The Economic Measurement of Medical Errors

Sponsored by
Society of Actuaries' Health Section

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INTRODUCTION

The Society of Actuaries Health Section sponsored Milliman, Inc. to measure the annual frequency of medical errors in the United States and the total measurable cost to the United States economy of these errors. This effort is based upon an analysis of an extensive claim database, and it therefore relies upon medical events which have been submitted for payment by medical providers.

Measureable costs of medical errors include increased medical costs, costs related to an increased mortality rate, and costs related to lost productivity after the occurrence of an error. Most other costs of medical errors, such as pain and suffering, are not measureable from medical claim databases. Neither malpractice costs nor insurance payments have been measured; nor have we attempted to identify the cost associated with prevention of errors.

An error is defined as a preventable adverse outcome of medical care that is a result of improper medical management (a mistake of commission) rather than a progression of an illness due to lack of care (a mistake of omission).

This report is intended for the benefit of the Society of Actuaries. Although we understand that this report will be made widely available to third parties, Milliman does not assume any duty or liability to such third parties with its work. In particular, the results in this report are technical in nature and are dependent upon specific assumptions and methods. No party should rely upon these results without a thorough understanding of those assumptions and methods. Such an understanding may require consultation with qualified professionals. This report should be distributed and reviewed only in its entirety.

EXECUTIVE SUMMARY

Using medical claim data, we identified costs of medical errors in the United States of $19.5 billion during the year 2008. Of this amount, the vast majority identified (about 87% or $17 billion) was a direct increase in the medical costs of providing inpatient, outpatient, and prescription drug services to individuals who are affected by medical errors. We also identified increases in indirect costs of approximately $1.4 billion related to increased mortality rates among individuals who experience medical errors and approximately $1.1 billion related to lost productivity due to related short-term disability claims.

Using medical claim data for a large insured population to extrapolate to the United States population, we estimate that 6.3 million measurable medical injuries occurred in the United States in 2008. In an inpatient setting, seven percent of the admissions in the claim database resulted in some type of medical injury. Of the 6.3 million injuries, we estimate that 1.5 million were associated with a medical error. We measured the total cost per error as approximately $13,000, resulting in a total cost to the United States economy of $19.5 billion. Additionally, these errors resulted in over 2,500 excess deaths and over 10 million excess days missed from work due to short-term disability.

Estimates of mortality costs and lost productivity are based on limited data and are likely to be underestimated. Both are limited to a one-year period following an error, and deaths are further limited to those which occur in the hospital.

It is important to note that not all material costs related to medical errors can be identified using medical claims data. Errors which are uncoded in claim databases are not measured, as further discussed below. Unmeasured costs of errors also include deaths which occur in a location other than a hospital, and mortality and disability costs more than one year after the error. Pain and suffering is not measureable from claim databases. We also did not measure malpractice judgments or insurance payments. Some of these may be considered transfer payments in compensation for the error, rather than additional costs to society. We also did not measure any administrative costs associated with legal proceedings or insurance payment. As such, the actual costs of medical errors could be much higher than is measurable.

Medical errors are not coded in claim databases; however, medical injuries can be coded using a set of ICD-9 (diagnosis) codes. Medical injuries are any adverse events which occur due to medical intervention, but not all injuries are necessarily errors. A medical error is defined as an injury which results from inappropriate medical care. For example, an allergic reaction to a medication is a medical injury. This injury is only a medical error if the allergy to that medication was known prior to administration of the medication. Medical errors are therefore, by definition, a subset of medical injuries, and we relied upon clinicians to estimate the rate that any injury might be caused by an error. Errors could be identified by review of the medical charts, but generally cannot be individually discerned using claim databases.

In a study by Layde et al,[(1)] clinical researchers completed chart review of patients who had occurrences of ICD-9 diagnosis codes related to medical injury and determined that in 90 percent of cases, a medical injury did indeed occur. The researchers in the Layde et al study presented the list of ICD-9 codes that were used to identify these medical injuries. We relied on this list of ICD-9 codes, plus ICD-9 codes for a group of hospital-acquired conditions (also known as Medicare “never events”), to identify claims in our datasets that should be included in our analyses. Note that, in the Layde et al study, among patients without any such ICD-9 code in their records, 14 percent were also found to have an injury (based on 50 chart reviews). Depending on the number and severity of uncoded injuries, these false negatives could represent a significant additional cost. Our estimate based on claim data is that seven percent of inpatient admissions resulted in a medical injury. Adding 14 percent false negatives to this estimate would triple the estimated number of medical injuries in the inpatient setting. A similar adjustment would need to be made to the outpatient injury total to account for the false negative rate. Because not all medical injuries are coded on a claim, this suggests that our starting estimate should be viewed as a lower bound on the actual medical injury rate.

After selecting claims for each type of injury, we then estimated the likelihood that such an injury was caused by a medical error rather than the result of appropriate medical treatment, and assigned each injury into one of the frequency categories shown in Table 1 below. The categorization of medical injuries into the five error percentage categories is shown in Appendix A. To calculate the final frequency of a specific type of medical error, we multiplied the calculated frequency of the specified type of injury by the midpoint of the error percentage category. For example, the projected number of injuries for injuries considered to be an error 65 to 90 percent of the time was multiplied by 77.5 percent to calculate the final frequency of errors.

For each type of medical injury, we created a matched control sample, and we compared the medical costs, costs associated with increased deaths, and short-term disability costs between the injury group and the control group. The control groups were constructed to be as similar to the injury groups as possible by searching for individuals who had the same procedure performed in the same year, had similar chronic conditions, and were of the same age group and gender. (For one type of error, pressure ulcers, further adjustments were made to reflect the higher morbidity rate of the error group versus the control group.)

The cost per error was estimated as the increase in cost over the control group for those who experienced a medical injury (if statistically significant). All costs included in this report represent the present value of costs as of the error date, discounted at 3% per year. Medical cost per case includes increased inpatient, outpatient, and prescription drug costs for up to five years following an inpatient error and one year following an outpatient error. Mortality cost per case includes an estimate of the present value of future lost earnings based on the age and gender of the patient. Mortality rates include only in-hospital deaths for one year following a medical injury. Disability cost per error represents the increased value of earnings lost as a result of missing more days from work due to increased short-term disability claims in the year following a medical error. No costs are available for long-term disability claims.

Table 1 presents the results of our analysis.

Table 1: Total Measurable Costs of Medical Errors

% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
> 90%	810,898	770,353	$12,306	$950	$643	$13,899	$10,707
65 – 90%	9,949	7,710	$5,764	$3,496	$-	$9,260	$71
35 – 65%	345,838	172,919	$9,999	$1,279	$898	$12,176	$2,105
10 – 35%	1,684,003	378,901	$10,522	$592	$936	$12,051	$4,566
< 10%	3,468,799	173,440	$10,644	$1,144	$443	$12,232	$2,121
Total Errors		1,503,323	$11,366	$933	$720	$13,019	$19,571

We measured approximately $80 billion in annual costs associated with injuries, whether or not they resulted in errors. Table 2 presents these results. Note that the estimate of error frequency assumed that less than 24 percent of medical injuries in 2008 were the result of a medical error using the methodology of our sample.

Table 2: Total Measurable Costs of Medical Injuries						
% of injuries that are errors	**Count of Injuries (2008)**	**Medical Cost per Injury**	**In Hospital Mortality Cost per Injury**	**STD Cost per Injury**	**Total Cost per Injury**	**Total Cost of Injury (millions)**
> 90%	810,898	$12,306	$950	$643	$13,899	$11,271
65 – 90%	9,949	$5,764	$3,496	$-	$9,260	$92
35 – 65%	345,838	$9,999	$1,279	$898	$12,176	$4,211
10 – 35%	1,684,003	$10,522	$592	$936	$12,051	$20,293
< 10%	3,468,799	$10,644	$1,144	$443	$12,232	$42,430
Total Injuries	6,319,486	$10,782	$983	$624	$12,390	$78,297

Table 3 shows a more detailed breakdown of the most expensive errors. These five errors make up over 55 percent of the total estimated cost of errors.

Table 3: Errors with the Largest Annual Measurable Cost								
Error Type	**% of injuries that are errors**	**Count of Injuries (2008)**	**Count of Errors (2008)**	**Medical Cost per Error**	**In Hospital Mortality Cost per Error**	**STD Cost per Error**	**Total Cost per Error**	**Total Cost of Error (millions)**
Pressure Ulcer (Medicare Never Event)	> 90%	394,699	374,964	$8,730	$1,133	$425	$10,288	$3,858
Postoperative infection	> 90%	265,995	252,695	$13,312	$-	$1,236	$14,548	$3,676
Mechanical complication of device, implant, or graft	10 – 35%	268,353	60,380	$17,709	$426	$636	$18,771	$1,133
Postlaminectomy syndrome	10 – 35%	505,881	113,823	$8,739	$-	$1,124	$9,863	$1,123
Hemorrhage complicating a procedure	35 – 65%	156,433	78,216	$8,665	$2,828	$778	$12,272	$960

LITERATURE REVIEW AND COMPARISON

The Harvard Medical Practice Study was the first study to use population-based data to estimate costs of adverse events. This study determined incidence rates of all types of medical injuries in New York in 1984[2] and estimated the healthcare costs for these injuries to be $3.8 billion. Implied national cost of errors based on this study was slightly more than $50 billion[3].

Building on this previous research, Thomas, et al[4] released a study entitled *Costs of Medical Injuries in Utah and Colorado.* This analysis estimated the costs of all types of patient injuries in Utah and Colorado based on clinical review of a representative sample of 14,732 randomly selected 1992 discharges. They estimated the total costs for all adverse events in the two states during the year, including medical costs, lost household production, and lost income, to be $662 million (in 1996 dollars), of which $308 million was associated with preventable medical errors. Healthcare costs, including both inpatient and outpatient services, represented 57 percent of the costs for adverse events and 46 percent of the costs for preventable adverse events. The total cost of adverse events and preventable adverse events represent 4.8 percent and 2.2 percent of per capita health expenditures in the states. Extrapolation to all admissions in the United States resulted in an estimate of $37.6 billion for the national cost of adverse events and $17 billion for the national cost of preventable adverse events. It is important to note that these cost estimates represent the total cost of care, including errors, not the excess costs over a matched control sample, implying that those costs have not been adjusted to exclude the cost of care that would have otherwise occurred.

Thomas et al grouped the adverse events into five large categories of errors: operative, drug related, diagnostic or therapeutic, procedure related, and other, based on individual chart reviews conducted by nurses and physicians. Of these, errors related to postoperative complications were the most costly, representing 35 percent of costs for adverse events and 39 percent of costs for preventable adverse events.

Based upon the values in the Thomas study, it appears that non-medical costs may be many times greater than the amounts which we were able to measure. Table 4 compares the design and results of our study with the previously released study by Thomas et al and the Harvard Medical Practice Study.

Additional research by Layde et al looked into the rate and costs of medical injury. Their research identified that the rate of medical injury was 133.3 per 1,000 hospitalizations. Additional findings indicated that patients with a medical injury incurred 18.5 percent more in hospital charges and had 14.6 percent longer hospital stays than patients without a medical injury. The ICD-9 codes used to indicate medical injury in this study served as the basis for the list of injuries which we included in our study.

Table 4: Comparison of Study Results (This Table Spans Multiple Pages)

	Our Study	Thomas, et al	Harvard Medical Practice
Sample Size	Over 564,000 medical injuries identified in an inpatient setting and a control sample of over 2 million similar individuals; nearly 1.8 million medical injuries identified in an outpatient setting and a control sample of over 6.7 million similar individuals	459 inpatient adverse events, selected by reviewing 14,732 randomly selected discharges	31,429 hospitalized patients sampled from 2,671,863 patients in NY in 1984

Table 4: Comparison of Study Results (This Table Spans Multiple Pages)			
	Our Study	**Thomas, et al**	**Harvard Medical Practice**
Sample Selection	Medical injuries identified by ICD-9 codes listed in Appendix D in either inpatient or outpatient claim data; number of errors calculated as a percentage of medical injuries, based on type of injury	Adverse events identified by manual chart review of inpatient discharges; researchers also determined whether each adverse event was preventable based on manual review	Adverse events and negligence identified by manual two-stage chart review of discharges; reviewers also graded their confidence that an adverse event had occurred
Control group	4:1 matched sample chosen where available; based on medical procedure, age, gender, and chronic conditions	None chosen, and therefore costs that would have occurred in absence of the event were not excluded	None chosen
Costs included	Measureable costs from claim databases: excess (error minus control group) medical costs, excess inpatient deaths within one year, and excess short-term disability costs within one year	Disability and healthcare utilization costs (inpatient, outpatient, and prescription drug costs), lost income, and lost household production	Medical care, lost earnings, and lost household production
How costs were identified	Review of claim and disability data for period following index date; statistical significance tests comparing the costs for the error and control samples	Researcher estimation and review of disability and use of health care services; lost income estimated using wage data from U.S. Census Bureau	Surveys of individuals involved in the study identified the quantity and duration of medical services and other information relating to economic cost of error; researchers used unit costs from various sources to estimate total costs
Rate of injury	7 percent of admissions	3.1 percent of admissions	3.7 percent of admissions resulted in an adverse event
Rate of error	1.7 percent of admissions	1.8 percent of admissions	1 percent of admissions (due to negligence)
Estimated frequency of error / preventable adverse event	24 percent of medical injuries in 2008 are the result of a medical error using the methodology of our study	61 percent were determined to be the result of a medical error	27.6 percent of adverse events were due to negligence

Table 4: Comparison of Study Results (This Table Spans Multiple Pages)

	Our Study	Thomas, et al	Harvard Medical Practice
Estimated total costs of errors / preventable adverse events	$19.5 billion (2008 dollars); this represents excess costs over the matched control group	$308 million in Utah and Colorado (1996 dollars), extrapolates to $17 billion for preventable adverse events in the United States; this represents total cost of the preventable adverse events	$3.8 billion of $20.3 billion in overall costs in New York was determined to be the result of iatrogenic injuries (adults only)
Percentage of costs relating to healthcare	87 percent	52 percent	47 percent
Error / preventable adverse event which represents the largest cost	Pressure ulcers	Postoperative complications	Unknown
Nursing home and home health costs	Nursing home and home health costs included in database only if they would be covered insurance benefits	Represent 40 percent of healthcare costs of preventable adverse events	Unknown

METHODOLOGY

To determine the measureable cost of medical errors to the United States economy, we completed the following steps:

- Identify probable and possible errors
- Calculate the injury and error rates and extrapolate to the US population
- Select a control group for each error group
- Measure the medical cost difference per injury
- Measure the inpatient mortality and short-term disability cost difference per injury

This section of the report explains in more detail how we completed each of the steps listed above and discusses an adjustment which we made to one error, pressure ulcers.

Identify probable and possible errors

In addition to the diagnoses included in the study on medical injuries by Layde et al, we added a small number of diagnoses related to Medicare's listing of hospital-acquired conditions to the list of diagnoses we used to identify a potential medical error in the claim dataset. Appendix D contains a complete listing of ICD-9 codes which we included in the analysis.

A group of clinicians with extensive experience in clinical inpatient medical record review reviewed this list of diagnoses. Based on clinical experience and judgment, they estimated how often each type of injury was likely to be associated with a medical error as opposed to an unavoidable consequence of the underlying disease state despite best practice. These clinicians classified injuries into the categories shown in Table 5 based on the likelihood that they were associated with a medical error. We then applied the midpoint of each range of likelihood of medical error to the frequency of each medical injury to establish the rate of medical error. For example, in the injury group that is associated with medical error in between 65 and 90 percent of occurrences, we multiplied the number of injuries by 0.775 to derive the estimated number of errors. Consistent with the finding in the Layde et al study, we reduced all frequencies by 10 percent for false positives. We did not increase our estimate for false negatives.

Table 5 presents the five groupings of error percentages used to adjust medical injury counts to drive medical error counts.

Table 5: Classification of Injuries into Error Frequency Groups

Frequency with which Injury is Associated with an Error	Midpoint (for frequency calculations)
> 90%	0.95
65 – 90%	0.775
35 – 65%	0.5
10 – 35%	0.225
< 10%	0.05

We used data from the Medstat MarketScan commercial and Medicare inpatient and outpatient databases between the years 2000 and 2008 (through third quarter) as the source for identifying a medical injury. We used the frequency of errors in the database during 2008 to estimate the frequency of errors in the United States. In order to expand the sample size and give a longitudinal estimate, cost per error estimates were developed from claims in all available years. For a more detailed description of the Medstat MarketScan databases used in the report, please refer to the Data Reliance section of the report.

We identified all individuals in each year with a claim containing any ICD-9 code relating to a medical injury (listed in Appendix D). We included individuals only once per year, and classified them to an injury group based on the first ICD-9 code relating to medical injury that occurred. If an individual had a medical injury of any type, regardless of the probability of its association with a medical error, this person was ineligible to be identified with a second injury during the same year. This was done to avoid double counting costs associated with the same person, who had more than one error during the year.

Our approach for identifying injuries depends on the accuracy of ICD-9 codes reported in claim data. To the extent that these codes do not accurately represent the situation that occurred, the results may change. Specifically, a group of ICD-9 codes used to identify medical injuries are the "E" codes. These codes are used with varying frequency by region across the US. To the extent that "E" codes are overutilized or underutilized in claim coding, our result will overstate or understate the frequency with which these types of injuries occur.

Calculate the injury and error rates and extrapolate to the U.S. population

We used the frequency of an injury's occurrence by age and gender in our 2008 sample in combination with population statistics from the United States Census Bureau[5] to determine the number of medical injuries in the United States during the year 2008. Table 6 presents an example of this calculation for postoperative infection in 45 – 64 year-old males.

Table 6: Calculating Frequency of Postoperative Infection Errors in 45 – 64 Year Old Males (2008)

			Errors Identified in Inpatient Setting	Errors Identified in Outpatient Setting
(a)	Postoperative infection diagnoses in 2008 MarketScan databases based on ICD-9 codes in Appendix D		1,401	1,271
(b)	Postoperative infections (adjusted for false positives)	(a X 0.9)	1,261	1,144
(c)	Postoperative infection errors (adjusted for error frequency)	(b X 0.95)	1,198	1,087
(d)	2008 days of MarketScan eligibility		797,497,325	797,497,325
(e)	Error frequency rate	(c / d X 365)	0.0548%	0.0497%
(f)	2008 U.S. population figures		38,103,272	38,103,272
(g)	Estimated errors in U.S.	(e X f)	20,890	18,951

Establish a control group for each error group

For each injury identified, we classified the injury as occurring in either an inpatient or outpatient setting. The primary basis for the assignment was based upon whether the ICD-9 code occurred in an inpatient or outpatient setting. However, for any injury which was diagnosed in an outpatient setting, if the individual had an admission within 30 days prior to the date of their injury diagnosis, we treated the injury as an inpatient injury. The process we used to identify an appropriate control group for each injury sample is described in more detail below.

INPATIENT INJURIES

For each inpatient injury, our goal was to obtain a 4:1 matched control set for comparison. We obtained these control patients from a list of all individuals who had an inpatient admission but did not have an inpatient medical injury during the year in question. Our aim was to produce a risk-matched control group by matching on characteristics that indicate degree of morbidity. Criteria used to obtain a match include:

1. Year of admission

2. DRG – When matching on DRG, it was important to consider that the ICD-9 code which indicated a medical injury could cause a change in the DRG code which was assigned. To find appropriate matches, we removed the ICD-9 code which caused identification of the admission as a medical injury and processed the claim data using the 3M Core Grouping Software 2009.2.1 to reassign a DRG to the claim. We used the DRG which resulted after removing the ICD-9 code associated with the error as the DRG code with which to match.

3. Chronic Conditions (up to three) – We identified 24 chronic conditions that were high-cost and/or high-frequency events. We then ranked these conditions based on per member per year cost and assigned each person up to 3 chronic conditions in each year based on the occurrence of an ICD-9 code relating to the condition during the year. Appendix E contains a list of the chronic conditions we used and the ICD-9 codes we used to identify them.

4. Age Group – We grouped individuals into age groups for matching. These groups included ages less than 16 years old, 16 – 25 years old, 26 – 35 years old, 36 – 45 years old, 46 – 55 years old, 56 – 65 years old, 66 – 75 years old, or greater than 75 years old.

5. Gender

We used random sampling to obtain matches for all members of the injury set. If a potential match was available on all seven criteria (including up to three chronic conditions), then we included that match in the control set. If not, we dropped criteria from the end of the list, starting with gender, and searched for the best available remaining match. We required all controls to match on at least year and DRG. This resulted in a control group with a ratio of 3.68:1 compared to the injury sample. Table 7 presents the results of the matching for inpatient injuries. This table shows how often we were able to obtain matches which resemble the injury sample to various degrees.

Table 7: Summary of Matching for Inpatient Injuries	
Conditions Matched	**% of matching sample**
Year of admission, DRG, 3 chronic conditions, age group, gender	52%
Year of admission, DRG, 3 chronic conditions, age group	7%
Year of admission, DRG, 3 chronic conditions	17%
Year of admission, DRG, 2 chronic conditions	11%
Year of admission, DRG, 1 chronic condition	9%
Year of admission, DRG	4%

OUTPATIENT INJURIES

For each injury that occurred in an outpatient setting, we attempted to obtain a 4:1 matched control set for comparison. We obtained these matches from a list of all individuals who had an outpatient encounter but did not have an outpatient medical injury during the year in question. As with the inpatient control group, our aim was to produce a matched sample that reflected degree of morbidity. Except for DRG, all criteria used for matching of inpatient injuries were also used to find controls for outpatient injuries. In place of DRG, we used the CPT code or HCPCS code with the greatest severity which occurred in the 30 days prior to the injury. Criteria used to obtain a match include:

1. Year of service

2. CPT Code, HCPCs Code, or Revenue Code –We looked for the service that occurred in the 30 days preceding the injury diagnosis which is associated with the largest number of relative value units[6]. If only evaluation and management (E&M) CPT codes (of the format “99XXX”) were present in the claim data during the 30 days prior to the injury diagnosis, we used a revenue code where one was available. Finally, if no other codes were available, we used the E&M code associated with the injury diagnosis as the code on which to match. In the small number of cases where both CPT codes and revenue codes were blank, we did not attempt to find matches for the case.

3. Chronic Conditions (up to three)

4. Age Group

5. Gender

We used a similar process to match both inpatient and outpatient injuries. For outpatient injuries, we tried to match as many of the criteria listed above as possible, and required all controls to match on at least year and procedure code. After matching, we obtained a control group with a ratio of 3.78:1 compared to the injury sample. Table 8 presents the results of the matching for outpatient injuries.

Table 8: Summary of Matching for Outpatient Injuries	
Conditions Matched	**% of matching sample**
Year of admission, CPT or Revenue Code, 3 chronic conditions, age group, gender	84%
Year of admission, CPT or Revenue Code, 3 chronic conditions, age group	3%
Year of admission, CPT or Revenue Code, 3 chronic conditions	6%
Year of admission, CPT or Revenue Code, 2 chronic conditions	3%
Year of admission, CPT or Revenue Code, 1 chronic condition	2%
Year of admission, CPT or Revenue Code	1%

Measure the medical cost difference per injury

After assembling the injury and control samples, the next step was to identify all medical claims for the members of these samples. We tracked these members in the Medstat MarketScan claim databases from the date of their injury or claim that was used for matching (index date) until either the end of their eligibility or the last month of claims available, September 2008. We identified the total allowed dollars in the medical claim database following the trigger and then grouped these into periods of first three months, next nine months, and each full year thereafter (for a total of five years for an inpatient error or one year for an outpatient error), where a month is defined as 30 days.

We applied medical cost trends to convert all dollars to a July 2008 basis. Because members may drop eligibility at any point following their index date, we adjusted dollars upward to account for the average number of days that members are eligible to incur charges being less than the total number of days in the period. Additionally, to account for differences in the age/gender composition between the injury group and the control group, we normalized the control group to the age/gender of the injury group.

Finally, we compared the total medical costs per individual in the injury sample with the total medical costs per individual in the control sample using a two sample t-test to determine if the injury group had greater costs. We performed a separate test for each injury type and time period (e.g., one t-test to compare average allowed dollars incurred in the first three months between people with an ICD-9 code indicating “blood type incompatibility” and their corresponding matched sample). We chose alpha to be 0.05 and treated any result with a p-value less than or equal to that value as significant. For any time period, if a t-test indicated the results were significant, then the entire difference was considered to be a cost of injury. To determine the medical cost of one injury, we discounted all significant differences in mean allowed dollars by period back to the date of the injury claim or its corresponding match using a discount rate of three percent.

Measure the mortality and disability cost difference per injury

The other components of cost which we considered in our analysis were related to the cost of lost productivity following a medical error. The two components we considered were productivity lost as a result of increased in-hospital death rates following a medical error and productivity lost due to increased short-term disability claims in the year following a medical error.

INPATIENT MORTALITY COST DIFFERENCE PER INJURY

To assess the inpatient mortality difference between the injury group and the control group, we compared the rate of hospital discharges with discharge status indicating "deceased" in each time period (defined consistently with medical cost) following the injury. In time periods in which the mortality rate for the injury group was significantly greater than the mortality rate for the control group, we applied an economic cost of death to the difference in mortality rates. For excess deaths which occurred in months four through twelve following the index date, we also reduced the result to be contingent on survival past the first three months.

A study published by Grosse et al[7] contains the present value of lifetime production, including both market production and household production, by age and sex. We used the values associated with a three percent discount rate, trended these values forward to July 2008 at three percent, and summarized by the age/gender classifications used in this report. Table 9 displays the values for cost of future lost productivity associated with one death by age and gender categories. For all deaths which occurred at any point following the index date, we used a three percent discount rate to decrease the lost productivity from the values shown in the table below.

Table 9: Cost of Future Lost Productivity, 2008

Age and Gender	Cost of Future Lost Productivity
Male, 0 – 17	$1,461,049
Male, 18 – 44	$1,676,546
Male, 45 – 64	$745,067
Male, 65 – 74	$239,994
Male, 75+	$105,169
Female, 0 – 17	$1,184,349
Female 18 – 44	$1,300,783
Female, 45 – 64	$625,382
Female, 65 – 74	$251,141
Female, 75+	$119,066

To compare the inpatient mortality rates in the injury sample and the control sample, we used the same sample of inpatient cases as was used to calculate inpatient medical costs. We adjusted the mortality rate of the control sample to account for differences in the age/gender composition between the injury and control samples[8]. We then used a Chi-square test to compare the rate of death in the hospital for each injury type and time period between the two samples. As with the comparison of medical costs, we chose the necessary significance level to be 0.05. Due to the infrequency of death in the hospital, situations arise in which the expected count in one or more of the cells of the Chi-square test was less than five. In these situations, we used Fisher's exact test (alpha = 0.05) as an alternative to the Chi-square test.

DISABILITY COST DIFFERENCE PER INJURY

We calculated lost productivity due to days missed from work as the product of (1) the statistically significant increase in days missed from work due to short-term disability during the first year following the index date between the injury sample and the control sample, and (2) the economic value by age and gender of one day of work.

We used the subset of the injury and control samples who had eligibility in the Medstat MarketScan Health and Productivity Management (HPM) database to determine the difference in days missed from work due to short-term disability claims. The number of members included in the HPM database is much smaller than the number of members in the claim and eligibility databases; therefore, these comparisons were based on much smaller sample sizes.

We used a two sample t-test (alpha = 0.05) to compare the average days missed from work during the first year following the index date for individuals in the injury sample and the control sample. To account for those whose eligibility was less than one year following their index claim, we adjusted their days missed from work up proportionally to what it would have been if they had been eligible for the entire year prior to performing the significance test.

To determine the economic value by age and gender of one day of work, we began with the annual per person total production (including market production and household production) from "Table 2: Daily Production of the US Population" by Grosse et al. We converted these figures to a daily value and trended them forward to July 2008. Table 10 shows the cost of a missed day of work by the age and gender categories in this report.

Table 10: Cost of a Day Missed from Work

Age and Gender	Per Person Daily Total Production
Male, 0 – 17	$-
Male, 18 – 44	$172.81
Male, 45 – 64	$183.86
Male, 65 – 74	$74.13
Male, 75+	$44.91
Female, 0 – 17	$-
Female 18 – 44	$139.06
Female, 45 – 64	$114.58
Female, 65 – 74	$64.53
Female, 75+	$44.33

Pressure ulcers

The cost of pressure ulcers represents a significant portion of our result. We believe that pressure ulcers are most often the result of an error and have therefore classified them into the injury group which is associated with an error in over 90 percent of cases. Previous research has estimated the yearly cost of treating pressure ulcers in the United States to be $11 billion [(9)(10)]. Russo and Elixhauser estimated mean length of stay for admissions relating to pressure ulcers at 13 days, with an average charge of $37,800. They found that in most cases where pressure ulcers were treated during an admission, other conditions were chiefly responsible for the admission. Septicemia, pneumonia, urinary tract infection, aspiration pneumonitis, and congestive heart failure were among the most common causes of these admissions[(11)].

An individual with a pressure ulcer is likely to have a higher level of morbidity than a person with similar co-morbidities but without a pressure ulcer. This higher morbidity level (such as one that causes immobility and hence, higher likelihood of acquiring a pressure ulcer) is not the effect of a pressure ulcer but rather a cause of a pressure ulcer. We have made an attempt to exclude any higher costs arising from this difference in morbidity level due to causes of pressure ulcers.

We used the discharge status on the admission where a pressure ulcer was identified to infer the level of care (and hence, the level of morbidity) needed for the patient. For pressure ulcers identified in an inpatient setting, we compared the distribution of discharge status of the index admission for those in the error group with those of the control group. Table 11 below summarizes these differences. Notably, fewer individuals in the error group were discharged to home and more were discharged to other places where continual follow-up care might be necessary, such as skilled nursing facilities.

Table 11: Summary of Discharge Status for Pressure Ulcer Group

Discharge Status	Percentage of error group	Percentage of control group
Discharged to home self-care	37.6%	58.6%
Transfer to short-term hospital	9.1%	5.3%
Transfer to SNF	20.9%	10.6%
Transfer to ICF	1.0%	0.6%
Died	2.8%	3.6%
Transfer to Other Facility	1.9%	1.1%
Discharged home under care	12.6%	9.2%
Nursing facility	1.9%	1.7%
Psych hospital/unit	1.2%	0.4%
Blank	7.4%	6.6%
Other	3.5%	2.1%

This distribution suggestions that patients who acquire pressure ulcers need more follow-up care and thus, will incur more medical costs in the long-term, than patients who have similar medical conditions without pressure ulcers. To adjust for the long-term cost differences in the error sample and the control sample for the pressure ulcer group, we removed the statistically-significant excess costs for the error sample in the period between 450 and 90 days prior to the index date from all years following the index date. A summary of this adjustment is shown in Tables 12 and 13 below, and again in the pressure ulcer exhibit in Appendix B. Table 12 shows the difference in medical costs for individuals in the error sample and the control sample in the one-year period beginning 450 days prior to the index date.

Table 12: Excess Costs for Pressure Ulcers in Period Prior to Index Date

Location of error occurrence	Error Sample	Control Sample	Difference
Inpatient	$40,751	$30,749	$10,271
Outpatient	$32,949	$25,079	$7,871

Table 13 shows the adjustment made to remove significant excess costs associated with the error sample for errors in the inpatient setting. As shown in Table 12, $10,271 is the expected difference in yearly costs between the error sample and the control sample. Accordingly, this amount has been removed from each of the years following the index date. In the first three months, we removed 25% of this difference and in the next 9 months, we removed the remaining 75% of the difference such that the total reduction for year 1 post error is $10,271.

Table 13: Adjustment of In-Hospital Pressure Ulcer Results to Account for Differences in Pre-Period Costs		
Period	**Significant Excess Average Costs per Error (alpha = 0.05)**	**Significant Excess Average Costs per Error, Adjusted for Differences in Pre-Period Costs**
1st 3 months	$26,737	$24,169
Next 9 months	$16,178	$8,474
Year 2	$11,397	$1,126
Year 3	$8,356	$0
Year 4	$5,859	$0
Year 5	$5,902	$0
All Periods (present value)	$71,634	$33,476

We made similar adjustments to the excess deaths and days missed from work based on the percentage of medical claim dollars which were determined to be due to the excess morbidity in the error sample. For example, for errors in the inpatient setting, in the first year following an error, we reduced excess medical costs by approximately 24 percent. Therefore, we also reduced excess days missed from work in the year following the error by a corresponding amount. This resulted in decreasing the number of excess deaths from 5,544 to 1,393 and the number of excess days missed from work per error from 29.39 to 22.39. Appendix B presents details of these calculations.

Data reliance

Error frequency and medical cost results were based on data contained in both the Medstat MarketScan Commercial Claims and Encounters and Medicare Supplemental and COB Databases. The MarketScan databases include multi-year claims and enrollment information for commercial employer group business and Medicare-eligible retirees. The data have a nationwide mix of Preferred Provider Organization (PPO) and Health Maintenance Organization (HMO) businesses. The data contain service-level details for inpatient, outpatient, and pharmacy claims. The relevant information available on the inpatient and outpatient claim data was the ICD-9 diagnosis codes, CPT/HCPC codes, revenue codes, DRG codes, and the allowed dollars. The inpatient data also contain the discharge status for the admission, which was used to determine whether the patient died in the hospital. The enrollment data have demographic information for the enrolled members. The data include members who were enrolled at any point from January 1, 2000 to the third quarter of 2008. Enrollment exceeds 24 million lives. A significant number of members were available in the data for several years and hence, could be followed longitudinally.

We also used the Medstat Health & Productivity Management (HPM) database which contains absence and short-term disability, and eligibility data for over one million lives (a subset of the MarketScan members). Data include members who were enrolled at any point from January 1, 2000 to December 31, 2007. These data contain the days absent from work which were used to estimate the lost productivity. This information is linkable to the medical, pharmacy, and enrollment data in MarketScan for these employees, making the resulting database a unique and valuable resource for examining health and productivity issues for an employed, privately insured population.

To the extent that these data do not represent universal coding practices, actual results may vary. Specifically, a subset of medical errors is identified using ICD-9 codes related to external causes of injury (E-codes). The frequency with which E-codes are used varies according to area of the country. For the full list of sources, please see the References Section of this report.

RESULTS

We identified the total cost of measurable medical errors in the United States during 2008 to be $19.5 billion, including direct costs of $17 billion and indirect costs of $2.5 billion. Table 1, in the Executive Summary section of this report breaks down these costs by type of error and shows the split between direct and indirect costs. We have repeated this table below as Table 14 for the reader's convenience.

Table 14: Total Measurable Costs of Medical Errors

% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
> 90%	810,898	770,353	$12,306	$950	$643	$13,899	$10,707
65 – 90%	9,949	7,710	$5,764	$3,496	$-	$9,260	$71
35 – 65%	345,838	172,919	$9,999	$1,279	$898	$12,176	$2,105
10 – 35%	1,684,003	378,901	$10,522	$592	$936	$12,051	$4,566
< 10%	3,468,799	173,440	$10,644	$1,144	$443	$12,232	$2,121
Total Errors		1,503,323	$11,366	$933	$720	$13,019	$19,571

Table 15 lists the ten errors that are most costly to the United States economy. These 10 errors account for approximately 69 percent of total error costs.

Table 15: Errors With the Largest Annual Measurable Cost

Error Type	% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
Pressure Ulcer (Medicare Never Event)	> 90%	394,699	374,964	$8,730	$1,133	$425	$10,288	$3,858
Postoperative infection	> 90%	265,995	252,695	$13,312	$-	$1,236	$14,548	$3,676
Mechanical complication of device, implant, or graft	10 – 35%	268,353	60,380	$17,709	$426	$636	$18,771	$1,133
Postlaminectomy syndrome	10 – 35%	505,881	113,823	$8,739	$-	$1,124	$9,863	$1,123
Hemorrhage complicating a procedure	35 – 65%	156,433	78,216	$8,665	$2,828	$778	$12,272	$960
Infection following infusion, injection, transfusion, vaccination	> 90%	9,321	8,855	$63,911	$14,172	$-	$78,083	$691
Pneumothorax	35 – 65%	51,119	25,559	$22,256	$-	$1,876	$24,132	$617
Infection due to central venous catheter	> 90%	7,434	7,062	$83,365	$-	$-	$83,365	$589
Other complications of internal (biological) (synthetic) prosthetic device, implant, and graft	< 10%	535,666	26,783	$14,851	$1,768	$614	$17,233	$462
Ventral hernia without mention of obstruction or gangrene	10 – 35%	239,156	53,810	$6,359	$260	$1,559	$8,178	$440

Table 16 lists the ten errors that are most frequent in the United States.

Table 16: Most Common Medical Errors

Error	% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)
Pressure Ulcer (Medicare Never Event)	> 90%	394,699	374,964
Postoperative infection	> 90%	265,995	252,695
Postlaminectomy syndrome	10 – 35%	505,881	113,823
Hemorrhage complicating a procedure	35 – 65%	156,433	78,216
Accidental puncture or laceration during a procedure, NEC	> 90%	66,714	63,378
Mechanical complication of device, implant, or graft	10 – 35%	268,353	60,380
Ventral hernia without mention of obstruction or gangrene	10 – 35%	239,156	53,810
Hematoma complicating a procedure	35 – 65%	101,259	50,630
Unspecified adverse effect of drug medicinal and biological substance not elsewhere classified	< 10%	778,675	38,934
Mechanical complication of cardiac device, implant, or graft	10 – 35%	137,659	30,973

Table 17 lists the ten errors that are most costly on a per error basis.

Table 17: Errors that are Most Costly on a Per Error Basis

Error	% of injuries that are errors	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error
Postoperative Shock	10 – 35%	$47,099	$46,584	$-	$93,682
Infection due to central venous catheter	> 90%	$83,365	$-	$-	$83,365
Infection following infusion, injection, transfusion, vaccination	> 90%	$63,911	$14,172	$-	$78,083
Gastrostomy complications - Infection	> 90%	$60,273	$6,492	$-	$66,765
Complications of transplanted organ	< 10%	$55,654	$10,510	$494	$66,658
Infection and inflammatory reaction due to internal prosthetic device, implant, and graft	< 10%	$58,746	$2,862	$657	$62,265
Tracheostomy complications	< 10%	$51,384	$3,200	$1,895	$56,479
Gastrostomy complications - Mechanical	10 – 35%	$45,955	$9,265	$-	$55,219
Infusion or transfusion reaction	10 – 35%	$41,082	$10,603	$-	$51,686
Gastrostomy complications	< 10%	$38,018	$11,096	$-	$49,115

Table 18 shows total measurable medical costs of errors split by age.

Table 18: Measurable Medical Costs of Errors by Age

Age Band	Medical Cost (Inpatient Errors)	% IP Medical Cost	Medical Cost (Outpatient Errors)	% OP Medical Cost	Total Medical Cost
0 – 17 years old	$668,504,781	4.9%	$172,040,166	5.0%	$840,544,947
18 – 44 years old	$2,356,091,298	17.3%	$770,049,487	22.4%	$3,126,140,784
45 – 64 years old	$4,193,682,577	30.7%	$1,249,428,792	36.4%	$5,443,111,369
65 – 74 years old	$2,313,583,913	16.9%	$600,992,305	17.5%	$2,914,576,218
Over 75 years old	$4,119,043,755	30.2%	$643,339,892	18.7%	$4,762,383,647
Total	$13,650,906,325	100.0%	$3,435,850,640	100.0%	$17,086,756,965

Table 19 shows the mortality costs split by age. This indicates roughly one fifth of the mortality costs are incurred by those 65 and older. More people in these advanced ages experience deaths related to errors, but the costs associated with a death at these ages are smaller than for individuals at younger ages, as shown in Table 9.

Table 19: Measurable Mortality Costs by Age

Age Band	In Hospital Mortality Cost (Inpatient Errors)	% IP Mortality Cost	In Hospital Mortality Cost (Outpatient Errors)	% OP Mortality Cost	Total In Hospital Mortality Cost
0 – 17 years old	$125,039,378	11.4%	$61,303,698	20.2%	$186,343,076
18 – 44 years old	$348,997,180	31.7%	$139,221,060	46.0%	$488,218,240
45 – 64 years old	$398,921,180	36.3%	$77,636,401	25.6%	$476,557,581
65 – 74 years old	$104,137,405	9.5%	$14,385,509	4.8%	$118,522,914
Over 75 years old	$122,679,417	11.2%	$10,302,356	3.4%	$132,981,773
Total	$1,099,774,560	100%	$302,849,025	100%	$1,402,623,584

There were an estimated 2,861 measurable excess inpatient deaths due to medical errors in 2008. The total mortality cost of these excess errors was $1.4 billion. Table 20 presents the errors which resulted in the most excess inpatient deaths.

Table 20: Total 2008 Excess Measurable Inpatient Deaths

Error	Estimated Errors	In Hospital Mortality Cost per Case	Total Excess Deaths
Pressure Ulcer (Medicare Never Event)	374,964	$1,133	1,393
Hemorrhage complicating a procedure	78,216	$2,828	302
Infection following infusion, injection, transfusion, vaccination	8,855	$14,172	151
Gastrostomy complications – Mechanical	7,819	$9,265	117
Iatrogenic cerebrovascular infarction or hemorrhage	4,949	$10,942	103
Catheter – associated urinary tract infection (Medicare Never Event)	12,839	$1,892	83

Table 21 shows the short-term disability costs split by age.

Table 21: Measurable Short-Term Disability Costs by Age

Age Band	Disability Cost (Inpatient Errors)	% IP Disability Cost	Disability Cost (Outpatient Errors)	% OP Disability Cost	Total Disability Cost
0 – 17 years old	$0	0.0%	$0	0.0%	$0
18 – 44 years old	$157,174,495	27.1%	$166,140,532	33.1%	$323,315,028
45 – 64 years old	$260,633,095	45.0%	$245,484,478	48.8%	$506,117,573
65 – 74 years old	$70,751,397	12.2%	$54,844,839	10.9%	$125,596,236
Over 75 years old	$90,881,480	15.7%	$36,127,867	7.2%	$127,009,347
Total	$579,440,467	100%	$502,597,716	100%	$1,082,038,183

On average, an error resulted in 7.1 extra days missed from work at a cost of $102.14 per day. Table 22 shows the errors which resulted in the largest increase in average days of work missed.

Table 22: Short-Term Disability Average Measurable Excess Days Missed

Error	Estimated Errors	Disability Cost per Case	Average 2008 Days Missed
Amputation stump complication	563	$3,419	28.99
Complication of prosthetic joint	22,513	$2,293	26.65
Persistent postoperative fistula, NEC	438	$2,628	24.39
Pneumothorax	25,559	$1,876	20.02
Tracheostomy complications	935	$1,895	19.05

Table 23 presents the five errors which resulted in the most total excess days missed due to error in the year following the index date.

Table 23: Short-Term Disability Total Measurable Excess Days Missed

Error	Estimated Errors	Disability Cost per Case	Total 2008 Days Missed
Postoperative infection	252,695	$1,236	2,710,458
Pressure Ulcer (Medicare Never Event)	374,964	$425	2,189,437
Postlaminectomy syndrome	113,823	$1,124	1,060,213
Ventral hernia without mention of obstruction or gangrene	53,810	$1,559	717,094
Complication of prosthetic joint	22,513	$2,293	600,005

Calculations example: postoperative infection

As an example of how we calculated the frequency of an injury and the increased medical costs, mortality costs, and disability costs, shown below is a detailed illustration of the calculations for postoperative infection. Appendix B contains tables similar to those presented here for each of the errors which cost over $10 million per year to the United States economy.

INJURY FREQUENCY

Postoperative infection is defined using ICD-9 codes 998.51 or 998.59, and we consider it to be an error over 90 percent of time.

We queried the Medstat MarketScan databases to determine how often we observed these two ICD-9 codes in 2008. Using the total eligible days of exposure represented in the MarketScan databases in 2008 and U.S. population statistics from the U.S. Census Bureau, we developed separate frequency estimates for inpatient and outpatient errors. Table 6 shows the detailed development of the estimated error frequency for postoperative infection in 45 - 64 year-old males. Tables 24 and 25 show summaries of postoperative infection rates by age and gender. We estimate that just over 250,000 postoperative infections occurred in the United States during 2008.

Table 24: Inpatient Frequency by Age and Gender – Postoperative Infection

Age Group	Gender	Error Frequency Rate in 2008 (based on Medstat)	US Population By Age/Gender	Count of Errors in US Population By Age/Gender
0-17	M	0.010%	37,833,517	3,761
18-44	M	0.021%	57,523,012	12,089
45-64	M	0.055%	38,103,272	20,890
65-74	M	0.087%	9,264,928	8,072
Over 75	M	0.104%	7,199,875	7,471
0-17	F	0.006%	36,108,331	2,318
18-44	F	0.048%	55,666,902	26,989
45-64	F	0.064%	39,954,974	25,429
65-74	F	0.084%	10,858,013	9,161
Over 75	F	0.075%	11,546,900	8,686
Total		0.041%	304,059,724	124,866

Table 25: Outpatient Frequency by Age and Gender – Postoperative Infection				
Age Group	**Gender**	**Error Frequency Rate in 2008 (based on Medstat)**	**US Population By Age/Gender**	**Count of Errors in US Population By Age/Gender**
0-17	M	0.011%	37,833,517	4,197
18-44	M	0.026%	57,523,012	14,691
45-64	M	0.050%	38,103,272	18,951
65-74	M	0.088%	9,264,928	8,183
Over 75	M	0.110%	7,199,875	7,900
0-17	F	0.009%	36,108,331	3,223
18-44	F	0.047%	55,666,902	26,042
45-64	F	0.062%	39,954,974	24,639
65-74	F	0.091%	10,858,013	9,853
Over 75	F	0.088%	11,546,900	10,150
Total		**0.042%**	**304,059,724**	**127,830**

MEASURABLE MEDICAL COST OF MEDICAL INJURY

Table 26 shows a detailed summary of the calculation of measurable medical costs for postoperative infection. Total medical costs of postoperative infection are over $3 billion. The cost of an inpatient error ($22,012) is over four times the cost of an outpatient error ($4,814).

Table 26: Total medical cost – Postoperative Infection			
	Errors	**Cost per Error**	**Total Cost ($millions)**
Inpatient	124,866	$22,012	$2,749
Outpatient	127,830	$4,814	$615
Total	**252,695**	**$13,312**	**$3,364**

Tables 27 and 28 present the results of each t-test and show which time periods had excess costs following the medical error. For postoperative infections, over half of the measurable costs of the inpatient error are concentrated in the first year following the error.

Table 27: Significance Testing, Medical Costs, Inpatient Errors – Postoperative Infection

Period	N (cases)	N (controls)	Mean (cases)	Mean (controls)	Difference in Means	P-value	Significant Excess Average Costs per error (alpha = 0.05)
1st 3 months	49,719	176,700	$45,613	$31,998	$13,615	0.000	$13,615
Next 9 months	43,886	149,544	$23,112	$18,369	$4,743	0.000	$4,743
Year 2	28,415	93,659	$22,352	$19,771	$2,581	0.000	$2,581
Year 3	17,845	59,436	$19,063	$17,639	$1,424	0.000	$1,424
Year 4	10,915	36,634	$16,735	$16,632	$103	0.407	$0
Year 5	6,573	22,398	$17,090	$16,145	$945	0.058	$0
All Periods (present value)							$22,012

Table 28: Significance Testing, Medical Costs, Outpatient Errors – Postoperative Infection

Period	N (cases)	N (controls)	Mean (cases)	Mean (controls)	Difference in Means	P-value	Significant Excess Average Costs per error (alpha = 0.05)
1st 3 months	52,283	206,467	$11,945	$9,931	$2,014	0.000	$2,014
Next 9 months	46,971	182,624	$15,409	$12,549	$2,860	0.000	$2,860
All Periods (present value)							$4,814

INPATIENT MORTALITY COST OF MEDICAL INJURY

Because the statistically significant excess inpatient mortality costs of postoperative infection total $0, we have used a different type of error to illustrate mortality cost calculations. The tables below summarizing results of mortality costs are based on the group of errors called “hemorrhage complicating a procedure” which has a total measurable inpatient mortality cost of $221 million. As shown in Table 29, medical errors related to hemorrhage result in 302 excess deaths in an inpatient setting. The cost per death is $731,738, which represents the lost economic production of each person who dies. The cost per error is $2,828.

Table 29: Total Inpatient Mortality Cost – Hemorrhage Complicating a Procedure

	Errors	Excess IP Deaths	Cost per IP Death	Cost per Error	Total Cost ($millions)
Inpatient	32,852	246	$687,690	$5,150	$169
Outpatient	45,365	56	$924,173	$1,147	$52
Total	78,216	302	$731,738	$2,828	$221

Tables 30 through 34 present the results of significance testing and other key values for both the inpatient and outpatient injury and control samples. Table 30 shows the assumed distribution of inpatient deaths by age and gender. This represents the proportion of errors that occur in each sample. “N/A” is used to indicate cases where no excess inpatient deaths occurred as a result of the error.

Table 30: Age/Gender Distribution of Excess Inpatient Deaths – Hemorrhage Complicating a Procedure

Age / Gender	Percent of IP Deaths (Inpatient Error Sample)	Percent of IP Deaths (Outpatient Error Sample)
Male, 0-17	4%	9%
Male, 18-44	6%	15%
Male, 45-64	18%	10%
Male, 65-74	10%	6%
Male, Over 75	13%	10%
Female, 0-17	2%	9%
Female, 18-44	16%	21%
Female, 45-64	15%	9%
Female, 65-74	7%	4%
Female, Over 75	9%	6%

*N/A means there are no excess deaths for this error

Tables 31 and 32 present significance testing and other key results for inpatient errors. As shown in Table 31, the inpatient mortality rate is significantly higher in the error sample than the control sample throughout the first year following the index date. These significant differences in inpatient mortality rate were then multiplied by the number of people with errors who survived to the start of the period to compute excess inpatient deaths during the period. For example, in the first three months, multiplying the number of people who survived to the beginning of the period (all 32,853 people who experienced medical errors during 2008) by the significant difference in inpatient mortality rate (0.479 percent) results in the number of excess inpatient deaths in the error sample during the first three months following the index date (157). Based on the age distribution of the sample, we then calculate the cost per inpatient death and the total costs of excess inpatient deaths. Please note that we did not allow cost savings based on a higher inpatient mortality rate in the control sample.

Table 31: Significance Testing (Inpatient Errors) – Hemorrhage Complicating a Procedure						
Period	**N (cases)**	**N (controls)**	**IP Deaths (cases)**	**IP Deaths (controls)**	**Difference in IP Death Rate**	**P-value**
1st 3 months	25,461	95,550	554	1,616	0.479%	0.0000
Next 9 months	22,164	82,534	282	824	0.274%	0.0004

Table 32: Key Values for Inpatient Deaths – Hemorrhage Complicating a Procedure					
Period	**Probability of Survival to the Start of Period**	**Mean Significant Excess IP Death Rate**	**Excess IP Deaths**	**Cost per IP Death (PV)**	**Cost of Excess IP Deaths (PV)**
1st 3 months	1.00	0.479%	157	$691,339	$108,883,411
Next 9 months	0.98	0.274%	89	$681,197	$60,292,646

Tables 33 and 34 present similar results for outpatient errors. Once again, a significant difference in inpatient death rate occurs immediately following the index date. This difference results in 56 excess inpatient deaths which represent $52 million in costs.

Table 33: Significance Testing (Outpatient Errors) – Hemorrhage Complicating a Procedure						
Period	**N (cases)**	**N (controls)**	**IP Deaths (cases)**	**IP Deaths (controls)**	**Difference in IP Death Rate**	**P-value**
1st 3 months	35,012	130,560	284	894	0.124%	0.0140
Next 9 months	30,956	114,916	56	182	0.023%	0.3789

Table 34: Key Values for Outpatient Error IP Deaths – Hemorrhage Complicating a Procedure					
Period	**Probability of Survival to the Start of Period**	**Mean Significant Excess IP Death Rate**	**Excess IP Deaths**	**Cost per IP Death (PV)**	**Cost of Excess IP Deaths (PV)**
1st 3 months	1.00	0.124%	56	$924,173	$52,040,360
Next 9 months	0.99	0.000%	0	$-	$-

SHORT-TERM DISABILITY COST OF MEDICAL INJURY

As shown in Table 35 below, total short-term disability costs for postoperative infection are $312 million. Errors in an inpatient setting result in nearly double the cost of errors in an outpatient setting.

Table 35: Total Short-Term Disability Cost – Postoperative Infection

	Errors	Cost per Error	Total Cost ($millions)
Inpatient	124,866	$1,654	$206
Outpatient	127,830	$829	$106
Total	252,695	$1,236	$312

Table 36 below contains the summary statistics used in the t-tests for the disability cost calculation for postoperative infection. Note that only individuals with eligibility in the Medstat HPM database during the year their injury occurred are included in the t-test. In this case, the results are significant at the 5 percent level for both inpatient and outpatient injuries.

Table 36: T-Test Summary for Short-Term Disability Days – Postoperative Infection

Service Category	N = Cases	N = Controls	Mean Days Cases	Mean Days Controls	Difference in Means	p-value
Inpatient	1,671	5,777	67	53	14.23	0.0000
Outpatient	1,598	6,213	31	24	7.30	0.0000

Table 37 below, using frequency figures generated as demonstrated in Tables 24 and 25 above, shows the full development of disability costs related to loss of productivity associated with postoperative infection errors. The daily productivity values shown represent the dollar value of a day of productivity trended at three percent to July 2008 by age/gender combination. We weighted the productivity figures using disability statistics[12] to obtain a productivity value applicable to the age bands used in our report. To calculate total estimated costs, we multiplied the difference in means shown in Table 36 by the daily productivity value to determine the cost per error and then multiplied by the number of errors.

Table 37: Short-Term Disability Costs of Postoperative Infection				
Age Group	**Daily Productivity Value**	**Inpatient Estimated STD Costs ($millions)**	**Outpatient Estimated STD Costs ($millions)**	**Total Estimated STD Costs ($millions)**
Male, 0-17	$-	$-	$-	$-
Male, 18-44	$172.81	$30	$19	$48
Male, 45-64	$183.86	$55	$25	$80
Male, 65-74	$74.13	$9	$4	$13
Male, Over 75	$44.91	$5	$3	$7
Female, 0-17	$-	$-	$-	$-
Female, 18-44	$139.06	$53	$26	$80
Female, 45-64	$114.58	$41	$21	$62
Female, 65-74	$64.53	$8	$5	$13
Female, Over 75	$44.33	$5	$3	$9

Overall results

Table 38 shows the frequency rate and cost of specified medical errors which result in a cost of at least ten million dollars annually. To see a corresponding table for all other errors, please reference Appendix C.

Table 38: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)									
Error Type	**Appendix page number**	**% of injuries that are errors**	**Count of Injuries (2008)**	**Count of Errors (2008)**	**Medical Cost per Error**	**In Hospital Mortality Cost per Error**	**STD Cost per Error**	**Total Cost per Error**	**Total Cost of Error (millions)**
Pressure Ulcer (Medicare Never Event)	231	> 90%	394,699	374,964	$8,730	$1,133	$425	$10,288	$3,858
Postoperative infection	223	> 90%	265,995	252,695	$13,312	$-	$1,236	$14,548	$3,676
Mechanical complication of device, implant, or graft	167	10 - 35%	268,353	60,380	$17,709	$426	$636	$18,771	$1,133
Postlaminectomy syndrome	219	10 - 35%	505,881	113,823	$8,739	$-	$1,124	$9,863	$1,123
Hemorrhage complicating a procedure	123	35 - 65%	156,433	78,216	$8,665	$2,828	$778	$12,272	$960

Table 38: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)

Error Type	Appendix page number	% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
Infection following infusion, injection, transfusion, vaccination	143	> 90%	9,321	8,855	$63,911	$14,172	$-	$78,083	$691
Pneumothorax	207	35 - 65%	51,119	25,559	$22,256	$-	$1,876	$24,132	$617
Infection due to central venous catheter	139	> 90%	7,434	7,062	$83,365	$-	$-	$83,365	$589
Other complications of internal (biological) (synthetic) prosthetic device, implant, and graft	195	< 10%	535,666	26,783	$14,851	$1,768	$614	$17,233	$462
Ventral hernia without mention of obstruction or gangrene	259	10 - 35%	239,156	53,810	$6,359	$260	$1,559	$8,178	$440
Gastrostomy complications - Mechanical	115	10 - 35%	34,751	7,819	$45,955	$9,265	$-	$55,219	$432
Accidental puncture or laceration during a procedure, NEC	43	> 90%	66,714	63,378	$6,360	$-	$367	$6,728	$426
Infection and inflammatory reaction due to internal prosthetic device, implant, and graft	135	< 10%	135,423	6,771	$58,746	$2,862	$657	$62,265	$422
Disruption of operation wound	99	10 - 35%	109,806	24,706	$14,827	$714	$1,467	$17,008	$420
Hematoma complicating a procedure	119	35 - 65%	101,259	50,630	$6,594	$-	$917	$7,511	$380
Catheter - associated urinary tract infection (Medicare Never Event)	63	> 90%	13,515	12,839	$24,901	$1,892	$-	$26,793	$344
Complications of transplanted organ	87	< 10%	102,935	5,147	$55,654	$10,510	$494	$66,658	$343

Table 38: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)

Error Type	Appendix page number	% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
Gastrostomy complications - Infection	111	> 90%	4,708	4,473	$60,273	$6,492	$-	$66,765	$299
Infection of amputation stump	151	> 90%	6,310	5,994	$40,609	$5,338	$-	$45,947	$275
Complication of prosthetic joint	75	10 - 35%	100,060	22,513	$8,115	$-	$2,293	$10,407	$234
Iatrogenic cerebrovascular infarction or hemorrhage	131	> 90%	5,209	4,949	$29,739	$10,942	$-	$40,681	$201
Mechanical complication of cardiac device, implant, and graft	163	10 - 35%	137,659	30,973	$5,946	$-	$-	$5,946	$184
Complications affecting specified body systems, not elsewhere classified	79	< 10%	217,695	10,885	$13,645	$1,686	$1,085	$16,416	$179
Hypotension - Iatrogenic	127	35 - 65%	37,027	18,514	$8,023	$-	$-	$8,023	$149
Infusion or transfusion reaction	155	10 - 35%	11,922	2,682	$41,082	$10,603	$-	$51,686	$139
Surgical complication of the respiratory system	243	10 - 35%	30,704	6,908	$17,002	$2,020	$-	$19,022	$131
Non-healing surgical wound	179	< 10%	114,309	5,715	$16,253	$2,114	$1,789	$20,156	$115
Colostomy and enterostomy complications - Infection	71	> 90%	2,208	2,098	$47,506	$-	$-	$47,506	$100
Mechanical complication of genitourinary device, implant, and graft	171	10 - 35%	65,693	14,781	$4,490	$850	$1,044	$6,384	$94
Mechanical complication of other specified prosthetic device, implant, and graft	175	< 10%	167,003	8,350	$10,330	$683	$242	$11,256	$94

Table 38: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)

Error Type	Appendix page number	% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
Object left in body (Medicare Never Event)	183	> 90%	12,305	11,690	$8,031	$-	$-	$8,031	$94
Poisoning	211	< 10%	499,471	24,974	$3,265	$-	$382	$3,647	$91
Blood-Type Incompatibility (Medicare Never Event)	55	> 90%	6,685	6,350	$5,911	$5,827	$-	$11,738	$75
Seroma complicating a procedure	235	10 - 35%	66,557	14,975	$4,883	$-	$-	$4,883	$73
Disorders of the pituitary gland and its hypothalamic control	95	65-90%	9,949	7,710	$5,764	$3,496	$-	$9,260	$71
Postoperative Shock	227	10 - 35%	3,323	748	$47,099	$46,584	$-	$93,682	$70
Colostomy and enterostomy complications	67	< 10%	33,272	1,664	$31,921	$3,646	$716	$36,283	$60
Gastrostomy complications	107	< 10%	21,988	1,099	$38,018	$11,096	$-	$49,115	$54
Tracheostomy complications	247	< 10%	18,690	935	$51,384	$3,200	$1,895	$56,479	$53
Other complications or adverse effects not elsewhere classified	199	< 10%	108,639	5,432	$7,530	$651	$932	$9,113	$50
Infection following other infusion, injection, transfusion, or vaccination	147	> 90%	3,736	3,549	$13,289	$-	$-	$13,289	$47
Postgastric surgery syndrome	215	10 - 35%	20,110	4,525	$8,357	$-	$281	$8,638	$39
Unspecified adverse effect of drug medicinal and biological substance not elsewhere classified	255	< 10%	778,675	38,934	$810	$-	$50	$860	$33
Dermatitis due to substances taken internally	91	< 10%	174,714	8,736	$2,682	$-	$172	$2,854	$25

Table 38: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)

Error Type	Appendix page number	% of injuries that are errors	Count of Injuries (2008)	Count of Errors (2008)	Medical Cost per Error	In Hospital Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
Tracheostomy complications - Infection	251	10 - 35%	2,365	532	$37,091	$4,771	$-	$41,861	$22
Substances causing adverse effects in therapeutic use	239	< 10%	76,485	3,824	$4,708	$987	$-	$5,695	$22
Amputation stump complication	51	< 10%	11,250	563	$27,042	$-	$3,419	$30,460	$17
Other and unspecified disorders of the nervous system	187	< 10%	61,168	3,058	$4,837	$-	$566	$5,402	$17
Cataract fragments in eye following cataract surgery	59	> 90%	10,590	10,061	$1,498	$-	$-	$1,498	$15
Persistent postoperative fistula, NEC	203	< 10%	8,751	438	$30,929	$-	$2,628	$33,558	$15
Late effects of other and unspecified external causes	159	< 10%	21,439	1,072	$10,231	$2,212	$639	$13,081	$14
Complications of medical care, not elsewhere classified	83	< 10%	95,489	4,774	$2,817	$-	$-	$2,817	$13
Air Embolism (Medicare Never Event)	47	> 90%	335	318	$26,100	$12,358	$-	$38,458	$12
Emphysema (subcutaneous) (surgical) resulting from procedure	103	10 - 35%	4,861	1,094	$9,537	$-	$-	$9,537	$10
Other and unspecified noninfectious gastroenteritis and colitis	191	< 10%	25,487	1,274	$5,741	$2,072	$-	$7,813	$10

Detailed results by medical injury type

Detailed results for all errors with costs over $10 million are presented in Appendix B. These results include details of frequency calculation and an overall cost summary of the error on page one. Pages two through four include details of the medical, inpatient mortality, and short-term disability cost calculations, similar to what we have presented for postoperative infection in Tables 26 through 37.

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APPENDIX A: PERCENT OCCURRENCES BY ERROR

Appendix A: Percent of Occurrences with Error (This Table Spans Multiple Pages)	
Error Type	**Percent of Occurrences With Error**
Abnormal reaction due to other procedures without mentioning of misadventure	< 10
Abnormal reaction due to other procedures without mentioning of misadventure	< 10
Abnormal reaction due to surgery without mentioning of misadventure	< 10
Accidental cut, puncture, perforation, or hemorrhage	> 90
Accidental puncture or laceration during a procedure, NEC	> 90
Acute reaction to foreign substance accidentally left in during procedure	> 90
Air Embolism (Medicare Never Event)	> 90
Amputation stump complication	< 10
Blind loop syndrome	< 10
Blood-Type Incompatibility (Medicare Never Event)	> 90
Cataract fragments in eye following cataract surgery	> 90
Catheter - associated urinary tract infection (Medicare Never Event)	> 90
Colostomy and enterostomy complications	< 10
Colostomy and enterostomy complications - Infection	> 90
Complication of prosthetic joint	10 - 35
Complications affecting other specified body systems, not elsewhere classified	< 10
Complications affecting specified body systems, not elsewhere classified	< 10
Complications of labor and delivery	< 10
Complications of medical care, not elsewhere classified	< 10
Complications of reattached extremity or body part	< 10
Complications of the administration of anesthetic or other sedation in labor and delivery	< 10
Complications of the Puerperium (670-677)	< 10
Complications of transplanted organ	< 10
Complications peculiar to certain specified procedures	< 10
Contact dermatitis and other eczema	< 10
Contaminated transfusion, injection, drug	> 90
Dermatitis due to substances taken internally	< 10

Appendix A: Percent of Occurrences with Error (This Table Spans Multiple Pages)	
Error Type	**Percent of Occurrences With Error**
Disorders of the pituitary gland and its hypothalamic control	65 - 90
Disruption of operation wound	10 - 35
Dosage failure in shock therapy	> 90
Emphysema (subcutaneous) (surgical) resulting from procedure	10 - 35
Encephalitis, myelitis, and encephalomyelitis	< 10
Failure in suture and ligature during surgical operation	> 90
Failure of sterile precautions during procedure	> 90
Failure to introduce or remove other tube or instrument	> 90
Gastrostomy complications	< 10
Gastrostomy complications - Infection	> 90
Gastrostomy complications - Mechanical	10 - 35
Generalized vaccinia as a complication of medical care	10 - 35
Hematoma complicating a procedure	35 - 65
Hemorrhage complicating a procedure	35 - 65
Hypotension – Iatrogenic	35 - 65
Iatrogenic cerebrovascular infarction or hemorrhage	> 90
Inappropriate temperature in local application and packing	> 90
Incorrect amount or dilution of fluid during transfusion or infusion	> 90
Infection and inflammatory reaction due to internal prosthetic device, implant, and graft	< 10
Infection due to central venous catheter	> 90
Infection following infusion, injection, transfusion, vaccination	> 90
Infection following other infusion, injection, transfusion, or vaccination	> 90
Infection of amputation stump	> 90
Infusion or transfusion reaction	10 - 35
Late effects of other and unspecified external causes	< 10
Malignant Hyperthermia	< 10
Mechanical complication of cardiac device, implant, and graft	10 - 35
Mechanical complication of device, implant, or graft	10 - 35
Mechanical complication of genitourinary device, implant, and graft	10 - 35

Appendix A: Percent of Occurrences with Error (This Table Spans Multiple Pages)	
Error Type	**Percent of Occurrences With Error**
Mechanical complication of other specified prosthetic device, implant, and graft	< 10
Mechanical failure of instrument or apparatus	> 90
Neuroma of amputation stump	10 - 35
Nonadministration of necessary drug or medicinal substance	> 90
Non-healing surgical wound	< 10
Noninfectious disorders of lymphatic channels	< 10
Noxious influences affecting fetus or newborn via placenta or breast milk	10 - 35
Noxious influences affecting fetus or newborn via placenta or breast milk – antiinfectives	< 10
Object left in body (Medicare Never Event)	> 90
Other and unspecified disorders of the nervous system	< 10
Other and unspecified extrapyramidal diseases and abnormal movement disorders	< 10
Other and unspecified noninfectious gastroenteritis and colitis	< 10
Other complications of internal (biological) (synthetic) prosthetic device, implant, and graft	< 10
Other complications or adverse effects not elsewhere classified	< 10
Other failure in dosage	> 90
Other specified types of cystitis	< 10
Overdose or inadvertent exposure to radiation	> 90
Persistent postoperative fistula, NEC	< 10
Pneumothorax	35 - 65
Poisoning	< 10
Poisoning - Anesthetics	10 - 35
Postcholecystectomy syndrome	10 - 35
Postgastric surgery syndrome	10 - 35
Postlaminectomy syndrome	10 - 35
Postoperative infection	> 90
Postoperative Shock	10 - 35
Pressure Ulcer (Medicare Never Event)	> 90
Radiation Kyphosis or scoliosis	< 10
Respiratory conditions due to other and unspecified external	< 10

Appendix A: Percent of Occurrences with Error (This Table Spans Multiple Pages)	
Error Type	**Percent of Occurrences With Error**
agents	
Seroma complicating a procedure	10 - 35
Serum reaction	10 - 35
Shock due to anesthesia	10 - 35
Substances causing adverse effects in therapeutic use	< 10
Surgery on the wrong limb / person (Medicare Never Event)	> 90
Surgical complication of the respiratory system	10 - 35
Thyroiditis	10 - 35
Tracheostomy complications	< 10
Tracheostomy complications - Infection	10 - 35
Unspecified adverse effect of drug medicinal and biological substance not elsewhere classified	< 10
Urethral stricture	10 - 35
Ventilator associated pneumonia	> 90
Ventral hernia without mention of obstruction or gangrene	10 - 35
Wrong fluid in transfusion	> 90

APPENDIX B: DETAILED RESULTS FOR EACH ERROR TYPE (SEPARATE DOCUMENT)

APPENDIX C: HIGH-LEVEL RESULTS FOR ERRORS THAT RESULT IN ANNUAL COSTS LESS THAN TEN MILLION DOLLARS

Appendix C: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)

Error Type	Estimated Number of Injuries (2008)	Estimated Number of Errors (2008)	Medical Cost per Error	IP Mortality Cost per Error	STD Cost per Error	Total Cost per Error	Total Cost of Error (millions)
Complications of the Puerperium (670-677)	38,722	1,936	$2,479	$-	$-	$3,826	$7
Postcholecystectomy syndrome	8,465	1,905	$3,718	$-	$-	$3,718	$7
Serum reaction	29,977	6,745	$923	$-	$-	$923	$6
Respiratory conditions due to other and unspecified external agents	8,506	425	$3,424	$10,604	$-	$14,028	$6
Blind loop syndrome	3,466	173	$21,837	$7,779	$-	$29,616	$5
Acute reaction to foreign substance accidentally left in during procedure	272	259	$13,589	$4,651	$-	$18,240	$5
Abnormal reaction due to surgery without mentioning of misadventure	2,896	145	$21,457	$1,652	$1,588	$24,697	$4
Noninfectious disorders of lymphatic channels	39,457	1,973	$897	$368	$-	$1,265	$2
Other and unspecified extrapyramidal diseases and abnormal movement disorders	1,276	64	$24,605	$13,190	$-	$37,795	$2
Complications peculiar to certain specified procedures	8,811	441	$4,922	$-	$-	$4,922	$2
Shock due to anesthesia	1,198	269	$-	$7,836	$-	$7,836	$2
Neuroma of amputation stump	1,983	446	$4,486	$-	$-	$4,486	$2
Generalized vaccinia as a complication of medical care	22,173	4,989	$371	$-	$-	$371	$2
Complications of reattached extremity or body part	1,885	94	$15,341	$-	$-	$15,341	$1
Abnormal reaction due to other procedures without mentioning of misadventure	2,781	139	$7,334	$-	$-	$7,334	$1
Other specified types of cystitis	11,118	556	$1,430	$-	$-	$1,430	$1
Poisoning - Anesthetics	1,991	448	$1,689	$-	$-	$1,689	$1
Malignant Hyperthermia	650	32	$5,383	$8,353	$-	$13,736	$0
Complications of the administration of anesthetic or other sedation in labor and delivery	6,742	337	$1,200	$-	$-	$1,200	$0

Appendix C: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)							
Error Type	**Estimated Number of Injuries (2008)**	**Estimated Number of Errors (2008)**	**Medical Cost per Error**	**IP Mortality Cost per Error**	**STD Cost per Error**	**Total Cost per Error**	**Total Cost of Error (millions)**
Complications of labor and delivery	2,065	103	$3,185	$-		$3,185	$0
Encephalitis, myelitis, and encephalomyelitis	377	19	$5,213	$-		$5,213	$0
Contact dermatitis and other eczema	100,649	5,032	$-		$-	$-	$-
Urethral stricture	12,909	2,905	$-		$-	$-	$-
Complications affecting other specified body systems, not elsewhere classified	30,240	1,512	$-		$-	$-	$-
Noxious influences affecting fetus or newborn via placenta or breast milk	2,893	651	$-		$-	$-	$-
Thyroiditis	1,213	273	$-		$-	$-	$-
Failure of sterile precautions during procedure	284	269	$-		data not available	$-	$-
Contaminated transfusion, injection, drug	243	231	$-		$-	$-	$-
Accidental cut, puncture, perforation, or hemorrhage	165	157	$-		$-	$-	$-
Inappropriate temperature in local application and packing	43	41	$-	$-	data not available	$-	$-
Nonadministration of necessary drug or medicinal substance	33	32	$-	$-	data not available	$-	$-
Ventilator associated pneumonia	31	30	$-	$-	data not available	$-	$-
Radiation Kyphosis or scoliosis	548	27	$-	$-	$-	$-	$-
Failure in suture and ligature during surgical operation	22	20	$-	$-	data not available	$-	$-
Mechanical failure of instrument or apparatus	22	20	$-	$-	data not available	$-	$-
Dosage failure in shock therapy	19	18	$-	$-	data not available	$-	$-
Noxious influences affecting fetus or newborn via placenta or breast milk - antiinfectives	57	3	$-	$-	data not available	$-	$-
Failure to introduce or remove other tube or instrument	0	0	$-	$-		$-	$-
Incorrect amount or dilution of fluid during transfusion or infusion	0	0	$-	$-		$-	$-
Other failure in dosage	0	0	$-	$-		$-	$-

Appendix C: Frequency and Measurable Cost of Medical Errors (This Table Spans Multiple Pages)							
Error Type	**Estimated Number of Injuries (2008)**	**Estimated Number of Errors (2008)**	**Medical Cost per Error**	**IP Mortality Cost per Error**	**STD Cost per Error**	**Total Cost per Error**	**Total Cost of Error (millions)**
Overdose or inadvertent exposure to radiation	0	0	$-	$-	$-	$-	$-
Surgery on the wrong limb / person (Medicare Never Event)	0	0	$-	$-	$-	$-	$-
Wrong fluid in transfusion	0	0	$-	$-	$-	$-	$-

APPENDIX D: ICD-9 CODES INCLUDED IN THE ANALYSIS

Appendix D: ICD-9 Codes for Injuries Associated with an Error (This Table Spans Multiple Pages)	
Injury Type	**ICD-9 Code List**
Abnormal reaction due to other procedures without mentioning of misadventure	E879.0, E879.1, E879.2, E879.3, E879.4, E879.5, E879.6, E879.7, E879.8, E879.9
Abnormal reaction due to surgery without mentioning of misadventure	E878.0, E878.1, E878.2, E878.3, E878.4, E878.5, E878.6, E878.8, E878.9
Accidental cut, puncture, perforation, or hemorrhage	E870.1, E870.3, E870.4, E870.5, E870.6, E870.8, E870.9
Accidental puncture or laceration during a procedure, NEC	998.2
Acute reaction to foreign substance accidentally left in during procedure	998.7
Air Embolism (Medicare Never Event)	999.1
Amputation stump complication	997.60, 997.69
Blind loop syndrome	579.2
Blood-Type Incompatibility (Medicare Never Event)	999.6, 999.7, E876.0
Cataract fragments in eye following cataract surgery	998.82
Catheter - associated urinary tract infection (Medicare Never Event)	996.64
Colostomy and enterostomy complications	569.60, 569.69
Colostomy and enterostomy complications – Infection	569.61
Complication of prosthetic joint	996.41, 996.42, 996.43, 996.44, 996.47
Complications affecting other specified body systems, not elsewhere classified	997.91
Complications affecting specified body systems, not elsewhere classified	997.00, 997.01, 997.09, 997.1, 997.2, 997.39, 997.4, 997.5, 997.99
Complications of labor and delivery	669.40, 669.41, 669.42, 669.43, 669.44
Complications of medical care, not elsewhere classified	999.2, 999.9
Complications of reattached extremity or body part	996.90, 996.91, 996.92, 996.93, 996.94, 996.95, 996.96, 996.99
Complications of the administration of anesthetic or other sedation in labor and delivery	668.00, 668.01, 668.02, 668.03, 668.04, 668.10, 668.11, 668.12, 668.13, 668.14, 668.20, 668.21, 668.22, 668.23, 668.24, 668.80, 668.81, 668.82, 668.83, 668.84, 668.90, 668.91, 668.92, 668.93, 668.94
Complications of the Puerperium (670-677)	674.10, 674.12, 674.14, 674.20, 674.22, 674.24, 674.30, 674.32, 674.34
Complications of transplanted organ	996.80, 996.81, 996.82, 996.83, 996.84, 996.85, 996.86, 996.87, 996.89
Complications peculiar to certain specified procedures	996.45, 996.46
Contact dermatitis and other eczema	692.3

Appendix D: ICD-9 Codes for Injuries Associated with an Error (This Table Spans Multiple Pages)	
Injury Type	**ICD-9 Code List**
Contaminated transfusion, injection, drug	E875.0, E875.1, E875.2, E875.8, E875.9
Dermatitis due to substances taken internally	693.0
Disorders of the pituitary gland and its hypothalamic control	253.7
Disruption of operation wound	998.3, 998.30, 998.31, 998.32
Dosage failure in shock therapy	E873.4
Emphysema (subcutaneous) (surgical) resulting from procedure	998.81
Encephalitis, myelitis, and encephalomyelitis	323.5, 323.51, 323.52
Failure in suture and ligature during surgical operation	E876.2
Failure of sterile precautions during procedure	E872.0, E872.1, E872.3, E872.4, E872.6, E872.8, E872.9
Failure to introduce or remove other tube or instrument	E876.4
Gastrostomy complications	536.40, 536.49
Gastrostomy complications - Infection	536.41
Gastrostomy complications - Mechanical	536.42
Generalized vaccinia as a complication of medical care	999.0
Hematoma complicating a procedure	998.12
Hemorrhage complicating a procedure	998.11
Hypotension - Iatrogenic	458.2, 458.21, 458.29
Iatrogenic cerebrovascular infarction or hemorrhage	997.02
Inappropriate temperature in local application and packing	E873.5
Incorrect amount or dilution of fluid during transfusion or infusion	E873.0
Infection and inflammatory reaction due to internal prosthetic device, implant, and graft	996.60, 996.61, 996.62, 996.63, 996.65, 996.66, 996.67, 996.68, 996.69
Infection due to central venous catheter	999.31
Infection following infusion, injection, transfusion, vaccination	999.3
Infection following other infusion, injection, transfusion, or vaccination	999.39
Infection of amputation stump	997.62
Infusion or transfusion reaction	999.8, 999.89
Late effects of other and unspecified external causes	909.0, 909.2, 909.3, 909.5
Malignant Hyperthermia	995.86
Mechanical complication of cardiac device, implant, and graft	996.00, 996.01, 996.02, 996.03, 996.04, 996.09
Mechanical complication of device, implant, or graft	996.1, 996.2, 996.4, 996.40, 996.49

Appendix D: ICD-9 Codes for Injuries Associated with an Error (This Table Spans Multiple Pages)	
Injury Type	**ICD-9 Code List**
Mechanical complication of genitourinary device, implant, and graft	996.30, 996.31, 996.32, 996.39
Mechanical complication of other specified prosthetic device, implant, and graft	996.51, 996.52, 996.53, 996.54, 996.55, 996.56, 996.57, 996.59
Mechanical failure of instrument or apparatus	E874.0, E874.1, E874.4, E874.5, E874.8, E874.9
Neuroma of amputation stump	997.61
Nonadministration of necessary drug or medicinal substance	E873.6
Non-healing surgical wound	998.83
Noninfectious disorders of lymphatic channels	457.0
Noxious influences affecting fetus or newborn via placenta or breast milk	760.72, 760.76
Noxious influences affecting fetus or newborn via placenta or breast milk - antiinfectives	760.74
Object left in body (Medicare Never Event)	998.4, E871.0, E871.1, E871.2, E871.3, E871.5, E871.6, E871.7, E871.8, E871.9
Other and unspecified disorders of the nervous system	349.0, 349.1
Other and unspecified extrapyramidal diseases and abnormal movement disorders	333.92
Other and unspecified noninfectious gastroenteritis and colitis	558.1
Other complications of internal (biological) (synthetic) prosthetic device, implant, and graft	996.70, 996.71, 996.72, 996.73, 996.74, 996.75, 996.76, 996.77, 996.78, 996.79
Other complications or adverse effects not elsewhere classified	995.89, 998.89, 998.9
Other failure in dosage	E873.8, E873.9
Other specified types of cystitis	595.82
Overdose or inadvertent exposure to radiation	E873.2, E873.3
Persistent postoperative fistula, NEC	998.6
Pneumothorax	512.1
Poisoning	960.0, 960.1, 960.2, 960.3, 960.4, 960.5, 960.6, 960.7, 960.8, 960.9, 961.0, 961.1, 961.2, 961.3, 961.4, 961.5, 961.6, 961.7, 961.8, 961.9, 962.0, 962.1, 962.2, 962.3, 962.4, 962.5, 962.6, 962.7, 962.8, 962.9, 963.0, 963.1, 963.2, 963.3, 963.4, 963.5, 963.8, 963.9, 964.0, 964.1, 964.2, 964.3, 964.4, 964.5, 964.6, 964.7, 964.8, 964.9, 965.00, 965.02, 965.09, 965.1, 965.4, 965.5, 965.61, 965.69, 965.7, 965.8, 965.9, 966.0, 966.1, 966.2, 966.3, 966.4, 967.0, 967.1, 967.2, 967.3, 967.4, 967.5, 967.6, 967.8, 967.9, 968.0, 968.1, 969.0, 969.1, 969.2, 969.3, 969.4, 969.5, 969.7, 969.8, 969.9, 970.0, 970.1, 970.8, 970.9, 971.0, 971.1, 971.2,

Appendix D: ICD-9 Codes for Injuries Associated with an Error (This Table Spans Multiple Pages)	
Injury Type	**ICD-9 Code List**
	971.3, 971.9, 972.0, 972.1, 972.2, 972.3, 972.4, 972.5, 972.6, 972.7, 972.8, 972.9, 973.0, 973.1, 973.2, 973.3, 973.4, 973.5, 973.6, 973.8, 973.9, 974.0, 974.1, 974.2, 974.3, 974.4, 974.5, 974.6, 974.7, 975.0, 975.1, 975.2, 975.3, 975.4, 975.5, 975.6, 975.7, 975.8, 976.0, 976.1, 976.2, 976.3, 976.4, 976.5, 976.6, 976.7, 976.8, 976.9, 977.0, 977.1, 977.2, 977.3, 977.4, 977.8, 977.9, 978.0, 978.1, 978.2, 978.3, 978.4, 978.5, 978.6, 978.8, 978.9, 979.0, 979.1, 979.2, 979.3, 979.4, 979.5, 979.6, 979.7, 979.9, E850.1, E850.2, E850.3, E850.4, E850.6, E850.7, E850.8, E850.9, E851., E852.2, E852.4, E852.8, E852.9, E853.0, E853.1, E853.2, E853.8, E853.9, E854.0, E854.2, E854.3, E854.8, E855.0, E855.1, E855.2, E855.3, E855.4, E855.5, E855.6, E855.8, E855.9, E856., E857., E858.0, E858.1, E858.2, E858.3, E858.4, E858.5, E858.6, E858.7, E858.8, E858.9, E950.0, E950.1, E950.2, E950.3, E950.4, E950.5, E962.0, E980.0, E980.1, E980.2, E980.3, E980.4, E980.5
Poisoning - Anesthetics	968.2, 968.3, 968.4, 968.5, 968.6, 968.7, 968.9
Postcholecystectomy syndrome	576.0
Postgastric surgery syndrome	564.2
Postlaminectomy syndrome	722.80, 722.81, 722.82, 722.83
Postoperative infection	998.51, 998.59
Postoperative Shock	998.0
Pressure Ulcer (Medicare Never Event)	707.0, 707.00, 707.01, 707.02, 707.03, 707.04, 707.05, 707.06, 707.07, 707.09, 707.20, 707.22, 707.23, 707.24
Radiation Kyphosis or scoliosis	737.11, 737.33
Respiratory conditions due to other and unspecified external agents	508.0, 508.1
Seroma complicating a procedure	998.13
Serum reaction	999.4, 999.5
Shock due to anesthesia	995.4
Substances causing adverse effects in therapeutic use	357.6, E930.0, E930.1, E930.2, E930.3, E930.4, E930.5, E930.6, E930.7, E930.8, E930.9, E931.0, E931.1, E931.2, E931.3, E931.4, E931.5, E931.6, E931.7, E931.8, E931.9, E932.0, E932.1, E932.2, E932.3, E932.4, E932.5, E932.6, E932.7, E932.8, E932.9, E933.0, E933.1, E933.2, E933.3, E933.4, E933.5, E933.6, E933.7, E933.8, E933.9, E934.0, E934.1, E934.2, E934.3, E934.4, E934.5, E934.6, E934.7, E934.8, E934.9, E935.1, E935.2, E935.3,

Appendix D: ICD-9 Codes for Injuries Associated with an Error (This Table Spans Multiple Pages)	
Injury Type	**ICD-9 Code List**
	E935.4, E935.5, E935.6, E935.7, E935.8, E935.9, E936.0, E936.1, E936.2, E936.3, E936.4, E937.0, E937.1, E937.2, E937.4, E937.6, E937.8, E937.9, E938.0, E938.1, E938.2, E938.3, E938.4, E938.5, E938.6, E938.7, E938.9, E939.0, E939.1, E939.2, E939.3, E939.4, E939.5, E939.7, E939.8, E939.9, E940.1, E940.8, E940.9, E941.0, E941.1, E941.2, E941.3, E941.9, E942.0, E942.1, E942.2, E942.3, E942.4, E942.5, E942.6, E942.7, E942.8, E942.9, E943.0, E943.1, E943.2, E943.3, E943.4, E943.5, E943.6, E943.8, E943.9, E944.0, E944.1, E944.2, E944.3, E944.4, E944.5, E944.6, E944.7, E945.0, E945.1, E945.2, E945.3, E945.4, E945.5, E945.6, E945.7, E945.8, E946.0, E946.1, E946.2, E946.3, E946.4, E946.5, E946.6, E946.7, E946.8, E946.9, E947.0, E947.1, E947.2, E947.3, E947.4, E947.8, E947.9, E948.0, E948.1, E948.3, E948.4, E948.5, E948.6, E948.8, E948.9, E949.0, E949.1, E949.3, E949.4, E949.5, E949.6, E949.7, E949.9
Surgery on the wrong limb / person (Medicare Never Event)	E876.5
Surgical complication of the respiratory system	997.3
Thyroiditis	245.4
Tracheostomy complications	519.00, 519.02, 519.09
Tracheostomy complications - Infection	519.01
Unspecified adverse effect of drug medicinal and biological substance not elsewhere classified	995.2, 995.20, 995.21, 995.22, 995.23, 995.27, 995.29
Urethral stricture	598.2
Ventilator associated pneumonia	997.31
Ventral hernia without mention of obstruction or gangrene	553.21
Wrong fluid in transfusion	E876.1

APPENDIX E: CONDITIONS USED IN MATCHING

Appendix E: Chronic Conditions Used in Matching (This Table Spans Multiple Pages)

Condition	Rank	ICD-9 Codes
Cancer – Metastatic	1	196.0, 196, 196.1, 196.2, 196.3, 196.5, 196.6, 196.8, 196.9, 197.0, 197, 197.1, 197.2, 197.3, 197.4, 197.5, 197.6, 197.7, 197.8, 198.0, 198, 198.1, 198.2, 198.3, 198.4, 198.5, 198.6, 198.7, 198.8, 198.81, 198.82, 198.89, 199.0, 199, 199.1, 199.2
Cancer - Lung, Bronchi, Pleura	2	162.0, 162, 162.2, 162.3, 162.4, 162.5, 162.8, 162.9, 163.0, 163, 163.1, 163.8, 163.9, 165.0, 165, 165.8, 165.9, 231.0, 231, 231.1, 231.2, 231.8, 231.9, V10.11, V10.12, V10.20
Cancer - Non Hodgkin's Lymphoma	3	200, 200.00, 200.0, 200.01, 200.02, 200.03, 200.04, 200.05, 200.06, 200.07, 200.08, 200.1, 200.10, 200.11, 200.12, 200.13, 200.14, 200.15, 200.16, 200.17, 200.18, 200.20, 200.2, 200.21, 200.22, 200.23, 200.24, 200.25, 200.26, 200.27, 200.28, 200.30, 200.31, 200.32, 200.33, 200.34, 200.35, 200.36, 200.37, 200.38, 200.40, 200.41, 200.42, 200.43, 200.44, 200.45, 200.46, 200.47, 200.48, 200.50, 200.51, 200.52, 200.53, 200.54, 200.55, 200.56, 200.57, 200.58, 200.60, 200.61, 200.62, 200.63, 200.64, 200.65, 200.66, 200.67, 200.68, 200.70, 200.71, 200.72, 200.73, 200.74, 200.75, 200.76, 200.77, 200.78, 200.80, 200.8, 200.81, 200.82, 200.83, 200.84, 200.85, 200.86, 200.87, 200.88, 202.00, 202.0, 202, 202.01, 202.02, 202.03, 202.04, 202.05, 202.06, 202.07, 202.08, 202.1, 202.10, 202.11, 202.12, 202.13, 202.14, 202.15, 202.16, 202.17, 202.18, 202.2, 202.20, 202.21, 202.22, 202.23, 202.24, 202.25, 202.26, 202.27, 202.28, 202.3, 202.30, 202.31, 202.32, 202.33, 202.34, 202.35, 202.36, 202.37, 202.38, 202.70, 202.71, 202.72, 202.73, 202.74, 202.75, 202.76, 202.77, 202.78, 202.80, 202.8, 202.81, 202.82, 202.83, 202.84, 202.85, 202.86, 202.87, 202.88, 202.9, 202.90, 202.91, 202.92, 202.93, 202.94, 202.95, 202.96, 202.97, 202.98, V10.71
Cancer - Colon / Rectum	4	153.0, 153, 153.1, 153.2, 153.3, 153.4, 153.5, 153.6, 153.7, 153.8, 153.9, 154.0, 154, 154.1, 154.2, 154.3, 154.8, 230, 230.3, 230.4, 230.5, 230.6, 230.9, V10.05, V10.06
Renal Failure	5	585, 585.1, 585.2, 585.3, 585.4, 585.5, 585.6, 585.9, 669.34, 792.5, V56, V56.0, V56.1, V56.2, V56.31, V56.32, V56.8
Cancer – Breast	6	174.0, 174, 174.1, 174.2, 174.3, 174.4, 174.5, 174.6, 174.8, 174.9, 175.0, 175, 175.9, 233.0, 233, V10, V10.3
Congestive Heart Failure	7	402.01, 402.11, 402.91, 428.0, 428, 428.1, 428.2, 428.20, 428.21, 428.22, 428.23, 428.30, 428.3, 428.31, 428.32, 428.33, 428.4, 428.40, 428.41, 428.42, 428.43, 428.9
Cancer - Prostate Gland	8	185, 233.4, V10.46
Stroke, Cerebral	9	430, 431, 432.0, 432, 432.9, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434, 434.01, 434.1, 434.11, 434.91, 436, 438.0, 438.1, 438.10, 438.12, 438.19
Coronary Artery Disease	10	410, 410.0, 410.00, 410.01, 410.02, 410.1, 410.10, 410.11, 410.12, 410.2, 410.20, 410.21, 410.22, 410.3, 410.30,

Appendix E: Chronic Conditions Used in Matching (This Table Spans Multiple Pages)		
Condition	**Rank**	**ICD-9 Codes**
		410.31, 410.32, 410.4, 410.40, 410.41, 410.42, 410.5, 410.50, 410.51, 410.52, 410.6, 410.60, 410.61, 410.62, 410.7, 410.70, 410.71, 410.72, 410.8, 410.80, 410.81, 410.82, 410.9, 410.90, 410.91, 410.92, 411, 411.0, 411.1, 411.8, 411.81, 411.89, 412, 413.0, 413, 413.1, 413.9, 414.00, 414.0, 414, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.10, 414.1, 414.11, 414.12, 414.19, 414.2, 414.3, 414.8, 414.9, 429.7, 429.79
Anemia	11	280.0, 280, 280.1, 280.8, 280.9, 281, 281.0, 281.1, 281.2, 281.3, 281.4, 281.8, 281.9, 282, 282.0, 282.1, 282.3, 282.4, 282.41, 282.42, 282.49, 282.5, 282.60, 282.61, 282.62, 282.63, 282.64, 282.68, 282.69, 282.7, 282.8, 282.9, 283, 283.0, 283.10, 283.1, 283.11, 283.19, 283.9, 284, 284.0, 284.01, 284.09, 284.1, 284.2, 284.8, 284.81, 284.89, 284.9, 285, 285.0, 285.1, 285.2, 285.21, 285.22, 285.29, 285.8, 285.9, 648.20, 648.2, 648.21, 648.22, 648.23, 648.24
Tumor, Uncertain Behavior	12	235, 235.0, 235.1, 235.2, 235.3, 235.4, 235.5, 235.6, 235.7, 235.8, 235.9, 236, 236.0, 236.2, 236.3, 236.4, 236.5, 236.6, 236.9, 236.90, 236.91, 236.99, 237, 237.0, 237.1, 237.2, 237.3, 237.4, 237.5, 237.6, 237.9, 238, 238.0, 238.1, 238.3, 238.5, 238.6, 238.8, 238.9, 239.0, 239, 239.1, 239.2, 239.3, 239.4, 239.5, 239.6, 239.7, 239.8, 239.9, 523.8, 526.3, 611, 611.7, 611.72, 782.2, 786.6, 789.30, 789.3, 789.31, 789.32, 789.33, 789.34, 789.35, 789.36, 789.37, 789.39
Hepatitis	13	070.0, 070, 070.1, 070.20, 070.2, 070.21, 070.22, 070.23, 070.30, 070.3, 070.31, 070.32, 070.33, 070.4, 070.41, 070.42, 070.43, 070.44, 070.49, 070.5, 070.51, 070.52, 070.53, 070.54, 070.59, 070.6, 070.70, 070.71, 070.9, 130.5, 571.1, 571.4, 571.40, 571.41, 571.42, 571.49, 573, 573.1, 573.2, 573.3, V02.6, V02.60, V02.61, V02.62, V02.69
Chronic Obstructive Pulmonary Disease	14	491, 491.0, 491.1, 491.20, 491.2, 491.21, 491.8, 491.9, 492, 492.0, 492.8, 493.20, 493.2, 493.21, 493.22, 496
Osteoarthritis	15	715.00, 715, 715.0, 715.04, 715.09, 715.10, 715.1, 715.11, 715.12, 715.13, 715.14, 715.15, 715.16, 715.17, 715.18, 715.20, 715.2, 715.21, 715.22, 715.23, 715.24, 715.25, 715.26, 715.27, 715.28, 715.30, 715.3, 715.31, 715.32, 715.33, 715.34, 715.35, 715.36, 715.37, 715.38, 715.8, 715.80, 715.89, 715.90, 715.9, 715.91, 715.92, 715.93, 715.94, 715.95, 715.96, 715.97, 715.98
Rheumatoid Arthritis	16	714.0, 714, 714.1, 714.2, 714.30, 714.3, 714.31, 714.32, 714.33, 714.4, 714.8, 714.81, 714.89, 714.9
Diabetes Mellitus	17	249, 249.00, 249.01, 249.10, 249.11, 249.20, 249.21, 249.30, 249.31, 249.40, 249.41, 249.50, 249.51, 249.60, 249.61, 249.70, 249.71, 249.80, 249.81, 249.90, 249.91, 250, 250.0, 250.00, 250.01, 250.02, 250.03, 250.1, 250.10, 250.11, 250.12, 250.13, 250.2, 250.20, 250.21, 250.22, 250.23, 250.3, 250.30, 250.31, 250.32, 250.33, 250.4, 250.40, 250.41, 250.42, 250.43, 250.5, 250.50, 250.51, 250.52, 250.53, 250.6, 250.60, 250.61, 250.62, 250.63, 250.7, 250.70, 250.71, 250.72, 250.73, 250.8, 250.80,

Appendix E: Chronic Conditions Used in Matching (This Table Spans Multiple Pages)		
Condition	**Rank**	**ICD-9 Codes**
		250.81, 250.82, 250.83, 250.9, 250.90, 250.91, 250.92, 250.93, 251.3, 357.2, 362.0, 362, 362.01, 362.02, 362.03, 362.04, 362.05, 362.06, 362.07
Osteoporosis	18	268, 268.2, 733.0, 733.00, 733, 733.01, 733.02, 733.03, 733.09, 756.52
Cancer - Skin, Other Than Melanoma	19	173.0, 173, 173.1, 173.2, 173.3, 173.4, 173.5, 173.6, 173.7, 173.8, 173.9, 232.0, 232, 232.1, 232.2, 232.3, 232.4, 232.5, 232.6, 232.7, 232.8, 232.9, V10.83
Hypertension	20	401, 401.0, 401.1, 401.9, 402.00, 402.0, 403.00, 403.0, 403, 403.01, 403.10, 403.1, 403.11, 403.90, 403.9, 403.91, 404.00, 404, 404.0, 404.01, 404.02, 404.03, 404.10, 404.1, 404.11, 404.12, 404.13, 404.90, 404.9, 404.91, 404.92, 404.93, 405, 405.0, 405.01, 405.09, 405.1, 405.11, 405.19, 405.9, 405.91, 405.99, 642.0, 642.00, 642, 642.01, 642.02, 642.03, 642.04, 642.1, 642.10, 642.11, 642.12, 642.13, 642.14, 642.20, 642.2, 642.21, 642.22, 642.23, 642.24, 642.3, 642.30, 642.31, 642.32, 642.33, 642.34, 642.4, 642.40, 642.41, 642.42, 642.43, 642.44, 642.5, 642.50, 642.51, 642.52, 642.53, 642.54, 642.90, 642.9, 642.91, 642.92, 642.93, 642.94, 997.91
Back Sprain or Strain	21	724, 724.1, 724.2, 724.5, 846.0, 846, 846.1, 846.2, 846.3, 846.8, 846.9, 847.0, 847, 847.1, 847.2, 847.3, 847.9
Hypercholesterolemia	22	272, 272.0, 272.1, 272.2, 272.3, 272.4, 272.9
Psychosis, Neurosis, Depression, Psychotherapy	23	291, 291.0, 291.1, 291.2, 291.3, 291.4, 291.5, 291.8, 291.81, 291.82, 291.89, 291.9, 292, 292.0, 292.1, 292.11, 292.12, 292.2, 292.8, 292.81, 292.82, 292.83, 292.84, 292.85, 292.89, 292.9, 293.0, 293, 293.1, 293.8, 293.81, 293.82, 293.83, 293.84, 293.89, 293.9, 294.0, 294, 294.1, 294.10, 294.11, 294.8, 294.9, 295, 295.00, 295.0, 295.01, 295.02, 295.03, 295.04, 295.05, 295.1, 295.10, 295.11, 295.12, 295.13, 295.14, 295.15, 295.20, 295.2, 295.21, 295.22, 295.23, 295.24, 295.25, 295.30, 295.3, 295.31, 295.32, 295.33, 295.34, 295.35, 295.4, 295.40, 295.41, 295.42, 295.43, 295.44, 295.45, 295.5, 295.50, 295.51, 295.52, 295.53, 295.54, 295.55, 295.6, 295.60, 295.61, 295.62, 295.63, 295.64, 295.65, 295.70, 295.7, 295.71, 295.72, 295.73, 295.74, 295.75, 295.8, 295.80, 295.81, 295.82, 295.83, 295.84, 295.85, 295.90, 295.9, 295.91, 295.92, 295.93, 295.94, 295.95, 296, 296.00, 296.0, 296.01, 296.02, 296.03, 296.04, 296.05, 296.06, 296.1, 296.10, 296.11, 296.12, 296.13, 296.14, 296.15, 296.16, 296.20, 296.2, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.3, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.40, 296.4, 296.41, 296.42, 296.43, 296.44, 296.45, 296.46, 296.50, 296.5, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.6, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.7, 296.75, 296.76, 296.80, 296.8, 296.81, 296.82, 296.89, 296.90, 296.9, 296.99, 297.0, 297, 297.1, 297.2, 297.3, 297.8, 297.9, 298, 298.0, 298.1, 298.2, 298.3, 298.4, 298.8, 298.9, 299.10, 299.1, 299.11,

Appendix E: Chronic Conditions Used in Matching (This Table Spans Multiple Pages)		
Condition	**Rank**	**ICD-9 Codes**
		299.8, 299.80, 299.81, 299.90, 299.9, 299.91, 300.00, 300.0, 300, 300.01, 300.02, 300.09, 300.1, 300.10, 300.11, 300.13, 300.14, 300.15, 300.16, 300.19, 300.3, 300.4, 300.5, 300.6, 300.7, 300.8, 300.81, 300.82, 300.89, 300.9, 306, 306.2, 306.3, 306.4, 306.5, 306.50, 306.51, 306.52, 306.53, 306.59, 306.6, 306.7, 306.8, 306.9, 307.9, 308, 308.0, 308.1, 308.2, 308.3, 308.4, 308.9, 309, 309.0, 309.1, 309.2, 309.21, 309.22, 309.23, 309.24, 309.28, 309.29, 309.3, 309.4, 309.8, 309.81, 309.82, 309.83, 309.89, 309.9, 310.0, 310, 310.2, 310.8, 310.9, 311, 648.40, 648.4, 648.41, 648.42, 648.43, 648.44, V11, V11.0, V11.1, V11.2, V11.8, V11.9
Asthma	24	493, 493.0, 493.00, 493.01, 493.02, 493.1, 493.10, 493.11, 493.12, 493.81, 493.82, 493.90, 493.9, 493.91, 493.92