Methods Appendix

The methods used in the current report, "Trends and Variation in End-of-Life Care for Medicare Beneficiaries with Severe Chronic Illness," as well as the additional data provided on our web site, were developed over a number of years and have been described in detail in peer-reviewed publications.[24,25,26] This appendix provides a summary of these methods. In some instances, the methods were modified from those used in previous Dartmouth Atlas measures for chronically ill patients near the end of life[1], and these changes could affect the comparability of data between the previous 2001-05 and current 2003-07 study periods. Users should be aware of these changes when comparing and interpreting the rates, especially for smaller hospitals and areas. All changes are indicated with italics.

Databases used in the analysis

The primary database is derived from eight research files from the Centers for Medicare and Medicaid Services (CMS) for traditional (fee-for-service) Medicare: the Denominator file (which provides information on all Medicare beneficiaries' demographic data, eligibility status and date of death); and seven files that contain records of Medicare claims, namely, the MedPAR file (acute care discharges and stays in skilled nursing, rehabilitation, psychiatric, and other long-stay facilities), the Inpatient file (used to classify intermediate- and high-intensity subtypes of intensive care unit stays), Physician/Supplier Part B (physician services for a 20% sample of Medicare beneficiaries), the Outpatient file (the facility component of outpatient services for a 20% sample of Medicare beneficiaries), and the Home Health Agency (HHA), Hospice, and Durable Medical Equipment (DME) files.

Study populations

The follow-back from death studies reported in this edition of the Atlas are for two study populations, one based on assignment of decedents to the hospital they most frequently used in the last two years of life (data for specific hospitals), the other on place of residence at time of death (data for regions and states). To allow for two years of follow-back for all patients, the populations are restricted to those whose age on the date of death was 67 to 99 years, and to those having full Part A and Part B entitlement throughout the last two years of life. Persons enrolled in managed care organizations were excluded from the analysis.

Populations assigned to specific hospitals. We identified Medicare beneficiaries who died over the five-year period from January 1, 2003 to December 31, 2007 and who were hospitalized in an acute care hospital at least once during the last two years of life for a medical (non-surgical) condition. Patients with surgical admissions only were excluded, because the surgery may not have been offered by the hospital and medical staff that usually provided their care; in other words, a patient whose only hospital admission was for bypass surgery could only be assigned to the hospital where the surgery was performed, even if most of his or her care was provided by physicians associated with another hospital. Excluding these patients also reduces the likelihood that a surgical complication was the cause of death.

We further restricted the analysis to patients who had one or more of nine chronic illnesses associated with a high probability of death[27] coded on at least one of their hospital discharge claims. *The changes in diagnostic codes (ICD-9-CM 204) used in the current cohort were: cancer – addition of.xx to 208.xx and of 209.21-23, 209.30, 511.81; coronary artery disease – addition of 414.2, 414.3; peripheral vascular disease – addition of 440.4; diabetes with end organ damage – addition of 249.xx, 362.03-362.07; chronic renal failure - deletion of 585.1-585.3.*

Patients were assigned a primary chronic condition based on the first qualifying ICD-9-CM diagnosis code encountered on the claim closest to death. Discharge claims were then used to assign each patient to the hospital to which the patient was admitted most often during the last two years of life. In the case of a tie (equal number of discharges from more than one hospital), patients were assigned to the hospital associated with the discharge closest to date of death. Because seriously ill patients are highly loyal to the hospital where they receive their care—as has been shown elsewhere[28]—hospital-specific utilization rates reflect the approach to chronic disease management of the physicians who practice in association with that hospital. In some instances there were too few deaths at the hospital to calculate reliable measures and a numeric rate is not reported. The minimum population count for reporting hospital measures based on the 100% MedPAR, Inpatient, Hospice, HHA, and DME files is 80 deaths; for the 20% Part B and Outpatient files it is 400 deaths.

Several changes were made in the selection and exclusion criteria for the hospital and physician claims compared to previous cohorts. The net result of these changes was minor. (1) We excluded discharges from long-term care units of hospitals that are not reimbursed through prospective payment, and from hospital beds with skilled nursing facility (SNF) swing-bed designation. This could affect measures for small hospitals with disproportionately high numbers of these claims. Excluding some of these non-acute care discharges could also eliminate some patients from the cohort if these discharges were the sole basis for their inclusion in the hospitalized cohort. (2) We excluded outpatient claims that did not include physician encounters (e.g., filling prescriptions). The effect of this (the reduction in the number of patients) was small, because it was very rare that patients who had chronic conditions coded in these encounters did not have any other physician encounters during the last two years of life. The total impact of these two changes was examined for the same year (2005) using the previous and current methods. Summary of impact of changes: (1) Hospitalized cohort population was reduced by 1%; (2) Regional cohort population was reduced by 2%. (3) Number of hospital claims in the last two years of life was reduced by 4%.

Populations grouped by place of residence. The state- and region-level analyses are based on patients who were residents of a given geographic area at the date of death. Data are a 20% sample of deaths occurring over the five-year period 2003-07 (specifically, those deaths that were included in the CMS Part B claims of a 20% beneficiary sample). The state and regional analyses include all hospitalizations (including the patients excluded in the hospital-specific studies who only had

surgical hospitalizations) and all patients who had one or more of the nine chronic illnesses, whether or not they were hospitalized during the last two years of life. Non-hospitalized patients with chronic illness were identified as those with two or more physician encounters (on different days) with one or more of the nine chronic conditions coded; each patient's primary chronic condition was that which occurred most frequently in the physician encounter claims data for their last two years of life.

Table A provides information on the number of decedents according to primary chronic condition for the hospital-specific chronic illness cohort and the geographic chronic illness cohort. Table B describes the characteristics of decedents who were hospitalized, according to their cause of hospitalization (and thus whether they are included in the hospital-specific chronic illness cohort). Table C describes the characteristics of decedents and chronic illness and hospitalization status.

Table A. Number of Decedents According to Cohort and Primary Chronic Condition, 2003–07

Primary Chronic Condition	2003–07 Hospital-Specific Chronic Illness Cohort*	2003–07 Geographic Chronic Illness Cohort**
	Number of Decedents	Number of Decedents
Malignant Cancer/Leukemia	809,926	201,691
Congestive Heart Failure	1,497,465	342,278
Chronic Pulmonary Disease	903,696	218,932
Dementia	570,479	192,562
Diabetes with End Organ Damage	48,342	17,838
Peripheral Vascular Disease	108,696	39,522
Chronic Renal Failure	349,611	80,035
Severe Chronic Liver Disease	52,841	11,586
Coronary Artery Disease	325,152	105,608
Total Decedents	4,666,208	1,210,052

* From a 100% sample of Medicare beneficiaries.

** From a 20% sample of Medicare beneficiaries.

Table B. Hospital-Specific Chronic Illness Cohort and Excluded Hospitalized Decedents, 2003–07

	2003–07 Hospitalized Decedents	
	Number of Decedents	% of All Decedents
Hospital-Specific Chronic Illness Cohort	4,666,208	69.99
Hospitalized Decedents Excluded from Cohort		
Chronic Illness, Surgery Only	344,249	5.16
Other Medical Illness	459,380	6.89
Other Surgery	101,043	1.52
Assigned to Non-U.S.* Hospitals	551	0.01
All Hospitalized Decedents	5,571,431	83.57
Total Decedents	6,667,105	100.00

*Non-U.S. hospitals include those in U.S. territories such as Puerto Rico, the U.S. Virgin Islands, Guam, American Samoa, and others.

The hospital-specific chronic illness cohort includes only those hospitalized with at least one medical admission and a diagnosis of one of the nine chronic illnesses listed in Table A on at least one admission record. Data are based upon a 100% sample of Medicare enrollees.

Table C. Decedents 2003–07 According to Cohort Membership Status

	2003-07 Geographic Database		
	Percent of Decedents		
	Number of Decedents	% of Chronically Ill	% of All Decendents
Chronic Illness Cohort	1,210,052	100.00	90.81
Hospital-Specific Cohort	933,894	77.18	70.09
Chronic Illness, Hospital Surgery Only	68,758	5.68	5.16
Hospital, Other Medical Illness	53,650	4.43	4.03
Hospital, Other Surgery	12,305	1.02	0.92
Assigned to Non-U.S. Hospitals	96	0.01	.01
Not Hospitalized	141,349	11.68	10.61
Excluded Decedents (without chronic illness)	122,415		9.19
Hospitalized Decedents	45,527		3.42
Not Hospitalized	76,888		5.77
Total Decedents	1,332,467		100.00

The chronic illness cohort includes all decedents with one of the nine chronic illnesses listed in Table A, regardless of whether they were hospitalized during the last two years of life. The hospital-specific chronic illness cohort corresponds to the cohorts described in Tables A and B, but is smaller due to the use of a 20% sample of beneficiaries.

Measures of resource inputs

Measures of resource inputs, including physician labor (provided in this report) hospital beds, intensive care beds, and Medicare program spending (reimbursements) (provided on our web site) are presented as summary measures over the last six months or two years of life. Bed input rates were calculated by summing patient days and dividing by 365. Physician labor inputs were measured by summing the work relative value units (W-RVUs) on a specialty-specific basis and dividing by the average annual number of W-RVUs produced by that specialty. The measure was used to estimate the standardized full-time equivalent (FTE) physician clinical labor input. Both bed and FTE physician resources are expressed as inputs per 1,000 decedents.

Inpatient reimbursements were calculated by summing Medicare reimbursements from the MedPAR record and reflect total reimbursements, including indirect costs for medical education, disproportionate share payments, and outlier payments. Part B payments are for all services included in the Part B Physician Supplier file; likewise, payments for outpatient, SNF, hospice, home health and DME services reflect all services included in their respective files. Inpatient reimbursements and payments from Part B and all other files are measured as spending per decedent. All resource input rates were calculated based on the total experience of the population over the given period of time, not only from the care received at the assigned hospital or physicians associated with that hospital. In the case of the geographic studies, it includes care given by providers located out of region as well as in region.

Measures of utilization

We calculated and have provided in this report and/or on our web site hospital days, intensive care unit days (high-intensity and intermediate-intensity days, overall and

separately) and physician visits (overall and separately for primary care physicians and medical specialists) for each patient over the last six months and the last two years of life; additional measures include home health visits, and days spent in SNFs and hospice. Physician visits were also calculated by place of service, by grouping selected HCPCS codes from Part B line item data. We also included visits to rural health centers and federally qualified health centers, obtained from the Outpatient file. Utilization rates were calculated on the total experience of the cohort, not just the services provided by the hospital and the physicians associated with the hospital to which the decedent was assigned. The proportion of total hospital care provided by the assigned hospital (loyalty) was high, so the variations in utilization among hospital cohorts primarily reflect clinical choices made by the associated physicians.[29] Similarly, in the geographic studies, most care was provided by hospitals and physicians located within the state or region. The measures of utilization—patient days in hospital and other facilities, patient days in intensive care units, and physician visits—are traditional epidemiologic, population-based rates of events occurring over a designated period of time.

Quality of care indicators

Two claims-based quality of care measures were used. The percent of patients seeing ten or more physicians is a measure of the propensity to refer patients. High scores on this measure could indicate lack of continuity of care. The percent of deaths occurring during a hospitalization that involved one or more stays in an ICU is an indicator of the aggressiveness with which terminal patients were treated. In light of the evidence that more aggressive care in managing patient populations with chronic illness does not lead to longer length of life or improved quality of life, higher scores on this measure can be viewed as an indicator of lower quality of death. By contrast, the percent of decedents receiving hospice benefits indicates less aggressive end-of-life care.

The measure of the percent of patients seeing ten or more different physicians during the last six months of life was updated to include the Outpatient file. The previous estimate would have been low for patients living in rural or underserved areas who relied upon federally qualified and/or rural health centers for their primary care.

Statistical methods

We compared measures of resource inputs, utilization, and quality at fixed intervals prior to death among geographic regions and hospitals. All utilization and resource input measures were further adjusted for differences in age, sex, race, primary chronic condition, and whether patients had more than one of the nine chronic conditions. The adjustments used ordinary least squares to adjust the Medicare spending variables provided on our web site[30] and used overdispersed Poisson regression models for all other variables; 95th percentile confidence limits were calculated for all variables.

Statistical models and patient assignment to hospitals

Previously we assigned patients to hospitals without regard for whether the hospital was open at the end of the study period (2005). The models were run with all hospitals that fit inclusion criteria, and then hospitals that were closed, had merged with another, or had transitioned to another designation (long-term care hospital, rehabilitation facility, SNF, etc.) by the end of 2005 were excluded from reporting.

For 2003-07 measures, we tracked hospitals that transitioned from one acute care to another acute care provider number (stemming from mergers, changes in ownership, etc.) or to another status during the study period. In the case of mergers or acquisitions, the old provider identification number was mapped to the new one, and the combined entity was treated as one facility for the duration of the study. These changes may have a sizeable impact on the cohort sizes for hospitals that absorbed patients previously assigned to other hospitals by way of mergers.

Where hospitals had closed or transitioned, they were not run individually in the models, but rather, grouped into residual categories. As before, hospitals with small cohort populations (< 80 deaths assigned to hospital for events based on a 100% sample: < 400 deaths for events based on a 20% sample) were also grouped for modeling purposes.

Caveats and limitations

Certain limitations of our measures need to be mentioned.

Sample sizes and data issues. The data are for the traditional Medicare (Part A and Part B) program and do not include Medicare enrollees enrolled in managed care organizations under Medicare Part C. The measures of physician resource input and utilization are based on a 20% sample, reducing the precision of our estimates. For hospital-specific cohorts, we addressed this by limiting reporting for these services to 2,826 hospitals with 400 decedents (expected 20% sample size for 5 years = 80 deaths). Data fields for measures based on Part B are left blank for hospitals with fewer than 400 decedents. Approximately 16% of hospitals (682) failed to report on their use of intensive care beds, and, for these hospitals, measures related to intensive care utilization are left blank. Our measure of the propensity to use multiple physicians—the percent of decedents seeing ten or more physicians—depends on the accuracy of the coding of individual physician encounters using the UPIN number; if a given patient was seen by multiple physicians but only one UPIN number was recorded, this would result in an underestimate of the number of individual physicians seen.

Denominator for hospital-specific cohorts. The hospital-specific studies are based on Medicare decedents with one or more medical hospitalizations during the last two years of life (as shown in Table B). Because we had no reliable method for assigning non-hospitalized patients with chronic illness to hospitals, decedents who were not hospitalized were not included in the denominator used in calculating population-based resource input and utilization rates for the hospital-specific cohort.

This limitation does not exist at the regional level where patients were assigned to regions on the basis of their place of residence, making it possible to identify patients who were not hospitalized.

To estimate the impact of not including non-hospitalized patients with chronic illness in the denominator for calculating rates for the hospital-specific cohort, we compared rates for regions calculated without the inclusion of non-hospitalized chronically ill decedents in the denominator (Hospitalized Cohort Denominator Method) to rates calculated with the inclusion of non-hospitalized decedents (Full Cohort Denominator Method). This analysis, from a previous edition of the Atlas[1], compared rates under each of these two methods, which were calculated for the 306 regions for deaths occurring in 2000-03. The key findings were:

• The proportion of Medicare decedents with severe chronic illness who were not hospitalized at least once for a medical (non-surgical) admission varied substantially from region to region—from less than 15% to more than 35% among regions.

• Regions with lower percentages not hospitalized tended to have higher per capita utilization rates. The correlation among regions between the percent of chronically ill decedents who were not hospitalized during the last two years of life and patient days per decedent calculated under the Hospitalized Cohort Denominator Method had an $R^2 = 0.39$ (negative association) (Figure A); and the same correlation using the patient days calculated under the Full Cohort Denominator Method had an $R^2 = 0.49$ (negative association) (Figure B).
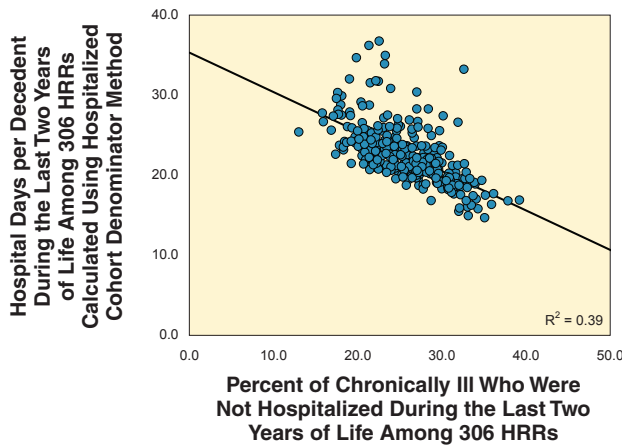

Figure A. The Relationship Between the Percent Not Hospitalized and Hospital Days per Decedent During the Last Two Years of Life (Hospitalized Cohort Denominator Method) Among Hospital Referral Regions (Deaths Occurring 2000–03)
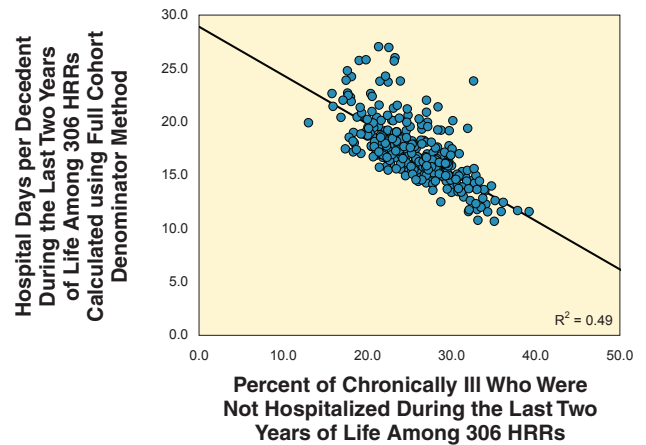

Figure B. The Relationship Between the Percent Not Hospitalized and Hospital Days per Decedent During the Last Two Years of Life (Full Cohort Denominator Method) Among Hospital Referral Regions (Deaths Occurring 2000–03)

• In examining the estimates of patient days per decedent obtained by the two methods, it became apparent that (1) the correlation between rates generated using the two methods was very high: $R^2 = 0.97$ (Figure C); and (2) variation was less (measured by the extremal range, interquartile ratio, and coefficient of variation) when the rates were calculated using the Hospitalized Cohort Denominator Method (Figure D).

These studies show that the Hospitalized Cohort Denominator Method (which we use for our hospital-specific analyses) underestimates the "true" population-based rates to a greater extent in regions with lower utilization rates. A reasonable inference would be that our hospital-specific analyses underestimate the variation among hospitals, and that those hospitals with lower patient day rates would actually be even more conservative (have even lower rates) than we report if we were able to include all decedents cared for by the hospital and its associated physicians.

Exclusion of isolated surgical hospitalizations. The hospital-specific follow-back studies of the chronically ill were designed to require at least one medical (non-surgical) hospitalization to qualify for inclusion. This was done to avoid confusing (1) a surgical referral as evidence that a given hospital was involved in the medical management of chronic illness and (2) a surgical death as a death from chronic illness. In the regional analysis, our interest in accounting for all Medicare spending and utilization in patients with chronic illness led us to include all Medicare hospitalizations (and Part B services) in the rates.
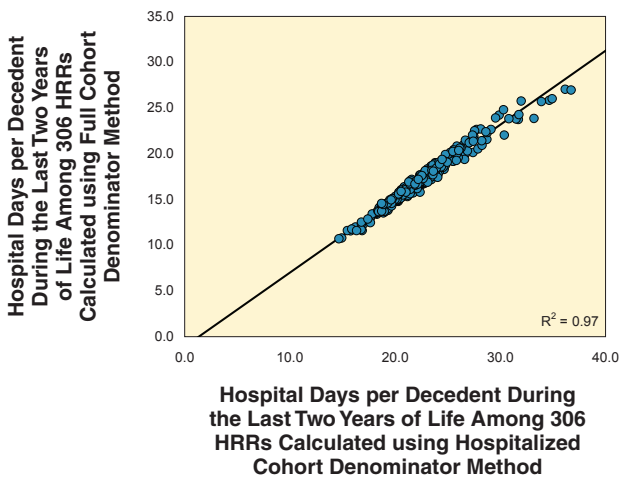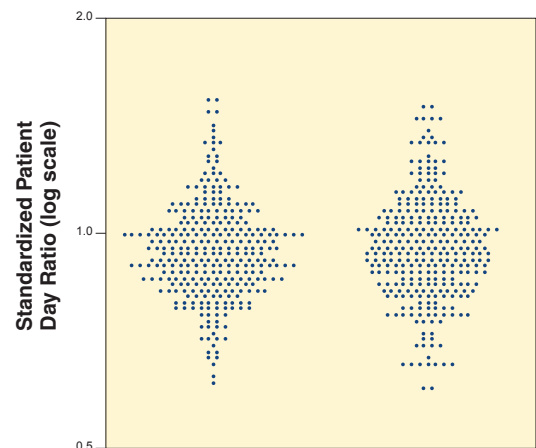

Figure C. The Relationship Between Hospital Days per Decedent During the Last Two Years of Life Among Hospitalized Cohort and Full Cohort Denominators Among Hospital Referral Regions (Deaths Occurring 2000–03)

	Hospitalized Cohort Denominator Method	Full Cohort Denominator Method
Extremal ratio	2.50	2.53
Interquartile ratio	1.19	1.23
Coefficient of variation	15.9	17.2

Figure D. Hospital Days per Decedent During the Last Two Years of Life Among Hospitalized Cohort and Full Cohort Denominators Among Hospital Referral Regions (Deaths Occurring 2000–03)