesota	8296	15499	16909	-1409	10545	10691	-146	12036	12351	-314	3425	4516	-1091	4787	5992	-1205	4916	6176	-1260	6839	8400	-1561
13	Idaho	2003	15714	17219	-1505	10482	10791	-309	11625	12486	-860	4056	4690	-634	5116	6196	-1080	5199	6385	-1186	7176	8543	-1367
27	Montana	2271	15580	17178	-1598	10426	10571	-145	11803	12274	-471	3746	4861	-1114	5026	6375	-1349	5123	6564	-1440	6875	8691	-1817
16	Iowa	7342	14935	16801	-1866	10191	10350	-159	11699	12133	-434	3203	4626	-1423	4581	6211	-1630	4711	6409	-1697	6541	8591	-2050
38	Oregon	4176	15691	17941	-2250	11211	11342	-131	12563	13089	-527	3092	4808	-1716	4330	6359	-2029	4444	6555	-2111	6346	8749	-2403
12	Hawaii	1251	15415	18303	-2888	10984	11154	-170	12576	13175	-599	2812	5082	-2270	4247	6873	-2627	4404	7103	-2699	6333	9404	-3071
40	Puerto Rico	1611	13698	16591	-2893	10215	9877	338	12527	12078	449	1158	4473	-3315	3086	6416	-3330	3470	6674	-3204	5762	9200	-3439
2	Alaska	675	13600	17484	-3884	10714	10841	-127	11920	12653	-733	1668	4789	-3121	2779	6400	-3621	2874	6601	-3727	4585	8817	-4232
48	Virgin Islands	89	13988	18321	-4334	10327	10840	-513	12168	12630	-462	1815	5645	-3830	3558	7253	-3694	3656	7435	-3779	4672	9710	-5037
65	Guam	4	15573	20307	-4734	8013	8828	-815	8013	10895	-2883	7538	9347	-1809	7538	11191	-3653	7538	11414	-3876	8705	13515	-4810

Report 7c: Actual and expected 90 day episode payments by services included in episode by MSA, all episodes, PPRs

			Trigger hosp+ PAC + Readmit			Trigger Hospital + MD			Trigger Hosp + MD + Readmits			Any PAC			Any PAC + Readmits			Any PAC + Readmits + Readmit MD			Any PAC + Readmits+ Readmit MD + Other Post Discharge Services		
MSA	Description	Count	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff
11540	Appleton, WI	265	17687	16929	758	11038	11167	-130	12411	12693	-282	5239	4199	1039	6522	5592	930	6612	5725	887	8551	7928	623
13380	Bellingham, WA	300	17806	17398	408	12549	12638	-89	14252	14181	71	3505	3179	326	5058	4569	488	5207	4721	486	7321	6759	562
20940	El Centro, CA	181	13936	14369	-433	9922	9886	35	11354	11191	163	2565	3139	-574	3819	4297	-478	3998	4444	-446	6323	6616	-293
21300	Elmira, NY	296	15580	15932	-352	10469	10450	19	12086	12255	-169	3452	3634	-182	4874	5245	-371	5068	5438	-369	6961	7591	-630
24020	Glens Falls, NY	284	16219	14984	1235	10151	10105	46	12426	11726	700	3759	3229	530	5807	4695	1112	6033	4849	1184	8189	6991	1198
24300	Grand Junction, CO	230	17757	17152	606	12264	12045	219	13900	13134	766	3804	3970	-166	5249	4944	305	5440	5059	381	7736	7252	484
26180	Honolulu, HI	929	16123	16719	-596	11736	11707	29	13332	13358	-27	2760	3328	-569	4185	4808	-624	4355	4979	-624	6429	7183	-754
29100	La Crosse, WI-MN	364	17332	17278	54	11950	12094	-144	13550	13597	-47	3734	3641	93	5164	4982	182	5334	5144	190	7194	7195	-1
31460	Madera, CA	65	14513	13474	1038	8150	8032	119	9518	9698	-181	4966	3747	1219	6178	5256	922	6333	5414	919	8176	7337	839
32780	Medford, OR	444	16483	17087	-604	11949	11928	22	13365	13542	-178	3078	3500	-422	4357	4955	-598	4493	5115	-621	6959	7376	-416
42060	Santa Barbara-Santa Maria-Goleta, CA	618	17260	16578	682	11370	11406	-36	12879	12868	11	4329	3668	662	5694	4988	706	5839	5130	709	8153	7288	865
42220	Santa Rosa-Petaluma, CA	559	16482	16745	-263	11041	11058	-17	12218	12411	-193	4227	4292	-66	5285	5507	-222	5403	5646	-242	7686	7830	-144

Report 7d: Actual and expected 90 day episode payments by services included in episodes by conditions for five percent highest (Top) and lowest (Bottom) MSAs, PPRs

Cond	Description	Acuity	Top Bottom	Count	Trigger hosp+ PAC + Readmit			Trigger Hospital + MD			Trigger Hosp + MD + Readmits			Any PAC			Any PAC + Readmits			Any PAC + Readmits + Readmit MD			Any PAC + Readmits+ Readmit MD + Other Post Discharge Services		
					Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff	Act	Exp	Diff
064	Intracranial hemorrhage or cerebral infarction	1	Top	2139	25464	22872	2592	8290	8076	214	10331	9655	676	15003	13104	1899	16779	14501	2278	17044	14683	2361	19489	16874	2615
064	Intracranial hemorrhage or cerebral infarction	1	Bottom	1384	20252	22544	-2293	7947	8024	-77	9262	9497	-236	10902	12935	-2033	12084	14239	-2155	12217	14408	-2191	14071	16563	-2492
064	Intracranial hemorrhage or cerebral infarction	1	All	3523	23416	22743	673	8155	8056	100	9911	9593	318	13392	13037	355	14934	14398	537	15148	14575	573	17360	16752	609
064	Intracranial hemorrhage or cerebral infarction	2	Top	441	30429	28683	1746	10601	10408	193	13855	13075	779	16439	15482	958	19186	17812	1374	19693	18149	1544	22477	20628	1849
064	Intracranial hemorrhage or cerebral infarction	2	Bottom	214	23753	28132	-4379	10418	10296	121	12923	12860	63	10740	15148	-4408	12969	17388	-4420	13246	17712	-4466	15401	20206	-4804
064	Intracranial hemorrhage or cerebral infarction	2	All	655	28248	28503	-255	10541	10372	170	13550	13005	545	14577	15373	-795	17154	17674	-519	17586	18006	-420	20166	20490	-325

Report 8 presents R^2 values for MS-DRGs/ACRGs for payments and charges across different episode windows, approaches to readmission and different bundles of service. R^2 measures the ability of a classification system to estimate expected resource use accurately. In the context of a payment system this is important because it relates to the level of payment accuracy and provider financial risk.

The first three columns in Report 8 specify the episode window length, the approach to readmissions (PPRs, all cause) and the financial measure (payments, charges). The next four rows define the scope of the service bundle as follows:

- Trigger hospitalization + PAC + HH + readmissions + associated MD services
- Trigger hospitalization + PAC + HH + associated MD services
- PAC + HH + associated MD services
- PAC + HH + readmissions + associated MD services

An inclusive bundling alternative that includes the trigger hospitalization, PAC, home health, readmissions and associated MD services. For this bundle the R^2 for charges with PPRs is 61.96% at 30 days and 44.52% for 90 and 30 days, respectively. Since Medicare payments for inpatient hospital care are based MS-DRGs, the relatively high R^2 for payments for service bundles that include the trigger hospitalization reflects the fact that the episodes are build on the current IPPS payment method. Since the larger bundle is predicting subsequent resource use, these results for charges are surprisingly good. Of course, the great advantage of an inclusive bundle is that the incentives created are for efficient utilization of both acute and PAC services across the spectrum.

Report 8: R^2 for charges and payment within the bundle by services included in 30, 90 day episode across all episodes, PPRs and all cause

Window	Readmit	Financial Measure	Hosp Trigger, PAC, HH, and Readmit with MD	Hosp Trigger, PAC, HH with MD	PAC, HH with MD	PAC, HH and Readmit with MD
30	PPR	Payments	61.96	67.18	22.09	17.49
90	PPR	Payments	44.52	53.04	18.65	14.77
30	All cause	Payments	55.67	67.58	22.35	13.28
90	All cause	Payments	36.25	51.39	18.10	12.10
30	PPR	Charges	39.26	42.99	16.52	7.90
90	PPR	Charges	33.94	42.13	15.70	8.32
30	All cause	Charges	34.93	42.99	16.86	5.35
90	All cause	Charges	27.16	41.57	15.03	6.74

Report 9 presents the average payment for the combination of MS-DRGs and ACRG status (5 – 9) and ACRG severity level (1 -5) for various service packages. This excerpt continues to use DRG 064, Intracranial hemorrhage or cerebral infarction. This report shows that it would be possible to establish prices that vary by acuity (MS-DRGs) and burden of chronic comorbidities (CRGs). Where there are a small number of episodes in any MS-DRG/CRG cell, larger aggregations of the classifications may be used to establish and accurate payment level.

Report 9: Payment by Condition by CRG Status and Severity Level by sources included in 90 day episode, all episodes, PPR

						Severity				
MS DRG	Acuity	Description	Patient Group	CRG Status	Count	Level 1	Level 2	Level 3	Level 4	Level 5
064	1	Intracranial hemorrhage or cerebral infarction	01. Trigger plus PAC plus HH plus readmit with MD	5	845	17802	27885	24472	0	24403
064	1	Intracranial hemorrhage or cerebral infarction	02. Trigger Event	5	845	7642	7760	7907	0	7566
064	1	Intracranial hemorrhage or cerebral infarction	03. Trigger Event and readmissions	5	845	8945	9979	9463	0	9332
064	1	Intracranial hemorrhage or cerebral infarction	04. All PAC	5	845	8764	17777	14907	0	14926
064	1	Intracranial hemorrhage or cerebral infarction	05. PAC Less HH	5	845	7649	15616	13372	0	13832
064	1	Intracranial hemorrhage or cerebral infarction	06. HH	5	845	1115	2162	1535	0	1094
064	1	Intracranial hemorrhage or cerebral infarction	07. Readmissions - includes MD services	5	845	1303	2219	1556	0	1765
064	1	Intracranial hemorrhage or cerebral infarction	08. PAC plus readmissions	5	845	10067	19996	16463	0	16691
064	1	Intracranial hemorrhage or cerebral infarction	09. PAC plus readmissions Less Home Health	5	845	8951	17835	14928	0	15597
064	1	Intracranial hemorrhage or cerebral infarction	10. HH plus readmissions	5	845	2418	4381	3091	0	2859
064	1	Intracranial hemorrhage or cerebral infarction	15. All PAC and Readmits with PAC / Readmit MD	5	845	10160	20125	16566	0	16836
064	1	Intracranial hemorrhage or cerebral infarction	16. PAC and Readmits with PAC / Readmit MD no HH	5	845	9045	17964	15030	0	15738
064	1	Intracranial hemorrhage or cerebral infarction	17. HH with Readmits w/no Institutional PAC	5	845	2448	4419	3094	0	2899
064	1	Intracranial hemorrhage or cerebral infarction	01. Trigger plus PAC plus HH plus readmit with MD	6	5819	19843	22137	24252	25426	26207
064	1	Intracranial hemorrhage or cerebral infarction	02. Trigger Event	6	5819	7670	7838	7949	8060	8250
064	1	Intracranial hemorrhage or cerebral infarction	03. Trigger Event and readmissions	6	5819	9662	10213	10313	10816	10953
064	1	Intracranial hemorrhage or cerebral infarction	04. All PAC	6	5819	10090	11814	13813	14487	15135
064	1	Intracranial hemorrhage or cerebral infarction	05. PAC Less HH	6	5819	8770	10484	12246	12794	13387
064	1	Intracranial hemorrhage or cerebral infarction	06. HH	6	5819	1321	1329	1566	1693	1749
064	1	Intracranial hemorrhage or cerebral infarction	07. Readmissions - includes MD services	6	5819	1992	2374	2364	2756	2702
064	1	Intracranial hemorrhage or cerebral infarction	08. PAC plus readmissions	6	5819	12082	14188	16177	17243	17838
064	1	Intracranial hemorrhage or cerebral infarction	09. PAC plus readmissions Less Home Health	6	5819	10761	12859	14610	15550	16089
064	1	Intracranial hemorrhage or cerebral infarction	10. HH plus readmissions	6	5819	3312	3704	3930	4449	4451

Report 10 presents the percent of users of PAC services by CRG status and severity. For example, Intracranial hemorrhage or cerebral infarction. Acuity 1 CRG status 6 has 5819 episodes. 64.0% of these use some PAC services. The percent for acuity level 2 is similar, at more than 50%. In general, the percent tends to increase as CRG status and severity increase. However, this is not always true, even for episodes with a relatively large N size.

Report 10: Percent of episodes that use PAC by MS-DRG and Acuity, by CRG and severity across all episodes, all cause

						Severity									
						Level 1		Level 2		Level 3		Level 4		Level 5	
MS DRG	Acuity	Description	CRG Status	Total Count	Weighted Average of those who use PAC	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate
064	1	Intracranial hemorrhage or	5	845	56.4	497	46.5	141	74.5	123	63.4	---	---	84	75.0
064	1	Intracranial hemorrhage or	6	5819	64.0	889	53.4	1252	58.2	1144	63.8	1658	68.9	876	74.2
064	1	Intracranial hemorrhage or	7	3426	66.2	315	54.0	552	61.4	1346	66.7	505	71.3	708	70.8
064	1	Intracranial hemorrhage or	8	344	65.1	113	62.8	178	68.5	53	58.5				
064	1	Intracranial hemorrhage or	9	77	63.6	38	63.2	30	63.3	9	66.7				
064	2	Intracranial hemorrhage or	5	58	65.5	15	60.0	4	75.0	20	70.0	---	---	19	63.2
064	2	Intracranial hemorrhage or	6	732	70.8	30	60.0	58	56.9	83	75.9	264	72.7	297	71.4
064	2	Intracranial hemorrhage or	7	624	67.6	13	38.5	45	82.2	222	70.3	105	72.4	239	61.9
064	2	Intracranial hemorrhage or	8	64	65.6	8	62.5	41	65.9	15	66.7				
064	2	Intracranial hemorrhage or	9	273	62.6	18	83.3	119	68.1	136	55.1				

Functional Status Categories

As described in Appendix C, the impact of functional status of service use during an episode was examined using a composite 9-way categorization of four domains of functional health status (self care, mobility, cognition and incontinence). In order to examine the impact of functional status on payments/ charges during an episode a series of regression analyses were performed. The independent variables in the regression equations were age, sex, "entered hospital from a nursing home", the nine functional status dummy (0/1) variables corresponding to the nine composite functional categories and expected payment/charge based on the MS-DRG/CRG category assign to a patient. The overall conclusions from the function status analysis are as follows:

- The addition of functional status to the MS-DRG/CRG expected value substantially increases R^2 for a PAC-only bundle (i.e., only institutional PAC and home health)
- The addition of age, sex and admission from a nursing home to functional status (FS) provides only a minimal increase in R^2 for a PAC-only bundle
- For the subset of patients who received PAC services the increase in R^2 due to functional status is substantially lower because the contribution of functional status in predicting the need for PAC services is eliminated since every episode in this subset of beneficiaries used PAC services.
- The addition of functional status to the MS-DRG/CRG expected value results in a minimal increase in R^2 for trigger hospitalization
- The increase in R^2 due to addition of functional status to the MS-DRG/CRG expected value is substantially less for a bundle that includes the both the trigger hospitalization and PAC services versus a PAC-only bundle.

Overall, functional status is an important variable for understanding which patients will get PAC services and the extent of PAC services delivered.

5. Conclusions

The most important conclusions from this research are:

- It is possible to design alternative bundles of services
- The ability to explain variation in charges or payments varies with the composition of the bundle
- R^2 is improved by including chronic comorbidities and functional status in the risk adjustment model
- Long and inclusive bundles with greatest incentive to coordinate care have good R^2 values
- The observed variation in PAC spending and in readmission rates represents opportunities for lower spending.

It is important to combine a measure of chronic illness burden with MS-DRGs to create a bundled acute and post acute care payment system that recognizes the patient characteristic that lead to more post acute care services. The predictive performance within an episode payment system can be further improved if a measure of patient functional status is included in the risk adjustment method.

A higher R^2 is only one of the criteria that needs to be evaluated in assessing alternative payment bundles. More comprehensive bundles provide greater accountability and increased financial incentives to provide greater care coordinating during the post acute care period. While the more comprehensive bundles do result in a lower R^2, the level of predictive performance is still high enough for an operational bundled payment system.

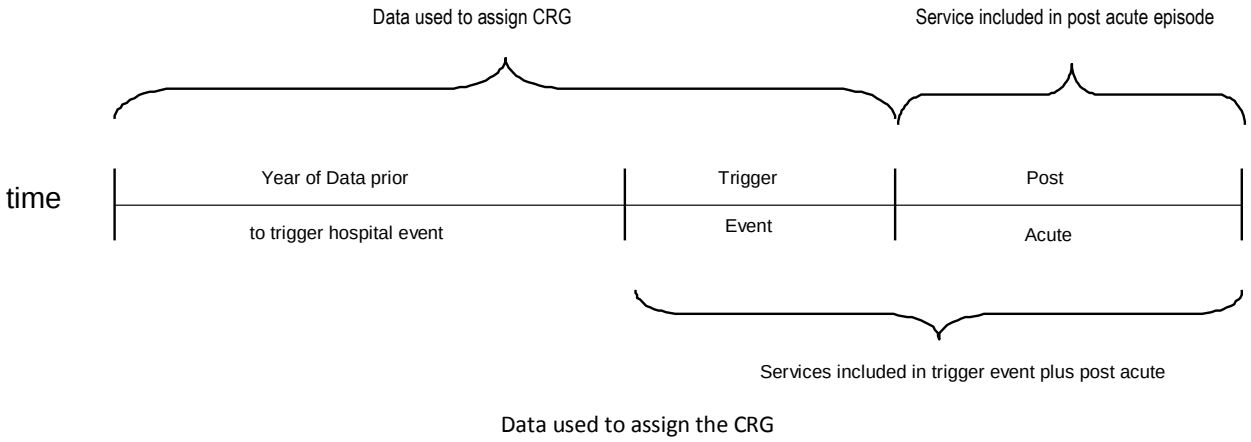
Appendix A

Clinical Risk Groups

This project used MS-DRGs to differentiate unique types of hospital-based episodes. Because MS-DRGs focus on inpatient care, the categorization of patients is largely driven by the time-limited treatment of acute illnesses (e.g., pneumonia) or acute deteriorations of chronic illnesses (e.g., acute exacerbations of heart failure or emphysema) while relatively serious but stable chronic conditions are attached less significance. Because any comprehensive definition of an episode will encompass diverse types of care delivered in different care settings over an extended post discharge period of time, the beneficiary's chronic illness burden as well as the acute illnesses that precipitated the hospitalization will impact post discharge resource use. All beneficiaries in an episode will have a similar baseline cost associated with the hospitalization that precipitated the episode. An episode payment system must further differentiate beneficiaries based on the incremental cost they are expected to incur beyond the baseline hospital cost. Therefore, although patient acuity as measured by MS-DRGs is important for specifying the unique types of episodes, a measure of a patient's chronic disease burden is also needed for differentiating the resources used during an episode.

Clinical Risk Groups (CRGs) are a categorical clinical model that uses standard claims data to assign a beneficiary to a single mutually exclusive category that reflects the chronic illness burden of a beneficiary. Since MS-DRGs and CRGs are independent categorical clinical models, each patient can be assigned to both an MS-DRG and a CRG. This allows each MS-DRG to be differentiated by the CRG category assigned to the beneficiary. Since the assignment of the MS-DRG and the CRG to a beneficiary are independent processes, the two assignments can be combined together for the purpose of predicting resource use within an episode. Essentially, the MS-DRG are used to identify the reason for hospitalization and acuity of the beneficiary during the hospitalization and the CRGs are used to differentiate patients in terms of their chronic disease burden. Based on the CRG assign to the beneficiary each MS-DRG can be subdivided into CRG based subgroups that differentiate resource use during the post acute period that is associated with the beneficiary's chronic illness burden.

As illustrated below, the CRG is assigned using the diagnoses and procedures present during the hospitalization plus any diagnosis and procedures that occurred one year prior to the date of hospital discharge. The resources that are included in the post acute care episode are those resources that were delivered during the episode window starting on the day following discharge.



Data used to assign the CRG

The combination of the base MS-DRG (reason for hospitalization), MS-DRG severity level (acuity) and CRG (chronic illness burden) define unique types of episodes (payment bundles) with each combination having a separate expected level of resource use.

Similar to MS-DRGs, each CRG is composed of a base CRG that describes the patient's most significant chronic conditions and a severity of illness level (e.g., a patient with diabetes and heart failure at severity level 3). There are 272 base CRGs which are subdivided into up to six severity of illness levels for a total of 1,080 CRGs. The 1080 CRGs are also aggregated into three predefined CRG hierarchical consolidations into 416, 151 and 38 CRGs. The aggregated CRGs sacrifice some clinical precision but with only a slight loss of predictive performance. Because the episodes included only beneficiaries who were hospitalized, implying a minimum level severity of illness, the 38 CRG categories were further consolidated into 23 CRG categories. These 23 CRG categories are referred to as ACRGs and range from patients with no significant chronic disease to patients with multiple major chronic diseases at high severity.

Essentially, every combination of a MS-DRG (inpatient episode trigger event), window, and service scope defines a unique type of episode. With a categorical definition of episodes based on the combination of MS-DRGs and CRGs, this diversity is manageable because the process of estimating episode resource use is straightforward and simply involves computing the historical average resource use of patients in each MS-DRG/CRG cell for each unique type of episode. Although the original objective of CRGs was to define chronic illness burden for the purpose of risk adjusting capitated payments, the categorical structure of CRGs allows CRGs to also be used to determine the impact of chronic illness burden for a post acute episode of care.

The purpose of this Appendix is to describe the development and structure of CRGs.

Overview of CRG Clinical Logic

The CRG clinical logic is implemented in four phases.

Phase I	A disease profile and history of past medical interventions is created
Phase II	For each organ system, the most significant primary chronic disease under active treatment is identified and its severity of illness level is determined
Phase III	The primary chronic disease(s) and its (their) associated severity of illness level are used to determine the CRG
Phase IV	The CRGs are consolidated into three successive tiers of aggregation

Figure 1 provides an overview of the process of assigning a CRG.

The four phase process for determining the CRG assignment for an individual is based on precise, hierarchically structured and detailed clinical logic. In particular, the development of clinical logic for identifying individuals with multiple interacting comorbid diseases and their associated severity of illness level has been emphasized.

Phase I: Creation of a Disease Profile and History of Past Medical Interventions

The International Classification of Diseases, 9th Revision, Clinical Modifications (ICD-9-CM) is used to code not only diseases, but also signs, symptoms, findings and other factors influencing health status. Each of the diagnosis codes is categorized into one of 37 mutually exclusive and exhaustive categories referred to as Major Disease Categories (MDCs). The diseases in each MDC correspond to a single organ system (e.g., respiratory system, digestive system, etc.) or etiology (e.g., malignancies, systemic infectious diseases, etc.). With the exception of malignancies and multiple trauma, which were each assigned to their own MDC, diseases that included both a particular organ system and a particular etiology (e.g., urinary tract infection) were assigned to the MDC corresponding to the organ system involved. Systemic infectious diseases such as septicemia were assigned the systemic infections disease MDC. Diabetes was given its own MDC. Some diseases are considered catastrophic (e.g., persistent vegetative state) and are assigned to catastrophic MDCs. The 37 MDCs are listed in Table 1.

The diseases in each MDC are further subdivided into Episode Disease Categories (EDCs). There are a total of 562 mutually exclusive and exhaustive EDCs across the 37 MDCs. Each EDC is assigned to one of six EDC types. Four of the EDC types relate to chronic diseases and two of the EDC types relate to acute diseases. There are several disease progressions that are considered chronic. A disease is classified as chronic if the duration of the disease is lifelong.

Figure 1: Overview of the process of assigning a CRG

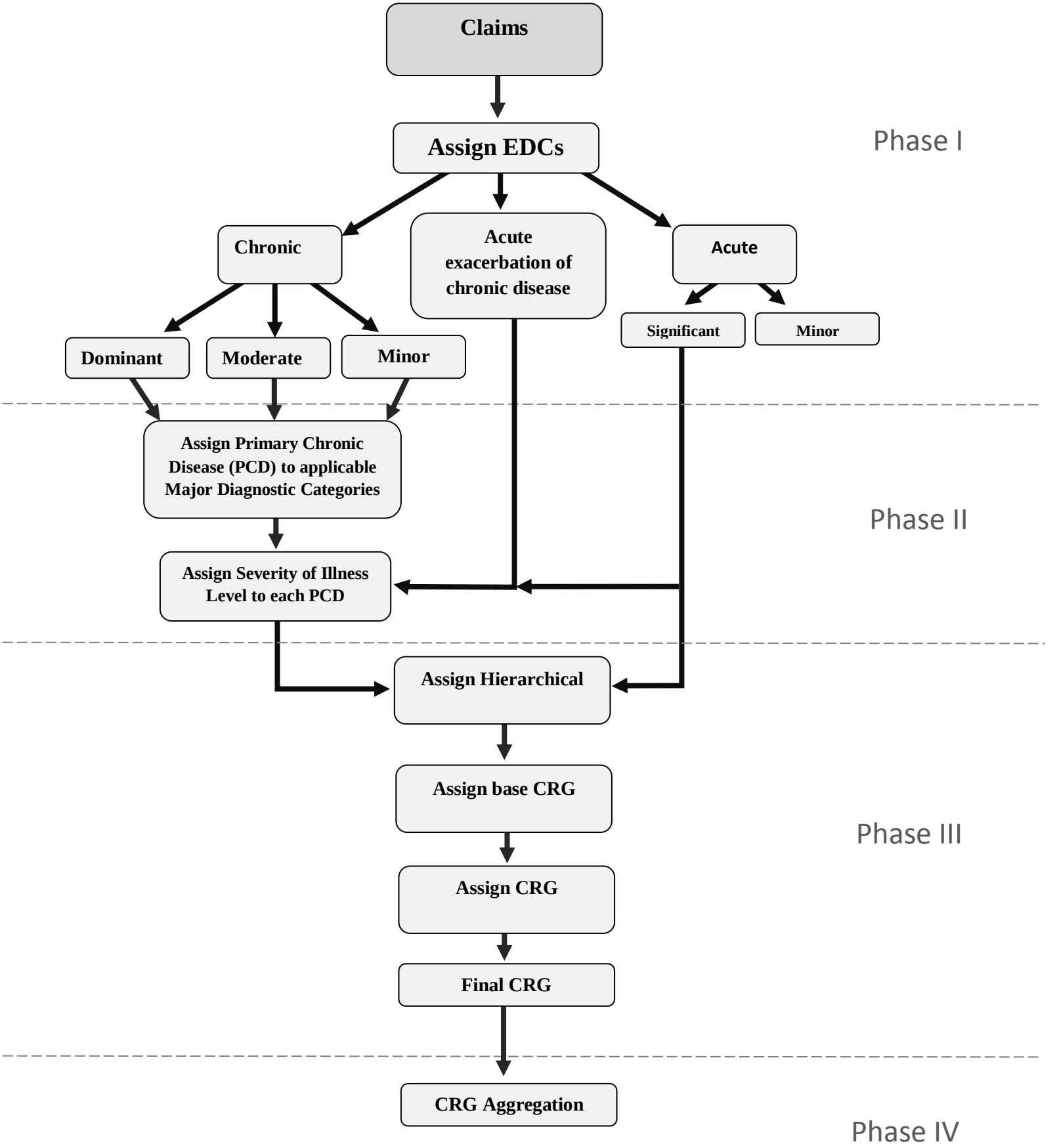


Table 1: List of Major Disease Categories (MDCs)

MDC	MDC Description
11	Diseases & Disorders Of The Nervous System
12	Catastrophic Neurological Conditions
21	Diseases And Disorders Of The Eye
31	Diseases And Disorders Of The Ear, Nose, Mouth And Throat
32	Craniofacial Anomalies
41	Diseases And Disorders Of The Respiratory System
42	Catastrophic Respiratory Conditions
51	Diseases And Disorders Of The Cardiovascular System
52	Peripheral Vascular Disease And Other Non-Cardiac Vascular Diseases
53	Heart Transplant Status
61	Diseases & Disorders Of The Digestive System
71	Diseases & Disorders Of The Hepatobiliary System & Pancreas
72	Liver Or Pancreas Transplant Status
81	Diseases And Disorders Of The Musculoskeletal System
82	Connective Tissue Diseases
91	Diseases And Disorders Of The Skin, Subcutaneous Tissue, And Breast
101	Diabetes Mellitus
102	Other Endocrine, Metabolic And Thyroid Disorders
111	Diseases & Disorders Of The Kidney And Urinary Tract
121	Diseases And Disorders Of The Male Reproductive System
131	Diseases And Disorders Of The Female Reproductive System
141	Pregnancy, Childbirth And The Puerperium
151	Newborns And Other Neonates
152	Chromosomal Anomalies, Mental Retardation And Other Developmental / Cognitive Diagnoses
161	Disease And Disorders Of The Blood And Blood Forming Organs
162	Bone Marrow Transplant Status
171	Secondary Malignancy
172	Malignancies
173	Neoplasms of Uncertain Behavior
181	Infectious And Parasitic Diseases
191	Mental Diseases And Disorders
201	Substance Abuse
211	Injuries, Poisoning And Toxic Effects Of Drugs
221	Burns
231	Factors Influencing Health Status And Other Contacts With Health Services
241	HIV Infection
251	Other Trauma

(e.g., diabetes). Diseases which have a prolonged duration, but for which a cure (i.e., no evidence of the disease) is possible, are considered chronic (e.g., malignancies). Lifelong or prolonged diseases controlled by medication or other means (e.g., hypertension) are also considered chronic. A disease is classified as acute if the duration of the disease is short and the disease would naturally resolve (e.g., pneumonia) or a treatment exists which cures the disease (e.g., fractured leg). Signs, symptoms and findings (e.g., chest pain) are also considered acute. The six EDC types of are defined as follows:

Dominant Chronic EDCs

Serious chronic diseases which often result in the progressive deterioration of an individual's health and often times lead to or significantly contribute to an individual's debility, death and future need for medical care (e.g., congestive heart failure, diabetes).

Moderate Chronic EDCs

Serious chronic diseases which usually do not result in the progressive deterioration of an individual's health but can significantly contribute to an individual's debility, death and future need for medical care (e.g., asthma, epilepsy).

Minor Chronic EDCs

Minor chronic diseases can usually be managed effectively throughout an individual's life with typically few complications and limited effect upon an individual's debility, death and future need for medical care (e.g., migraine headache, hearing loss) However, minor chronic diseases may be serious in their advanced stages or may be a precursor to more serious diseases (e.g., hyperlipidemia).

Chronic Manifestation EDCs

A manifestation or acute exacerbation of a chronic disease (e.g., diabetic neuropathy). The chronic manifestation EDC describes the manifestation or acute exacerbation (i.e., the neuropathy) and indicates the presence of the underlying chronic disease (i.e., diabetes). In addition, they are used to identify uncommon, but distinct diseases within a more frequently occurring EDC and are used in determining the severity level of the EDC.

Significant Acute EDCs

Serious acute illness which can be a precursor to or place the individual at risk for the development of chronic disease (e.g., chest pain) or can potentially result in significant sequelae (e.g., head injury with coma). In the CRG logic, an acute illness is only classified as a significant acute illness if it occurred in the most recent six months as determined by dates specified when running the software.

Minor Acute EDCs

Minor acute illnesses or events that may be mild or more serious but are self limiting, are not a precursor to chronic disease, do not place the individual at risk for the development of chronic disease and do not result in significant sequelae (e.g., fractured arm, common cold, appendicitis).

Of the 562 EDCs, 61 are dominant chronic (DC), 64 are moderate chronic (MC), 41 are minor chronic (C), 107 are chronic manifestation (CM), 157 are significant acute (SA) and 132 are minor acute (A). Table 2 contains the categorization of the EDCs in the circulatory MDC. In the CRG clinical logic, the categorization of an EDC as chronic or acute is an important distinction because individuals who have

Table 2: EDCs for the Circulatory MDC

Rank	Type	EDC
1	DC	Complex Cyanotic and Major Cardiac Septal Anomalies
2	DC	Other Major Congenital Heart Diagnoses Except Valvular
3	DC	Congestive Heart Failure
4	DC	Other Cardiovascular Diagnoses - Major
5	DC	Valvular Disorders
6	DC	History of Myocardial Infarction
7	DC	Angina and Ischemic Heart Disease
8	MC	Atrial Fibrillation
9	MC	Cardiac Dysrhythmia and Conduction Disorders
10	MC	History of Coronary Artery Bypass Graft
11	MC	History of Percutaneous Transluminal Coronary Angioplasty
12	MC	Cardiac Device Status
13	MC	Coronary Atherosclerosis
14	MC	Hypertension
15	C	Ventricular and Atrial Septal Defects
16	C	Chronic Cardiovascular Diagnoses - Minor
	CM	Defibrillator Status
	CM	Coronary Graft Atherosclerosis
	CM	Malfunction Coronary Bypass Graft
	CM	Malignant and Other Significant Hypertension
	CM	Mechanical Complication of Cardiac Devices, Implants and Grafts
	CM	Cardiomyopathy
	CM	Pulmonary Hypertension
	CM	Unstable Angina
	SA	Acute Myocardial Infarction except Subendocardial - Initial
	SA	Acute Myocardial Infarction except Subendocardial - Subsequent/Unspecified
	SA	Subendocardial Infarction - Initial
	SA	Subendocardial Infarction - Subsequent/Unspecified
	SA	Atrial Flutter
	SA	Cardiac and Respiratory Arrest
	SA	Cardiac Inflammation
	SA	Cardiomegaly and Other Moderate Acute Cardiovascular Diagnoses
	SA	Chest Pain
	SA	Complete Heart Block
	SA	Congestive Heart Failure Age Unspecified
	SA	Cyanosis
	SA	Hypertension NOS/NEC
	SA	Hypotension
	SA	Other Valvular Disorders
	SA	Shock
	SA	Tachycardia and Palpitations
	SA	Ventricular Tachycardia
	A	Acute Cardiovascular Diagnoses - Minor
	A	Malfunctions of Vascular Grafts
	A	Other Complications Due to Cardiovascular Devices, Implants, and Grafts
	A	Reaction to Cardiovascular Devices, Implants, and Grafts

chronic EDCs from multiple organ systems (i.e., MDCs) are assigned to a distinct set of CRGs. For example, individuals who have both congestive heart failure (CHF) and chronic obstructive pulmonary disease (COPD) form a separate CRG, and individuals who have CHF, COPD and diabetes form another CRG.

Every ICD-9-CM code submitted to the grouper is assigned an EDC. However, not all EDCs are considered valid for the purposes of CRG assignment or severity adjustment. Only valid diagnoses may be used to assign the CRG or its severity level. For an EDC to be valid it must meet all the following criteria:

1. Diagnoses are excluded from the analysis if their associated date falls outside of the date range specified for CRG assignment. For example, if the software is being used to assign CRGs based on the latest year of data, data from prior years are not used.
2. Diagnoses are excluded if they are fall outside the maximum age acceptable for the EDC. Diagnoses for an otherwise valid EDC will not be used after they reach a cutoff point. For most uses this requirement is of no concern because data generally do not extend beyond the cutoff point.
3. Only those diagnoses reported by institutions (e.g., hospitals, skilled nursing facilities, etc.), physicians, and other medical professionals (e.g., nurse practitioners, physician's assistants, physical therapists, etc.) are used. Diagnoses from other sources such as ambulance companies, durable medical equipment suppliers, laboratories, or pharmacies are not used.
4. Diagnoses from unknown sites of service are not used.
5. Site or place of service in combination with provider type is also used as an internal edit.

All data must meet at least one of these three criteria.

- Inpatient diagnoses from an institutional provider need only be reported once.
- Outpatient diagnoses reported by institutions and all diagnoses from physicians and other medical professionals must be reported on at least two different days or they are not used. With a few exceptions, a diagnosis reported only on a single day is not considered sufficiently reliable. The requirement of multiple days rather than multiple reports is used because a single contact on a single day may generate multiple reports of a diagnosis. Single inpatient institutional diagnoses are accepted because inpatient coding practices are generally more rigorous than those used in outpatient settings.
- For a subset of EDCs a single occurrence from an institutional or professional provider is sufficient. These EDCs are clinically significant and clinically unambiguous but rarely reported because they are untreatable. For example, blindness is an important piece of clinical information but is rarely reported. Therefore, all diagnoses of blindness from institutional or professional providers are considered valid.

Some diseases that are generally considered chronic may, under certain conditions, be initially classified as an acute disease. For example, congestive heart failure is generally considered a chronic disease. However, congestive heart failure when it occurs in children is usually associated with an underlying congenital anomaly and reflects the status of the underlying anomaly. Therefore, in children congestive heart failure is considered an acute disease. The one exception is congestive heart failure due to rheumatic fever which is always considered chronic. In the CRG logic, there are also some diseases generally considered chronic that are only categorized as chronic under certain conditions. For example, hypertension is a chronic disease. However, because there is the possibility that a series of visits for hypertension may reflect a prudent monitoring blood pressure over a short period of time, hypertension is assumed to be an acute condition (e.g., "white coat syndrome") unless the hypertension is reported at least twice over a period of time that spans at least 90 days.

Within each MDC the dominant, moderate and minor chronic EDCs were ranked hierarchically by a clinical panel in terms of their relative contribution to an individual's need for medical care, debility and death. Chronic EDCs which result in progressive deterioration of an individual's health are ranked highest in the chronic EDC hierarchy. Dominant chronic EDCs (DC) are always ranked higher in the EDC hierarchy than moderate (MC) or minor chronic (C) EDCs. Similarly, moderate chronic EDCs are always ranked higher than minor chronic EDCs. Table 2 contains the EDCs, the disease type and the chronic EDC rank for the cardiovascular system MDC. In table 2 the column labeled rank refers to the chronic EDC rank and is numbered with one being the highest rank. The column labeled "type" refers to the EDC type assigned to the EDC (dominant chronic (DC), moderate chronic (MC), minor chronic(C), chronic manifestation (CM), significant acute (SA), and acute (A)).

Procedures performed in hospitals are reported using ICD-9-CM procedure codes. Professional services and procedures performed in an ambulatory setting are reported using Current Procedural Terminology (CPT) and Healthcare Common Procedure Coding System (HCPCS). All procedure codes were categorized into 639 mutually exclusive and exhaustive categories referred to as Episode Procedure Categories (EPCs). The EPCs have limited use in the CRG clinical logic. Similar to the logic for diseases (EDCs), procedures (EPCs) are not used if they occur outside of the date range of the data being grouped and if they exceed certain predetermined limits. For example, chemotherapy is not used if it the treatment occurred more than two years prior to the latest day of the data used to assign the CRG.

One hundred fifty-one EPCs are used in the CRG logic. The EPCs are used to identify individuals who are dependent on some medical technology (e.g., mechanical ventilation), who had a procedure that is indicative of advanced or active disease (e.g., leg amputation for a diabetic or chemotherapy for a person with a malignancy), has had a procedure that has long term sequelae (e.g., heart transplant), or had a procedure that indicates the presence of some significant but yet to be identified illness in an individual who has no identified chronic conditions.. The occurrence of these EPCs creates a chronic EDC that specifies a history of the procedure (e.g., history of heart transplant), is used in assigning the severity level. In the CRG assignment logic, no distinction is made between chronic EDCs associated with the history of a procedure and chronic EDCs associated with a disease.

The use of procedures in the CRGs is limited. The primary use of procedures is to indicate more advanced disease in the severity of illness leveling (e.g., a diabetic with circulatory complications who requires an above-the-knee amputation). For the purpose of CRG assignment (as opposed to MS-DRG assignment), it was recognized that the inclusion of some procedures could result in higher future payments for individuals who had one of these procedures. Theoretically this could create the financial incentive to perform more procedures. However, the increase in future payments with few exceptions will be small relative to the cost of the procedure. Moreover, the gains from the procedure are far from assured as they are conditional upon the continued enrollment of the beneficiary who may die, move, or drop their enrollment for some other reason. Therefore it is unlikely that any fiscally prudent organization would incur substantial short-term costs in order to receive relatively small and far from guaranteed increases in future payments. The other argument against a substantial use of procedures in CRG assignment is that providers who deliver poor quality care cause the need for the procedure (e.g., the diabetic only needed the above-the-knee amputation because of poor care) would receive additional future financial compensation. However, the financial incentive remains to avoid procedures for the reasons just discussed. Moreover, it is essential that there be no financial incentive to avoid individuals with a history of a major procedure. The overall functioning of the system and access to care are better served when there is a clear recognition of the future costs of individuals, especially those with significant health problems. Thus, there is a highly selective use of procedures in the CRGs because, on balance, financial incentives to avoid individuals with a history of certain major procedures was viewed as a more serious issue than potentially providing some additional future compensation for individuals who had a procedure that may have been avoidable.

Based on the individual's chronic disease profile and history of past medical interventions, the initial step in Phase I is to identify the EDCs (diseases) and EPCs (procedures) assigned to the individual. EDCs and EPCs are then added or deleted based on the nature of and temporal relationship among the EDCs and EPCs using the following rules:

Chronic Manifestation EDCs Create Chronic EDCs

All chronic manifestation EDCs create a chronic EDC that specifies the underlying chronic disease associated with the manifestation or acute exacerbation. For example, the diabetic neuropathy chronic manifestation EDC creates the diabetes EDC.

Multiple Occurrences of an Acute EDC can Create Chronic EDCs

Selected acute EDCs that have multiple occurrences over a period of time create a chronic EDC that indicates the recurrence of the acute EDC. For example, if the acute EDC for urinary tract infection occurs at least three times over a period of time that spans at least 180 days, the chronic EDC for recurrent urinary tract infection is created.

Acute EDCs can Create Chronic EDCs

Some acute EDCs can create a chronic EDC for the history of the acute EDC. For example, an

Acute Myocardial Infarction (AMI) is an acute event that creates an acute EDC. It also creates a chronic EDC for the history of the AMI. A chronic EDC is only created for those acute EDCs which indicates a significant progression of an underlying disease (e.g., an AMI or a cerebrovascular accident (CVA)) or which may have long term sequelae (e.g., hip fracture). The creation of a chronic EDC from an acute EDC may be dependent on the individual's age. For example, the acute EDC for hip fracture creates the chronic EDC for history of hip fracture only if the individual is 65 years or older as it indicates a significant deterioration of health among older individuals.

EPCs can Create EDCs

Selected procedures that are indicative of advanced disease or have long term sequelae create a chronic EDC for the history of the major procedure. For example, the EDC for coronary bypass surgery creates the chronic EDC for history of coronary bypass surgery.

A Temporal Relationship Between EDCs can Eliminate an EDC

If specific EDCs occur prior to the first occurrence of another specified EDC, the EDC is eliminated. For example, if the CVA EDC occurs prior to the first occurrence of the hemiplegia EDC, the CVA EDC is eliminated because the hemiplegia is a sequelae of the CVA and subsumes the CVA. However, if a CVA occurs after the first occurrence of hemiplegia, the CVA EDC is not eliminated since it represents a second CVA. The temporal relationship between CVA and hemiplegia is the basis for determining whether there has been a second CVA. A second CVA may be used to indicate a further deterioration in the individual's health.

A Temporal Relationship Between and EDC and EPC can Eliminate the EDC

If specific EDCs occur prior to the occurrence of a specified EPC, the EDC is eliminated. For example, if the angina EDC occurred prior to the coronary bypass EPC, the angina EDC is eliminated because the coronary bypass is expected to cure the angina for at least the immediate future. However, if angina occurs after the coronary bypass EPC, the angina EDC is not eliminated since it indicates that the coronary bypass was not successful.

A Temporal Relationship Between EPCs can Eliminate an EPC

If a specific EPC occurs prior to the occurrence of another specified EPC, the EPC is eliminated. For example, if a dialysis EPC occurs prior to a kidney transplant EPC, the dialysis EPC is eliminated because the kidney transplant is expected to eliminate the need for dialysis. However, if dialysis occurs after the kidney transplant EPC, the dialysis EPC is not eliminated since it indicates that kidney transplant was not successful. This is subject to some temporal criteria to eliminate the possibility that data from dialysis batch bills and dialysis performed around the time of surgery are not used to indicate an unsuccessful kidney transplant.

At the end of Phase I a complete list of EDCs and EPCs is created which describes the individual's disease profile and history of past medical interventions.

Phase II: Selection of Primary Chronic Disease(s) and the Assignment of Severity of Illness Levels

In Phase II, the EDC that represents the most significant chronic disease under active treatment, referred to as the primary chronic disease (PCD), is identified for each organ system (i.e., MDC).

An underlying assumption of CRGs is that individuals with chronic diseases from multiple organ systems are especially at risk to have poor outcomes and require significant medical care. A single chronic disease (i.e., a dominant chronic, moderate chronic, or minor chronic EDC) must first be selected from each major organ system (i.e., MDC) that has chronic illnesses for the purpose of identifying the individuals with chronic disease in multiple organ systems.

The first step in Phase II is to eliminate from consideration those chronic EDCs that are secondary to another chronic EDC. Physician panels identified those chronic diseases that are secondary to (i.e., a by-product of or an integral part of) another chronic disease. These do not have to be in the same MDC. For example, if an individual with diabetes is also diagnosed with peripheral vascular disease, the peripheral vascular disease is assumed to be a manifestation of the underlying diabetes. Therefore in the presence of diabetes, peripheral vascular disease will never become a PCD. Most such cases, however, are found in the same MDC. For example, in the presence of Congestive Heart Failure, Angina another dominant chronic EDC will never be selected to be the PCD.

The second step in Phase II is to identify the chronic illness that will become PCDs. After an MDC with at least one dominant chronic EDC is found the next task is to identify the PCD. If there is only one EDC in the MDC available for selection, that EDC becomes the PCD for the MDC. If more than one EDC in an MDC is eligible, PCD selection criteria are used (Table 3). The PCD selection hierarchy uses site of service, recency and duration of treatment to identify which EDC is the most significant. Treatment in a hospital as a principal diagnosis (PDX) within the most recent year is highest in the selection hierarchy followed by treatment in an ambulatory setting that had duration of at least 90 days within the most recent year. An underlying assumption of CRGs is that the diseases under active treatment have the greatest impact on the subsequent need for medical care, debility and death. If more than one EDC meets the same PCD selection criteria, the EDC rank in the MDC is used to select the EDC to be the PCD (discussed in Table 2).

Table 3: PCD Selection Criteria

Site of Service	Recency of Treatment	Duration of Treatment
Hospital	Last Year	
Ambulatory	Last Year	90 days

The same logic is applied when reviewing moderate chronic EDCs. When reviewing minor chronic EDCs, however, when an MDC has more than one minor chronic EDC, the one with the highest rank within the MDC is chosen.

After a MDC's PCD is selected, it is assigned a severity of illness level(SoI). SOI describes the extent and progression of the disease selected as the PCD. A high level of severity is indicative of a high degree of treatment difficulty and a need for substantial future medical care. The assignment of the

severity level is specific to each PCD and takes into account factors associated with a more severe or advanced forms of the disease. This includes: a more severe form of the disease as identified through a chronic manifestation EDC (*eg*, intractable epilepsy); comorbid chronic and acute EDCs from the same organ system (*eg*, cardiac valve disease with congestive heart failure); chronic EDCs from other body systems when they are secondary to and caused by the PCD (nephritis for systemic lupus); acute EDCs from other body systems when they are specifically related or a reliable indicator of general health status (*eg*, acute infections, neurologic and gastrointestinal EDCs) and selected therapies or procedures if they are indicative of advance disease or may have long term sequelae (*eg*, history of coronary bypass disease).

All chronic EDCs have a severity matrix, consisting of the of EDCs and EPCs that determine the assignment of the severity level. The severity matrices were developed by physician panels with access to extensive historical data specifying the inpact of each EDC and EPC on historical expenditures

The severity level for a PCD is determined based on the following steps:

1. From the complete list of EDCs and EPCs created in Phase I, the subset of EDCs and EPCs that are present in the severity leveling matrix for the PCD are identified
2. For each EDC and EPC identified in step 1, the conditionality rules in the severity leveling matrix are evaluated and the severity level for each EDC and EPC is determined
3. The severity level for the PCD is equal to the highest severity level associated with any of the EDCs and EPCs from step 2

Along with the list of EDCs and EPCs are conditionality rules which for each EDC and EPC in the severity matrices specify the conditions that must be met in order for a specific severity level to be assigned. For example, an individual with a PCD of congestive heart failure who had been hospitalized with cardiac valve disease in the most recent year or had been treated at any site for a cardiac valvular disease in the most recent six months is considered to have congestive heart failure at severity level 4. However, if the individual had not been hospitalized for the cardiac valvular disease during the most recent year nor had been treated at any site for the cardiac valvular disease during the most recent six months, the individual is considered to have congestive heart failure at severity level 3. Thus, the severity level associated with the cardiac valvular disease differs depending on conditionality rules relating to recency of treatment and the site of treatment. In addition to the recency and site of treatment,

conditionality rules used in the severity leveling matrices can relate to the duration of treatment or the age of the individual. There is a unique severity leveling matrix for each chronic EDC.

The severity leveling matrix for congestive heart failure is shown in Table 4. The EDCs at severity level 4 are primarily acute cardiac events (shock, cardiac arrest, AMI, unstable angina and ventricular tachycardia) that either occurred recently or required inpatient care. In addition, severity level 4 includes the recent occurrence of acute EDCs that are indicative of advanced congestive heart failure (pleural effusion). Comorbid cardiac diseases (cardiac valve disease, congenital heart disease, and major chronic cardiac diseases) that interact with the congestive heart failure and increase treatment difficulty are also included at severity level 4. Finally, EDCs and EPCs (tracheostomy) that relate to the dependence on a respirator are included at severity level 4.

Severity level 3 for congestive heart failure includes some of the same EDCs as level 4 (AMI, unstable angina, major chronic cardiac disease and congenital heart disease) but without a recent occurrence or requiring inpatient care. Other moderate chronic or significant acute cardiac or circulatory EDCs are included at severity level 3 (complete heart block, cardiac dysrhythmia, thrombophlebitis, atrial fibrillation, coronary atherosclerosis, pulmonary emboli, history of coronary bypass and history of defibrillator). Recent acute endocrine, metabolic and neurological problems are also included at severity level 3 since these significant acute diseases can increase the treatment difficulty of the CHF and worsen general health status. Finally, the presence of EPCs that are indicative of significant debility such as a hospital bed for the home or the need for a motorized wheelchair are included at severity level 3.

Severity level 2 for congestive heart failure includes some acute cardiac EDCs (chest pain, atrial flutter, stable angina and cardiac inflammation) plus some of the moderate cardiac or circulatory EDCs from severity level 3 (e.g., atrial fibrillation without the condition of having a duration of at least 90 days). Severity level 2 also includes a wide range of acute problems from other MDCs (e.g., infections, mental health diagnoses, skin diagnoses, etc.) that are indicative of general health status. Finally, an extended list of history of significant cardiac procedures (e.g., cardiac pacemaker) and EPCs related to medical supplies that are indicative of debility or impaired functional status (e.g., walker, commode) are included at severity level 2.

If none of the EDCs and EPCs and associated conditions in severity levels 2 through 4 is present, the congestive heart failure PCD is assigned severity level 1.

The number of severity levels varies across EDCs. Minor chronic EDCs and nondominant /nonmetastatic malignancy EDCs have only two severity levels specified because of the limited clinical spectrum of these diseases. All dominant chronic, moderate chronic and EDCs have four severity levels. Metastatic malignancies and catastrophic conditions are assigned a default level with the actual severity level assigned later in the CRG logic.

Table 4: Severity Leveling Matrix for Congestive Heart Failure

Severity Level	EDC	Type	Recency	Site	Duration
4	Cardiac Valve Diseases	DC	2 Years	Inpatient	
	Cardiac Valve Diseases	DC	6 Months		
	Moderate Congenital Heart Diseases	DC	2 Years		
	Major Congenital Heart Diseases	DC	2 Years		
	Major Chronic Cardiac Diseases	DC	2 Years	Inpatient	
	History of AMI	DC	6 Months		
	Unstable Angina	CM	1 Year		90 Days
	Unstable Angina	CM	1 Year	Inpatient	
	Pleural Effusion	SA	1 Year		
	Hypotension	SA	6 Months		
	Shock	SA	1 Year		
	Cardiac Arrest	SA	1 Year		
	Ventricular Tachycardia	SA	6 Months		
	Ventricular Tachycardia	SA	1 Year	Inpatient	
	Dependence on Respirator	MA	1 Year		
	Permanent Tracheostomy	EPC	2 Years		
	Temporary Tracheostomy	EPC	2 Years		
3	Cardiac Valve Diseases	DC	2 Years		
	Major Congenital Heart	DC	2 Years		
	Major Chronic Cardiac Diseases	DC	2 Years		
	History of AMI	DC	2 Years		
	Atrial Fibrillation	MC	2Years		90 Days
	History of PTCA	MC	2 Years		
	Cardiac Dysrhythmia	MC	2 Years		90 Days
	Cardiac Dysrhythmia	MC	6 Months		
	Coronary Atherosclerosis	MC	6 Months		
	Unstable Angina	CM	1 Year		
	History of Defibrillator	CM	2 Years		
	Graft Atherosclerosis	CM	2 Year		
	Convulsions	SA	1 Year		90 Days
	Moderate Neurological SSFs	SA	1 Year		90 Days
	Extreme Neurological SSFs	SA	1 Year		90 Days
	Pulmonary Emboli	SA	1 Year		
	Subendocardial AMI	SA	1 Year		
	Thrombophlebitis	SA	1 Year		90 Days
	AMI Except Subendocardial	SA	1 Year		
	Moderate Acute Cardiac Diseases	SA	6 Months		
	Complete Heart Block	SA	1 Year		
	Nausea, Vomiting & Diarrhea	SA	1 Year		90 Days
	Malfunction Coronary Bypass Graft	MA	1 Year		
	Wheelchair	MA	1 Year		
	Metabolic / Endocrine Diseases	MA	6 Months		
	Mechanical Ventilation	EPC	2 Years		
	Respiratory Therapy	EPC	2 Years		90 Days
	Hospital Bed	EPC	2 Years		
	Wheelchair (Motorized)	EPC	2 Years		

Table 4: Severity Leveling Matrix For Congestive Heart Failure (continued)

Severity Level	EDC	Type	Recency	Site	Duration
2	Angina	DC	2 Years		
	History of CABG	MC	2 Years		
	Atrial Fibrillation	MC	2 Years		
	Minor Chronic Artery & Vein Diseases	C	1 Year		90 Days
	Morbid Obesity	CM	2 Years		
	Moderate Neurological SSFs	SA	1 Year		
	Extreme Acute Neurological Diseases	SA	1 Year		
	Chest Pain	SA	1 Year		90 Days
	Hypotension	SA	1 Year	Inpatient	
	Significant Acute GI Diagnoses	SA	1Year		
	Minor Acute GI Diagnoses	SA	1 Year		
	Acute Pancreatitis	SA	1 Year		
	Hypovolemia	SA	1 Year	Inpatient	
	Cellulitis	SA	1 Year		90 Days
	Major Infections	SA	6 Months		
	Major Acute Mental Health Diseases	SA	6 Months		
	High Mortality Acute Diseases	SA	1 Year		
	Cardiac Inflammation	MA	1 Year	Inpatient	
	Atrial Flutter	MA	1 Year		
	Acute Skin Diagnoses	MA	1 Year		90 Days
	Minor Bacterial Infections	MA	1 Year		90 Days
	Minor Infection	MA	6 Months		
	Coronary Bypass	EPC	2 Years		
	Major Cardiac Procedure	EPC	2 Years		
	Permanent Cardiac Pacemaker	EPC	2 Years		
	Oxygen Therapy	EPC	2 Years		
	Walkers	EPC	2 Years		
	Commode	EPC	2 Years		
	Wheelchair (Standard)	EPC	2 Years		

Since the same EDCs and EPCs can be used in the severity leveling matrix for PCDs in more than one MDC, it is possible that the same EDC or EPC could determine the severity level for more than one PCD. In order to avoid this possibility the severity level for each PCD is determined with the constraint that no EDC or EPC can determine the severity level (i.e., be the EDC or EPC used in step 3) of more than one PCD. Physician panels rank or ordered the MDCs as shown in Table 5. If an EDC or EPC can be used for determining the severity level of more than one PCD, the EDG or EPC will be used in the PCD that is in the MDC ranked highest. In addition if a chronic EDC from a different MDC is used to assign a severity level, that EDC is precluded from being used as a PCD.

PCDs are created until no more chronic EDCs are available for assignment. At the end of this step individuals can have multiple PCDs or, if the data indicate no chronic conditions, have no PCDs assigned.

Table 5: MDC Rank Order

MDC	MDC Rank	MDC Description
42	1	Catastrophic Respiratory Conditions
12	2	Catastrophic Neurological Conditions
53	3	Heart Transplant Status
72	4	Liver Or Pancreas Transplant Status
162	5	Bone Marrow Transplant Status
241	6	HIV Infection
171	7	Secondary Malignancy
172	8	Malignancies
11	9	Diseases & Disorders Of The Nervous System
51	10	Diseases And Disorders Of The Cardiovascular System
41	11	Diseases And Disorders Of The Respiratory System
101	12	Diabetes Mellitus
61	13	Diseases & Disorders Of The Digestive System
71	14	Diseases & Disorders Of The Hepatobiliary System & Pancreas
111	15	Diseases & Disorders Of The Kidney And Urinary Tract
161	16	Disease And Disorders Of The Blood And Blood Forming Organs
181	17	Infectious And Parasitic Diseases
21	18	Diseases And Disorders Of The Eye
31	19	Diseases And Disorders Of The Ear, Nose, Mouth And Throat
52	20	Peripheral Vascular Disease And Other Non-Cardiac Vascular Diseases
81	21	Diseases And Disorders Of The Musculoskeletal System
82	22	Connective Tissue Diseases
102	23	Other Endocrine, Metabolic And Thyroid Disorders
121	24	Diseases And Disorders Of The Male Reproductive System
131	25	Diseases And Disorders Of The Female Reproductive System
151	26	Newborns And Other Neonates
91	27	Diseases And Disorders Of The Skin, Subcutaneous Tissue, And Breast
191	28	Mental Diseases And Disorders
201	29	Substance Abuse
221	30	Burns
231	31	Factors Influencing Health Status And Other Contacts With Health Services
141	32	Pregnancy, Childbirth And The Puerperium
251	33	Other Trauma
211	34	Injuries, Poisoning And Toxic Effects Of Drugs
173	35	Neoplasms of Uncertain Behavior
152	36	Chromosomal Anomalies, Mental Retardation And Other Developmental / Cognitive Diagnoses
32	37	Craniofacial Anomalies

Phase III: Determination of the Base CRG and Severity Level for the Individual

At the end of Phase III all PCDs have been identified and assigned a severity level. Based on the PCDs and EPCs that are present, the individual is assigned to one of nine CRG statuses. The CRG status is assigned hierarchically starting with catastrophic. The highest status in the hierarchy, for which the status criteria are met, is assigned as the CRG status. Statuses are typically referred to by the number, ranging from the highest or most significant, Status 9. Catastrophic Conditions, to Status 1, healthy.

Catastrophic Conditions

Catastrophic conditions include long term dependency on a medical technology (e.g., dialysis, respirator, TPN) and life-defining chronic diseases or conditions that dominate the medical care required (e.g., persistent vegetative state, cystic fibrosis, history of heart transplant).

Dominant, Metastatic and Complicated Malignancies

A malignancy that dominates the medical care required (e.g., brain malignancy) or a nondominant malignancy (e.g., prostate malignancy) that is metastatic.

Dominant Chronic Disease in Three or More Organ Systems

Dominant chronic disease in three or more organ systems identified by the presence of three or more dominant PCDs. In selected instances, criteria may be met by selected a moderate chronic PCDs.

Significant Chronic Disease in Multiple Organ Systems

Significant chronic diseases in multiple organ systems is identified by the presence of two or more PCDs of which at least one is a dominant or moderate PCD. PCDs that are a severity level 1 minor chronic disease are not considered a significant chronic disease and are not used to identify the presence of significant chronic disease in multiple organ systems, but minor chronic PCDs that are severity level 2 are used.

There are 11 catastrophic base CRGs, each of which is divided into four severity levels, for a total of 44 catastrophic CRGs.

Dominant, Metastatic and Complicated Malignancies

Second in the CRG status hierarchy is Status 8, Dominant, Metastatic, or Complicated Malignancies. Certain malignancies (e.g., brain, pancreas, etc.) are similar to catastrophic conditions in that they are life defining and dominate an individual's medical care. Other malignancies (e.g., prostate, colon, etc.) do not dominate the future medical care required unless they are metastatic or unusually complicated.

When multiple malignancies are present, the CRGs contain logic to identify the primary malignancy and any metastatic sites (e.g., a bone malignancy is considered metastatic to a prostate malignancy). A malignancy is considered a metastasis if there is a related primary malignancy present. There are also some conditions that indicate that a primary malignancy is unusually complicated (e.g., severe malnutrition or the need for a second course of chemotherapy). Malignancies that are not dominant, metastatic, or complicated are treated like any other chronic disease and are included in the subsequent portions of the CRG status hierarchy.

For each Status 8 malignancy there is a four level severity leveling matrix that is specific to the primary malignancy. In addition, since individuals with a dominant or metastatic primary malignancy can also have diseases in organ systems that are not directly related to the primary malignancy, the severity level is adjusted based on the presence of PCDs from organ systems unrelated to the primary malignancy. The additional adjustment to the severity level is done to insure that the severity level of the dominant or metastatic primary malignancy fully reflects the total burden of illness.

There are 22 dominant or metastatic malignancy base CRGs, each of which is divided into four severity levels, for a total of 88 dominant, metastatic, or complicated malignancy CRGs.

Dominant Chronic Disease In Three Or More Organ Systems

Third in the CRG status hierarchy is Status 7, Dominant Chronic Disease in Three or More Organ Systems. This status consists of explicit combinations of three dominant PCDs (e.g., congestive heart failure, diabetes and chronic obstructive pulmonary disease) as well as broader combinations that include categories consisting of dominant chronic PCDs that are not explicitly identified. Some moderate chronic PCDs are included in these combinations. These are explicitly identified. For example, four PCDs from the cardiovascular MDC meet the criteria for a combined group called Advanced Coronary Artery Disease (CAD). These are: History of Myocardial Infarction (MI), Angina, History of Coronary Artery Bypass Graft (CABG), and History of *Percutaneous Transluminal Coronary Angioplasty (PTCA)*. The last two are moderate chronic PCDs.

Individuals are assigned to a base CRG based on the three PCDs with the highest severity levels. For example, if an individual has four PCDs which could meet the Status 7 criteria, (e.g., congestive heart failure, diabetes and chronic obstructive pulmonary disease, and Parkinson's Disease) the three with the highest severity levels are chosen as the basis of the group. In the event of a tie, the PCD combinations are ranked hierarchically. If in the aforementioned example, congestive heart failure, and chronic obstructive pulmonary disease have the highest severity levels and the severity level of the Parkinson's Disease is higher that the diabetes, the Parkinson's Disease will be chosen before diabetes. If the situation is reversed diabetes will be chosen. In the event of a tie, the named combination, congestive heart failure, diabetes and chronic obstructive pulmonary disease, would be assigned.

Each base CRG in this status has six severity levels. The severity level for the Status 7 CRG is initially determined using the combined severity levels for each of the PCDs that comprise the CRG.

These are identified in Table 7. The criteria in Table 7 are applied hierarchically from top to bottom. The severity level for the CRG is assigned based on the first criteria that is matched in Table 7. For example, if the PCDs that comprise the CRG have severity levels of 4, 4 and 2, the severity level of the CRG would be 4. The severity level that results from Table 7 is generic. The generic CRG severity level may be further adjusted based on clinical criteria that are specific to that base CRG. For example, the generic severity level for the base CRG comprised of congestive heart failure, diabetes and chronic obstructive pulmonary disease is increased by one if the EDC for unstable angina is present and the unstable angina has been actively treated in the most recent six month period. Although unstable angina is often treated by performing coronary bypass surgery, an individual with diabetes and emphysema may be too ill to undergo surgical treatment resulting in a difficult to treat, severely ill individual.

There are 21 base CRGs for individuals with three or more dominant chronic diseases, each of which is divided into 6 severity levels for a total of 126 CRGs.

Table 7. Severity Levels for CRGs Composed of Three or More Dominant PCDs

CRG Severity Level	Severity Level of PCDs Comprising the CRG		
	4	**3**	**2 or 1**
6	3 or more		
5	2	1 or more	
4	2	None	1 or more
4	1	2 or more	
3	1	1	1or more
3	1	None	2 or more
3		3 or more	
2		2	1 or more
2		1	2 or more
1			3 or more

Significant Chronic Disease In Multiple Organ Systems

Fourth in the CRG status hierarchy is Status 6, Significant Chronic Disease in Multiple Organ Systems. For individuals who do not meet the criteria for Status 7, multiple chronic PCDs with at least one dominant or moderate chronic disease, explicit combinations of two PCDs are identified (e.g., the dominant chronic PCDs for congestive heart failure and diabetes). Severity level 1 minor PCDs are not used in identifying combinations of two significant chronic diseases since they have minimal impact on the individual's need for medical care.

Status 6 base CRGs are assigned in the following order.

- Two Dominant Chronic PCDs
- One Dominant Chronic PCD and One or more Moderate Chronic PCD

- One Dominant Chronic PCD and One or more Minor Chronic PCD of Severity Level 2
- Two or more Moderate Chronic PCDs
- One Moderate Chronic PCD and one or more Minor Chronic PCD of Severity Level 2

There can be multiple Moderate Chronic PCDs which meet the criteria for inclusion. If this happens, the Moderate Chronic PCD or PCDs with the highest severity levels are selected. If there continues to be a tie, the individual is assigned to the base CRG that corresponds to the first match in the hierarchy of base CRGs. Multiple Minor Chronic PCDs of severity level 2 are not problematic as they are only assigned when there is just one Dominant or Moderate PCD and there are no explicit Minor Chronic PCDs used in the assignment of Status 6.

Each base CRG that is comprised of two PCDs is subdivided into 2, 4 or 6 severity levels. The number of severity levels depends on the PCDs that comprise the combination. A combination that is comprised of a nonmetastatic malignancy PCD and a severity level 2 minor PCD has only two severity levels, since nonmetastatic malignancies has only two severity levels and the minor chronic PCD is limited to severity level 2.. A combination that is comprised of a dominant or moderate PCD and a severity level 2 minor PCD or a nonmetastatic malignancy PCD has four severity levels. All other combinations of PCDs have six severity levels. The severity level for the combination that comprises the CRG is determined using the severity level for each of the PCDs that comprise the combination. Since the individual PCDs that comprise the combination can be very different in terms of relative clinical significance (e.g., the combination of congestive heart failure and diabetes versus the combination of congestive heart failure and asthma) the criteria used to determine the severity level for the CRG is specific to the pair of PCDs that comprise the combination. Table 8 shows the severity levels for a CRG composed of the dominant PCD for diabetes and the dominant PCD for congestive heart failure.

Based on the criteria in Table 8, if the diabetes PCD is severity level 3 and the congestive heart failure PCD is severity level 4, the severity level for the CRG is 5. There are 9 different versions of assignment logic for determining the CRG severity level from the severity level of two PCDs. The different versions

Table 8. Severity levels for the CRGs that is comprised of the PCDs for Congestive Heart Failure and Diabetes

CHF SoI Level	Diabetes SoI Level			
	4	**3**	**2**	**1**
4	6	5	4	4
3	5	4	3	3
2	4	3	2	2
1	3	2	2	1

of the assignment logic reflect the relative clinical significance of the two PCDs. If one of the PCDs has greater clinical significance the criteria gives more weight to that PCD.

The CRG severity level that results from the application of criteria like that in Table 8 is further adjusted based on additional clinical criteria that are specific to that base CRG. For example, the CRG severity level for the base CRG comprised of congestive heart failure and diabetes is increased by one if the PCD for chronic gastric ulcer is present and the chronic gastric ulcer has been actively treated in the most recent six month period. Since the gastric ulcer PCD is not a dominant chronic disease the individual is not assigned to one of the CRGs for three dominant chronic diseases. However, the chronic ulcer disease can complicate the treatment of the congestive heart failure and diabetes and, therefore, increases overall the severity level of the individual.

There are 61 base CRGs for individuals with significant chronic disease in multiple organ systems, each of which is divided into 2, 4 or 6 severity levels for a total of 328 CRGs.

Single Dominant Or Moderate Chronic Disease

Fifth in the CRG status hierarchy is Status 5, Single Dominant or Moderate chronic disease. These individuals have only one PCD which, therefore, becomes the base CRG (i.e., if the single PCD for the individual is diabetes, the base CRG is diabetes). The severity level for the CRG is the same as the PCD severity level. The nondominant/nonmetastatic malignancy PCDs have two severity levels and all other moderate and dominant PCDs have four severity levels.

There are 107 base CRGs for individuals with a single moderate or dominant chronic disease, each of which is divided into 2 or 4 severity levels for a total of 400 CRGs.

Minor Chronic Disease In Multiple Organ Systems

Sixth in the CRG status hierarchy is Status 4, Minor Chronic Disease in Two or More Organ Systems. Individuals with two or more minor chronic diseases are assigned to a single base CRG which has four severity levels based on the number of minor chronic PCDs present and the severity level of those minor chronic PCDs.

Single Minor Chronic Disease

Seventh in the CRG status hierarchy is Status 3, Single Minor Chronic Disease. These individuals have only one minor chronic PCD. The base CRG is the same as the PCD. The severity level for the CRG is the same as the PCD severity level.

There are 41 base CRGs for individuals with a single minor chronic disease, each of which is divided into 2 severity levels for a total of 82 CRGs.

History of Significant Acute Disease

Eighth in the CRG status hierarchy is Status 2, History of Significant Acute Disease. The individual has no PCDs present but in the most recent six month period has had at least one significant acute EDC or significant EPC present. If the significant acute EDC (e.g., AMI) creates a chronic EDC for the history of the significant acute (e.g., history of AMI), the individual would have a PCD present. Therefore, they would not be assigned to the status for history of significant acute disease. Thus, individuals with significant acute diseases with significant sequelae and create chronic conditions such as AMI are not included in this status.

However, the significant acute diseases that are present in this status can be a precursor to chronic disease or place the individual at risk for the development of chronic disease (e.g., chest pain). Thus, although the individuals in the history of significant acute disease status do not have any chronic diseases, they are distinct from healthy individuals. Certain EPCs are also considered equivalent to a significant acute disease. For example, if the skin graft EPC is present, the individual is assigned to the history of significant acute disease status even if no significant acute EDCs are present. The performance of a skin graft is considered indicative of significant acute disease. There are six base CRGs for individuals with history of significant acute disease which include a CRG for multiple significant acute diseases from different MDCs.

The six base CRGs are assigned hierarchically based on the number and duration of treatment of the significant acute diseases present. There are no severity levels assigned to the history of significant acute disease CRGs.

Healthy

The ninth and final status in the CRG status hierarchy is Status 1, Healthy. These individuals have had no PCDs and no significant acute EDCs or EPCs in the most recent six month period. They may have minor acute EDCs present (e.g., upper respiratory infection) but are otherwise have no reported problems. It is possible that this Status includes individuals with chronic diseases who did not access the medical care system during the time period used to assign the CRGs.

There are two CRGs for healthy individuals. One is for individuals with encounters with the health care system. The other status includes individuals who have had no medical care encounters. There are no severity levels assigned.

Phase IV: Consolidation of CRGs into Three Successive Tiers of Aggregation

In order to facilitate CRG use, the 1080 CRGs are consolidated into three standard tiers of aggregation Each standard successive tiers of aggregation has fewer base CRGs. Across the CRG aggregations, the CRG status is maintained. The severity levels within are also maintained though are subject to modification to compensate for disparate clinical significance among base CRGs. Although the aggregation of CRGs reduces clinical and statistical precision, the successive tiers of aggregation maintain clinical meaningfulness. The successive tiers of aggregation take into consideration the future medical care needs and clinical similarity of the individuals assigned to the aggregated CRGs. The aggregated CRGs are

referred to as ACRGs and the successive tiers of aggregation are referred to as ACRG1, ACRG2 and ACRG3, with ACRG3 being the highest level of aggregation. The number of base CRGs are 272, 104, 38 and 9 and the number of CRGs including severity levels are 1080, 416, 151 and 38 for CRG, ACRG1, ACRG2 and ACRG3, respectively.

The process of aggregating CRGs into successive tiers of ACRGs is illustrated in Table 9 for CRG status 5 consisting of single dominant and moderate chronic diseases for the MDCs for cardiovascular diseases, peripheral vascular and non cardiac vascular diseases and respiratory diseases. In these three MDCs there are 24 base CRGs, each with 4 severity levels for a total of 96 CRGs. The 24 base CRGs from these three MDCs are consolidated into six base ACRG1s. The severity level for the ACRG1 is the same as the severity level for CRG (e.g., if the severity for the angina CRG is level 3, the severity level for the ACRG1 for dominant chronic circulatory diseases except CHF is also level 3). Thus, the 96 CRGs in these three MDCs for the single dominant or moderate chronic disease status are aggregated into 24 ACRG1s.

. The aggregation CRGs to ACRG1s combines the MDCs for heart and cardiac vascular disease together with the MDC for peripheral vascular and noncardiac vascular disease into circulatory diseases which has the following four circulatory base ACRG1s

- Congestive heart failure
- Dominant chronic circulatory diseases except CHF
- Moderate chronic circulatory diseases except hypertension
- Hypertension

The CRGs in the respiratory system are aggregated into two base ACRG1s

- Dominant chronic respiratory diseases
- Asthma

In the next step, the four ACRG1 base CRGs from the cardiovascular diseases and peripheral vascular and non-cardiac vascular diseases are aggregated into a single circulatory Base ACRG2. The two respiratory Base ACRG1s are combined into one base ACRG2. For both sets of aggregations, there is significant clinical disparity between the ACRG1s. Therefore, in light of the disparity, the number of severity levels was increased to five to maintain the distinction. This can be seen in Table 10 for the Status 5 Circulatory MDC and Status 5 Respiratory MDCs where, for example, the congestive heart failure severity levels are

Table 9: Aggregation of Cardiopulmonary CRGs into ACRGs for the CRG Status Consisting of a Single Dominant or Moderate Disease

CRGs	ACRG1s	ACRG2s
Heart and Coronary Vascular Diseases 14 Base CRGs 4 SoI Levels 58 CRGs **Peripheral and Noncardiac Vascular Diseases** 3 Base CRGs 4 SoI Levels 12 CRGs **Respiratory Diseases** 5 Base CRGs 4 SoI Levels 20 CRGs	**Circulatory Diseases** 4 Base ACRG1s 4 SOI Levels 16 ACRG1s **Respiratory Diseases** 2 Base ACRG1s 4 SoI Levels 8 ACRG1s	**Cardiopulmonary Diseases** 1 Base ACRG2 6 SoI Levels 6 ACRG2s
DC Congestive Heart Failure	DC Congestive Heart Failure	DC Congestive Heart Failure
DC Major Congenital Heart		DC Major Congenital Heart
DC Moderate Congenital Heart	DC Major Congenital Heart	DC Moderate Congenital Heart
DC Major Cardiac Diagnoses	DC Moderate Congenital Heart	DC Major Cardiac Diagnoses
DC Cardiac Valve Diagnoses	DC Major Cardiac Diagnoses	DC Cardiac Valve Diagnoses
DC History of AMI	DC Cardiac Valve Diagnoses	DC History of AMI
DC Angina	DC History of AMI	DC Angina
MC Atrial Fibrillation	DC Angina	DC Peripheral Vascular Disease
MC Cardiac Dysrhythmia	DC Peripheral Vascular Disease	DC Moderate Artery and Vein Disease
MC History of CABG	DC Moderate Artery and Vein Diseases	DC COPD and Bronchiectasis
MC History of PTCA		DC BPD/Major Lung Anomaly
MC History of Cardiac Device	MC Atrial Fibrillation	DC Other Sig Chronic Pulmonary Diagnoses
MC Coronary Atherosclerosis	MC Cardiac Dysrhythmia	DC Tracheostomy Status
MC Hypertension	MC History of CABG	MC Atrial Fibrillation
	MC History of PTCA	MC Cardiac Dysrhythmia
DC Peripheral Vascular Disease	MC History of Cardiac Device	MC History of CABG
DC Moderate Artery and Vein Disease	MC Coronary Atherosclerosis	MC History of PTCA
MC Leg Varicosities with Ulcer	MC Leg Varicosities with Ulcer	MC History of Cardiac Device
		MC Coronary Atherosclerosis
DC COPD and Bronchiectasis	MC Hypertension	MC Leg Varicosities with Ulcer
DC BPD/Major Lung Anomaly		MC Hypertension
DC Significant Pulmonary Disease	DC COPD and Bronchiectasis	MC Asthma
DC Tracheostomy Status	DC BPD/Major Lung Anomaly	
MC Asthma	DC Significant Pulmonary Disease	
	DC Tracheostomy Status	
	MC Asthma	

Table 10 – The ACRG1 – ACRG2 Aggregation of the Status 5 Circulatory and Respiratory MDCs

		ACRG2 - Severity Level					
ACRG1	Severity	1	2	3	4	5	6
Congestive Heart Failure	1		X				
	2			X			
	3				X		
	4					X	
Dominant Chronic - Circulatory Except Congestive Heart Failure and Hypertension	1	X					
	2		X				
	3			X			
	4				X		
Moderate Chronic - Circulatory Except Hypertension	1	X					
	2		X				
	3			X			
	4				X		
Hypertension	1	X					
	2	X					
	3		X				
	4			X			
Dominant Chronic - Respiratory	1		X				
	2			X			
	3				X		
	4					X	
Asthma	1	X					
	2		X				
	3			X			
	4				X		

incremented by one. On the other hand the hypertension ACRG is assigned severity levels between one and three.

For other ACRG1s, for example, the one based on Chronic Renal Failure, the disparity is greater, so when aggregating to ACRG2, six rather than five severity levels are assigned.

The final aggregation is to the ACRG 3 aggregation. Here too, the aggregation is within Status with the base CRG being the status. The severity of illness levels are maintained. One of the features of the CRG approach to aggregation is that it can be customized to meet situational needs. For the episodes an additional aggregation, referred to as ACRG4, was used. This aggregation, shown in Table 11, reduced the number of ACRG 3 groups from 38 to 23. Unlike the standard aggregations, these cross status lines and merge severity levels. In Table 11, the shaded area shows where the severity level is not applicable for a ACRG 3. The numbers in the cells show how the 38 ACRG 3s were mapped down to the 23 ACRG 4s. Thus, CRG status 1 and 2 are combined together to form ACRG3 group 1. CRG status 3 severity levels 1and 2 and CRG status 4 severity levels 1 through 4 are combined together to form ACRG3 group 2 and so on.

Summary

The clinical logic in the four phase process for determining CRG assignment results in a severity adjusted set of mutually exclusive and exhaustive categories that differentiate the relative need for future medical care as well as debility and death. The CRGs were constructed as a categorical clinical model using an approach of iterative sequential hypothesis testing by panels of clinical experts with repetitive data verification. For the purposes of differentiating, the chronic illness burden of beneficiaries during a post acute care episode the 23 ACRG4s take into account all of a beneficiary's comorbidities and provide the basis for estimating resource use during the episode.

Table 11: Conversion of ACRG 3 to ACRG 4

CRG Status		Severity Level					
		1	2	3	4	5	6
1.	Healthy	1					
2.	History of Significant Acute Disease	1					
3.	Single Minor Chronic Disease	2	2				
4.	Minor Chronic Disease in Multiple Organ Systems	2	2	2	2		
5.	Single Dominant or Moderate Chronic Disease	3	4	5	6	7	7
6.	Dominant or Moderate Chronic Disease in Multiple Organ Systems	8	9	10	11	12	12
7.	Dominant Chronic Disease in Three or More Organ Systems	13	14	15	16	17	17
8.	Dominant and Metastatic Malignancies	18	18	18	19	20	20
9.	Catastrophic Conditions	21	21	21	22	23	23

Appendix B

The Effect on Explained Variation (R^2) of Medicare Payments and Provider Charges of Including Potential Measures of Frailty in Episode Definitions

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Richard Averill, M.S., Jon Eisenhandler, PhD, James Vertrees, Ph.D.,
Anthony Quain, M.A., James Switalski, B.S and Norbert Goldfield, M.D.

3M Health Information Systems, Inc

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The purpose of this analysis is to ascertain the extent which three potential measures of frailty are able to explain variation (as measured by R^2) in Medicare payments and in provider charges. The three potential measures of frailty are age (a surrogate variable for frailty), entry into the hospital from a nursing home, and functional status. Age and entry into a hospital from a nursing home are relatively easy to audit and are inexpensive to collect. Functional status is used as used as a factor for determining payment levels in most post acute care payment systems (e.g., home health). There are a broad range of measures of functional ability, but these data are relatively expensive to collect and are not consistently applied across all settings. However, functional ability has the potential to be a driver of treatment cost for both acute and post acute care. Hence, this is an important issue to address.

Alternative Measures of Frailty

Individuals who enter the trigger event hospitalization from a nursing home may have higher costs for the episode. Nursing home care (as distinct from care in a Skilled Nursing Facility) is not a covered Medicare benefit. This means that ascertaining if a person was admitted to the hospital from a nursing home must be determined in a somewhat indirect way. Therefore, the professional claims for the beneficiary from the 30 days prior to the date of admission to the hospital were examined. If there was professional claim for the beneficiary within the prior 30 days containing at least one claim line with a site of service of nursing home (site of service 32) then the beneficiary was designated as having been admitted to the hospital from a nursing home. If this variable were to be used in a payment context, collection could be more direct.

In a separate project, four domains of functional health status (self care, mobility, cognition and incontinence) were constructed from beneficiary assessment data. These domains were chosen because of their clinical importance and the availability of mappings for these domains across different functional status assessment instruments.

Measuring Functional Status

Since the functional status data was collected using different assessment instruments (OASIS, MDS, IRF PAI)), each of the functional status measures from the different instruments was co-calibrated into a three level scale (high, moderate, low level of impairment) based upon prior research (Mallinson, T et al). The 81 possible combinations of the three levels in the four functional status domains were consolidated into a nine category composite categorization of limitations in functional ability that was exhaustive and mutually exclusive. Based on a beneficiary's level of functional status in each of the four domains, the beneficiary is assigned to one of the nine composite functional categories that represent the extent of overall beneficiary functional status impairment. The nine categories are defined based on an overall hierarchy of the four domains that was defined by the project clinical team (self care, mobility, incontinence, cognitive reasoning).

Using the domain hierarchy, the levels within each domain were evaluated in terms of their impact on expenditures in the coming year resulting in the formation of the nine composite categories as described in Appendix C. Even though the episodes are of a shorter duration (30 or

90 days) the definition of the nine composite categories was not changed. Because the measure of functional status is a categorical model, the relative impact of each of the functional status categories on episode expenditures can be independently determined. Thus, the relative weight give to each functional status category is different for expenditures in the coming year versus for an episode. Indeed, the relative weight given to each of the functional status categories can vary depending on the definition of the episode (e.g., readmissions included or excluded). Throughout the analysis the definition of the functional status categories was held constant, but the relative weight given to each category was allowed to vary depending on its impact on episode expenditures. The nine composite functional categories are summarized in Figure 1.

The functional assessment instrument used is determined by the site of service as follows:

- home health (OASIS),
- skilled nursing (MDS)
- rehabilitation (IRF_PAI) encounters.

Because a beneficiary can have more than one assessment, it was necessary to develop rules for choosing which functional assessment best described the functional status of the beneficiary at the time of the episode. Functional assessments performed in the 90 days prior to the trigger hospitalization admission date and in the 30 days after discharge from the trigger hospitalization were evaluated. The rules for selecting which assessment to use were:

1. If more than one pre-assessment exist, choose the latest one.
2. If more than one post-assessment exist, choose the earliest one.
3. If both a pre- and post- exist, choose the post-.
4. If two exist on the same day, choose OASIS over MDS over IRF.

Impact of Measures of Frailty on Episode Payments and Charges

In order to examine the impact of functional status on payments/ charges during an episode a series of regression analyses were performed. The independent variables in the regression equations were age, sex, "entered hospital from a nursing home", the nine functional status dummy (0/1) variables corresponding to the nine composite functional categories and expected payment/charge. If there were no functional assessments performed in the 90 days prior to the trigger hospitalization admission date and no assessments performed in the 30 days after discharge from the trigger hospitalization, all nine functional status dummy variables were given a value of zero. This group appears in the constant term.

The expected payment/charge was computed using the combination of MS-DRGs and Clinical Risk Groups (CRGs). The MS-DRGs account for differences in clinical severity across patients during their hospital stay. Each episode was assigned to a base MS-DRGs and acuity level. Acuity level 1 identifies episodes without a major complication or comorbid condition (MCC); Acuity level 2 includes episodes with a MCC. A base MS-DRGs was split into the two acuity levels even if the standard MS-DRGs used by Medicare was not differentiated by the presence of an MCC.

The average payment/charge in each MS-DRG/acuity cell was then further risk adjusted using the CRGs (Hughes, et al., 2003). CRGs account for differences in the chronic illness burden of patients at the time of the discharge from the hospital based on the diagnostic and procedure information gathered from hospital and physician claims during the year prior to the episode. The CRGs were consolidated into 23 categories and a relative payment/charge weight for each of the 23 consolidated CRGs was computed. Upon discharge from the hospital that initiated the episode the MS-DRG, acuity and CRG were assigned to the beneficiary. The expected payment/charge for an episode was computed as the product of the average payment/charge in the MS-DRG/acuity cell times the CRG relative weight.

From the regression equations the R^2 value for payments and charges for a variety of combinations of episode windows (30 and 90 days) and readmission criteria were computed. Bundles that included readmissions were constructed using either Potentially Preventable Readmissions (PPRs) (Goldfield, et al., 2008) or all-cause readmissions. When PPRs are used only potentially preventable readmissions are included in the bundle. When all-cause is used all readmissions are included in the bundle. Using PPRs, when a readmission that was not potentially preventable occurred during the 90-day period following the hospital discharge, the episode is terminated and excluded from the analysis. The readmission that is not potentially preventable could then initiate a new episode. The dependent variables in the regressions were actual episode charge or payment for a patient as well a constructed (actual – expected) payment or charge variable.

The charge and payment dependent variables included in the episode were composed of various combinations of services as follows:

- Inpatient facility and physician service
- Inpatient facility and physician services and readmission facility and physician services
- Institutional Post Acute Care (PAC) and home health
- Institutional PAC, home health and facility and physician services during the readmission.
- Institutional PAC, home health, readmission facility and physician services and all other post discharge services (ER visits, physician office visits, etc.)
- Inpatient facility and physician services, readmission facility and physician services, institutional PAC and home health
- Inpatient facility and physician services, readmission facility and physician services, institutional PAC, home health and all other post discharge services (ER visits, Physician office visits, etc.)

One issue for post acute care is that some episodes will use no institutional PAC or home health services. This means that there is decision to use PAC services (yes/no) and, then, given that some PAC services will be used, there is a second decision as to how much PAC services will be used. Thus, it also is of interest to examine episodes where PAC was used separately from those where it was not used to determine if it might prove useful to separate these two situations (use/non-use) in a payment context. Therefore, the following Tables begin with Tables 1 and 2 that included all episodes irrespective of whether PAC services were used. Table 3 and 4 contain

only episodes where there were some PAC services used. Tables 6 and 7 are based only episodes where there were no PAC services used.

R^2 Results

Tables 1, 3 and 6 use Medicare payments as the dependent variable, while Tables 2, 4, 7 use provider charges as the dependent variable. Columns 6 – 12 are the various bundles of services included in the episode beginning with the trigger hospitalization and ending with all of the services in the entire episode.

The first ten rows of each table use the Potentially Preventable Readmissions (PPRs) to define readmissions while the second 10 rows used all cause to define readmissions. Both 30 and 90 day post acute care windows are shown. There are five different combinations of independent variables used in the regressions as follows:

- Age, sex, entry into the hospital from a nursing home, and the nine functional status categories (row in table = Age, Sex, NH, FS)
- MS-DRG/CRG expected charge or payment (Exp)
- Age, sex, entry into the hospital from a nursing home, the nine functional status categories and MS-DRG/CRG expected charge or payment (Exp, Age, Sex, NH, FS)
- Nine functional status categories (FS)
- MS-DRG/CRG expected charge or payment and nine functional status categories (Exp, FS)

Turning to Table 1 for payments (which includes episodes that both used and did not use PAC services), the PAC bundle (institution PAC plus home heath) for a 30-day post acute episode has an R^2 of 22.10 for the MS-DRG/CRG based expected value and a R^2 of 23.99 for the composite functional status variable. When both the expected value and the functional status are included in the regression the R^2 increases to 35.00 indicating that the MS-DRG/CRG expected value and the function status have an independent impact on episode payments. The addition of age, sex and admission from a nursing home only increases the R^2 to 36.02. When PPR based readmissions are added to the post acute care bundle the R^2 drops from 35.00 to 29.15. If all cause readmission are included in the bundle the R^2 drops further to 23.83. If the episode window is expanded to 90 days the R^2 for the PAC bundle drops from 35.00 to 31.73. Adding readmissions to the 90-day episode drops the R^2 further to 25.62 and 21.41 for PPRs and all cause, respectively.

If the bundle is expanded to include the initial hospitalization as well as PAC services and PPR based readmissions, the R^2 for the expected value is 61.96 and for functional status is 11.49. Because initial hospital payment is based on MS-DRGs the high R^2 for the expected value is expected. This reflects the reality that event based episodes are simply an extension of Medicare's PPS. When both the expected value and the functional status are included in the regression there is an increase in R^2 from 61.96 to 68.68. If all cause readmission are used the R^2 drops from 68.68 to 59.90. If the episode window is expanded to 90 days, the R^2 drops from 68.68 to 50.53. For a 90-day episode with all cause readmission the R^2 drops from 68.68 to

42.39. In general, when the trigger hospitalization is included in the bundle, the impact of functional status decreases. For example, for a 30 day bundle composed of PAC services and PPR readmissions the R^2 for functional status is 20.72 but when the trigger hospitalization is added to the bundle the R^2 for functional status decreases to 11.49. This result is due to the very low R^2 (2.05) for functional status for a trigger hospital only bundle.

The general conclusions from Table 1 are that the addition of functional status to the MS-DRG/CRG expected value substantially increases R^2 for a PAC bundle. The addition of readmissions to the PAC bundle reduces R^2. Readmissions are costly and infrequent and are difficult to predict based solely on clinical factors related to the individual. The reduction in R^2 is less for PPR based readmission than for all cause readmissions. The expansion of the episode window from 30 to 90 days also reduces R^2. The combined effect of expanding the episode window to 90 days and including readmission results in a substantial reduction in R^2.

The inclusion of the trigger hospitalization in the bundle substantially increases R^2 but reduces the contribution of functional status to the R^2 because function status has minimal impact on expenditures during the trigger hospitalization. Although the contribution of functional status to the R^2 is less when the trigger hospitalization is included in the bundle, the extent of the increase is still significant. For example for a 90 day bundle that includes PAC services, PPRs and the trigger hospitalization the addition of functional status to the MS-DRG/CRG expected value increases the R^2 from 44.52 to 50.53.

The R^2 results for charges in Table 2 show the same general pattern as payments except that the R^2 values are uniformly lower. The PAC bundle (institution PAC plus home heath) for a 30-day post acute episode has an R^2 of 16.47 for the MS-DRG/CRG based expected value and a R^2 of 10.10 for the composite functional status variable. When both the expected value and the functional status are included in the regression the R^2 increases to 21.52. The addition of age, sex and admission from a nursing home only increases the R^2 to 21.85. When PPR based readmissions are added to the post acute care bundle the R^2 drops from 21.52 to 11.14. If all cause readmission are included in the bundle the R^2 drops further to 8.13. If the episode window is expanded to 90 days the R^2 for the PAC bundle drops from 21.52 to 20.56. Adding readmissions to the 90-day episode drops the R^2 further to 11.15 and 8.97 for PPRs and all cause, respectively.

If the bundle is expanded to include the initial hospitalization as well as PAC services and PPR based readmissions, the R^2 for the expected value is 39.26 and for functional status the R^2 is 4.64. When both the expected value and the functional status are included in the regression there is a small increase in R^2 from 39.26 to 40.62. If all cause readmission are used the R^2 drops from 40.62 to 36.56. If the episode window is expanded to 90 days, the R^2 drops from 40.62 to 35.72. For a 90-day episode with all cause readmission the R^2 drops from 40.62 to 29.10. While the pattern for charges is similar to payments the impact on R^2 of readmissions is greater while the impact of the expansion of the episode window to 90 days is less. Further, the improvement in R^2 for charges due to the addition of the functional status to the MS-DRG/CRG expected value is less than for payments. In general, when the trigger hospitalization is included in the bundle, the

impact of functional status decreases. For example, for a 30 day bundle composed of PAC services and PPR readmissions the R^2 for functional status is 5.88 but when the trigger hospitalization is added to the bundle the R^2 for functional status decreases to 4.64. This result is due to the low R^2 (2.45) for functional status for a bundle containing only the trigger hospital.

Tables 3 and 4 contain the R^2 values for only those patients who received PAC services. Although for payments (Table 3) the pattern of R^2 values is generally the same for the PAC user population as for the total population, the R^2 are lower for the PAC user population than the total population. The R^2 for functional status (for PAC services for a 30 day window with PPRs) is 20.72 but drops to 4.93 when patients who do not use PAC services are excluded. Similarly, when the bundle is expanded to include the initial hospitalization as well as PAC services and PPR based readmissions, the R^2 for functional status for a 30 day window drops from 11.49 to 1.34. Functional status influences both the decision to use PAC services as well as the amount of PAC services utilized. When the population is limited to only PAC users, the contribution of functional status to the prediction of PAC service use is eliminated resulting in a substantial drop in R^2. The one other difference in the R^2 pattern for PAC users is that when readmissions are included, the expansion of the episode window to 90 days results in a slight increase in R^2 as opposed to the decrease for the total population. With consistently lower R^2 values the pattern for charges for the PAC user population is the same as for payments.

The R^2 results from Tables 1-4 are summarized in Table 5.

Tables 6 and 7 contain the R^2 values for the population of patients who did not use any PAC services. Post discharge services are limited to readmissions and ER visits, physician office visits and other post discharge services. From Table 6 if the bundle includes PAC services, PPR based readmissions and the initial hospitalization, the R^2 for payments for the expected value is 63.54 and for functional status is 0.65. When both the expected value and the functional status are included in the regression the R^2 there is virtually no increase in R^2 (63.66). If all cause readmission are used the R^2 drops from 63.66 to 51.98. If the episode window is expanded to 90 days, the R^2 drops from 63.66 to 50.17. For a 90-day episode with all cause readmission the R^2 drops from 63.66 to 36.11. The pattern for charges (Table 7) is similar to payments except that the R^2 values are lower than for payments.

Table 8 contains the R^2 values for selected base MS-DRGs for the bundle that includes PAC services, PPR based readmissions and the initial hospitalization for a 90-day window. For payments the R^2 for functional status is higher than the MS-DRG/CRG expected value except for three surgical base MS-DRGs (coronary bypass, major bowel procedures and spinal fusions). The combined MS-DRG/CRG expected value and functional status has an R^2 greater than 10 for all base MS-DRGs except for the hip and femur fractures and hip and femur procedure MS-DRGs. For charges the R^2 for functional status is substantially lower than for payments for all base MS-DRGs while the R^2 increase for the MS-DRG/CRG expected value for all MS-DRGs except the three surgical base MS-DRGs. As a reference point, if each base MS-DRGs is split into major CC, CC or no CC subgroups the resulting R^2 based on inpatient charges is typically less than 10. For example the R^2 for the pneumonia, CHF and septicemia MS-DRGs for three

way CC split is 7.11, 6.59 and 3.96, respectively and the R^2 for the corresponding episodes is 4.45, 3.24 and 3.44 for the MS-DRG/CRG expected value and 10.08, 7.81 and 9.80 for the combined MS-DRG/CRG expected value and functional status, respectively.

Summary

The overall conclusions from Tables 1 through 8 are as follows:

- The addition of functional status to the MS-DRG/CRG expected value (exp) substantially increases R^2 for a PAC bundle (institutional PAC and home health)
- The addition of age, sex and admission from a nursing home to functional status (FS) provides only a minimal increase in R^2 for a PAC bundle
- The addition of preventable readmissions (PPRs) to the PAC bundle reduces R^2.
- The reduction in R^2 due to the addition of readmissions is more substantial for all cause readmission than for PPRs
- The expansion of the episode window from 30 to 90 days reduces R^2.
- The combined effect of expanding the episode window to 90 days and including readmission results in a substantial reduction in R^2
- For the subset of patients who received PAC services the increase in R^2 due to functional status is substantially lower because the contribution of functional status in predicting the need for PAC services is eliminated
- At the individual MS-DRG level the increase in R^2 due to functional status tends to be higher for medical case than surgical cases
- Generally, the pattern of R^2 increase and decreases is the same for both payments and charges although the R^2 for charges is consistently lower than payments
- Generally, the pattern of R^2 increase and decreases is the same when the hospitalization that triggered the episode is included in the bundle though the R^2 with the trigger hospitalization included is consistently higher than when the trigger hospitalization is excluded from the bundle
- The addition of functional status to the MS-DRG/CRG expected value results in a minimal increase in R^2 for a trigger hospitalization only bundle
- The increase in R^2 due to addition of functional status to the MS-DRG/CRG expected value is substantially less for a bundle that includes the both the trigger hospitalization and PAC services versus a PAC only bundle.

A higher R^2 is only one of the criteria that needs to be evaluated in assessing alternative payment bundles. More comprehensive bundles provide greater accountability and increased financial incentives to provide greater care coordinating during the post acute care period. While the more comprehensive bundles do result in a lower R^2, the level of predictive performance is still high enough for an operational bundled payment system, especially if some form of outlier protection is included in the payment system design.

Functional Status Categories

Because of the significant contribution of functional status in explaining episode payments and charges, the regression coefficients for the nine functional status composite categories were examined to determine the relative contribution of each of the categories as compared to age, sex and entry from a nursing home.

The analysis was performed on payments for a bundle that included inpatient facility and physician services, readmission facility and physician services, institutional PAC and home health but excluded other post discharge services (ER visits, Physician office visits, etc.). The readmissions included in the bundle were only those that were potentially preventable (PPRs). A 90-day episode window was used. The dependent variable used in this analysis is the actual Medicare payments for the episode minus the expected payments based on MS-DRGs/CRG. Thus, dependent variable is the residual variation in episode payments unexplained by the MS-DRG/CRG classification of episodes. The regression seeks to explain this residual variation using age, admission from a nursing home and functional status. A positive value for a coefficient means that the variable is associated with higher Medicare payments while a negative value for a coefficient means that the variable in question is associated with lower than expected payments. The results are presented in Table 9.

The R^2 for the model was 7.77 percent meaning that age, admission from a nursing home and functional status explain only a modest amount of the residual variation in episode payments unexplained by the MS-DRG/CRG classification of episodes. The intercept reflects the omitted observations, in this case, individuals who did not have any functional status information. These individuals had costs that were $6,081 lower than expected. Age was entered as a continuous variable. When the other factors have been taken into account, one year of additional age is associated with $63 in higher cost. Males had Medicare payments $1,438 lower than expected as compared to females, while entry from a nursing home (not a SNF) resulted in payments that were $136 more than expected given that the beneficiary's functional ability has been taken into account separately.

Most important, the functional status groups 1–9 are consistently associated with higher Medicare payments, ranging from $143 for functional status group 9 (no significant mobility or self care impairment, low incontinency and cognitively impaired) to $12,244 for functional status group 6 (significant mobility and self care impairment, extreme incontinency and cognitively impaired). As expected functional status group 6 had the greatest impact on payments since it contains beneficiaries with significant impairment in all four domains. However, it is an anomaly that functional status group 8 with low impairment in all four domains did not have the lowest impact on payment (i.e., lowest coefficient). If a functional status assessment was reported but the assessment was not thoroughly done (no impairments reported), then those patients would be assigned to group 8. The higher than expected coefficient for group 8 is likely due to inadequately assessed records being assigned to group 8 resulting in patients with functional impairments being inappropriately included in group 8. These results are averages, and, while significant, it is also important to remember that the R^2 for the model was a modest 7.77 percent. This implies that there is significant variation within the various functional status (as well as the other) categories. Further research and refinement of the functional status

categories may be warranted. However, these results indicate that the extent of functional status impairment has a consistent and significant upward effect on Medicare payments. This holds true even after the effects of age and admission from a nursing home have been taken into account. Thus, as Medicare moves toward bundled payment alternatives, the use of functional status data to improve the accuracy of the expected cost estimates should be considered.

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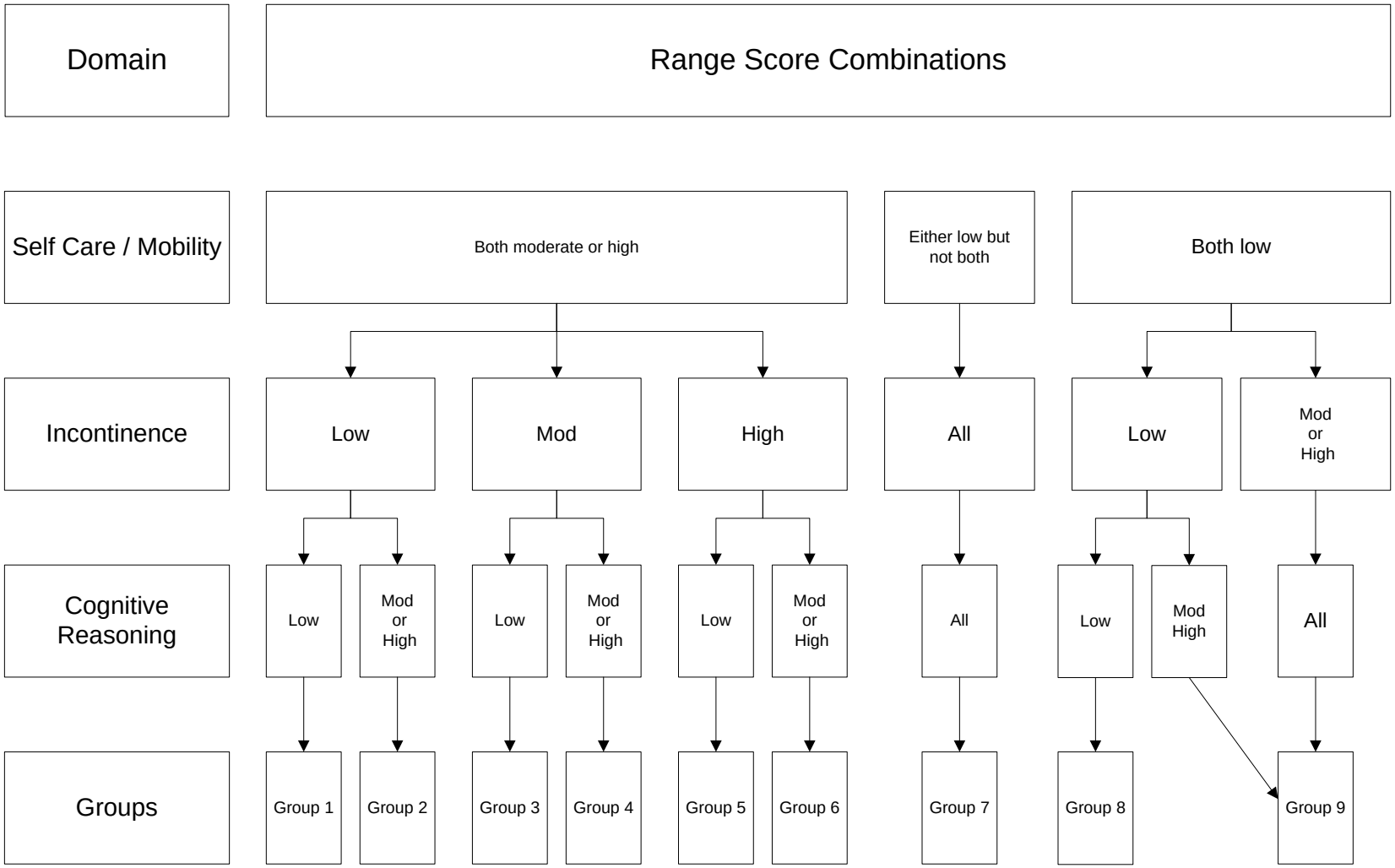

Figure 1: Nine functional status groups

Table 1
R^2 Values With and Without Functional Status Across All Episodes for Payments, All Episodes

Window	Readmit	Financial Measure	Dependant Variable	Independent Variables	Hosp Trigger with MD	Hosp Trigger and Readmit with MD	Institutional PAC and HH	Institutional PAC and HH and Readmit with MD	Institutional PAC and HH and Readmit with MD and Post Discharge	Hosp Trigger and Institutional PAC and HH and Readmit with MD	Entire Episode
30	PPR	Payments	Act-Exp	Age, Sex, NH, FS	0.37	0.44	14.45	11.29	10.16	7.25	6.68
30	PPR	Payments	Actual	Exp	80.06	70.37	22.10	17.49	17.71	61.96	60.99
30	PPR	Payments	Actual	Exp, Age, Sex, NH, FS	80.13	70.66	36.02	29.86	29.07	65.90	64.83
30	PPR	Payments	Actual	FS	2.05	2.85	23.99	20.72	19.59	11.49	11.33
30	PPR	Payments	Actual	Exp, FS	80.10	70.63	35.00	29.15	28.57	68.68	64.66
90	PPR	Payments	Act-Exp	Age, Sex, NH, FS	0.37	0.40	13.72	9.58	8.25	7.77	6.76
90	PPR	Payments	Actual	Exp	80.06	58.02	18.66	14.77	15.40	44.52	43.66
90	PPR	Payments	Actual	Exp, Age, Sex, NH, FS	80.13	58.48	32.85	26.28	25.61	50.80	49.51
90	PPR	Payments	Actual	FS	2.05	3.13	22.44	17.96	16.66	14.08	13.47
90	PPR	Payments	Actual	Exp, FS	80.10	58.47	31.73	25.62	25.24	50.53	49.36
30	All cause	Payments	Act-Exp	Age, Sex, NH, FS	0.35	0.82	15.21	9.71	8.95	7.48	6.99
30	All cause	Payments	Actual	Exp	81.81	60.40	22.37	13.28	13.84	55.67	54.73
30	All cause	Payments	Actual	Exp, Age, Sex, NH, FS	81.89	60.98	36.60	24.22	24.06	60.08	59.05
30	All cause	Payments	Actual	FS	2.00	3.17	24.39	17.63	16.79	11.82	11.61
30	All cause	Payments	Actual	Exp, FS	81.85	60.94	35.59	23.83	23.79	59.90	58.91
90	All cause	Payments	Act-Exp	Age, Sex, NH, FS	0.35	0.64	14.25	7.85	6.91	6.96	6.17
90	All cause	Payments	Actual	Exp	81.81	42.75	18.10	12.10	13.13	36.25	35.77
90	All cause	Payments	Actual	Exp, Age, Sex, NH, FS	81.89	43.58	32.58	21.72	21.75	42.56	41.68
90	All cause	Payments	Actual	FS	2.00	3.12	22.57	14.82	13.74	13.31	12.62
90	All cause	Payments	Actual	Exp, FS	81.85	43.49	31.47	21.41	21.60	42.39	41.58

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 2
R^2 Values With and Without Functional Status Across All Episodes for Charges, All Episodes

Window	Readmit	Financial Measure	Dependant Variable	Independent Variables	Hosp Trigger with MD	Hosp Trigger and Readmit with MD	Institutional PAC and HH	Institutional PAC and HH and Readmit with MD	Institutional PAC and HH and Readmit with MD and Post Discharge	Hosp Trigger and Institutional PAC and HH and Readmit with MD	Entire Episode
30	PPR	Charges	Act-Exp	Age, Sex, NH, FS	0.38	0.47	4.45	2.16	1.93	1.14	1.11
30	PPR	Charges	Actual	Exp	42.38	38.19	16.47	7.90	9.08	39.26	39.53
30	PPR	Charges	Actual	Exp, Age, Sex, NH, FS	42.86	38.89	21.85	11.21	12.09	40.67	40.92
30	PPR	Charges	Actual	FS	2.45	2.89	10.10	5.88	5.75	4.64	4.64
30	PPR	Charges	Actual	Exp, FS	42.82	38.85	21.52	11.14	12.04	40.62	40.87
90	PPR	Charges	Act-Exp	Age, Sex, NH, FS	0.38	0.47	3.98	1.68	1.37	1.27	1.16
90	PPR	Charges	Actual	Exp	42.38	33.01	15.75	8.32	9.60	33.94	34.07
90	PPR	Charges	Actual	Exp, Age, Sex, NH, FS	42.86	33.84	20.86	11.20	12.08	35.74	35.81
90	PPR	Charges	Actual	FS	2.45	3.02	9.08	5.15	4.81	5.22	5.11
90	PPR	Charges	Actual	Exp, FS	42.82	33.80	20.56	11.15	12.05	35.72	35.77
30	All cause	Charges	Act-Exp	Age, Sex, NH, FS	0.48	0.78	4.92	1.99	1.90	1.54	1.52
30	All cause	Charges	Actual	Exp	42.45	33.50	16.82	5.35	6.44	34.93	35.21
30	All cause	Charges	Actual	Exp, Age, Sex, NH, FS	42.96	34.46	22.43	8.17	9.16	36.63	36.91
30	All cause	Charges	Actual	FS	2.45	3.11	10.48	4.60	4.59	4.87	4.87
30	All cause	Charges	Actual	Exp, FS	42.91	34.40	22.06	8.13	9.10	36.56	36.83
90	All cause	Charges	Act-Exp	Age, Sex, NH, FS	0.48	0.66	4.33	1.39	1.25	1.43	1.35
90	All cause	Charges	Actual	Exp	42.45	25.74	15.00	6.74	8.21	27.16	27.54
90	All cause	Charges	Actual	Exp, Age, Sex, NH, FS	42.96	26.80	20.33	8.98	10.28	29.15	29.49
90	All cause	Charges	Actual	FS	2.45	2.96	9.31	3.91	3.74	5.02	4.90
90	All cause	Charges	Actual	Exp, FS	42.82	26.71	20.01	8.97	10.24	29.10	29.40

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 3
R^2 Values With and Without Functional Status Across All Episodes with PAC for Payments

Window	Readmit	Financial Measure	Dependant Variable	Independent Variables	Hosp Trigger with MD	Hosp Trigger and Readmit with MD	Institutional PAC and HH	Institutional PAC and HH and Readmit with MD	Institutional PAC and HH and Readmit with MD and Post Discharge	Hosp Trigger and Institutional PAC and HH and Readmit with MD	Entire Episode
30	PPR	Payments	Act-Exp	Age, Sex, NH, FS	0.54	0.74	5.14	3.29	2.79	2.47	2.08
30	PPR	Payments	Actual	Exp	82.77	71.73	14.98	12.72	14.10	62.84	62.30
30	PPR	Payments	Actual	Exp, Age, Sex, NH, FS	82.84	72.02	20.05	16.23	17.03	63.72	63.09
30	PPR	Payments	Actual	FS	0.75	1.10	6.76	4.93	4.33	1.34	1.27
30	PPR	Payments	Actual	Exp, FS	82.80	71.98	19.87	16.13	17.01	63.71	63.08
90	PPR	Payments	Act-Exp	Age, Sex, NH, FS	0.60	0.46	7.12	4.16	3.34	3.64	2.85
90	PPR	Payments	Actual	Exp	82.71	57.04	13.76	11.60	13.03	41.82	42.06
90	PPR	Payments	Actual	Exp, Age, Sex, NH, FS	82.78	57.48	20.83	16.15	16.69	44.13	43.97
90	PPR	Payments	Actual	FS	0.84	0.89	8.92	6.05	5.14	3.11	2.72
90	PPR	Payments	Actual	Exp, FS	82.75	57.32	20.20	15.87	16.55	44.05	43.93
30	All cause	Payments	Act-Exp	Age, Sex, NH, FS	0.39	0.95	5.42	2.63	2.30	2.14	1.85
30	All cause	Payments	Actual	Exp	83.87	63.52	14.99	9.66	10.91	57.62	57.05
30	All cause	Payments	Actual	Exp, Age, Sex, NH, FS	83.92	64.08	20.25	12.61	13.47	58.57	57.93
30	All cause	Payments	Actual	FS	0.71	1.31	6.85	4.09	3.62	1.40	1.33
30	All cause	Payments	Actual	Exp, FS	83.89	63.96	20.06	12.58	13.44	58.55	57.89
90	All cause	Payments	Act-Exp	Age, Sex, NH, FS	0.46	1.10	6.99	3.04	2.56	2.66	2.20
90	All cause	Payments	Actual	Exp	83.78	41.97	13.09	9.14	10.51	33.85	34.10
90	All cause	Payments	Actual	Exp, Age, Sex, NH, FS	83.84	43.16	20.02	12.65	13.51	35.94	35.95
90	All cause	Payments	Actual	FS	0.88	0.93	8.62	4.65	3.94	2.76	2.40
90	All cause	Payments	Actual	Exp, FS	83.82	42.49	19.40	12.54	13.34	35.88	35.81

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 4

R^2 Values With and Without Functional Status Across All Episodes with PAC for Charges

Window	Readmit	Financial Measure	Dependant Variable	Independent Variables	Hosp Trigger with MD	Hosp Trigger and Readmit with MD	Institutional PAC and HH	Institutional PAC and HH and Readmit with MD	Institutional PAC and HH and Readmit with MD and Post Discharge	Hosp Trigger and Institutional PAC and HH and Readmit with MD	Entire Episode
30	PPR	Charges	Act-Exp	Age, Sex, NH, FS	0.15	0.23	1.37	0.76	0.73	0.29	0.30
30	PPR	Charges	Actual	Exp	42.07	37.88	15.71	8.88	10.29	39.57	40.02
30	PPR	Charges	Actual	Exp, Age, Sex, NH, FS	42.41	38.34	17.04	9.75	11.13	40.05	40.53
30	PPR	Charges	Actual	FS	0.54	0.67	2.04	1.17	1.02	0.61	0.61
30	PPR	Charges	Actual	Exp, FS	42.18	38.08	16.97	9.66	10.96	39.78	40.22
90	PPR	Charges	Act-Exp	Age, Sex, NH, FS	0.14	0.26	1.57	0.82	0.77	0.37	0.38
90	PPR	Charges	Actual	Exp	41.90	32.04	16.36	9.16	10.59	33.81	34.35
90	PPR	Charges	Actual	Exp, Age, Sex, NH, FS	42.17	32.60	17.90	10.18	11.58	34.38	35.00
90	PPR	Charges	Actual	FS	0.61	0.59	2.45	1.20	0.95	0.67	0.64
90	PPR	Charges	Actual	Exp, FS	42.01	32.25	17.88	9.98	11.22	34.11	34.62
30	All cause	Charges	Act-Exp	Age, Sex, NH, FS	0.18	0.46	1.57	0.87	0.90	0.49	0.52
30	All cause	Charges	Actual	Exp	42.51	34.74	15.13	6.22	7.35	36.42	36.85
30	All cause	Charges	Actual	Exp, Age, Sex, NH, FS	42.81	35.37	16.65	7.24	8.41	37.06	37.54
30	All cause	Charges	Actual	FS	0.53	0.79	2.22	1.08	0.99	0.70	0.71
30	All cause	Charges	Actual	Exp, FS	42.61	42.61	16.56	7.02	8.08	36.71	37.14
90	All cause	Charges	Act-Exp	Age, Sex, NH, FS	0.16	0.71	1.66	1.22	1.32	0.74	0.83
90	All cause	Charges	Actual	Exp	42.31	25.49	14.54	6.96	8.32	27.29	27.89
90	All cause	Charges	Actual	Exp, Age, Sex, NH, FS	42.55	26.51	16.19	8.40	9.91	28.26	29.01
90	All cause	Charges	Actual	FS	0.67	0.59	2.53	1.08	0.93	0.67	0.65
90	All cause	Charges	Actual	Exp, FS	42.43	25.81	16.18	7.83	9.08	27.69	28.77

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 5
R^2 Values With and Without Functional Status

			All Episodes		Episodes with PAC	
Bundle	**Independent Variable**	**Financial Measure**	**30 days**	**90 days**	**30 days**	**90 days**
Institutional PAC and HH	Exp	Payment	22.10	18.66	14.98	13.76
Institutional PAC and HH	FS	Payment	23.99	22.44	6.76	8.92
Institutional PAC and HH	Exp; FS	Payment	35.00	31.73	19.87	20.20
Institutional PAC and HH and Readmit (PPR) with MD	Exp; FS	Payment	29.15	25.62	16.13	15.87
Institutional PAC and HH and Readmit (all cause) with MD	Exp; FS	Payment	23.83	21.41	12.58	12.54
Institutional PAC and HH	Exp	Charges	16.47	15.75	15.71	16.36
Institutional PAC and HH	FS	Charges	10.10	9.08	2.04	2.45
Institutional PAC and HH	Exp; FS	Charges	21.52	20.56	16.97	17.88
Institutional PAC and HH and Readmit (PPR) with MD	Exp; FS	Charges	11.14	11.15	9.66	9.98
Institutional PAC and HH and Readmit (all cause) with MD	Exp; FS	Charges	8.13	8.97	7.02	7.83
Hosp Trigger with MD	Exp	Payment	80.06	80.06	82.77	82.71
Hosp Trigger with MD	FS	Payment	2.05	2.05	0.75	0.84
Hosp Trigger with MD	Exp; FS	Payment	80.10	80.10	82.80	82.75
Hospital Trigger and Institutional PAC and HH and Readmit (PPR) with MD	Exp; FS	Payment	68.68	50.53	63.71	44.05
Hospital Trigger and Institutional PAC and HH and Readmit (all cause) with MD	Exp; FS	Payment	59.90	42.39	58.55	35.88
Hosp Trigger with MD	Exp	Charges	42.38	42.38	42.07	41.90
Hosp Trigger with MD	FS	Charges	2.45	2.45	0.54	0.61
Hosp Trigger with MD	Exp; FS	Charges	42.82	42.82	42.18	42.01
Hospital Trigger and Institutional PAC and HH and Readmit (PPR) with MD	Exp; FS	Charges	40.62	35.72	39.78	34.11
Hospital Trigger and Institutional PAC and HH and Readmit (all cause) with MD	Exp; FS	Charges	36.56	29.10	36.71	27.69

Exp = expected value based on MS-DRG/CRG assigned
FS = nine category functional status measure

Table 6
R^2 Values With and Without Functional Status for Episodes without PAC for Payments

Window	Readmit	Financial Measure	Dependant Variable	Independent Variables	Hosp Trigger with MD	Hosp Trigger and Readmit with MD	Readmit with MD	Readmit with MD and Post Discharge	Hosp Trigger and Institutional PAC and HH and Readmit with MD	Entire Episode
30	PPR	Payments	Act-Exp	Age, Sex, NH, FS	0.66	0.23	1.31	1.32	1.27	1.26
30	PPR	Payments	Actual	Exp	76.48	67.71	0.47	1.28	63.54	61.54
30	PPR	Payments	Actual	Exp, Age, Sex, NH, FS	76.56	67.74	1.19	2.10	63.76	61.78
30	PPR	Payments	Actual	FS	0.35	0.65	0.76	0.83	0.65	0.71
30	PPR	Payments	Actual	Exp, FS	76.53	67.72	1.02	1.76	63.66	61.65
90	PPR	Payments	Act-Exp	Age, Sex, NH, FS	0.56	0.34	2.32	2.39	2.10	2.18
90	PPR	Payments	Actual	Exp	76.41	57.66	1.28	2.98	49.99	46.07
90	PPR	Payments	Actual	Exp, Age, Sex, NH, FS	76.48	57.73	1.90	3.74	50.41	46.62
90	PPR	Payments	Actual	FS	0.41	0.72	0.43	0.38	0.72	0.72
90	PPR	Payments	Actual	Exp, FS	76.45	57.69	1.47	3.08	50.17	46.26
30	All cause	Payments	Act-Exp	Age, Sex, NH, FS	0.54	0.10	0.50	0.55	0.46	0.49
30	All cause	Payments	Actual	Exp	78.64	55.33	0.80	1.85	51.95	50.31
30	All cause	Payments	Actual	Exp, Age, Sex, NH, FS	78.72	55.43	1.73	2.81	52.15	50.55
30	All cause	Payments	Actual	FS	0.20	0.71	1.01	1.09	0.71	0.77
30	All cause	Payments	Actual	Exp, FS	78.69	55.38	1.51	2.47	51.98	50.34
90	All cause	Payments	Act-Exp	Age, Sex, NH, FS	0.47	0,22	1.47	1.57	1.43	1.51
90	All cause	Payments	Actual	Exp	78.64	41.54	2.40	4.76	35.97	34.27
90	All cause	Payments	Actual	Exp, Age, Sex, NH, FS	78.71	41.73	3.01	5.48	36.50	34.91
90	All cause	Payments	Actual	FS	0.26	0.59	0.38	0.36	0.60	0.58
90	All cause	Payments	Actual	Exp, FS	78.68	41.57	2.53	4.84	36.11	34.41

* could not be calculated for this sub-population.

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 7
R^2 Values With and Without Functional Status for Episodes without PAC for Charges

Window	Readmit	Financial Measure	Dependant Variable	Independent Variables	Hosp Trigger with MD	Hosp Trigger and Readmit with MD	Readmit with MD	Readmit with MD and Post Discharge	Hosp Trigger and Institutional PAC and HH and Readmit with MD	Entire Episode
30	PPR	Charges	Act-Exp	Age, Sex, NH, FS	0.27	0.17	0.26	0.38	0.34	0.36
30	PPR	Charges	Actual	Exp	40.61	36.26	0.53	1.39	35.50	35.63
30	PPR	Charges	Actual	Exp, Age, Sex, NH, FS	40.64	36.32	1.06	1.98	35.58	35.73
30	PPR	Charges	Actual	FS	0.48	0.76	0.61	0.68	0.76	0.79
30	PPR	Charges	Actual	Exp, FS	40.62	36.29	0.95	1.75	35.54	35.67
90	PPR	Charges	Act-Exp	Age, Sex, NH, FS	0.25	0.22	0.71	0.97	0.57	0.67
90	PPR	Charges	Actual	Exp	41.00	32.06	1.08	2.74	30.71	30.42
90	PPR	Charges	Actual	Exp, Age, Sex, NH, FS	41.05	32.15	1.48	3.24	30.83	30.61
90	PPR	Charges	Actual	FS	0.56	0.81	0.36	0.34	0.81	0.80
90	PPR	Charges	Actual	Exp, FS	41.02	32.11	1.24	2.83	30.75	30.47
30	All cause	Charges	Act-Exp	Age, Sex, NH, FS	0.18	0.11	0.19	0.23	0.16	0.18
30	All cause	Charges	Actual	Exp	39.78	29.12	0.98	1.93	28.49	28.76
30	All cause	Charges	Actual	Exp, Age, Sex, NH, FS	39.82	29.30	1.63	2.62	28.68	28.98
30	All cause	Charges	Actual	FS	0.30	0.77	0.83	0.89	0.77	0.80
30	All cause	Charges	Actual	Exp, FS	39.79	29.23	1.52	2.43	28.58	28.86
90	All cause	Charges	Act-Exp	Age, Sex, NH, FS	0.18	0.14	0.42	0.57	0.40	0.48
90	All cause	Charges	Actual	Exp	40.36	23.27	2.04	4.12	22.28	22.77
90	All cause	Charges	Actual	Exp, Age, Sex, NH, FS	40.41	23.45	2.39	4.54	22.51	23.07
90	All cause	Charges	Actual	FS	0.38	0.64	0.33	0.31	0.64	0.62
90	All cause	Charges	Actual	Exp, FS	0.09	23.34	2.16	4.19	22.35	22.84

* could not be calculated for this sub-population.

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 8
R^2 Values by Condition for all Episodes
Bundle: Trigger + PAC + PPR
90 day window

				Stroke	Pneumonia	Coronary bypass	CHF	Major bowel procedure	Major Joint replacement	Hip, Femur procedures	Fracture Hip, Femur	UTI	Septicemia	ALL
Readmit	**Financial Measure**	**Dependant Variable**	**Independent Variables**	**64**	**193**	**233**	**291**	**329**	**469**	**480**	**535**	**689**	**871**	
PPR	Payment	Act-Exp	Age, Sex, NH, FS	20.73	15.33	5.23	11.36	7.03	16.10	7.81	9.33	11.47	9.12	10.38
PPR	Payment	Actual	Exp	1.42	4.45	16.84	3.24	26.75	12.44	2.29	0.66	3.74	3.44	24.64
PPR	Payment	Actual	Exp, Age, Sex, NH, FS	23.94	20.57	24.18	15.29	36.06	28.34	9.85	9.88	16.24	14.15	33.50
PPR	Payment	Actual	FS	22.44	17.12	9.44	12.50	18.42	13.44	4.52	7.41	13.16	11.95	13.75
PPR	Payment	Actual	Exp, FS	23.09	19.22	22.41	14.40	35.30	21.83	6.60	7.85	14.70	13.85	32.61
PPR	Charges	Act-Exp	Age, Sex, NH, FS	6.96	4.06	1.90	2.91	2.24	2.12	1.16	2.32	2.76	2.78	2.39
PPR	Charges	Actual	Exp	4.31	5.32	14.45	4.32	21.16	10.17	5.22	3.34	5.20	6.31	20.61
PPR	Charges	Actual	Exp, Age, Sex, NH, FS	12.48	10.31	17.19	8.03	24.68	12.93	6.07	5.51	8.52	9.96	23.06
PPR	Charges	Actual	FS	9.22	6.67	5.22	4.62	9.61	4.05	0.78	2.30	4.90	5.05	5.13
PPR	Charges	Actual	Exp, FS	12.16	10.08	17.00	7.81	24.56	12.25	5.82	5.24	8.16	9.80	22.97

Where Act = actual value of financial measure
Exp = average value of MS-DRG/CRG cell assigned
NH = 0/1 indicator of whether admission was from nursing home
FS = nine category functional status measure

Table 9

Effect of Age, Sex, Admit from Nursing Home, and Functional Status on Medicare Payments
Bundle: Trigger hospital readm, PAC, PPRs
90 day Window
Includes all Episodes (w and w/o PAC)

N = 572,331 R^2 = 0.0777

Variable	Parameter Estimate	Significant > .0001 (Y/N)
Intercept	-$6081	Y
Age	+$63	Y
Sex = Male	-$1438	Y
Enter Hosp. from Nursing Home	+$136	N
1. Significant mobility and self-care impairment, low incontinency and cognitively intact	+$6186	Y
2. Significant mobility and self-care impairment, low incontinency and cognitively impaired	+$8814	Y
3. Significant mobility and self-care impairment, moderate incontinency and cognitively intact	+$5797	Y
4. Significant mobility and self-care impairment, moderate incontinency and cognitively impaired	+$6643	Y
5. Significant mobility and self-care impairment, extreme incontinency and cognitively intact	+$10924	Y
6. Significant mobility and self-care impairment, extreme incontinency and cognitively impaired	+$12244	Y
7. Either significant mobility or self-care impairment but not both	+$1059	Y
8. No significant mobility or self-care impairment, low incontinency and cognitively intact	+$3621	Y
9. No significant mobility or self-care impairment, with incontinency and/or cognitive impairment.	+$143	N

Appendix C

Incorporating the Use of Functional Health Status Within a Diagnosis Driven Clinical Risk Adjustment Model

Norbert I. Goldfield, M.D., Richard Fuller, M.S., John S. Hughes, M.D.

3M Health Information Systems, Inc

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Introduction

Individuals with serious chronic conditions and/or functional limitations are likely to be relatively expensive to treat. Absent some method to account for the cost of these conditions, providers facing bundled payments would try to avoid these individuals. Adjusting for risk of the probable higher treatment cost for certain individuals is known as "risk adjustment". Effective risk adjustment eliminates incentives for entities assuming financial and/or clinical risk to avoid people who are in poor health and likely to incur above average costs.[1] Risk adjustment can ensure that efficient levels of service provision are adequately funded for all covered individuals regardless of their relative resource requirements. If risk adjustment is sufficiently reliable and valid, entities accountable for providing care can compete on the basis of quality and efficiency and not on the basis of whether they can attract healthy people.

While researchers advocate[2] incorporating health status measures into risk adjustment for payment, testing has only recently begun on the impact of functional status information on statistical performance of classification systems used to adjust capitation payments.[3] Policymakers have now begun to use functional status to risk adjust capitation payments for those populations for whom functional status is clearly an important variable.[4] This paper extends this research and provides an estimation of the impact of functional status on risk adjustment for capitated payment using measures of functional status that are already collected and thus are readily available today. These measures are collected as part of already existing prospective payment systems for nursing home stays, rehabilitation hospitalizations and home health services. However, the measures of functional status collected in these three sites are not standardized differing in observed activities, definitions of patient abilities, and timing of patient observation.

Therefore, the first objective of this study is to create a standardized measure of functional status derived from the different source measures of functional ability. The second objective is to examine the extent to which functional health status information can improve the measurement of burden of illness over a year's period of time.

In the analysis a baseline for determining the clinical risk without the presence of functional status assessment data is established using claims data with a categorical clinical model developed specifically for risk adjustment - Clinical Risk Groups (CRGs). The utility of adding functional status information is measured using data from those individuals for whom a functional status assessment was provided, namely those receiving post-acute care in skilled nursing, rehabilitation or home health settings. There are alternative payment contexts for which this more comprehensive risk adjustment may be used. The focus of this analysis is upon patient resource use (payment) in a subsequent period hence functional status data is collected from all patients at discharge from the post-acute setting. Alternative payment purposes may require other data points, for example a focus on quality of care within the setting may require a difference in measure between admission and discharge. Finally, this paper summarizes policy options for the incorporation of functional health measures into risk adjusted payment systems.

Data

A 5% sample of all Medicare claims for its FFS enrollees including functional status assessments but excluding drug claims within a two-year period, 2006 and 2007, was used. These data comprised 1,021,356 enrollees. In addition, 232,194 (23%) enrollees were identified as having one of the three functional status assessments. These assessments were from three sources:

1. Home health assessments (OASIS)
2. Skilled nursing facility assessments (MDS) and
3. Assessments from rehabilitation hospitals (IRF-PAI).

Each assessment instrument is completed under its own guidelines with its own specific questions and response options. However, each instrument contains questions related to four functional domains of particular interest;

1. self care,
2. mobility,
3. cognitive reasoning, and,
4. incontinence.

Mobility and self-care domains were standardized across the three instruments using an approach developed by Trudy Mallinson of the University of Southern California. Cognitive reasoning and incontinence domains were standardized using an approach developed by 3M HIS Clinical and Economics Research in consultation with the technical advisory panel.

Methods

To achieve the first objective (to create a standardized scale from the various sources of functional ability) within each of the above instruments, appropriate individual questions were selected from each domain. The scores for all questions for each domain were subsequently summed.

For the self care and mobility domains, the research performed by Professor Mallinson included using multiple assessors trained in each of the instruments assessing approximately 200 patients for each of the instruments.

The self care domain contains variables from the instruments for dressing, bathing, toileting, grooming and eating. Note, for the FIM, the lower score value is sicker (1 being the sickest and 7 being the least sick); in OASIS and MDS it is the reverse where a point score of 0 is the least sick. Table 1 presents the specific assessment variables used from each instrument for the self care domain.

Table 1: Self Care Domain Assessment Variables

Self Care								
IRF			MDS			OASIS		
Variable Name	Assessment Item	FIMS Score *	Variable Name	Assessment Item	Points Score**	Variable Name	Assessment Item	Points Score**
f_ledress	E_DressLow	7-1	m2_bath	G0120 Bathing SP	0-4	o_ledress	M1820	0-3
f_bath	C Bath	7-1	m2_dress	G0110 G Dressing	0-4	o_bath	M1830	0-6
f_toilet	F Toilet	7-1	m2_toilet	G0110 I Toilet self use	0-4	o_uedress	M1810	0-3
f_uedress	D DressUp	7-1	m2_groom	G0110 J Personal hygiene sp	0-4	o_groom	M1800	0-3
f_groom	B Groom	7-1	m2_eat	G0110 H Eating	0-4	o_eat	M1870	0-5
f_eat	A eating	7-1						
* Score Values High to Low			** Score Values Low to high			** Score Values Low to high		

The mobility domain contains variables from the three instruments for climbing stairs, walking, managing tub/shower, bed mobility, and transferring between areas. Table 2 presents the specific assessment variables used from each instrument for the mobility domain.

Table 2: Mobility Domain Assessment Variables

Mobility								
IRF			MDS			OASIS		
Variable Name	Assessment Item	FIMS Score *	Variable Name	Assessment Item	Points Score**	Variable Name	Assessment Item	Points Score**
f_stairs	M Stairs	7-1	m2_locosnf	G0110 E locomotion on unit (s	0-4	o_locomotn	M1860	0-6
f_wlkwhl	L w/w	7-1	m2_trnsfr	G0110 B transfer (sp)	0-4	o_toilet	M1840	0-4
f_tubtrns	K Tub,Shwr	7-1	m2_locounit	G0110 F locomotion off unit (s	0-4	o_transfr	M1850	0-5
f_bedtrns	I BCW	7-1	m2_wlkcorr	G0110 D walk corridor (sp)	0-4			
f_toiltrns	J Toilet	7-1	m2_wlkroom	G0110 C walk room (sp)	0-4			
			m2_bedmob	G0110 A bed mobility (sp)	0-4			
* Score Values High to Low			** Score Values Low to high			** Score Values Low to high		

In keeping with professor Mallinson's approach, scores for the selected assessment items for the mobility and self-care domains were summed for each of the instruments and converted into similarly scaled (co-calibrated) scores between 0 and 100.[5] The raw summed scores and converted co-calibrated scores for the three instruments developed by Dr. Mallinson's are shown in Attachment 1 for the self-care and mobility domains.

The cognitive reasoning and incontinence domains were chosen on a clinical basis (in consultation with the technical advisory panel) and were not formally co-calibrated since the domains contain few individual items. For this reason, these domains are not included in Attachment 1. Table 3

Table 3: Cognitive Reasoning and Incontinence Domain Assessment Variables

Cognition								
IRF			MDS			OASIS		
Variable Name	Assessment Item	FIMS Score *	Variable Name	Assessment Item	Points Score**	Variable Name	Assessment Item	Points Score**
	q problem solving	7-1	Cognitive Skills for Daily	C1000	0-3	Cognitive Functioning	M1700	0-4
	r memory	7-1						
Incontinence								
IRF			MDS			OASIS		
Variable Name	Assessment Item	FIMS Score *	Variable Name	Assessment Item	Points Score**	Variable Name	Assessment Item	Points Score**
	G Bladder	7-1	Urinary Continence	H0300	0-3	Urinary Incontinence	M1610	0-2
* Score Values High to Low			** Score Values Low to high			** Score Values Low to high		

displays the specific assessment variables used from each instrument for the cognition and incontinence domains.

As noted above, the scores for (1) self care and (2) mobility were summed and the resulting scores co-calibrated while scores for (3) cognitive reasoning and (4) incontinence were simply summed. After constructing the domain scores, three scoring ranges, high impairment (h), medium impairment (m) and low impairment (l), were defined for each of the four domains. This was achieved by reviewing the relative distribution of enrollees, irrespective of whether the instrument is the IRF, MDS, or OASIS. These three scoring ranges were created for the purpose of obtaining sufficient volume of enrollees in each range. The result is a measure of functional status that is standardized across the three instruments permitting a consistent comparison of functional impairment within each of the four functional domains.

Attachment 2 presents the method for assigning a scoring range (high, medium, low) using then relevant instrument (IRF, MDS, OASIS) for each domain (self care, mobility, cognitive reasoning and incontinence) based on the raw score from each of the instruments. The co-calibration was needed to establish consistent high, medium, low scoring ranges across the three instruments. However, as shown in attachment 2, once the scoring ranges were established, they were translated back to the raw values for each of the instruments. Thus, operationally only the raw scores from each instrument are needed to assign the high, medium, low scores for each instrument.

The three scoring ranges were created for the purpose of obtaining a stable, standardized yet predictive volume of enrollees in each range. It was not the intent at this stage of research to

optimize the range cut-offs but to understand patterns of interaction between the domains. The result is a definition of functional status common to the three instruments permitting the

comparison of broad ranges of impairment across the four functional domains. Note that the scores are ordinal, not cardinal, numbers. This means that, while one can say that a score of 10 is higher than a score of 5, one cannot say that it is twice as high.

To achieve the second objective (examine the extent to which functional health status information can improve the measurement of burden of illness over a year's period of time), the subsequent period resource use as measured by payments of the 232,194 enrollees with assessments was compared to the payment derived from the non-assessment enrollees to measure the effect on resource use (payment) of functional ability limitations. By definition, the enrollee group without a functional assessment has no measured baseline functional impairment. We are therefore measuring the difference in resource use (payments) from a baseline that may contain individuals who also have significant impairment. While this problem is mitigated by the volume of enrollees within which these individuals are dispersed, it would be preferable for all enrollees to have a functional assessment upon discharge.

Within this limitation, comparison of individuals also requires classification into comparable clinical groups (i.e., risk adjusted). To this end, individuals were grouped into Clinical Risk Groups (CRGs)[6]. CRGs are a system of mutually exclusive risk categories for stratifying individuals according to their expected use of healthcare resources in a future year. Each person is assigned to one and only one CRG. Each CRG is composed of a base CRG that describes the patient's most significant chronic conditions and a severity of illness level (e.g., a patient with diabetes and heart failure at severity level 3). CRGs are composed of nine health status categories which are further subdivided into 272 base CRGs. These base CRGs are further subdivided into up to six severity of illness levels for a total of 1,080 severity adjusted CRGs. The CRGs also include three predefined CRG hierarchical consolidations of 1,080 CRGs into 416, 151 and 38 CRG aggregations. The aggregated CRGs sacrifice some clinical precision but with only a slight loss of predictive performance. The 38 CRG level of aggregation is composed of the nine statuses each divided into severity levels as shown in Table 4. This level of aggregation was used for subsequent analyses.

CRGs have several important characteristics; (1) they are based on readily available computerized claims data obviating the need for chart abstraction; (2) they recognize the interaction of two or more chronic health conditions and the gradations of severity of illness within the underlying conditions; (3) they are accompanied by a complete specification of the CRG logic permitting access to clinical review of their validity by stakeholders; and (4) expected expenditures for each group are established separately from the clinical algorithm.

After testing the effect of interaction between the domain ranges upon subsequent year payment the four individual domain scores, ranges of high, medium and low were combined into nine

Table 4: CRG statuses and severity levels

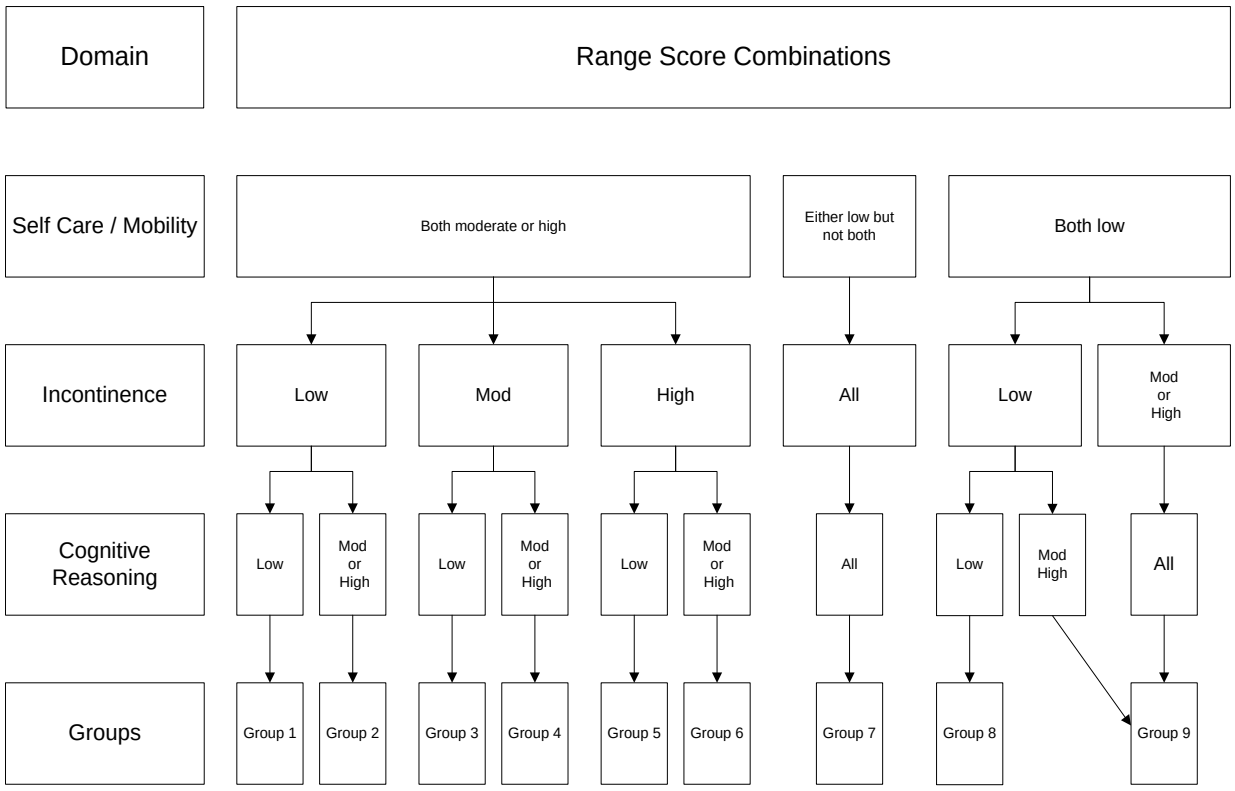
CRG Status	Number of Severity Levels
1.	Healthy
2.	History of Significant Acute Disease
3.	Single Minor Chronic Disease
4.	Minor Chronic Disease in Multiple Organ Systems
5.	Single Dominant or Moderate Chronic Disease
6.	Dominant or Moderate Chronic Disease in Multiple Organ Systems
7.	Dominant Chronic Disease in Three or More Organ Systems
8.	Dominant and Metastatic Malignancies
9.	Catastrophic Conditions

categorical variables. The algorithm to assign an individual to one of the nine groups based on his/her scores for the 4 domains is shown in Figure 1.

The first axis of classification is different levels of self-care/mobility. The second axis is incontinence and cognitive reasoning. These two axes of classification resulted in 9 mutually exclusive categories: Group 1: Significant mobility and self-care impairment, low incontinency and cognitively intact; Group 2: Significant mobility and self-care impairment, low incontinency and cognitively impaired; Group 3: Significant mobility and self-care impairment, moderate incontinency and cognitively intact; Group 4: Significant mobility and self-care impairment, moderate incontinency and cognitively impaired; Group 5: Significant mobility and self-care impairment, extreme incontinency and cognitively intact; Group 6: Significant mobility and self-care impairment, extreme incontinency and cognitively impaired; Group 7: Either significant mobility or self-care impairment but not both; Group 8 : No significant mobility or self-care impairment, low incontinency and cognitively intact; Group 9: No significant mobility or self-care impairment, with incontinency and/or cognitive impairment.

Each enrollee was assigned a CRG using claims data supplied in 2006.The average resource use (payment) for each CRG with severity level observed in 2007 was calculated for those with and without assessments in 2006. Enrollees with paid amounts equal to $0 or greater than $100,000 in 2007 were omitted from the analysis. While a limited number of high resource use (payment) enrollees have subsequent year expenses greater than $100,000 the purpose of the analysis was to test the adjustment for the enrollees that may be routinely enrolled. The $100,000 cut off mitigated the undue influence of the few high resource use (payment) cases.

Figure 1: Functional Status and Domain Interactions



Enrollees with assessment data were assigned their respective levels (high, moderate and low) for the four domains and one of nine functional categories based upon the last assessment submitted in 2006. Every enrollee was assigned their 2007 actual total payments, based upon their 2007 claims, as well as their expected total payments based on their assigned CRG's average payments.

A regression model was specified to identify the independent effect of severity, base CRG (chronic disease burden) and functional status on payments. This interaction among these variables was not expected to be additive but rather multiplicative hence the use of the log of the 2007 total payments as the dependent variable. The reference CRG payments for the enrollees without assessment data was calculated as the mean of the log of claim payments (the geometric mean).

The resulting model is given by:

$$\text{Ln (Payment 2007}_i\text{)} = \alpha + \beta(\text{CRG Severity Payment}_i) + \delta(\text{CRG Status Level}_i) + \lambda(\text{8 of the 9 functional status groups}_i) + \varepsilon$$

Where;

Ln Payment 2007$_i$ is the natural log of the 2007 claim payment for enrollee i where enrollee has an assessment in 2006.

CRG Severity payment$_i$ is the mean of the log of the claim payments for the CRG assigned to the enrollee constructed from enrollees having no assessment in 2006.

CRG Level, is the CRG status level of the CRG assigned to the enrollee.

Functional status group$_i$ are eight of the nine groups. Group 8 omitted, and, therefore, appears in the constant term α.

Results

Table 5 presents count and percent of high, medium and low individual scores for Self Care (SC), Mobility (M), Incontinence (I), and Cognitive Reasoning (CR) for the 232,194 enrollees with at least one assessment. As displayed in Table 5 cognitive reasoning has a comparatively few enrollee scores in the high range (only 11.8% scored high for cognitive reasoning) while the low range for incontinence and cognitive reasoning is more common (more than half of the individuals scored low) than that for self-care and mobility where about 1/3 of the individuals scored in the low range.

Table 5: Distribution of Enrollee scores within Assessment Domain Ranges

	Self-Care	**Mobility**	**Incontinence**	**Cognitive Reasoning**
Count				
High	57,356	49,971	56,569	27,310
Moderate	94,580	111,773	52,535	71,503
Low	80,258	70,450	123,090	135,816
%				
High	24.7%	21.5%	24.4%	11.8%
Moderate	40.7%	48.1%	22.6%	30.8%
Low	34.6%	30.3%	53.0%	58.5%

Table 6: Consistent identification of Distribution of Enrollees within Assessment Domain Ranges

Domain 1	**Domain 2**	**Count**	**%**
Self Care	Mobility	167,588	72.18%
Self Care	Cognitive Reasoning	106,503	45.87%
Self Care	Incontinence	120,324	51.82%
Mobility	Cognitive Reasoning	106,272	45.77%
Mobility	Incontinence	121,554	52.35%
Cognitive Reasoning	Incontinence	144,115	62.07%

Table 6 shows the degree to which the domains consistently identify high, medium and low impairment enrollees. The self care and mobility domains overlap for the majority of enrollees (72.18%), but there is much less overlap between mobility and cognitive reasoning (46.87%). In general, incontinence and cognitive reasoning overlap less often with the other domains suggesting they represent independent dimensions from the other two variables.

Table 7 presents the result of the regression analysis. The coefficients provide an estimate of the percent difference of the variable in question from the omitted variable G8. G8 is a user of post-acute care services with no significant mobility or self-care impairment, low incontinency and cognitively intact. The model is interpreted relative to the costliness of enrollees that did not have assessment data in the base year for a matched CRG and severity pair due to the introduction of the CRG severity payment variable. Thus while CRG status 6 has a negative coefficient the interpretation is that CRG status level 6 requires less adjustment from the baseline than those in other status levels for similar group and severity levels.

Table 7: The independent effect of chronic illness and limitations in functional ability on payment. Coefficients are percent difference from the omitted variable.

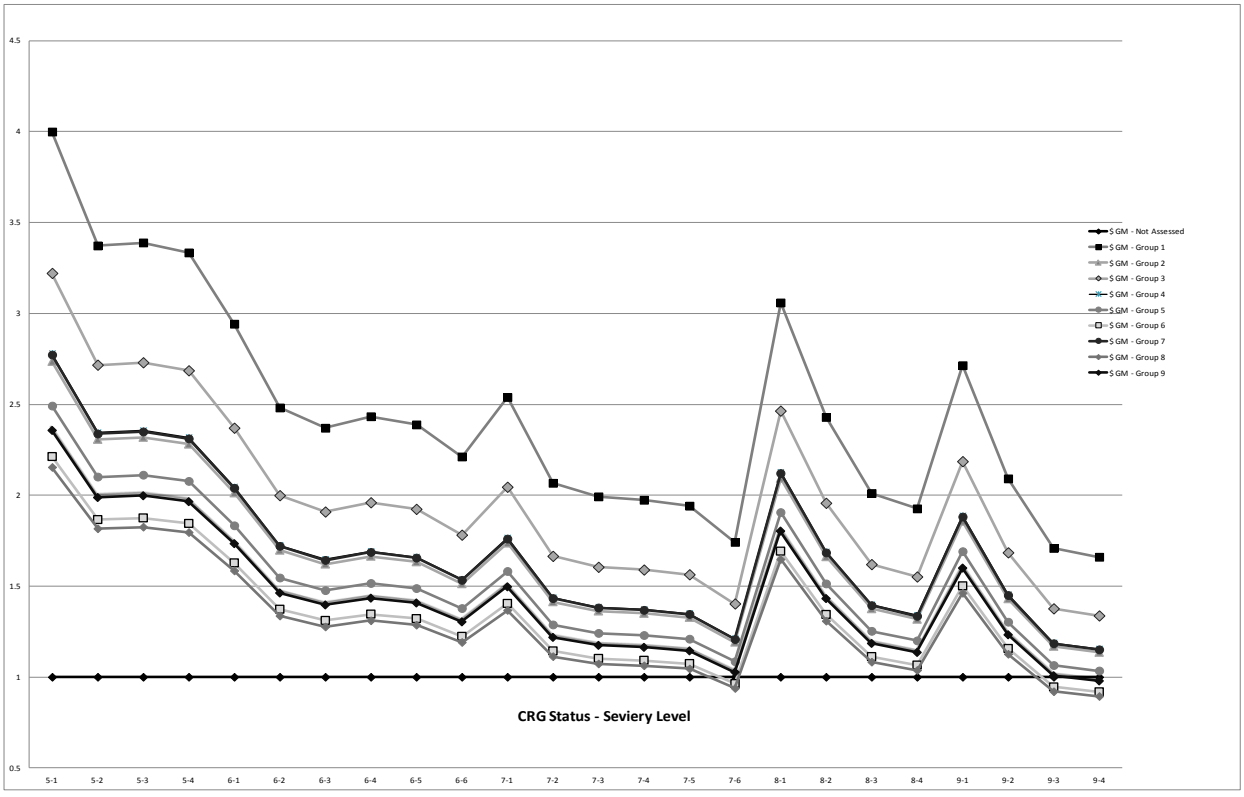
		Adj R^2	0.1134
Group Model			
	Coeff	**t-value**	**Pr > ltl**
G8 (Intercept)	4.0668	41.68	<.0001
CRG Severity Resource Use (payment)	0.5266	39.86	<.0001
CRG Status 6	-0.1390	-6.26	<.0001
CRG Status 7	0.0312	1.24	0.2136
CRG Status 8	0.1580	5.59	<.0001
CRG Status 9	0.3009	9.11	<.0001
CRG Level 2	0.0272	1.7	0.0889
CRG Level 3	0.0712	4.31	<.0001
CRG Level 4	0.1779	9.88	<.0001
CRG Level 5	0.2685	13.43	<.0001
CRG Level 6	0.3198	14.56	<.0001
Group 1	0.6186	60.37	<.0001
Group 2	0.2389	16.7	<.0001
Group 3	0.4024	28.1	<.0001
Group 4	0.25521	23.43	<.0001
Group 5	0.14555	9.98	<.0001
Group 6	0.02674	2.78	0.0054
Group 7	0.25228	24.91	<.0001
Group 9	0.08959	6.15	<.0001

The results demonstrate that the average payment predictions offered by the baseline CRG model require significant refinement to address variations in functional assessment and the magnitude of these adjustments vary by CRG and severity level.

Figure 2 graphs the 9 functional status groups (the lines) against the CRG Status and severity level on the horizontal axis and the percent increase in geometric mean payment on the vertical.

The line closest to the top of the graph is functional status Group 1. This group has the largest resource use (payment) difference from the baseline of users with no post-acute care assessment and therefore indicates the need for the largest adjustment as a result of utilizing functional assessment data. For ease of reference the baseline non-assessment group is reported as a straight line at 100% (the bottom straight line). Note that the variation between the non-assessment and assessment groups is greater at the lower CRG severity and health status levels indicating that the functional status assessment data represents another dimension from the CRG assignment data when classifying patients with more intensive needs. There is considerable separation between the functional status groups with groups 1 and 3 being the most costly from a payer perspective.

Figure 2: Percent difference in geometric mean payment by CRG Status and Severity Level for Functional Status Categories



Discussion

This paper documents the impact of two separately constructed classification systems (CRGs and the nine functional status groups) to predict payments over a year's period of time. This approach builds on a related approach to payment that also uses a categorical clinical model: Diagnosis Related Groups (DRGs). This allows for a clinically meaningful construction of functional status categories linked to already existing categorical classification system based on traditional claims data.

The framework laid out permits payment differentiation between more complex enrollees
The high, moderate and low domain scoring ranges, used were not tested to be optimal from a statistical point of view. The groups were created by the clinicians in the study based on their clinical experience. While these findings were reviewed with other clinical experts, repeated analysis may identify more efficient definitions of significant moderate and low impairment or indeed additional range values. The nine categories developed here have not been tested against data sets from other populations, such as Medicaid or the commercially insured. They have also not been tested against additional data drawn from another time period to confirm that they hold true over an extended period of time.

The regression results and the payment differences presented in Figure 2 indicate that functional ability represents an additional important data element for the prediction of resource consumption over and above chromic disease burden as measured by the Clinical Risk Group classification system. Taking functional ability into account is important and the magnitude of the adjustment needs to be tailored to the underlying risk adjustment model.

Most importantly, our study demonstrates that it is both feasible to merge functional assessment data and claims data within a clinical categorical model and that it reduces the risk of adverse selection.

Attachment 1: Co-Calibration

This attachment presents the co-calibration of the self care and mobility domain scores developed by Dr. Mallinson. The MDS co-calibrated measure requires the raw MDS scores to be first inverted, then scaled by a factor of 1.5 for the MDS total raw score.

SELF CARE

IRF-PAI TOTAL RAW SCORE	IRF-PAI CO-CALIBRATED MEASURE	MDS 2.0 TOTAL RAW SCORE	MDS CO-CALIBRATED MEASURE	OASIS TOTAL RAW SCORE	OASIS CO-CALIBRATED MEASURE
6	**23.1**	5	**19.6**	19	**0.4**
				18	11.0
				17	19.4
7	30.3	6	28.5	16	25.7
				15	31.4
8	34.7	7	35.1	14	36.2
9	37.5				
10	39.7	8	39.6	13	40.4
11	41.5				
12	43.2	9	42.9		
13	44.7	10	45.3	12	44.1
14	46.1				
15	47.4	11	47.3	11	47.4
16	48.6	12	49.1		
17	49.7				
18	50.9	13	50.9	10	50.4
19	51.9				
20	53.0	14	52.6	9	53.2
21	54.0	15	54.4		
22	55.0				
23	55.9	16	56.0	8	55.9
24	56.9				
25	57.9	17	57.6		
26	58.9	18	59.3	7	58.5
27	59.9				
28	60.9	19	60.9	6	61.4
29	62.0	20	62.4		
30	63.2	21	63.8		
31	64.4	22	65.1	5	64.6
32	65.7	23	66.5		
33	67.0	24	67.8	4	68.3
34	68.5	25	69.2		
35	70.1	26	70.7		
36	71.7	27	72.7	3	72.8
37	73.5				
38	75.3	28	75.4		
39	77.5			2	78.3
40	80.1	29	80.3		
41	84.2			1	86.6
42	**90.9**	30	**88.3**	0	**97.1**

MOBILITY					
IRF-PAI TOTAL RAW SCORE	IRF-PAI CO-CALIBRATED MEASURE	MDS 2.0 TOTAL RAW SCORE	MDS CO-CALIBRATED MEASURE	OASIS TOTAL RAW SCORE	OASIS CO-CALIBRATED MEASURE
				14	**0.3**
				13	10.5
		6	**21.5**	12	20.2
5	**27.2**	7	28.4	11	26.2
		8	32.6	10	30.1
6	33.8			9	32.9
		9	35.2	8	35.0
				7	36.9
7	37.3	10	37.3		
8	39.3	11	39.0	6	38.9
9	40.7	12	40.5		
10	41.9	13	41.9	5	42.0
11	42.9	14	43.2		
12	43.8				
13	44.7	15	44.4		
14	45.6	16	45.5		
15	46.4	17	46.5		
16	47.3	18	47.4	4	47.2
17	48.2	19	48.2		
18	49.1	20	48.9		
19	50.0	21	49.6		
		22	50.2		
20	50.9	23	50.8		
21	51.9	24	51.5		
22	53.0	25	52.1		
		26	52.7		
		27	53.4		
23	54.1	28	54.1	3	54.5
24	55.3	29	54.9		
		30	55.8		
25	56.7	31	56.8		
26	58.3	32	58.0		
27	60.2	33	59.6		
28	62.5	34	62.0		
29	65.4			2	64.6
30	69.0	35	66.2		
31	73.0	36	**73.5**		
32	77.2			1	76.4
33	81.8				
34	87.7			0	**86.9**
35	**95.9**				

Attachment 2: Domain Scoring Ranges

The following sections present the rules for assigning an individual to the high, medium, or low scoring ranges for Self Care, Mobility, Cognition, and Incontinence domains. The rules are different for the three instruments (IRF, MDA, and OASIS) utilizing the raw score for each instrument. For example, "High" for IRF for self care is a raw score of less than or equal to 18 and all three questions must be 3 or lower. For MDS the same "High" for self care is a score of 12 MDS points or higher. For OASIS, "High is greater than or equal to 10 OASIS points – implying that all questions must be at least level 2. Note, the rules take the fact that IRF scores run in the opposite direction (high score means low impairment).

Self Care			
	High	**Medium**	**Low**
IRF	Less than or =18 FIMS points summed across these sections (i.e. all qns should be at 3 or lower)	Less than or = 39 FIMS points summed across these sections (i.e. no more than 3 qns at 7)	More than 39 Fims points
MDS	More than or = 12 MDS points summed across these sections (i.e. no more than 3 qns at level 2 or below)	More than or = 2 MDS points summed across these sections (i.e. no more than 2 qns at level 0)	Fewer than 2 MDS points
OASIS	More than or = 10 OASIS points summed across these sections (i.e. all questions at least at level 2)	More than or = 2 OASIS points summed across these sections (i.e. no more than 2 qns at level 0)	Fewer than 2 OASIS points

Mobility			
	High	**Medium**	**Low**
IRF	Less than or =7 FIMS points summed across these sections (i.e. at most 2 qns should be at 2 or higher)	Less than or = 30 FIMS points summed across these sections (i.e. all questions at 6 or lower)	More than 30 Fims points
MDS	More than or = 16 MDS points summed across these sections (i.e. no more than 2 qns at level 2 or below)	More than or = 2 MDS points summed across these sections (i.e. no more than 4 qns at level 0)	Fewer than 2 MDS points
OASIS	More than or = 6 OASIS points summed across these sections (i.e. all questions at least at level 2)	More than or = 2 OASIS points summed across these sections (i.e. no more than 1 qn at level 0)	Fewer than 2 OASIS points

Cognition			
	High	**Medium**	**Low**
IRF	Less than or =4 FIMS points summed across these sections (i.e. at most 2 qns should be at 2 or higher)	Less than or = 12 FIMS points summed across these sections (i.e. all questions at 6 or lower)	More than 12 Fims points
MDS	3 MDS points summed across these sections (i.e. scores 3)	More than or = 1 MDS point summed across these sections (i.e. scores 1 or 2)	Fewer than 1 MDS point (0)
OASIS	More than or =3 OASIS points summed across these sections (i.e. scores 3 or 4)	More than or = 1 OASIS point summed across these sections (i.e. scores 1 or 2)	Fewer than 1 OASIS point (0)

Incontinence			
	High	**Medium**	**Low**
IRF	Less than or = 2 FIMS points summed across these sections (i.e. scores 1 or 2)	Less than or = 5 FIMS points summed across these sections (i.e. scores 5 through 3)	More than 5 Fims points (scores 6 or 7)
MDS	3 MDS points summed across these sections (i.e. scores 3)	More than or = 1 MDS point summed across these sections (i.e. scores 1 or 2)	Fewer than 1 MDS point (0)
OASIS	2 OASIS points summed across these sections (i.e. scores 2)	1 OASIS point summed across these sections (i.e. scores 1)	Fewer than 1 OASIS point (0)

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