Production of Quality in the Hospital Environment

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Abstract of the Dissertation

Production of Quality in the Hospital Environment

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This dissertation examines the contribution that patient volume makes to quality outcomes for patients hospitalized for Acute Myocardial Infarction (AMI) and who received Percutaneous Coronary Intervention (PCI) as part of their treatment. Volume-outcome effect was originally documented by Harold Luft, M.D. and colleagues in the New England Journal of Medicine in 1979. Strong evidence of the effect persists today. However, the causality of this relationship has not been clearly defined. While, initially, Luft postulated that the reason for the relationship was provider learning, many researchers argue that a referral effect is also possible. Providers with high skill and positive outcomes become known for quality, thereby generating high volume through reputation.

I examine models that have been used to confirm the volume-outcome relationship for physicians. I present three studies that contribute towards separating the effects of physician learning from reputation. First, I introduce a time sensitive cross-sectional model that improves the accuracy of the expression of the timing of the cases performed as they relate to the predicted outcome. I also allow for the examination of the physician's experience in performing both emergency and non-emergent PCIs. Next I examine factors that are likely to contribute to referral bias for AMI. I add variables expressing the presence of these factors to the model, and check their influence on outcomes, as well as their influence on the volume-outcome relationship. Because I do not identify a referral bias, I go on to explore possible stock models for learning. Finally, I present a panel data model. This model controls for potential fixed effects bias that may result from the inability to correctly express existing individual physician referral bias in the original model.

The results of these studies provide strong and robust evidence of physician learning as a primary causal factor in reduced mortality outcomes for AMI patients treated with PCI. Given the current concern for the production of value in the health care industry, these results can inform policy makers of advantageous delivery structures for AMI services.

Contents

List of Tables

List of Figures

Acknowledgements

Since early in my career, I have wanted to become involved in health care research. However, I knew that the investment in education this would require would be very large. Even so, after many years of a successful career in hospital finance and operations, I decided that I would be able to make a more meaningful contribution as a researcher.

Not many people return to school to earn a Ph.D. in Economics after pursuing a 20 year career, and not many who have a family and small children embark on this path. In the beginning neither my family, nor I, fully understood the reasons for this. Now we do. I would like to thank my husband, John Ricketts for his patience and endurance during my educational efforts. He has sacrificed some financial status, as well as time and companionship for several years. I also thank my children Amelia, Oliver, and Theodore Ricketts for their willing acceptance and support of my decision to choose this path. Each of them has given up a part of a mother-child relationship to allow me to achieve personal goals. I hope that in the long run, this will lead them to dream big and pursue their own goals, knowing that their efforts can pay off.

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1 Introduction

Recently there has been an explosion of interest in quality measures of health care and provision of quality health care services. In 2001, the National Academies Press published a landmark study by the Institute of Medicine, entitled, **Crossing the Quality Chasm: A New Health System for the 21st Century**. This study documented many quality concerns with the health care system, and focused strongly on patient safety. A major theme throughout the book is the need to establish consistent processes, through the use of evidence based care, in order to maximize patient safety and quality. A strong argument is presented that the use of consistent processes eliminates waste, and, therefore, increases the value of health care.

The Institute of Medicine presentation does not support traditional regulatory cost cutting measures in health care; in fact the authors argue against them. However, the premise that consistent process performance eliminates waste is persuasive. The United States currently leads the Organization for Economic Co-operation and Development (OECD) countries on both spending per capita and spending as a percentage of gross domestic product; but not in such outcome measures as life expectancy and infant mortality. (Nations, 2006)

Technological advances have greatly improved our ability to measure consistency of the process of delivering care, and enhanced our ability to measure and communicate performance. Evidence based care is facilitated through the use of automated communications of standards. Private organizations, such as LeapFrogGroup, and government organizations, including New York State Department of Health, and Centers for Medicaid and Medicare Services (CMS) routinely communicate organizations' performances in health care delivery, based on pre-specified criteria that support the provision of evidence based care. In the past, lack of capability to communicate standards and performance in a consistent manner presented barriers to understanding and implementing performance measures. We are rapidly overcoming these technical barriers.

Thus, we enter a period of time where consumers, government and third party payers are searching for value through consistent, reliable practices that conform with evidence based medicine. Consistency in performance, resulting in improved quality of care brings to mind the "Practice Makes Perfect" argument. Originally presented by Harold Luft and colleagues, this premise was based on findings that hospitals performing a higher volume of medical procedures had lower mortality and fewer complications than those performing lower volumes of the same procedures (Luft et al., 1979). Since this original work, there has been considerable confirmation of what is commonly called the "volume-outcome effect" for both physicians and hospitals. (See (Halm et al., 2000) for a summary of relevant studies.) However, the question of causality remains open. Critics of the "Practice Makes Perfect" theory argue that a referral bias may cause the volume-outcome effect. It may be true that high volume providers are able to build up their case volume because they are quality providers. If this is true, then it may not be the volume or procedures that drives the quality performance, but the quality of the provider that is driving the volume.

If the volume-outcome effect can be attributed to provider learning (Practice Makes Perfect), it is reasonable to argue that value of health care services can be improved through consolidation of practice locations and operators for many acute care interventions. However, if the effect is due to innate quality of providers that results in the attraction of higher case volume, consolidation would not be an effective approach for maximizing value.

This paper explores the performance of physicians providing percutaneous coronary interventions (PCIs) for patients hospitalized for acute myocardial infarction (AMI). Quality of care for AMI patients has received considerable focus over time because of relatively high in-hospital mortality rates. (In 1999 Mahon et al. placed the rate at 18% in tertiary care hospitals (Mahon et al., 1999)) CMS has established and regularly publishes hospital process performance measures for AMI recognized by the hospital industry as evidence based care and accepted by the Hospital Quality Alliance Organizations (CMS, 2008).

I examine the volume-outcome relationship for patients hospitalized for AMI who receive PCI as an intervention, for physician operators, in an effort to clarify the causality of the relationship. Immediately following this introduction, I present the data used for the study. I then present three major chapters, as follows:

In Chapter 1, I study the model specification. I ask whether modification of the Luft model can yield more consistent results, and whether we can use these results to substantiate that the volume-outcome relationship is at least partially the result of physician learning, as opposed to physician reputation.

In Chapter 2, I explore referral bias further, by examining how consumers currently select their physician specialists. I then adjust the volume outcome models in order to assess whether any referral bias resulting from the physician selection process might contribute to the volume outcome effect. When I do not find a significant contribution, I discuss and propose a stock model for physician learning.

Finally, in Chapter 3, I repeat the evaluation using a panel data model. By applying and evaluating fixed and random effects models, I am able to draw conclusions as to the relative importance of physician learning and referral bias for physician operators performing PCI on AMI patients.

2 Data Overview

Patient descriptive data is generated from New York State SPARCS data from the years 2000 through 2007, and includes all patients with the primary diagnosis code 410.xx. The data is merged with abstracts from the AMA physician master files from November 2005 and February 2006. These include information on physician's training, education, practice and personal characteristic. Specialties of Family Medicine, Internal Medicine, Cardiology, Cardiovascular Surgery, and General Practice are included. The Joint Commission risk adjustment methodology for AMI patients is utilized (JCAHO). Information concerning hospital's teaching status and system affiliation is accessed from the Hospital Association of New York State's web site.

Table 1: Descriptive Data

MD Practice Chars	MD's AMI Patient Activity	AMI Patient Chars	Hospital Chars
Years Experience	Volume AMI Patients	Race	System
Foreign Med Grad	Volume PCI Patients	Patient Sex	Teaching
Primary Specialty	Mortality	Age in Years	Hospital Bed Capacity
Board Certified		Referral Sources	Hospital AMI Volume
Age		Discharge Status	Hospital PCI Volume
		Insurance Status	
		Patient Admit time	
		Patient Diagnoses	
		Patient Procedures	

Table 1 displays the primary variables utilized for the analysis. MD practice characteristics include a variety of personal and professional traits. MD's AMI Patient Activity variables provide information on the physicians' level of activity and on the outcomes for the MDs' patients. Patient diagnoses and hospital demographic data are also included.

3 Chapter 1: Understanding Operating Physician Volume Outcome Relationship

Abstract

Context: The relationship between volume and outcomes remains an important consideration in determining allocation of health care resources. If increased volume leads to improved outcomes, one can argue that increased regionalization might improve quality and reduce costs. In this chapter, I explore means of addressing flaws in commonly applied methodology in order to bring clarity to the volume outcome relationships for Acute Myocardial Infarction (AMI) patients receiving Percutaneous Coronary Interventions in New York State from 2000 to 2007.

Objective: The objective is to improve accuracy of predictions of adverse outcomes for Acute Myocardial Infarction (AMI) patients by applying improved methodology for measuring physician operator and hospital volumes, and by more accurately sorting the patient population.

Design Setting, and Participants: The study applies retrospective data analysis of the volume-outcome relationship for AMI patients receiving Percutaneous Coronary Intervention (PCI) in New York State from 2000 to 2007. The analysis modifies the traditional cross-sectional methodology and improves accuracy of predictions obtained. In the revised methodology, physician and hospital annual volumes are calculated by using total cases from the immediate prior twelve months. I also examine whether the physician's total PCI volume (for all diagnoses), as opposed to the physicians volume of PCI cases for AMI only, is a more important predictor of outcomes, and I explore whether the relationship changes when PCI is used as the primary intervention for AMI, as opposed to a secondary treatment. Finally, the conventional methodology assesses the influence of peers by using the hospital total volume variable. The modified analysis removes the operator from the hospital volume when calculating the peer effect.

Main Outcome Measure: In-hospital mortality

Results: When testing whether a physician's total annual volume of PCI procedures performed (for any diagnosis) influences AMI patients' outcomes, the conventional and modified methodologies yield similar results: increasing physician volume is related to lower mortality for patients receiving primary PCIs and for those receiving PCIs as a secondary treatment for AMI. However, the conventional model does not predict that peer volume is important; whereas in the lagged model, peer volume for primary PCIs is important. When compared to 1st quartile peer volume (low); the odds ratio of in-hospital mortality for

2nd quartile peer volume is 0.735 (95% CI, 0.55 to 0.97, p = 0.005); the odds ratio for 3rd quartile peer volume is 0.749 (95% CI, 0.60 - 0.94, p = 0.011); and the odds ratio for 4th quartile peer volume is 0.685 (95% CI, 0.54 to 0.86, p = 0.001).

When testing whether a physician's annual volume of PCI procedures for AMI patients influences primary AMI patients' outcomes, use of the conventional methodology does not document that a relationship exists. In contrast, the modified methodology predicts a strong inverse relationship between physician volume and in-hospital mortality. Odds ratio of in-hospital mortality for operators with annual volume > 30 is 0.766 (95% CI, 0.60 - 0.98, p = 0.033); odds ratio of in-hospital mortality for operators with volume from 10 to 30 is 0.806 (95% CI, 0.63 - 1.04, p = 0.095); compared to the lowest volume operators. When AMI is not primary, the operator volume is insignificant for both methodologies. The conventional methodology predicts that the cases with peer volume in the top quartile of primary AMI cases will have fewer in-hospital mortalities (OR = 0.616, CI, 0.44 - 0.86, p = 0.005), when compared to the first quartile (low volume peers). The relationship for the second and third quartiles is not significant. On the other hand, the lagged model predicts that peer volume is consistently, inversely, and significantly related to in-hospital mortality. For the top quartile odds ratio is 0.677 (95% CI, 0.50 - 0.91, p = 0.009); for the third quartile odds ratio is 0.711 (95% CI, 0.54 to 0.94, p = 0.018); and for the second quartile odds ratio is 0.781 (95% CI, 0.62 - 0.98, p = 0.036); compared to the lowest quartile.

When testing whether a physician's volume of non-AMI cases influences in-hospital mortality of AMI cases, the lagged methodology identifies an inverse relationship for primary PCI cases, (For volume > 260, odds ratio of in-hospital mortality is 0.660 (95% CI 0.48 - 0.91; p = 0.011); for volume from 75 to 260, odds ratio of in-hospital mortality is 0.720 (95% CI, 0.56 - 0.92; p = 0.010); and for volume from 12 to 74 odds ratio of in-hospital mortality is 0.684 (95% CI, 0.53 - 0.88, p = 0.004). The conventional methodology results are not as strong. (For volume > 260, odds ratio of in-hospital mortality is 0.657 (95% CI 0.455 - 0.949; p = 0.025); for volume from 75 to 260, odds ratio of in-hospital mortality is 0.724 (95% CI, 0.54 - 0.98, p = 0.037); and for volume from 12 to 74 odds ratio of in-hospital mortality 0.755 (95% CI, 0.56 - 1.01; p = 0.06). For secondary PCIs, the lagged methodology predicts an odds ratio of 0.529 (95% CI, 0.35 - 0.81, p = 0.003) for operator volume > 260; odds ratio of 0.531 (95% CI, 0.37 - 0.75, p = 0.000) for operator volume of 75 to 260; and odds ration of 0.51 (95% CI, 0.38 - 0.79, p = 0.001) for operator volume of 12 to 74; compared to operator volume of 0 to 11. Again, the conventional methodology yields less consistent results, with odds ratio of in-hospital mortality for operators with volume > 260 estimated at 0.594 (95% CI 0.37 - 0.96, p = 0.035), for volumes of 75 to 260 the odds ration is 0.666 (95% CI, 0.44 - 1.01, p = 0.053), and for volumes of 11 to 74 the odds ratio is 0.626 (95%CI, 0.41 - 0.94, p = 0.026); compared to operator volume of 0 to 10.

I tested the combinations of physician and peer volume by interacting the two variables for the independent variables, all PCI cases, regardless of diagnoses, and PCI cases performed on AMI patients. I used both the conventional and lagged models. The conventional and lagged model yielded similar results, though the conventional model performed less consistently. (Frequently variables were dropped due to collinearity that results from counting the operating physician's volume in the peer volume.) For the independent variable all PCI cases, in-hospital mortality was inversely related to the combination of high physician volume (75 or more cases), and high peer volume (by quartiles). However, when physician volume was low, (< 75 cases), the size of the facility did not make any difference, when using low physician volume and low peer volume as a comparator. When I tested the independent variable volume of AMI cases with PCI, the peer volume improved mortality performance for both high and low physician volumes.

Uninsured patients experience higher inpatient mortality (OR = 1.69, p = 0.009) when PCI is primary. Patients admitted during off hours have higher mortality (on the weekend OR = 1.306, p = 0.002; and at night(7:00PM to 7:00 AM) OR = 1.21, p = 0.019) when PCI is primary. These findings are robust, regardless of the methodology employed. However, when PCI is not the primary procedure, the only patient demographic variable that significantly increases the chance of in-hospital mortality is admission at night (OR = 1.243, p = 0.040). Female patients tend toward having higher mortality when PCI is primary(OR = 2.29, p = 0.053 for independent variable all PCIs, and OR =2.33, p = 0.049 for independent variable volume AMI cases with PCI.)

Conclusions: Improvements in precision of estimations of operator volume and specificity in defining patient categories clarify affects of physician and hospital experience on in-hospital mortality. This analysis demonstrates that a physician's total experience in performance of PCI, as well as his or her AMI case volume has impact on in-hospital mortality. In addition, for patients undergoing primary PCI for AMI, there is increased risk of mortality based on a patient's time of admission, whether the patient is uninsured, and whether the patient is female. Research regarding the reasons for these findings needs to be conducted. Finally, the combination of hospital and physician volume is strongly and inversely related to in-hospital mortality. This is particularly true when the volume of AMI cases with PCI is used as the independent variable of interest. Since peer volume is the hospital volume less the operator volume, this result may indicate that hospitals caring for a large volume of AMI cases may respond to the urgent needs of their patients more rapidly and more consistently. Based on these findings, planning emergent PCI services for AMI patients so that they are accessible to the majority of patients at high volume hospitals with high volume operators should reduce mortality rates for all patients, and particularly for patients receiving primary PCI as an intervention for AMI.

This paper explores the performance of physicians, as major contributors to outcomes for patients hospitalized for acute myocardial infarction (AMI). Quality of care for AMI patients has received considerable focus over time because of relatively high in-hospital mortality rates. (In 1999 Mahon et al. placed the rate at 18% in tertiary care hospitals (Mahon et al., 1999)) Physicians have primary responsibility for the medical care received by patients in hospitals. They oversee the provision of care, deciding what treatments will be rendered, performing any necessary surgical procedures, and conducting quality assurance and peer review. For many surgical procedures, a positive relationship between the volume of cases performed and the quality of patient outcomes has been documented. (Henry S. Luft et al. receive primary credit for this work (Luft et al., 1979).) I examine this relationship for AMI patients receiving Percutaneous Coronary Intervention (PCI) during their hospitalization. Documentation of the relationship between physician volume and outcome for this patient type has been less consistent. Over recent years rapid changes in technology have improved overall outcomes for PCI patients. These improvements may have changed the nature of the volume outcome relationship.

In the past, evaluations of analyses of the volume-outcome relationship for AMI patients have raised questions concerning the accuracy of the original specification of the model presented by Luft, et al. Summarizing the results of a review done for the National Academy of Science, Ethan A. Halm et al. note that although there is considerable evidence that a relationship exists between physician volume and outcome, the cause of the relationship is not known. One specific concern is that these studies do not differentiate whether high physician volume improves performance due to a learning effect, or whether high physician volume is due to referral preferences (a physician with a good reputation is likely to get more referrals than one with a poor reputation). In addition, few studies have used a panel approach to these analyses (Halm et al., 2000). More recently, Yang Xie et al. suggest that Luft's model could be improved and yield more consistent results, if volume used to predict outcomes were lagged. (Xie et al., 2008). In this chapter, I expand on modifications of the Luft model proposed by Xie, et al., and consider whether we can use these results to substantiate that the relationship is at least partly due to physician learning, as opposed to a physician referral effect. (In Chapter 3, I present a longitudinal study of the data using a panel approach.) This chapter is organized as follows. First, a brief literature review on volume outcome relationship, particularly as it relates to AMI patients, is presented. This is followed by a discussion of the data to be analyzed. Next, I describe modifications applied to the conventional model presented by Luft, et al. Then, results of the study are presented. Finally, I discuss the findings and present conclusions.

3.1 Literature Review

In 1979 Henry S. Luft, et al. presented a landmark study of the relationship between volume and mortality for 12 surgical procedures. They found that surgeons with higher procedure volumes had fewer mortalities, relative to their lower volume peers. (Luft et al., 1979) They attributed this result to physician learning, concluding that the volume outcome relationship was most likely a result of physicians' developing greater skills from practicing with more patients. Following this work, several studies have documented positive relationships between physician volume outcomes for percutaneous coronary intervention procedures (PCIs), (See (Hannan et al., 1997), (Hannan et al., 1991),and (Ritchie et al., 1993) for examples.) Due to convincing evidence of the relationship between volume of procedures and quality outcomes, the American College of Cardiology and the American Heart Association (ACC/AHA) recommended in 1993 and again in 2001 that cardiologists should perform at least 75 PCI procedures per year to maintain competence. (Ryan et al., 1993) and (SC Smith et al., 2001). In addition, based on volume outcome research findings, in 1996 the Hanaway Act was implemented in Rhode Island. This act established minimum hospital volumes for a variety of hospital services, including angioplasty, a procedure often used to treat AMI (Zimmerman, 2002).

Surgical cases tend to be more predictable and less diverse than medical cases. Therefore, more documented evidence of relationship between volume and quality outcomes exists for surgical cases. However, as discussed below, some evidence of a volume quality outcome relationship exists for AMI cases, (although it is not consistent).

In 2000 Institute of Medicine (IOM) published a review that provides a focused description of the current understanding of volume outcome studies. Eighty-eight studies were evaluated and ranked for their quality of work (Halm et al., 2000). IOM criticized most of the studies for the following reasons:

- Only 16 studies considered independent effects of both physician and hospital;
- Of 24 studies that made adjustments for severity of illness, only 4 reported statistically robust models;
- Only 4 addressed specific process analysis in volume-outcome relationships; and
- Only 2 addressed appropriateness of patient selection.

Nevertheless IOM concluded that there is a strong body of evidence that higher volume is related to improved health outcomes. However, they commented that lack of rigorous methodologies has limited generalizability, prevented identification of a volume threshold over which the benefit of adding procedures is diminished, and provided little knowledge concerning differences in processes of care that may contribute to these outcomes. For example, both Babak Valiki et al. and Edward Hannan, et al. discuss the possibility that referral bias, rather than physician experience, drives the results of the model (Valiki et al., 2001) and (Hannan et al., 1991). In this scenario, physicians who perform well develop a positive reputation over time, resulting in additional referrals. The association between volume and positive outcomes, then, is due more to reputation than it is to practice or learning.

IOM identified three studies of AMI patients that met their quality criteria. In 1999, David R. Theimann et al. documented a volume outcome relationship for hospitals, with evidence that this relationship was influenced by hospital processes that had been more consistently adopted at higher volume hospitals (Theimann et al., 1999). They did not find a significant relationship between physician volume and patient outcome, however. Paul N. Casale et al. documented a volume outcome relationship for AMI patients using a Pennsylvania data base of 30,715 patients (Casale et al., 1998). They found that much of the effect of the positive outcomes for specialists results from the higher volume of patients managed by the specialists. Dean E. Farley and Ronald J. Ozminkowski performed a longitudinal study of volume outcome results, using a sample of 600 non-federal hospitals' AMI cases from 1980 to 1987 (Farley and Ozminkowski, 1992). (They also studied several additional hospital procedures.) They found that a 10 percent increase in caseload resulted in a 2.2 percent decrease in mortality. However, they did not address individual physician performance.

Finally, there is some evidence that a physician's performance will be influenced by exposure to peers. For example, research by Jonathan D. Kethcham, et al. in 2007 indicated that patients treated by solo practitioners were less likely to receive cardiac catheterization and angioplasty within a day of admission and more likely to die. (Ketham et al., 2007)

The conventional volume outcome model as presented by Luft, et al. related physicians' current year volume and the impact of the hospital's total case volume to the quality outcome of interest. However, Yang Xie, et al. point out that this methodology distorts the learning effect. (Xie et al., 2008) By counting the physicians' cases in the current year, the physician is given credit for learning on cases that may not have occurred yet. For example, a physician cannot benefit from the experience of a case to be performed in October 2007, if it is currently June 2007. In addition, including the physician who is being studied in the total hospital count distorts the peer effect. Instead, it is more accurate to subtract the volume of cases performed by the physician from the hospital's total. This will result in a true peer effect.

3.2 Data Overview

Patient descriptive data was generated from New York State SPARCS database from the years 2000 through 2007, for all patients with the primary diagnosis code 410.xx (Acute Myocardial Infarction). I use the Joint Commission risk adjustment methodology for AMI cases as a starting point to risk adjust the data. [1]

[1] The 2006 JCAHO methodology for risk adjustment identifies 51 risk categories based on patient characteristics and ICD-9-CM diagnoses codes found in the patient data abstract. Originally, I apply the complete JCAHO methodology, however, this results in collinearity issues that need to be addressed. Therefore, I adjust the methodology to include only the most relevant risk factors. For a detailed review of JCAHO 2006 clinical risk adjustment see (JCAHO).

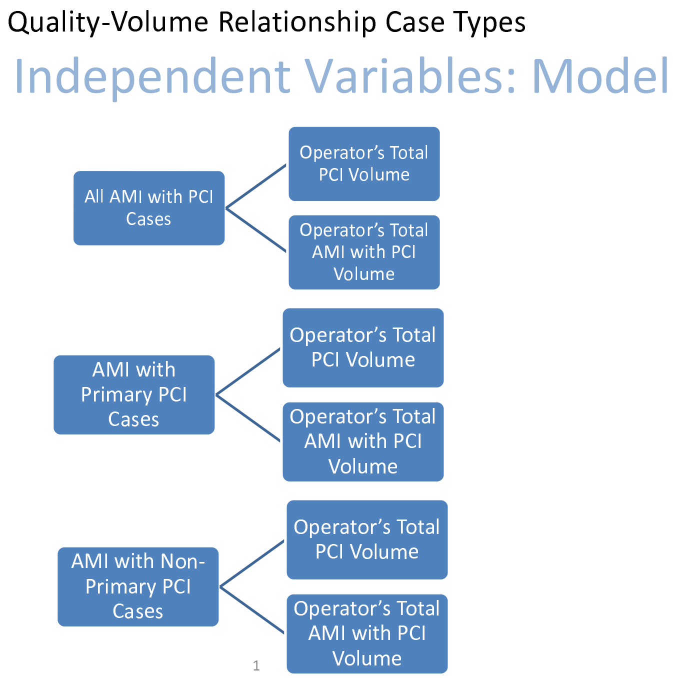

Figure 1: Independent Variables

I begin my study of volume outcomes by looking at AMI patients who received Percutaneous Coronary Intervention (PCI). For each operating physician treating an AMI patient, I collect the physician's total volume of elective and non-elective PCI cases; the physician's total volume of PCIs performed for AMI cases; and the physician's total volume of PCIs performed for non-AMI cases by month. I also collect the same statistics for physicians who performed primary PCIs on the AMI patients in the sample. (I define Primary PCI as a PCI performed on the day of the patient's admission to the hospital with an AMI diagnosis. See Figure 1 for a graphic representation of the relationships.) Table 2 summarizes the volumes of physicians and cases in this data base by year. [2]

I divide the operating physicians into volume categories, initially based on the total number of PCIs, both urgent and elective, that they perform. The case volume is skewed to the left, with many physicians having very few cases. Operators with low volume performed fewer than 12 PCIs per year, (or less than one per month.) Operators with moderate volume performed 12 to 74 cases per year. High volume operators met the ACC/AHA standards performing 75 or more PCIs per year. Very

[2] 2000 data is used for historical purposes only, in the lagged analysis, and detailed statistics are not presented here.

Table 2: PCI Detail by Year

	All Cases			PCI Primary		
Year	Oper MDs	Cases	Cases/MD	Oper MDs	Cases	Cases/MD
2001	1,005	11,159	11	760	5,871	8
2002	1,075	12,197	11	810	6,678	8
2003	1,044	12,665	12	790	7,208	9
2004	1,158	13,074	11	878	7.943	9
2005	1,120	13,114	12	886	8,228	9
2006	1,071	13,109	12	855	8,363	10
2007	1,110	12,372	11	911	7,966	9

high volume operators are defined as those performing more than 5 surgeries per week, or more than 260 procedures per year. (See the discussion in Section 3.2 *Modified Learning Model: Physician and Peer Volume* for discussion of the development of the volume categories.)

Table 3 displays the primary variables utilized for the analysis, sorted by physician volume category. The category Low Volume Physician has significantly higher raw mortality rates and average length of stay. Patients of low volume physicians tend to have more complicating diagnoses than those of higher volume physicians. In addition, lower volume physicians' patients appeared more likely to be admitted through the Emergency Department, during the weekend, or during non-traditional business hours. Low volume physicians treated more Medicare and fewer privately insured patients. I also compare average raw mortality to average risk adjusted predicted mortality using the modified risk adjustment methodology discussed above in Footnote 1. The results are displayed in Figure 2. For each physician category, Raw Mortality is slightly higher than Predicted Mortality, indicating, perhaps that the risk adjustment applied does not adequately account for all the risk. However, difference between raw and risk adjusted mortality for Low Volume operators is strikingly high (visually). This is not true for the other volume categories.

3.3 Modified Learning Model

3.3.1 Model Specification

In this chapter, I extend the empirical analysis performed by Xie et. al to determine whether a more consistent volume outcome effect can be documented when the most recent volume of cases performed by the physician are examined. I compare the volume outcome effect for three models: Conventional – no lagging (traditional model attributable to Luft et al), Calendar Year Lag – using cases from the prior calendar year (1 year lag model attributable to Xie, et al.), and Most Recent – lagging cases from the most recent prior 12 months. If one can document improved consistency as we correct the model to lag data, and assess the impact of applying more recent

Table 3: Demographic and Medical Characteristics of AMI Patients by Physician Volume Category

	MD Volume				**All Cases**
	Very High	High	Mod	Low	
No. of Patients	31,409	48,723	11,556	6,154	97,842
% Male	68.1	68.3	68.1	68.3	68.2
Mean Age Years	63.3	62.5‡	62.1‡	63.9∗	62.8
Race NonWhite %	35.3	32.7‡	38.9‡	36.1	34.5
Insurance					
Medicare %	43.2	42.1∗	40.4‡	46.1‡	42.5
Medicaid %	10.1	9.7	11.1∗	10.8	10.1
Private %	41.1	41.6	41.5	37.3‡	41.2
Other Insurance %	1.7	2.1‡	2.0∗	2.0	1.9
Uninsured %	3.9	4.4∗	5.1‡	3.9	4.3
Cardiac History					
Hist PTCA %	4.4	4.4	3.5‡	4.6	4.3
Hist CABG %	3.0	2.7∗	2.6∗	3.0	2.8
Hist MI %	7.4	6.9∗	6.1‡	7.0	7.0
Cardiac Diagnoses					
Anterior Infarct %	19.5	18.5†	20.2	20.5	19.1
Subend Infarct %	50.2	50.8	48.5∗	48.1∗	50.2
Cardiomyopathy %	1.4	1.8†	2.0‡	3.0‡	1.8
CHF %	15.8	14.1‡	13.9‡	22.6‡	15.1
Valve Disorder %	5.7	6.4‡	5.0†	8.6‡	6.2
Coagulopathy %	1.5	1.6	1.7	3.6‡	1.7
Med History and Diagnoses %					
Hist Smoker %	2.8	3.8‡	2.8	3.6†	3.3
Current Smoker %	15.7	21.7‡	17.6‡	15.1	18.9
Cancer Dx %	4.1	4.3	3.9	5.1†	4.2
Chron Cerebrovasc Dis %	1.1	1.1	1.2	1.3	1.1
Chron Liver Dis %	0.2	0.2	0.3	0.3	0.3
COPD %	7.0	8.0‡	6.8	8.5†	7.6
Hypertension %	58.7	57.9∗	58.1	56.4†	58.1
Paralysis %	0.7	0.7	0.8	1.0∗	0.8
Fluid Disorders %	4.4	5.2‡	5.2†	9.5‡	5.2
Other Neurologic Dis %	2.3	2.6∗	2.5	3.7‡	2.6
Chron Pulmonary Dis %	11.0	12.5‡	11.2	13.2‡	11.9
Diabetes wo Compli %	25.2	25.4	25.0	24.5	25.2
Diabetes Compli %	31.3	35.8‡	33.0†	45.1‡	34.6
Renal Failure %	2.9	3.1∗	3.4∗	4.5‡	3.2
Acute Liver Dis %	0.2	0.3	0.3	0.3	0.3
HIV %	0.2	0.2	0.3∗	0.3∗	0.2
Pt Admit on Weekend %	19.2	20.6‡	21.6‡	23.1‡	20.4
Pt Admit Off Hours %	26.3	27.4†	28.8‡	30.5‡	27.4
Pt Admit Through ER %	37.5	43.2‡	40.0‡	53.1‡	41.6
Pt Admit from LTC Fac. %	2.1	2.8‡	2.7†	2.3	2.5
Avg Length of Stay days	4.3	4.1‡	4.5†	8.4‡	4.5
Crude In-Hosp Mortality %	1.4	1.4	1.5	4.1‡	1.6

Compared to Very High Volume
$*p <= 0.05$, $\dagger p < .01$, $\ddagger p < .001$

cases; one can argue that improved performance is due, at least in part, to physician learning affects. (As we accurately express the recency of the cases, if results are more consistent with volume outcome theory, one can argue that the relevance of recency is that the physician remembers his most recent cases best, and therefore derives the most learning benefit from them.)

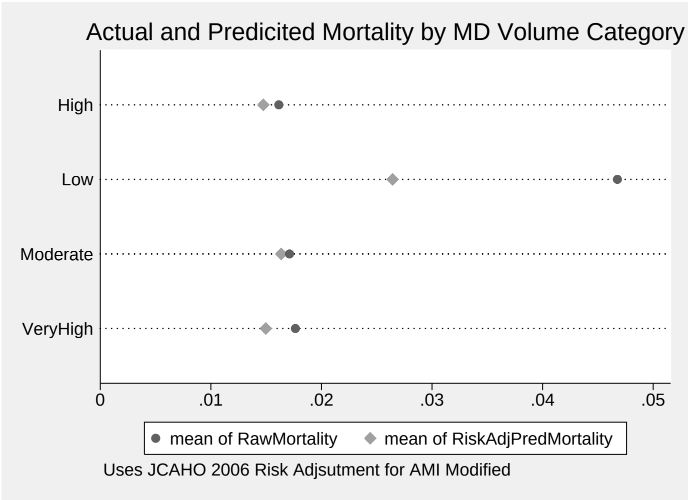

Figure 2: Raw Mortality and Risk Adjusted Predicted Mortality by MD Volume Category

I test the conventional volume-quality model:

$$prob(outcome_{it}) = \beta_0 + \beta_1 MDVOL_{jkt}$$
$$+\beta_2 \times HospVol_{kt} + \theta \times PtChar_{it} + \lambda \times MDChar_{jt} + \epsilon \ (1)$$

against the modified volume-quality model:

$$prob(outcome_{it}) = \beta_0 + \beta_1 \times MDVOL_{jkt-1} + \beta_2$$
$$\times(HospVol_{kt} - MDVOL_{jkt-1}) + \theta \times PtChar_{it} + \lambda \times MDChar_{jt} + \epsilon \ (2)$$

where:

- $Outcome_{it}$ is the clinical outcome of the ith patient in year t;
- $MDVOL_{jkt}$ is the volume of the jth physician at the kth hospital in year t;
- $HospVol_{kt}$ is the volume of the kth hospital in year t;
- $PtChar_{it}$ is a vector of characteristics of the ith patient at year t;
- $MDChar_{it}$ is a vector of characteristics of the jth physician in year t;
- ϵ is a randomly distributed error term; and
- $t-1$ denotes the time period beginning on the first day of the month beginning 13 months before the current month and ending on the last day of the month prior to the current month.

I hypothesize that the modified learning model will be more likely to consistently predict a relationship between physician volume and outcome for high volume physicians with larger peer groups. This result would strengthen the argument that learning plays a key role in defining this relationship. [3]

3.3.2 Physician and Peer Volumes

It is notable that patients arriving at hospitals with AMI are in need of immediate intervention. Many of the procedures performed on these patients are emergent in nature. However, surgeons who perform these emergent procedures have varying experience in the number of elective cases they perform. Babak Valiki et al. examined the volume outcome relationship for patients who received angioplasty as a primary intervention for AMI. They determined that physicians who performed a higher volume of primary procedures for AMI patients had superior outcomes when compared to those who performed fewer procedures (Valiki et al., 2001). However, they did not control for the number of procedures these physicians performed in total, (they only examined angioplasty procedures for AMI patients). As a follow up, in 2003, Babak Valiki and David Brown published an analysis in which they measured the relationship of operators' total PCI volume to mortality outcome. Using the volume threshold of 75 PCI proceudres to represent high volume, they concluded that there was not a consistent relationship between volume and mortality outcome for physicians; however they did identify such a relationship for hospitals, using a high volume threshold of 400 (Valiki and Brown, 2003). In 2005, as part of a larger analysis, Hannan et al. reported on volume outcome relationships for AMI patients treated with primary PCI in New York State from 1998 to 2000 using the volume of primary angioplasty as their key independent variable. (They noted that primary angioplasty volume was more powerful than total PCI volume.) Although they documented a relationship between volume and mortality for hospitals, they did not find that the relationship existed for operators (Hannan et al., 2005). Since many angioplasty procedures are performed electively, it is unclear as to whether the physicians' total volume of PCI procedures, the physicians' volume of PCI procedures on AMI patients, or the physicians' volume or primary PCIs contributes most to the volume outcome relationship. The impact of type of cases performed may be important in determining whether the current distribution of physician and hospital resources is efficient. For example, if the total volume of PCIs is the most powerful predictor, this would suggest that to maximize quality, patients need access to physicians with high overall PCI volume as opposed to high primary PCI volume. This analysis clarifies this issue by examining the total volume of procedures performed by each physician, as well as the volume of emergent procedures for AMI, both primary and nonemergent, applying the model described above.

As discussed above, in order to describe operators' total AMI experience, four

[3] Both Gary Becker in his work **Human Capital** and Kenneth Arrow in his paper *The Economic Implications of Learning by Doing* recognize the likelihood that physicians learn through practice. Arrow comments that rapidly changing technological environments require specialists to focus on minutia. The gain from this outweighs the loss of coordination, due to increasing numbers of specialists (Becker, 1964) and (Arrow, 1962).

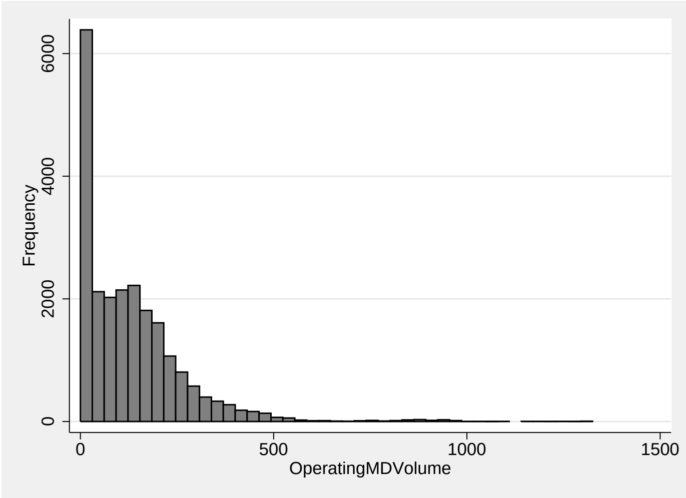

Figure 3: Operating Physician Volume Distribution

volume categories are utilized. (See Figure 1.) Low volume is defined as less than 12 per month; moderate volume is defined as 12 to 74 per month; high volume is defined as 75 to 260 per month; and very high volume is defined to be more than 260 per month. These volume categories were determined after reviewing the distribution of the data set. The data set is skewed to the left, such that, on average, 47.5 percent of the operators per year were classified as low volume. Therefore, defining categories by quartiles results in a low level of variation among the categories. (see Figure 3 for a histogram of the distribution of volume by physician.) Instead, the categories are designed to represent logical thresholds of interest. The low volume category represents operators whose average case volume is less than one per month. If practice improves performance, these physicians should be expected to have the poorest performance, yet they represent nearly half of the physicians available to perform PCIs for AMI patients. Operators in the moderate volume category perform fewer cases than the number recommended by the ACC/AHA ((Ryan et al., 1993) and (SC Smith et al., 2001)), so still may be expected to have poorer performance than those with higher case volume. The high volume category represents operators who practice at or above the ACC/AHA standard, performing 75 to 260 cases per year. Very high volume operators perform more than 260 cases per year. These are physicians who devote their full practice to the performance of PCI cases, completing an average of more than 5 per week. These physicians represent approximately 7 percent of the physicians performing AMIs. The inclusion of this category will allow us to assess whether the incremental increase in performance after a certain level declines.

When the independent variable of interest is the operator's volume of AMI cases only, the variability in cases per physician drops. Fewer then 5 percent of the physicians have operating volumes greater than 75 annually. I therefore combine the High volume and Very High Volume categories, and define this as more than 30 cases; moderate volume is 11 to 30 cases; and low volume is 1 to 10 cases per year. I also run the model using operator's volume of non-AMI PCI cases as the independent variable of interest. Here, volume categories are the same as for operator's total volume of PCI cases.

The model is run separately for all AMI cases and for primary PCI cases and non-primary PCI cases.

For physicians who practiced at more than one hospital, a weighted average peer volume was calculated for each period. Peer volume categories are separated into quartiles. Table 4 displays volume categories for peer groups when no lag is applied by year. The lagged peer volumes are similar, though slightly lower, because the physician's own volumes are removed from the hospital total. Total case volume trended upward from 2001 to 2006 and dropped slightly in 2007. It is possible that the 2007 drop is due to errors in hospital reporting that will be corrected over time.

Table 4: Peer Group Volume Categories for No Lag Model by Year

Year	Low	Moderate	High	Very High
2001	0 to 108	109 to 308	309 to 868	> 868
2002	0 to 111	112 to 344	345 to 976	> 976
2003	0 to 113	114 to 368	369 to 1,037	$> 1,037$
2004	0 to 137	138 to 416	417 to 1,133	$> 1,133$
2005	0 to 142	143 to 449	450 to 1,173	$> 1,173$
2006	0 to 152	153 to 537	538 to 1,238	$> 1,238$
2007	0 to 130	131 to 442	443 to 1,022	$> 1,022$

3.3.3 Quality Indicators

The quality indicator for this study is in-hospital mortality. Due to technological advance in PCI procedures throughout the late 1990s and into the 21st century, mortality for AMI patients with PCI intervention has steadily declined. This decline calls into question whether the volume outcome relationship still exists for in-hospital mortality.

3.4 Results

3.4.1 Using Operator's Total PCI Volume

I run logistic analyses on the AMI data set, using in-hospital expirations as the dependent variable and the operators' total volume of PCI cases, regardless of the diagnoses, as the independent variable of interest. Table 4 presents a comparison of the Conventional, Calender Year Lagged, and Most Recent 12 Month Lagged Models.

In the conventional model, peer volume is the volume of the hospital in which the physician practiced. (A weighted average hospital volume is applied if the physician practiced in more than one hospital.) For each of the lagged models, the physician's own cases are removed from the peer volume.

Table 5: Results: Conventional and Lagged Models with Independent Variable All Operator PCI Volume

Models	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	Z	P>Z	OR	Z	P>Z	OR	Z	P>Z
OpMDVeryHigh	0.540	-4.72	0.000	0.603	-3.99	0.000	0.621	-4.13	0.000
OpMDHigh	0.562	-5.07	0.000	0.658	-3.77	0.000	0.625	-4.70	0.000
OpMDModerate	0.605	-3.88	0.000	0.666	-3.33	0.000	0.648	-3.69	0.000
PeerVeryHigh	0.963	-0.22	0.826	0.688	-3.04	0.002	0.766	-2.74	0.006
PeerHigh	0.872	-0.82	0.413	0.771	-2.19	0.029	0.763	-2.87	0.004
PeerModerate	1.374	2.01	0.044	0.795	-1.86	0.063	0.750	-3.11	0.002

Both models predict that the operator's total volume of PCI cases is significantly and inversely related to in-hospital mortality. However, only the lagged model confirms the importance of the peer volume in predicting outcomes. Using a model that accounts for recency increases the predictive power of the model.

3.4.2 Using Operator's Total AMI Volume

Next, I replace the independent variable of interest with operator volume of AMI cases only. Physicians who perform the highest volume of PCI procedures for AMI patients may not be the same as those who perform the highest total volume of PCI procedures. Hospitals may provide 24 hour coverage with physicians who are less experienced in performing PCI procedures, resulting in physicians who have less procedure volume overall performing more of the emergent procedures. When operator volume of PCI procedures on AMI patients is used as the independent variable of interest, none of the models predict a volume outcome relationship. However, when the analysis is performed on AMI cases with Primary PCI only, the lagged models tend to predict a stronger relationship between volume and outcome; and the lagged model that accounts for recency predicts that physicians with volumes of more than 30 PCI Procedures for AMI cases will have 23.4% ($p = 0.033$) lower mortality than those who performed fewer than 30 cases. The results for peer volumes are striking. While the conventional model does not consistently predict the importance of this variable in determining outcomes, both of the lagged models do. This is likely because the conventional model includes the physician's own cases in the calculation of peer volume. (See (Ritchie et al., 1993) and (Jollis et al., 1997) for examples). This can potentially confound the data, especially when the operators volume represents a large portion of total hospital volume. Because we define peer volume as hospital volume minus the physician's own cases for the lagged models, the peer effect may be the result of high hospital volume, as well as the operators ability to learn from peers. Hospital performing higher volumes of AMI cases are more likely to have established routine procedures for addressing the patients' emergent needs. Therefore, regardless of whether the patient receives primary PCI, a patient's chance of survival appears to increase as the facility increases its volume of AMI cases. (See Table 6).

Table 6: Results: Conventional and Lagged Models with Independent Variable Operator's Total Volume of AMI Cases with PCI Procedures Performed

All Cases									
Models:	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	Z	P>Z	OR	Z	P>Z	OR	Z	P>Z
OpMDHigh	0.864	-1.22	0.222	0.948	-0.50	0.620	0.834	-1.75	0.080
OpMDModerate	0.936	-0.58	0.560	0.865	-1.32	0.186	0.830	-1.74	0.082
PeerVeryHigh	0.617	-2.80	0.005	0.524	-5.31	0.000	0.639	-3.61	0.000
PeerHigh	0.755	-1.87	0.062	0.674	-3.79	0.000	0.612	-4.13	0.000
PeerModerate	0.984	-0.10	0.918	0.813	-1.69	0.090	0.721	-3.43	0.001
PCI Primary									
Models:	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	Z	P>Z	OR	Z	P>Z	OR	Z	P>Z
OpMDHigh	0.784	-1.68	0.093	0.855	-1.21	0.226	0.766	-2.14	0.033
OpMDModerate	0.929	-0.53	0.596	0.838	-1.33	0.184	0.806	-1.67	0.095
PeerVeryHigh	0.634	-2.13	0.033	0.585	-3.64	0.000	0.678	-2.60	0.009
PeerHigh	0.754	-1.49	0.136	0.729	-2.47	0.014	0.711	-2.36	0.018
PeerModerate	0.917	-0.43	0.667	0.886	-0.79	0.428	0.781	-2.10	0.036
PCI NonPrimary									
Models:	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	Z	P>Z	OR	Z	P>Z	OR	Z	P>Z
OpMDHigh	1.38	0.17	0.864	1.196	0.91	0.36	1.008	0.04	0.967
OpMDModerate	1.001	0.00	0.997	0.933	-0.35	0.724	0.913	-0.45	0.652
PeerVeryHigh	0.508	-2.26	0.024	0.387	-4.33	0.000	0.507	-3.02	0.003
PeerHigh	0.652	-1.66	0.097	0.575	-3.01	0.003	0.442	-3.83	0.000
PeerModerate	1.043	0.16	0.872	0.699	-1.73	0.084	0.603	-3.05	0.002

3.4.3 Using Operator Total Non-AMI Volume

Finally, I consider physician outcomes with the independent variable Non-AMI PCI cases, asking whether the experience of performing PCIs on Non-AMI patients ultimately contributes to quality outcomes when performing PCIs on AMI patients. When all AMI cases are considered both the conventional and lagged model predict statistically significant inverse relationships between mortality and physician volume. However, the conventional model attributes more significance to peer volume, while the lagged model attributes more importance to operator volume. (See Table 7)

When I run the models for primary PCI cases only, I obtain fairly similar results, (though the operator results are less consistent for the conventional model, and the peer results are less consistent for the lagged model.) However, when I examine non-primary PCI cases, I find that the lagged model consistently predicts the significance of operator volume, but it does not predict that the peer volume will be significant. This result makes sense for non-primary PCIs. Primary PCIs rely on both physician experience in performing the operation, and hospital experience in ensuring that the patient receives timely and appropriate intervention, (for example low door to balloon time). However, when PCI is performed as a secondary intervention, the patients primary AMI treatment may not involve the same type of coordinated response on the part of the hospital; yet the operator skill at performance of the PCI remains critical to the patient's survival.

Table 7: Results: Conventional and Lagged Models with Independent Variable Operator's Total Non-AMI Volume Case Volume with PCI Performed

All Cases									
Models:	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	z	P>z	OR	z	P>Z	OR	z	P>z
OpMDVeryHigh	0.638	-3.05	0.002	0.552	-4.27	0.000	0.632	-3.58	0.000
OpMDHigh	0.7226	-2.65	0.008	0.661	-3.77	0.000	0.695	-3.60	0.000
OpMDModerate	0.728	-2.65	0.008	0.607	-4.37	0.000	0.671	-3.85	0.000
PeerVeryHigh	0.626	-3.07	0.002	0.760	-2.22	0.026	0.750	-2.77	0.006
PeerHigh	0.608	-3.37	0.001	0.815	-1.74	0.081	0.754	-2.84	0.005
PeerModerate	0.748	-2.45	0.041	0.774	-2.20	0.028	0.746	-3.09	0.002
PCI Primary									
Models:	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	z	P>z	OR	Z	P>z	OR	z	P>z
OpMDVeryHigh	0.657	-2.24	0.025	0.606	-2.84	0.004	0.686	-2.33	0.020
OpMDHigh	0.724	-2.09	0.037	0.738	-2.22	0.026	0.752	-2.28	0.022
OpMDModerate	0.755	-1.88	0.060	0.673	-2.81	0.005	0.710	-2.68	0.007
PeerVeryHigh	0.670	-1.93	0.054	0.699	-2.38	0.017	0.709	-2.73	0.006
PeerHigh	0.708	-1.91	0.057	0.835	-1.26	0.206	0.750	-2.38	0.017
PeerModerate	0.837	-1.02	0.307	0.812	-1.45	0.146	0.785	-2.12	0.034
PCI Non-Primary									
Models:	**Conventional**			**Calendar Year Lag**			**Most Recent Lag**		
Expired	OR	Z	P>Z	OR	Z	P>Z	OR	z	P>z
OpMDVeryHigh	0.594	-2.11	0.035	0.458	-3.39	0.001	0.546	-2.81	0.005
OpMDHigh	0.666	-1.93	0.053	0.488	-3.78	0.000	0.551	-3.38	0.001
OpMDModerate	0.626	-2.23.	0.026	0.456	-3.90	0.000	0.572	-3.06	0.002
PeerVeryHigh	0.519	-2.40	0.016	0.934	-0.31	0.758	0.809	-1.12	0.264
PeerHigh	0.466	-2.88	0.004	0.851	-0.76	0.446	0.804	-1.21	0.227
PeerModerate	0.624	-1.87	0.062	0.771	-1.27	0.204	0.716	-1.93	0.054

3.4.4 Operator/Peer Interaction

The results discussed above document the importance of accurately specifying both operator and peer volume when modeling volume outcomes. In the analyses above, we see that the peer volume appears to contribute more to the outcome, when PCI is primary. To explore this further, I run a logistic model using an interaction variable for physicians and peers as the variable of interest and comparing results from the conventional model to the model that applies the most recent 12 month. I test two independent variables: first the operator's total volume of PCI cases, regardless of diagnosis; and second, operator's volume of AMI cases for which PCIs were performed. I divide operator volume into 2 categories. For total volume of PCIs, the high volume category was 75 or more cases, and the low volume category was fewer than 75 cases. (This is the ACA/AHA threshold. (Ryan et al., 1993) and (SC Smith et al., 2001)) The high volume of AMI category was 31 or more cases of AMI treated with PCI. The low volume category was less then 31. This volume selection was somewhat arbitrary and arrived at by attempting to maintain a similar ratio of cases to that of the total PCI category. For each group, I compare the results for primary and non-primary PCI cases below in Tables 8 and 9.

Table 8 shows the importance of total physician experience in the performance of PCIs. In both the conventional and 12- month lag model, predicted mortality is significantly lower for high volume physicians. The one exception is for high volume physicians operating at a facility with a low volume peer group, when the PCI is primary (lagged model). This result is not present when PCI is not primary. (Odds ratio of patient mortality for Primary PCI = 0.9222 with CI = 0.703 to 1.210 for High Volume operators practicing with low volume peers; however, the odds ratio of patient mortality for non-primary PCIs = 0.476 with confidence interval of 0.293 to 0.773 when compared to Low Volume Low Peer Group operators.) We therefore have an indication that small peer volume, or (facility size) may adversely influence mortality rates for AMI patients treated with primary PCI, even when the physician volume is high. Generally the peer group size did not influence morality outcome for low volume physicians. There were no significant differences in mortality rates for low volume operators based on the peer group size.

If we examine the Conventional results in Table 8, we can see how the definition of Peer Group confounds the conventional model. The high operator volume category is dropped when combined with low facility volume, because of collinearity. The collinearity is a result of counting the physicians case volume in both the operating MD volume and the peer volume. A higher degree of collinearity will exist in every volume category for this reason.

Table 9 shows results from running the same analysis, with the independent variable operator's AMI with PCI volume only. For AMI cases, the combination of physician volume and peer volume significantly influence mortality. Mortality rates

Table 8: Results: Operator/Peer Interactions AMI Cases with Primary and Non-Primary PCI with All PCI Cases as Independent Variable: Comparison of Conventional Model Results to Most Recent 12 Month Lag Results

Prim PCI					
		Conventional		**Lagged**	
Peer Volume		**Operating MD Volume**		**Operating MD Volume**	
		>75	<75	>75	<75
4th Quartile	OR	0.640	0.788	0.618	1.039
4th Quartile	95% CI	0.456 - 0.897	0.517 - 1.203	0.494 - 0.773	0.801 - 1.347
3rd Quartile	OR	0.606	.700	0.678	1.023
3rd Quartile	95% CI	0.422 - 0.869	0.462 - 1.061	0.553 - 0.832	0.804 - 1.302
2nd Quintile	OR	0.855	1.494	0.712	0.866
2nd Quintile	95% CI	0.542 - 1.348	1.002 - 2.228	0.578- 0.876	0.663 - 1.132
1st Quintile	OR	...	1.000	0.9222	1.000
1st Quintile	95% CI	...		0.703 - 1.210	
Non-Primary PCI					
		Conventional		**Lagged**	
Peer Volume		**Operating MD Volume**		**Operating MD Volume**	
		>75	<75	>75	<75
4th Quartile	OR	0.424	0.443	0.669	0.811
4th Quartile	95% CI	0.270 - 0.670	0.246 - 0.798	0.493 - 0.909	0.574 - 1.147
3rd Quartile	OR	0.418	0.527	0.555	0.799
3rd Qartile	95% CI	0.255 - 0.684	0.301 - 0.923	0.412 - 0.746	0.561 - 1.137
2nd Quartile	OR	0.472	0.334	0.624	0.708
2nd Quartile	95% CI	0.212 - 1.050	0.706 - 2.080	0.462 - 0.841	0.487 - 1.028
1st Quartile	OR	...	1.000	0.476	1.000
1st Quartile	95% CI	...		0.293 - 0.773	

are lower for patients whose physicians performed a low volume of procedures, if the procedures were performed at facilities with higher peer volume. This is true both for primary and non-primary PCI cases. Therefore, we see that while the physician's total volume alone is of critical importance, when the independent variable is the doctor's volume of AMI cases, the combination of operator and peer volume play an important role in predicting mortality. This may be because facilities with higher AMI volumes are better positioned operationally to routinely provide consistent treatment to AMI patients.

Again, we see that the conventional model does not perform as well at predicting outcomes as the lagged model. The operator-peer interactions for high volume MDs with low and moderate peer volumes are dropped due to collinearity.

3.5 Volume Threshold Analysis

Having confirmed the volume outcome relationship exists, I used the independent variable, physicians total PCIs, to identify a volume threshold for which predicted mortality could be minimized. To do so, I established a high volume and a low

Table 9: Results: Operator/Peer Interactions AMI Cases with Primary and Non-Primary PCI with Operator's AMI with PCI Cases as Independent Variable: Comparison of Conventional Model Results to Most Recent 12 Month Lag Results

Primary PCI					
		Conventional		**Lagged**	
Peer Volume		**Operating MD Volume**		**Operating MD Volume**	
		>30	<30	>30	<30
4th Quartile	OR	0.496	0.599	0.547	0.489
4th Quartile	95% CI	0.356 - 0.689	0.417 - 0.858	0.442 - 0.678	0.346 - 0.691
3rd Quartile	OR	0.613	0.725	0.534	0.675
3rd Quartile	95% CI	0.387 - 0.971	0.509 - 1.036	0.425 - 0.672	0.508 - 0.897
2nd Quintile	OR	...	0.909	0.589	0.750
2nd Quintile	95% CI	...	0.612 - 1.350	0.424- 0.820	0.596 - 0.944
1st Quintile	OR	...	1.000	0.987	1.000
1st Quintile	95% CI	...		0.515 - 1.891	
Non-Primary PCI					
		Conventional		**Lagged**	
Peer Volume		**Operating MD Volume**		**Operating MD Volume**	
		>75	<75	>75	<75
4th Quartile	OR	0.526	0.511	0.517	0.400
4th Quartile	95% CI	0.339 - 0.817	0.313 - 0.836	0.381 - 0.703	0.233 - 0.688
3rd Quartile	OR	0.694	0.649	0.450	0.380
31-74	95% CI	0.351 - 1.378	0.402 - 1.042	0.328 - 0.616	0.250 - 0.579
2nd Quartile	OR	...	1.043	0.532	0.599
2nd Quartile	95% CI	...	0.626 - 1.738	0.328 - 0.862	0.439 -0.818
1st Quartile	OR	...	1.000	0.536	1.000
1st Quartile	95% CI	...		0.148 - 2.246	

volume category. I ran logit models to predict the odds ratio of mortality at various thresholds. Table 10 displays the results. The odds ratio is minimized when volume > 15. This threshold is much lower than the threshold of 75 documented for all PCIs, and is likely easier for hospitals and physicians to achieve operationally.

3.5.1 Other Variables of Interest

Certain demographic variables significantly influenced the likelihood of dying during hospitalization. Females undergoing primary PCIs tended to be more likely to have higher mortality, even after adjusting for age, than males undergoing the same procedure. (When total physician PCI volume is used as the variable of interest, p = 0.053, but when physicians volume is calculated using AMI cases 0nly p = 0.048.) Uninsured patients undergoing primary PCI were 1.69 times more likely to die, than Medicare patients (p = 0.009 when total operator PCI volume is used). Patients admitted for primary PCI over the weekend were 1.31 times more likely to die than those admitted on a week day (p = 0.002); and those admitted during off hours (from

Table 10: Results: Volume Threshold: Independent Variable Operating MD Volume ALL PCIs: All AMI Cases

Expired	Odds ratio	z	P > z
Operating MD Volume > 14	0.664	-4.31	0.000
Operating MD Volume > 15	0.661	-4.40	0.000
Operating MD Volume > 25	0.742	-3.33	0.001
Operating MD Volume > 50	0.799	-2.84	0.005
Operating MD Volume > 75	0.814	-2.85	0.005
Operating MD Volume > 100	0.840	-2.60	0.009
Operating MD Volume > 120	0.873	-2.12	0.034
Operating MD Volume > 125	0.885	-1.92	0.055

7:00 p.m. to 7:00 a.m.) were 21% more likely to die than those admitted during the day (7:00 a.m. to 7:00 p.m.) ($p = 0.019$). [4]. The model also documents significant progress in mortality reduction for AMI with primary PCI in 2003, 2005, 2006 and 2007, compared to 2001 (p = 0.009, 0.009, 0.006, and 0.012, respectively). These factors generally did not influence outcomes for patients admitted for AMI undergoing secondary PCIs, although patients admitted during off hours experienced 24% increased mortality as compared to those admitted during the day ($p = 0.04$) .

3.6 Discussion and Conclusions

This current analysis expands the contribution of Xie et al. ((Xie et al., 2008)) by improving the accuracy of volume outcome projections. Xie et al. lagged physician volume of PCIs by a calender year, in order to ensure that a physician' volume reflected past experience, as opposed to work that had yet to be done. This eliminated the assumption that physician volume is constant over time, and addressed such issues as rapid ramp up of volume experienced by new physicians entering the market. Yet, even applying this lag, there can be long gaps between current cases and a physician's experience. For example, the Xie et al. analysis measures experience of cases performed in December of 2006, based on 2005 cases. Thus, by the end of the year the experience measure is 12 to 23 months old. The current analysis measures experience as the accumulation of cases in the 12 months prior to the current month's cases; therefore, the experience is recent, and more relevant to the physician's current cases. Monthly fluctuations in volume are accounted for. Predictions made using this method are more consistent and stable than those using the conventional model or calendar year lag models.

Early volume outcome analysis has yielded inconsistent results when applied to AMI patients. For example, of the studies recognized in the IOM review ((Halm et al., 2000)) of myocardial infarction; Casele et al. (see (Casale et al., 1998)) documented a volume-outcomes relationship for physicians, while Theimann, et al. did

[4] The results reported are based on the model for which physician volume included all PCI cases, but were generally consistent for all lagged models

not ((Theimann et al., 1999)) and Farley and Ozimkowski (Farley and Ozminkowski, 1992) documented the relationship for hospitals only. A more recent study by Valiki et al. specifically examines patients with primary angioplasty as a treatment for AMI ((Valiki et al., 2001)). The authors find a an inverse relationship between the volume of primary PCIs as a treatment for AMI and mortality. They go on to document that for primary PCIs, the combination of high physician and operator volume produce the lowest mortality. However, the Valiki study uses only physician primary PCI volume as the variable of interest, and examines New York State cases from 1995. It therefore does not address the question of whether total PCI operator volume influences AMI outcomes. The follow-up study by Valiki and Brown ((Valiki and Brown, 2003) does not substantiate a voume-outcome relationship when all operator PCI volume is used. Edward Hannan et al. analyzes volume and in-hospital mortality relationship for primary PCI patients with discharge dates from 1998 to 2000, but finds no relationship (Hannan et al., 2005). The current study substantiates Valiki's 2001 findings, despite the considerable technological progress, and resulting decline in in-hospital mortality rates since 1995. These findings are important in themselves, since in my study of New York patients, an average of 58% of physicians treating AMI patients with primary PCI were low volume AMI providers. These physicians treated and average 21.2% of the cases (or 1,560 cases per year.) Since the odds ratio of a patient death when a high volume operator treats an AMI patient with primary PCI is .766, as compared with a low volume operator; we can estimate that on average 365 potentially avoidable deaths occurred annually from 2001 to 2007. As the number of Coronary Angioplasty facilities has increased, the percentage of cases performed by low volume providers has increased, as well. In 2001, 42 facilities in New York State performed coronary angioplasty on AMI patients. By 2007 this number had increased to 59. During this time the percentage of low volume operator cases rose from a low of 19.3% in 2002 to a high of 27.2% in 2007, so potentially avoidable deaths increased as well. [5]

This study adds considerable detail to the findings from Valiki et al. Namely, we conclude that a physicians' total PCI volume as well as the total volume of PCIs performed on AMI patients contribute to reduction in mortality for primary PCI and secondary PCIs when used as a treatment for AMI. However, when the independent variable is physician's volume of AMI cases with PCI, volume matters most for primary PCI, but is not as important when the PCI procedures is non-emergent. This may indicate that the physician's experience in providing *emergent* PCI is more important for emergent PCI patients. if the physician performs a procedure once the patient is stabilized, there is likely to be less risk. For Primary PCI patients, peer volume is always a significant predictor of mortality. Since peer volume and hospital volume are highly correlated, it is likely that the importance of peer volume when we

[5]Physician operators grew from 1,005 in 2001 to 2007 1,110 in 2007. Therefore if operators were spread evenly over all hospitals, there would have been an average of 23.9 cases per operator in 2001, but only 18.8 in 2007.

look at primary PCIs (as opposed to all PCIs) stems from the importance of hospital processes in provision of emergency care. In particular, many recent studies site the importance of "door-to-balloon" time in the production of successful primary PCI outcomes. This is the time from when the patient arrives in the Emergency Department to the time the PCI procedure begins. (See for example (Cannon et al., 2000), and (Jneid et al., 2008) discussed below.) In addition, patients arriving in the ER with AMI who do not need primary PCI, still need rapid and consistent treatment. It appears that larger hospitals (those with the highest peer volumes) are more likely to successfully provide this service. Interestingly, we also see that when AMI cases with non-Primary PCI cases are performed, the peer volume is not as important in predicting outcome. This is consistent, since such as issues as door to balloon time might take on less importance,

In 2000 Christopher Cannon et al. published findings that reducing Door-to-Balloon Time reduced mortality. They recommended that organizations such as the ACC/AHA and CMS develop guidelines addressing standards for indicator. (Cannon et al., 2000). Indeed, the CMS Hospital Compare program now requires that hospitals performing primary PCIs as an intervention for AMI to report on whether Door to Balloon time exceeded 90 minutes or not. (See (CMSHospitalCompare)) My finding that peer volume is a significant predictor of mortality for AMI patients treated with primary PCI in New York State could potentially be explained by challenges faced by lower volume hospitals in processing time for emergent patients .

Hospitals face particular challenges in providing rapid and efficient care to patients during low volume hours. Typically hospitals reduce staffing over the weekends and during evenings and nights, because of reduction in patient volumes. However, recent evaluations have found that lower availability of expert staff may increase mortality during off hours. In 2007, William Kotis et al., using data from the Myocardial Infarction Data Acquisition System (MIDAS), reported that New Jersey patients admitted on the weekend had higher mortality and lower rate of use of invasive procedures (Kotis et al., 2007). Hani Jneid et al. recently published results of a study completed for the *Get with the Guidelines Steering Committee and Investigators* documented that patients who arrived on the weekend and during off hours on week night (7:00P.M. to 7:00 A.M.) had fewer primary PCIs and revascularizations, and longer door-to-balloon times. However, they concluded that mortality for patients arriving during off hours and during daytime hours was similar. (Jneid et al., 2008) Our study finds that New York AMI patients undergoing primary PCI also have higher mortality if admitted over the weekend ($p = 0.002$) or in the evening ($p = 0.019$). These results are more similar to those reported by Kotis et al.

My study finds that females undergoing primary PCIs for AMI tend towards having higher mortality ($p = 0.048$ when AMI with PCI volume is used as the independent variable and $p = 0.053$ when all PCI volume is used.) This finding is consistent with publication of Boris Coronado, et al. ((Coronado et al., 1997). These authors found that females presenting with AMI had higher risk of mortality than their male counterparts. However, reasons for the differences in outcomes remain unexplained. Further research needs to be conducted to determine the causes.

This study finds that uninsured patients tend toward higher mortality when undergoing primary PCI for AMI ($p = 0.01$). This is not clearly an issue of access, because all of the patients in the study received PCI procedures. However, it is possible that the risk adjustment available was not adequate to detect differences in the severity of illness of these patients. Another possibility is that these patients are more likely to arrive in the hospital without known histories and without affiliations with cardiologists or other physicians. If this is so, time required to establish history and assign an operator may result in poorer outcomes.

4 Learning or Referral Bias: Examining Causality of Volume Outcome Effect

Abstract

Context: Chapter 1 contributes to the clarity of volume-outcome analysis. I confirm that improving model specification increases the consistency and robustness of models predicting volume-outcome effect. Because the model changes involve implementing a lagged model that relies on the physician's most recent case volume history, one can argue that this is evidence of the "practice makes perfect" explanation. However, many would argue that the causality still has not been clearly defined. In this chapter I focus on adding explanatory variables to the model that would support the existence of a referral bias. I run the models with the additional variables to determine whether they have an impact on the volume-outcome relationship. When they do not, I propose a knowledge stock accumulation model which can be used to understand how physicians acquire and maintain knowledge over longer periods of time.

Objective: The objective is to improve understanding of causality of the volume-outcome relationship, and specifically to determine whether a referral bias exists for AMI patients receiving PCIs. In addition, I suggest a knowledge stock accumulation physician learning model that is consistent with the volume-outcome relationship.

Design Setting, and Participants: I briefly review survey results concerning how consumers select physician specialists. I combine these results with information from researchers concerning variables that they have identified as potentially reflecting referral bias. I modify the volume- outcome model from Chapter 1 to evaluate these factors. I then propose a knowledge accumulation

model that is consistent with physician learning, using concepts of memory and learning presented by Yianis Sarafidis (Sarafidis, 2007).
Main Outcome Measure: In-hospital mortality
Results: Paul Casale et al. provide evidence that cardiologist have better outcomes for AMI patients than do general medicine doctors (Casale et al., 1998). If the general public is aware of this, a bias towards the use of cardiologist may exist. I therefore eliminate non-Cardiologist from the analysis and rerun the volume-outcome studies. The results are similar, but support Casale's findings that cardiologists are likely to have better outcomes. I add variables for physician board certification, foreign medical school attendance, year's experience, and whether the physician is affiliated with a teaching hospital or a hospital system member. None of these variables had a significant predictive impact on mortality, and their introduction into the model did not change the previously documented volume-outcome relationship. Finally, I explore a model on knowledge stock accumulation and use five years of physician activity to predict outcomes. The model has good predictive power and generates results that support "practice makes purpose causality".
Conclusions: The analyses conducted in this chapter are supportive of a physician learning model. They indicate that both flow and stock learning models are relevant to physician learning behavior. Their study can provide helpful information on allocation of physical, educational and labor resources.

This paper examines the question of how consumers select their physician specialists, and explores whether these consumer decisions could potentially result in referral bias. First information concerning the provider reputation and factors related to consumer choice are reviewed. Although I do not complete an extensive review of this literature, the information I assess is consistent, and provides useful insight into the current decision making process used by consumers. Based on conclusions from this analysis, models from Chapter 1 are adjusted to include variables expected to reflect referral bias, in that they are expected to influence a consumer's evaluation of the quality of their physician specialists. I then rerun the models to determine the impact of the new variables, thereby evaluating potential impact of referral bias.

4.1 How Do Consumers Select Physician Specialists?

I begin my study by examining two large National or Regional studies that provide the general public with quality rankings of hospitals or physicians. Such studies often provide exciting human interest stories on the activities of health care providers in the selected institutions and provide for dramatic reading. (See, for example, the stories accompanying the 2008 selections from **U.S. New and World Report** for the style of reporting (Comarow, 2008).) I review 2008 National Selections from **U.S. News and World Report**, and Regional Selections for Metropolitan New York from **New York Magazine**. The **U.S. News and World Report** article selects the best hospitals in the United States based on a combination of factors (including 1/3 reputation evaluated through a physician survey, 1/3 mortality performance, and 1/3 other factors). The report recognizes five hospitals among the top performers for Cardio-thoracic specialists. Of these, four are located in New York City, and one on Long Island (Comarow, 2008). The New York Magazine provides a listing of the 42 top Cardiovascular Disease Specialists in Metropolitan New York for 2008, based on the results of a peer review survey (**?**). Table 11 presents the distribution of physicians by geographic regions.

Table 11: New York Magazine 2008: Top 42 CardioVascular Disease Specialists

Region	**Volume Physicians**
Manhattan	19
New Jersey	5
Bronx	3
Brooklyn	3
Connecticut	3
Suffolk	3
Westchester	3
Nassau	1
Staten Island	1
Queens	1

While consumers may find large reports on the quality of providers interesting, the relatively small numbers of providers sited makes them difficult to use for the majority of the population with cardiovascular disease. In fact, the nature of cardiovascular disease makes it likely that a consumer will seek care locally, so that continuity of care can exist even during emergencies.

Consumers may not have an opportunity to exercise choice for a first AMI, but it is likely that many will seek a specialist, if they know that they have a diagnosis of cardiovascular disease. Because it is not practical to travel long distances for cardiovascular treatment, and because there is a general perception that of a high level of competence among cardiovascular specialists, consumers are likely to shop locally for these services. I therefore review the results of general surveys for which consumers responded to questions concerning how they selected specialists.

In 2003 **The Wall Street Journal.com** published the results of a Harris Poll assessing how consumers selected physicians. When consumers were asked *In your opinion, which three factors are most important indicators of quality medical care you* *can expect from a doctor?*, the top responses was Physician Reputation (65%). This was followed by Recommendation or referral from another doctor (57%); Personal recommendation from people you know (56%); Office staff are friendly and helpful (49%); and Has been highly rated in published evaluations of doctors (20%). However, when the same consumers were asked, *Thinking about the last time you chose a doctor, which of the following were the three most important factors in your making the choice?*, the top response was the Doctor was part of my insurance plan (46%); followed by Personal recommendations from people you know (36%); Very good reputations (36%); Office staff are friendly and helpful (27%); and Has been highly rated in published evaluations (8%) (Hughes and Pyhel).

In 2008, the Center for Studying Health Systems Change published a study in which consumers were asked what information sources they used to select a physician specialist. The top response was Referral from primary care physician (68.5%); followed by Friends and relatives (19.9%); Another doctor or health care provider (18.0%); a Health plan (10.5%); and the Internet (6.8%). Only 5.3% of consumers said that they use pricing information when choosing specialists, and only 10.3% said they use quality information. However, 12.5% said they consider cost, and 32.1% said they considered whether the specialist was in their health insurance network. 37.5% said they consider the reputation of the physician; 10.5% said they consider recommendation from another doctor; and 21.0% said they consider convenience. (Tu and Lauer).

A third consumer survey published in 2008 by the American Board of Specialties had a slightly different focus. The survey asked consumers to rank important qualities they look for in choosing a physician. 95% listed the physician's communications skills as important, with 34% stating this was most important. 91% said that whether the physician was Board Certified was important, with 25% saying this was most important. Of those who thought is was important 48% had checked to make sure that their physician was board certified, though 60% did not know what this meant. 42% had researched a physician on line, the most popular site was Web MD, though equally popular was to look at the web site of the physician's hospital. (ABM, 2008).

Taken together, these three surveys imply that consumers do consider specialists reputation when choosing a specialist. However, they generally do not confidently use quality information provided by current internet sights. Instead they use primary physician referrals and word of mouth referrals from friends and family. They consider physician board certification as in indicator of quality. And they are concerned about the cost of their own care, (which is primarily reflected by their consideration of whether the physician is in their insurance network.)

Although the issue of referral bias has been identified as important in determination of causality of volume outcome studies, relatively few studies have been conducted that address identification or elimination of such biases. Most of those that do, focus on hospital referral bias, as opposed to physician referral bias. Two interesting studies that document variables that might identify referral bias are Farley and Ozimkowski's assessment of the volume outcome relationship using a panel data approach (1992), and the Luft et al. study of 1987, in which the authors identify separate equations for predicting volume and outcome. (see (Farley and Ozminkowski, 1992) and (Luft et al., 1987).) These studies each use some of the following variables as predictors of quality or reputations: teaching hospital, medical school affiliation, member of council of teaching hospitals, hospital size, fraction of medical specialists that are board certified, transfers in and out, and number of hospital competitors. In addition, work has been presented that indicates that cardiac specialists have better results than generalist when treating AMI. (See (Casale et al., 1998) for example.)

4.2 Changes to Volume Outcome Model to Allow for Assessment of Referral Bias

Given the information concerning referral bias, I adjust the model discussed in Chapter 1 to include variables that may reflect the quality of the provider, and contribute toward referral bias. I begin by limiting my data sample to cardiologists only. To do so, I merge the AMA Masterfile abstract with the SPARCS data file. I eliminate all physicians who do not report a specialty related to Cardiology or Cardiac Surgery. Table 12 compares the size of the original data base to the cardiologist only data base. Table 13 compares volume of operating physicians and volume of cases by year for the complete data base and the cardiology only data base. Table 14 compares volume categories for the complete data base and the cardiology only data base.

Table 12: Comparison of Complete Data Base and Cardiology DataBase

	Cardiology Only	**Complete**
Volume of Cases	62,533	74,891
Operating Physicians	801	1,853
Cases/Physician	78.1	40.4

Next, I perform the most recent lagged regression model from Chapter 1, using cardiologist only. The independent variable of interest is Total Volume of PCIs performed by the operating physician. Table 15 presents a comparison of the results for cardiologist only and results for the entire data base.

The odds ratio for the cardiologist sample are lower, indicating that high volume cardiologists may perform better than high volume physicians in other specialties. However, the general direction of the results are the same. A volume outcome relationship is evident after adjusting for specialty.

Table 13: Comparison of Volume of MDs and Cases by Year: Complete Data Base and Cardiology DataBase

	All Case Data			**Cardiology Data**		
Year	Op MDs	Cases	Case/MD	Op MDs	Cases	Cases/MD
2001	1,005	11,159	11	393	7,549	19
2002	1,075	12,197	11	420	8,187	19
2003	1,044	12,665	12	423	8,148	19
2004	1,158	13,074	11	417	8,382	20
2005	1,120	13,114	12	392	8,241	21
2006	1,071	13,109	12	384	7,892	21
2007	1,110	12,172	11	374	7337	20

Table 14: Comparison of Volume Categories: Complete Data Base and Cardiology Data Base

Total PCI Cases **All MDs**	Avg Number MDs/Year	% MDs	Avg Number Cases/Year	%Cases
Low (0 to 11)	450	47.5%	879	9.5%
Moderate (12 to 74)	186	19.6%	1,651	13.9%
High (75 to 260	243	25.6%	6,960	53.6%
Very High (261+)	69	7.3%	3,037	23.0%
Total PCI Cases **Cardiologists**	Avg Number MDs/Year	% MDs	Avg Number Cases/Year	%Cases
Low (0 to 11)	199	43.9%	382	4.8%
Moderate (12 to 74)	105	23.2%	1,116	14.0%
High (75 to 260)	123	27.2%	4,771	59.9%
Very High (261+)	26	5.7%	1,692	21.3%

I also assess the optimal volume for Cardiologists. Table 16 implies that the optimal volume for Cardiologist is higher than the optimal volume when using all physicians. It may be that Cardiologist may derive additional benefit from speciality training that is maximized as volume increases.

Next I consider physician characteristics that might be related to referral bias. From review of survey results, I conclude that consumers are likely to receive referrals from their primary physicians. If so, the referrals are likely to be at least partially based on the consumer's insurance and physician affiliations. Referrals based on insurance are not as likely to be biased toward high quality as they are to be biased toward low cost. Physicians may also consider a colleague's board certification, years experience, and medical school attended in assessing quality.

Consumers consider word of mouth when they select physicians. But since most consumers are not actively pursuing the physician quality performance data available,

Table 15: All Physicians and Cardiologist Only Comparison with Independent Variable All Operator PCI Volume

	All MDs			**Cardiologist Only**		
	OR	Z	p>Z	OR	Z	p>Z
Op MD Very High	0.633	-3.94	0.000	0.535	-4.02	0.000
Op MD High	0.637	-4.47	0.000	0.514	-4.89	0.000
Op MD Moderate	0.660	-3.53	0.000	0.590	-3.29	0.001
Peer Very High	0.753	-2.88	0.004	0.992	-0.07	946
Peer High	0.735	-3.22	0.001	0.886	-1.02	0.307
Peer Moderate	0.733	-3.33	0.001	0.965	-0.32	0.748

Table 16: Optimal Volume: All Cases and cardiologist Only

All Physicians				
	> Volume	OR	Z	p>Z
Op MD High	14	0.664	-4.31	0.000
Op MD High	15	0.661	-4.40	0.000
Op MD High	25	0.742	-3.33	0.001
Cardiologists				
Op MD High	25	0.620	-4.02	0.000
Op MD High	30	0.604	-4.43	0.000
Op MD High	35	0.636	-4.23	0.000

word of mouth is likely to have more to do with the quality of the physician's communication than with the quality of care. AMA Master Files data contains information on physician Board Certification, and attendance as an American medical schools, as opposed to a foreign medical schools. In addition, a physician experience variable can be calculated by subtracting the current year (using 2006) from the graduation date. Table 17 summarizes the data available for the three variables. Unfortunately, all three of the variables have a relatively high level of missing data. To control for this, I develop a missing variable dummy for each of the three variables. In addition, 96% of physicians in the sample are board certified. Since so few cardiologists are not board certified their influence in the sample is insignificant. I add the variables to the regression to assess whether there is evidence of referral bias related to these physician characteristics.

Table 18 displays the result of adding the physician characteristics to the regression. None of the physician characteristics are significant, and the results of the regressions remain essentially unchanged.

Other researchers have considered hospital traits, including teaching status and size. I retrieved data on the Hospital's status from the web site of the Hospital

Table 17: Statistics for Board Certification, Foreign Medical Graduate and Experience

	Yes	No	Missing
Board Certification	497	12	304
FMG	95	327	379
	Avg Years	Std Dev	Missing
opmdExperience	29.3	9.4	326

Table 18: Cardiologist Only with Physician Characteristics Added: Independent Variable All Operator PCI Volume

	OR	Z	p>Z
Op MD Very High	0.543	-3.88	0.000
Op MD High	0.514	-4.85	0.000
Op MD Moderate	0.589	-3.28	0.001
Board Certified	1.277	0.72	0.474
Op MD Experience	1.000	0.04	0.968
Op MD FMG	0.954	-0.32	0.746

Association of New York State (**?**) and (**?**). Hospitals were categorized as teaching or non-teaching, as a member of a system or not, and as a large teaching hospital in a system (teaching hospitals having more than 500 beds in a system) or not. Table 19 displays the distribution of hospital status. Many physicians practice at more than one facility. In addition, many physicians' hospital affiliations change over time. For this analysis, a physician was assigned a primary hospital affiliation for each year based on the highest volume of cases admitted. If a physician clearly changed hospital affiliation during a year, the change was reflected in the month it occurred.

Table 19: Hospital Statistics

	Yes	No	%Yes
Teaching Hospital	57	11	83.82%
System	43	26	63.24%
Large Teaching System	18	50	26.47%

Hospital variables were added to the regression, first by adding Teaching Hospital and System; and then by adding Large Teaching System. Neither of these additions yielded significant changes, and the regression results remained essentially unchanged. (See table 20.)

Table 20: Cardiologist Only with Physician and Hospital Characteristics Added: Independent Variable All Operator PCI Volume

	OR	Z	p>Z	OR	Z	p>Z
Op MD Very High	0.541	-3.90	0.000	0.540	-3.91	0.000
Op MD High	0.513	-4.81	0.000	0.516	-4.77	0.000
Op MD Moderate	0.579	-3.38	0.001	0.589	-3.28	0.001
Board Certified	1.278	0.72	0.474	1.279	0.72	0.473
Op MD Experience	1.002	0.24	0.810	1.000	0.06	0.952
Op MD FMG	0.935	-0.46	0.648	0.952	-0.34	0.737
Teaching Hospital	0.798	-1.36	0.174			
System	1.013	0.14	0.889			
Large Teaching System				1.008	0.09	0.929

4.3 Towards a Stock Model for Physician Learning

I have evaluated factors that seem most likely to generate referral bias, based on feedback from consumer surveys and review of literature from authors exploring referral bias. The addition of variables that might reflect a referral bias did not change the volume outcome relationship, and none of the variables influenced the model significantly. I therefore conclude that the volume outcome effect is primarily caused by physician learning. If this conclusion is correct, then it is reasonable to explore establishing a stock model for learning. While the previous model examined the impact of the past year's cases on performance of current cases, it is also interesting to explore the longer term impact of physician activity on learning.

4.3.1 Motivation: The Role of Memory in Learning

Currently, I am unaware of models that address the volume-outcome effect utilizing a stock model for learning. However, conceptually, such a model is sensible. There is a large body of literature concerning physician education, and, specifically, education of surgeons that emphasizes the importance of practice in the development and continuation of surgical competence. I do not provide a full literature review on this topic; however, a few recent publications may serve to demonstrate the importance of practice for the development and maintenance on surgical skills. The first is an evaluation of surgical training programs using alternate strategies for teaching surgical techniques (Moulton et al., 2006). The authors evaluate the use of a “massed curriculum” approach, in which students learn surgical skills in short burst of intensive training; in comparison to an approach where surgeons receive less intensive training over longer periods of time. They find that the longer training periods are more beneficial. The second article discusses the benefits of surgical labs, which allow for surgical trainees to practice surgical techniques during points in their curriculum where performance of surgeries during their routine is not intensive (Perry, 2009). The final example is a piece published in the **Journal of Gastrointestinal Surgery** arguing that surgical training program must base their foundations on continuous professional development and practice based learning and improvement. This is considered to be necessary for surgeons to maintain their skill set over time (Sachdeva, 2007). Taken together, these articles present a strong argument that practice is a key component in the learning of surgical techniques, and that the timing and continuity with which such practice takes place is likely important.

Given this strong evidence of the importance of practice in the process of learning, I begin a search for potentially applicable learning models that might apply to physician accumulation of a stock of knowledge over time.

I begin by thinking of a physician making an effort to maximize his/her utility. The physician with derive utility from income, quality of care provided to the patients, personal characteristics that may dictate work activity preferences, and leisure. Income and practice activity will be somewhat intertwined, as reimbursement is generally fee for service in the United States. Regardless of this, if we assume that a learning model is in operation, and that the physician is aware of impact of practice on outcomes, s/he will attempt to maximize utility by making decisions concerning the amount of time invested in practicing surgery, performing other professional activities, and leisure. One could imagine constructing a utility model to be solved structurally, that would predict the physicians investment in various aspects of practice, (e.g. surgeries, office visits, research, and networking activities), and leisure time. The model would be influenced by the income generated by each activity and the utility of income, and the utility of the activity itself – not withstanding income. Assuming physicians derive utility from high quality performance, and physicians know there is a positive relationship between quality outcomes and the amount of time spent practicing, part of the physician's utility maximization process will be allocating the ideal amount of practice time. Solving this complex utility maximization model requires variables concerning the physician practices and preferences that are currently not available. However, data concerning physician investments in practice and resulting outcomes over several years are available.

The traditional models for predicting quality are flow models. They utilize one year (or less) physician volume to predict patient outcome. The application of this technique implies that the contribution to quality of the physician's past activities is adequately reflected in the outcomes generated through the volume of cases undertaken in the past year. This result would imply that a novice physician, just starting out, would rapidly come up to speed if s/he performed an adequate number of cases, and that gaps in activity that extend over significant periods of time do not matter; as long as there is adequate volume when the physician returns to practice. If this is true, continuous investment becomes less important. A relevant analogy might be that of riding a bicycle – once you learn, you never forget how. On the other hand, a stock model, in which the physician accumulates skill over several years of continuous practice has different implications. Extended gaps in service, or continued low volume matter. We expect the quality to decline over time. The analogy is that of the concert pianist – continued repetition is necessary to maintain virtuoso status. Gaps in career are likely to lead to detriment in performance.

Findings from educational models, a few of which are discussed above, generally support a stock model as opposed to a flow model. I therefore use the data available and some ideas on memory and learning presented by Yianis Sarafidis to begin to explore a stock model for learning.

4.4 Stock Model and Application and Results

Yianis Sarafidis describes a situation in which political candidates must decide the size of investment at various points of their campaigns, given assumptions concerning their constituencies' learning and memory processes. The learning and memory processes discussed are applicable to a variety of learning activities, including, I believe, the learning process for surgeons (Sarafidis, 2007).

Sarafidis bases his work on two important and well accepted facets of memory. First, that more recent memories are stronger than past memories – memories decay over time; and second, that a memory "rehearsal effect" exists. The "rehearsal effect" is due to the fact that repetition reinforces memory. An agent who repeats activities performed in the past, will reinforce these memories. Using these concepts, Sarafidis argues that memory decays over time, but that given existence of the rehearsal effect, repetition of activities over time will provide a memory boost(Sarafidis, 2007).

Following Sarafidis:

I assume that time is discrete, such that T = 1, 2, 3, ...T.

In each period, I assume an event (a physician performs surgery), e_t can occur. If an event occurs, $e_t = 1$. If not, $e_t = 0$. At the end of T periods, an event history $(e_1, e_2, e_3 ... e_T)$ exists.

Recall is imperfect. I define a variable for memorability, M_t^i for the strength of memory $e_i = 1$ at time T. At time T an agent will remember an event as an increasing function of event memorability M_t^i.

Memories fade over time: M_T^i decreases with time. Assume that memories decay exponentially at a constant rate ρ.

However, similarities and repetition increase memorability. Repeating an event today can trigger a memory of a past event, making the past even more memorable. Sarafidis defined a variable b_t^i to denote the enhancement of memory of a passed event in time i by the performance of a similar even in time t. b_t^i can be thought of as a memory boost. The size of the memory boost will depend on the time that has elapsed between the initial event and the event that rehearses it.

I now assume that rehearsal of a past event from time i by a similar event at time t + 1 is a fraction of $\kappa < 1$ of that event by a similar event at time t: $b_{t+1}^i = \kappa * b_t^i$. I also assume that the incremental memory boost of a t period event at t + 1 is less than its current memorability, so that $\kappa < \rho$. (The t+1 memorability of a t period event is ρ.)

Assuming that $i < t$, this can be summarized as follows: $M^i_{t+1} = \rho M^i_t + b^i_{t+1} I(e_{t+1} = 1)$ and $b^i_{t+1} = \kappa b^i_t$ where I is the indicator function and $I(e_t = 1) = 1$ if $e_t = 1$ and 0 otherwise.

The number of events that an agent remembers is a random variable, with an upper bound $\Sigma_{i=1} I e_i = 1$. If the probabilities of recall are proportional to the memorabilities at time T, M^I_T, then the expected number of events remembered at time T is proportional to the sum of the memorabilities at time T. Denote this a $A_T = \Sigma^T_{i=1} M^i_T$.

Now using the identity, $M^t_i = b^t_i = 1$ and the equations $M^i_{t+1} = \rho M^i_t + b^i_{t+1} I(e_{t+1} = 1)$ and $b^i_{t+1} = \kappa b^i_t$ from above, and summing over i we calculate the evolution of A over time:

$\Sigma^{t+1}_{i=1} = \Sigma^t_{i=1} M^i_{t+1} + I(e_{t+1} = 1) = \Sigma^t_{i=1}[\rho M^i_t = I(e_{t+1} = 1) b^i_{t+1}] + I(e_{t+1} = 1)$ $= \rho \Sigma^t_{i=1} M^i_t + I(e_{t+1} = 1)(1 + \Sigma^t_{i=1} b^i_{t+1}) = \rho \Sigma^t_{i=1} M^i_t + I(e_{t+1} = 1) * (1 + \kappa \Sigma^t_{i=1} b^i_t)$

and

$\Sigma^{t+1}_i b^i_{t+1} = \Sigma^t_{i=1} b^i_{t+1} + I(e_{t+1} = 1) = \kappa \Sigma^t_{i=1} b^i_t + I e_{t+1} = 1$

Sarafidis then defines $S_t = \Sigma^t_{i=1} b^i_t$, rehearsal stock and rewrites the equations for memorability:

$A_{t+1} = \rho A_t + I(e_{t+1} = 1) * (1 + \kappa S_t)$ and for memory stock:

$S_{t+1} = \kappa S_t + I(e_{t+1} = 1)$.

I make a small modification to Sarafidis' model, by assuming more than one event (a surgery) can occur in any given period. If more than on surgery occurs, I multiply the indicator by the number of surgeries completed for the model. For simplicity, I implement a model that lags each physician's case volume by one year, so that the physician's 2007 volume history would begin with the physician's 2006 cases. I apply the model first to all cases and to Cardiologists only. The model is then implemented as follows. Assume a physician works five periods and performs 3,4,2,0,5 cases. We calculate his memory stock at the beginning of the next period as follows:

$5 * 1$ (Assumes he has perfect memory of the cases from the prior period

$+2 * (\rho^2 + \kappa^2)$ (Since he performed no cases in the second most recent period, no memory boost occurs.)

$+4 * (\rho^3 + \rho\kappa^2 + \kappa^3) + 3 * (\rho^4 + \rho^2\kappa^2 + \rho\kappa^3 + \kappa^4)$

This model has two unknowns, ρ and κ. We assume that $0 < \kappa < \rho < 1$, so that memory decays over time, and the memory boost is always less than the memory decay. Though we can't actually solve the model, we can explore values for ρ and κ for the unknowns by performing a grid search. This will give us some ideas on how learning might work. We can ask how fast does memory decay occur, and is there evidence of a contribution to performance based on past experience? I begin by predicting one year's mortality (2007) using 7 year's data (from 2000 to 2006). I use the all case data base using the all case data base. I run the initial logit model repeatedly, for various values of ρ and κ until outcomes predicted are consistent wit the practice makes perfect theory and display storng goodness of fit. This occurs when $\rho = 0.2$ and $\kappa = 0.13$. However, because of the overall low mortality rate, one year does not have adequate predictive power. I therefore increase the years used to predict mortality to two, and then to three; using 6 and 5 years history to predict mortality, respectively, and maintaining the same values for ρ and κ. Results are displayed in Table 21.

Table 21: Learning Stock Model

Year = 2007, 7 Years History: 2000 to 2006			
Mortality	OR	Z	p>Z
Op MD High	0.569	-1.59	0.111
Op MD Moderate	0.555	-1.68	0.092
Peer Very High	0.803	-0.64	0.524
Peer High	1.003	0.01	0.993
Peer Moderate	1.275	0.71	0.476
Years = 2006 to 2007, 6 Years History: 2000 to 2006			
Mortality	OR	Z	p>Z
Op MD High	0.524	-1.85	0.064
Op MD Moderate	0.500	-2.01	0.045
Peer Very High	0.821	-0.58	0.564
Peer High	1.026	0.07	0.942
Peer Moderate	1.268	0.70	0.483
Years = 2005 to 2007, 5 Years History: 2000 to 2006			
Mortality	OR	Z	p>Z
Op MD High	0.559	-2.81	0.005
Op MD Moderate	0.622	-2.32	0.020
Peer Very High	0.723	-1.65	0.100
Peer High	0.747	-1.49	0.137
Peer Moderate	0.826	-0.97	0.333

These results imply that memory decay over a year's time is 80 percent, and that the memory boost from past events is 13 percent. For the purpose of comparison, Table 22 presents values for no memory decay or memory boost, $\rho = 0.8$ and $\kappa = 0.65$, and $\rho = 0.5$ and $\kappa = 0.37$ and adds Cardiologists only to the model. As can be seen, the results are stronger for Cardiologists than for the all case data base. This is most likely due to the fact that there a many more low volume physicians in the all case data base. Therefore, the data is skewed left. I have used terciles to separate volume categories, and the skewedness limits the variability of the data by volume category. Given these results, one might ask which model, the flow model or the stock model, predicts outcomes better. The models are difficult to compare, because the underlying assumptions and construction of the models are somewhat different. Both the flow and the stock model support the idea that increased volume results in better outcomes. If we apply the stock model without applying the discounting, the volume-outcome results are not as strong. Therefore, the discounting of past activity is important to the predictive power of the model. This also supports the theory that the effect is

Table 22: Learning Stock Model: Comparison of Values for ρ and κ

Year = 2005 to 2007: 5 Years History 2000 to 2006						
$\rho = 0.2$, $\kappa = 0.13$						
	All Cases			**Cardiologist Only Cases**		
Mortality	OR	Z	p>Z	OR	Z	p>Z
Op MD High	0.559	-2.81	0.005	0.367	4.69	0.000
Op MD Moderate	0.622	-2.32	0.020	0.404*3.82	0.000	
Peer Very High	0.723	-1.65	0.100	1.033	0.16	0.870
Peer High	0.747	-1.49	0.137	0.845	0.85	0.697
Peer Moderate	0.826	-0.97	0.333	1.142	0.65	
Year = 2005 to 2007: 5 Years History 2000 to 2006						
No Discounting						
	All Cases			**Cardiologist Only Cases**		
Mortality	OR	Z	p>Z	OR	Z	p>Z
Op MD High	0.718	-1.27	0.204	0.412	-4.04	0.000
Op MD Moderate	0.799	-0.87	0.382	0.597	-2.22	0.026
Peer Very High	0.610	-2.60	0.009	1.045	0.220.827	
Peer High	0.633	-2.42	0.016	0.838	0.90	0.369
Peer Moderate	0.770	-1.32	0.185	1.181	0.81	0.417
Year = 2005 to 2007: 5 Years History 2000 to 2006						
$\rho = 0.8, \kappa = 0.65$						
	All Cases			**Cardiologist Only Cases**		
Mortality	OR	Z	p>Z	OR	Z	p>Z
Op MD High	0.693	-1.40	0.162	0.435	3.77	0.000
Op MD Moderate	0.777	-0.98	0.3282	1.90	0.058	
Peer Very High	0.618	-2.51	0.012	1.035	0.17	0.865
Peer High	0.641	-2.34	0.019	0.832	0.83	0.406
Peer Moderate	0.775	-1.29	0.198	1.187	0.83	0.406
Year = 2005 to 2007: 5 Years History 2000 to 2006						
$\rho = 0.5, \kappa = 0.37$						
	All Cases			**Cardiologist Only Cases**		
Mortality	OR	Z	p>Z	OR	Z	p>Z
Op MD High	0.624	-2.00	0.046	0.374	-4.60	0.000
Op MD Moderate	0.750	-1.25	0.210	0.476	-3.18	0.001
Peer Very High	0.683	-1.92	0.055	1.051	0.25	0.803
Peer High	0.702	-1.79	0.073	0.844	0.86	0.391
Peer Moderate	0.814	-1.02	0.307	1.171	0.77	0.442

caused by learning, rather than by a physician's quality work performance resulting in increased referrals. The discounting effect applies to memory decay, which would not occur in the alternative model.

One way of understanding the contribution of stock and flow is to apply a mixed model. To do so, I look at the 12 month lag model to assess the first year's impact.

For the remainder of the years, I apply the stock model with memory decay, having removed the first lagged year. I find that when I examine all cases the results are not significant. However, this analysis most likely flawed due to the low level of variability in the sample. Recall that 47.5 percent of the physicians in our sample have volumes of fewer than twelve cases per year. For this reason I defined volume categories for the initial analysis based on thresholds of interest, rather than splitting the group evenly. However for the stock model, I split the data into terciles. This has the natural effect of reducing variability among the volume categories.

When analyzing the Cardiology data, however, I noted that the variability increased somewhat, when compared to the full data set, (though it was still skewed to the left). Applying the model to the Cardiologist only population predicts a significant contribution from memory stock. Table 23 presents the results for all cases and for cardiologists only. As can be seen, when flow and stock model are presented separately for cardiologist, both contribute to the predicted quality outcome. Thus,if this model is accurate we expect that the most recent activity influences cases. However, in addition, a physicians past experience including volume and continuity also influences current outcomes.

Table 23: Learning Stock Model: Lag and Stock Model Using All Cases and Cardiologists Cases Only

One year Lag Model						
	All Cases			**Cardiologist Only Cases**		
Mortality	OR	Z	p>Z	OR	Z	p>Z
Op MD Very High	0.603	-3.99	0.000	0.466	-4.91	0.000
Op MD High	0.658	-3.77	0.000	0.514	-4.94	0.000
Op MD Moderate	0.666	-3.33	0.000	0.549	03.84	0.000
Peer Very High	0.688	-3.04	0.002	0.956	-0.33	0.738
Peer High	0.771	-2.10	0.029	1.001	0.01	0.996
Peer Moderate	0.795	-1.86	0.063	0.912	-0.58	0.562
Memory decay						
Years = 2005 to 2007, 4 Years History: 2000 to 2005						
$\rho = 0.2, \kappa = 0.13$						
	All Cases			**Cardiologist Only Cases**		
Mortality	OR	Z	p>Z	OR	Z	$p > Z$
Op MD High	0.767	-1.38	0.169	0.445	-3.51	0.000
Op MD Moderate	0.826	-0.96	0.336	0.605	-1.98	0.048
Peer Very High	0.591	-2.74	0.006	1.015	0.07	0.942
Peer High	0.593	-2.68	0.007	0.813	-1.05	0.292
Peer Moderate	0.729	-1.51	0.130	1.155	0.70	0.486

Another way to evaluate the models effectiveness is to examine goodness of fit. Because the models contain nearly as many covariate patterns as observations, I cannot apply the Pearson chi^2 goodness-of-fit test. Instead I apply the grouping methodology proposed by Homser and Lemeshow in Chapter 5 of their book, **Applied Logistic Regression** (Hosmer and Lemeshow, 2000). This methodology groups the data by predicted probabilities into 10 groups of equal size. This estimation yields a χ^2 distributed statistic with 8 degrees of freedom. Table 24 compares the flow model results to the stock model results with and without memory decay using all cases.

Table 24: Physician Learning: Flow Model and Stock Models: All Cases

Flow Model			
Mortality	OR	Z	p>Z
Op MD Very High (261+ cases)	0.621	-4.13	0.000
Op MD High (75 - 260 Cases)	0.625	-4.70	0.000
Op MD Moderate (12 - 74 Cases	0.648	-3.69	0.000
Homser Lemeshow GOF ($\chi^2(8)$)	7.22	$Prob > \chi^2$	0.5135
Stock Model No Memory Decay			
Mortality	OR	Z	p>Z
Op MD High (Top Tercile)	0.718	-1.27	0.204
Op MD Moderate (Middle Tercile)	0.799	-0.87	0.382
Homser Lemeshow GOF ($\chi^2(8)$)	6.26	$Prob > \chi^2$	0.6179
Stock Model with Memory Decay			
Mortality	OR	Z	p>Z
Op MD High (Top Terceil)	0.559	-2.81	0.005
Op MD Moderate (Moddle Tercile)	0.622	-2.32	0.020
Homser Lemeshow GOF ($\chi^2(8)$)	7.22	$Prob > \chi^2$	0.5131

All three models have relatively strong goodness of fit measures. It should be noted, that the stock model proposed here is applied in a rather crude format. For convenience of computation, a year lag model is applied. It is likely that fitting a model similar to the most recent lag model in Chapter 1 would yield more accurate and stronger results. The stock model could be used to assess questions concerning long term learning and performance. For example, one could analyze whether gaps in practice result in changes in quality outcomes, and how long such gaps would need to exist before such an effect could be observed.

4.5 Discussion and Conclusions

This chapter assesses the issue of referral bias, by considering how patients are referred to physicians and adding variables reflecting documented referral patterns to the model. There is considerable evidence from surveys that consumers consider cost and/or insurance coverage when selecting a specialist. Insurance contracting that determines coverage is likely to be more related to low cost than high quality, and would therefore be unlikely to cause a quality referral bias. Consumers also consider their primary physician's recommendations, and recommendations from friends and family in selecting a specialist. However, there is also strong evidence that few consumers review quality or understand quality information that is currently posted on the internet. Therefore when consumers receive recommendations from family members, it is not likely that the input will be strongly reflective of quality outcomes. It is more likely that it will be related to the quality of physician's communication and "bed side manner" of the physician. This factor was found to be most important in the survey conducted by the American Board of Medical Specialists (ABM, 2008).

However, consumers are interested in quality of their physicians. This is reflected in their frequent inquiries as to board certification status (ABM, 2008), and their reliance on their primary care physician, most often a trusted expert in the eyes of the consumer, for specialist referrals (Tu and Lauer). It is difficult to predict all factors a referring physician may consider when making a specialist referral. Some of these may be influenced by networking and formal affiliations. For example, if the physicians are part of the same group practice or participate in the same commercial insurance plans, network referrals are likely. They may also consider quality. By considering the factors that researchers identified as being indicative of higher quality, and adding these factors to the model, I should be able to identify quality referral bias. However, none of the selected indicators influenced the outcome of the model, and none were significant in predicting mortality. I therefore conclude that for this population, it is unlikely that a quality referral bias exists, and the volume outcome effect is due to learning.

I make this assumption and begin to explore a stock model for the accumulation of knowledge through practice. Although I do not have access to necessary information to complete an analysis of physicians' decision making process in maximizing utility, the data on physicain volume and outcomes is rich. I incorporates the importance of practice through the recognition of a rehearsal effect suggested by Yianis Sarafidis (Sarafidis, 2007). I am able to fit a potential model that recognizes that memory declines over time, and that people are most likely to remember recent occurrences. However, repetition of events results in a memory boost, that allows for improved memories of past events when repeated. These concepts are consistent with current educational practices and theory. The application of this model implies that operators can maximize their effectiveness in provision of care to patients by investing enough time in the performance of surgical cases so that they maintain state-of-the-art skills. Developing the model further would allow for the examination of such issues as gaps in practice time and return on investment to the provider from additional practice.

In addition, it is clear from separating the Cardiology specialists from other practitioners, that many non-Cardiologist practitioners are performing a low volume of cases, perhaps as part of a coverage arrangements. Because of the importance of repetition for this service, the practice of using low volume physicians who do not perform PCI procedures frequently will likely result in an increased number in-hospital deaths for AMI patients undergoing PCIs.

5 Chapter Three: A Panel Model for Volume Outcome Analysis

Abstract

Context: A frequent criticism of volume-outcome analyses is that so few researhers have applied panel data analysis. In fact, most use cross-sectional approaches with few years of data. A panel data approach would allow for the analysis of the impact of changes in volume over time. In addition, the application of a fixed effect model might provide further clarification of the existence of referral bias. In this chapter I develop and fit a panel data model to the data set.

Objective: The objective is to gain a better understanding of the volume-outcome effect through the implementation of a panel data approach to analysis. Specifically, I explore whether any additional conclusions can be drawn regarding referral bias.

Design Setting, and Participants: A challenge for completing meaningful panel analysis using logistic model is identifying an appropriate means of grouping the data, given the number of low volume physicians in the data set. Physicians who have only a few cases per year, and those whose volume is sporadic over the years, may not experience changes in outcomes. Their data is therefore not included in a fixed analysis, since the fixed analysis relies in changes in performance over time. Initial analyses of physician data by category indicates that it is possible that low volume physicians have a tendency to treat patients with higher severity of illness. (See Table 3 for details.) In addition, case mix or severity adjustment is recognized widely as an acceptable and necessary technique for making meaningful comparisons. I therefore perform a cluster analysis, grouping physicians who have patients with the most similar diagnoses together. The result is 50 mutually exclusive groupings of physicians by patient clinical risk. I then apply conidtional logit (fixed effects model) and a random effect model to implement a panel data analysis.

Main Outcome Measure: In-hospital mortality

Results: Results confirm the existence of a robust volume-outcome effect.

The results are consistent over several methodological variations. A Hausman Test is implemented to determine whether the fixed or variable effects model is preferable. The results indicate that the random effects model is appropriate. Little evidence of referral bias exists.

Conclusions: This analysis provides strong evidence that the volume-outcome

effect for AMI patients treated with PCI is due to physician learning, as opposed to referral bias. It also provides a modeling technique that can be easily replicated to test other diagnoses. Policy makers should consider policies that would maximize the effect of physician learning throughout the delivery system, and eliminate the practice of using very low volume providers for emergent PCIs.

One important criticism of volume outcome studies is that few have used a panel data approach for modeling. The panel data approach would allow for the assessment of outcomes throughout the course of several years of practice, as opposed to only allowing brief snapshots derived from purely cross-sectional approaches. In addition, a panel data model would allow for assessment utilizing a fixed effects approach. The use of this approach, provides the opportunity to examine the issue of quality referral bias. The argument for the existence of a quality referral bias is that some physicians provide a higher level of care to patients, and that these physicians are known in the community. Because they are known, they receive more referrals and therefore have higher volume than those who do not have a reputation for high quality, (see (Luft et al., 1987) and (Farley and Ozminkowski, 1992) for examples of this discussion.) These effects are physician specific, and systematic; therefore, they are likely correlated with the conventional volume-outcome model's regressors or error term, even though they are not expressed in the model. The result is a biased model.

Since the factors are consistently associated over time with individual (high quality) physicians, we should be able to eliminate the factors through application of a fixed effect model, and, therefore, assess the effect of volume while controlling for referral bias. We can then compare the results with a random effects panel model to determine the most appropriate application. This chapter is organized as follows. First, the flow model from Chapter 1 is evaluated for potential weaknesses. Next logistic panel data models are fitted and evaluated, but found to be inapplicable. In the third section I explore modifications to the original model, and an alternative model is selected and presented. In the last section I discuss the implications of using the panel data model and conclude.

5.1 Evaluation of Pooled Cross-Sectional Flow Model

In Chapter 1, I adopt a pooled cross-sectional approach to modeling volume-outcome effect. I lag the physician volume data by month, so that the physician's current quality performance is predicted based on his/her most recent 12 months of historical volume. Year dummy variables are applied, so that influences in changes of technology or time are considered. This approach is an alternative to a panel data model and should yield similar results. However, concerns with application of this model exist. This method increases precision by increasing the number of observations by combining several time periods of data for each individual. But errors are more likely to be correlated over time by individual and to be heteroskedastic. This may result in inflated significance estimates. Standard errors may be underestimated and Z values overestimated. (See (Cameron and Trivedi, 2005) Chapter 21 for a more detailed discussion.) In order to control for these effects, it is necessary to apply panel-robust sandwich standard error estimates that correct for both heteroskedasticity and serial correlation. The estimator can be expressed as

$$\hat{V}[\hat{\theta}_{OLS}] = [\Sigma_{i=1}^{N}\widetilde{W}_i'\widetilde{W}_i]^{-1}\Sigma_{i=1}^{N}\widetilde{W}_i'\hat{u}_i\hat{u}_i'\widetilde{W}_i[\Sigma_{i=1}^{N}\widetilde{W}_i'\widetilde{W}_i]^{-1}$$

The results, displayed in Table 25 reveal little difference between the two models. Therefore, we can be satisfied that our results from Chapter 1 are robust to serial correlation and heteroskedasticity.

Table 25: Most Recent Lag Model Logit and Logit with Cluster Robust Standard Erros

	Default se			**Cluster Robust se**		
Mortality	OR	Z	p>Z	OR	Z	p>Z
Op MD Very High (261+ cases)	0.621	-4.13	0.000	0.620	-3.74	0.000
Op MD High (75 - 260 Cases)	0.625	-4.60	0.000	0.623	-4.52	0.000
Op MD Mod. (12 - 74 Cases)	0.649	-3.69	0.000	0.647	-3.62	0.000
Peer Very High	0.766	-2.74	0.006	0.766	-2.56	0.011
Peer High	0.763	-2.87	0.004	0.764	-2.59	0.010
Peer Moderate	0.750	-3.11	0.002	0.751	-2.83	0.005

5.2 Panel Data Model

I now move to fitting the data into a panel data model. I apply the most recent lag model from Chapter 1. In order to allow for recognition of changes in volume over time, I calculate the natural log of volume for each physician for each month, and use this as my primary independent variable. The model is a panel data model. Each physician will have individual effects. My dependent variable, y_{it} takes on the value of 0 if the patient is discharged alive from the hospital, and 1 if the patient dies in the hospital, with

$Pr[y_{it} = 1|x_{it}, \beta, \alpha_i] = \Lambda(\alpha_i + x'_{it}\beta)$
where:

- $\Lambda(.)$ is the logistic cdf with $\Lambda(z) = e^z/(1 + e^z)$,
- i = 1,2,3...,n in this case represent individual physicians, and
- t= 1,2,3..7 = time in years.

I assume conditional independence, and express the joint density for the i*th* observation as

$$f[y_i|X_i, \alpha_i, \beta] = \Pi_{t=1}^{T} F(\alpha_i + x'_{it}\beta)^{y_{it}}(1 - F(\alpha_i + x'_{it}\beta))^{1-y_{it}}$$

(See (Cameron and Trivedi, 2005), p. 795).

5.2.1 Fixed and Random Effects Model

For the logit model, the joint density function can be expressed as

$$f(y_i|\alpha_i, x_i, \beta) = (exp(\alpha_i \Sigma_t y_{it})exp((\Sigma_t y_{it} x'_{it})\beta))/\Pi_t[1 + exp(\alpha_i + x'_{it}\beta)]$$

The fixed effects model assumes that the individual effects are systematic, and, therefore, α_i must be eliminated, or it will bias the results of the model. Following Cameron and Trivedi's presentation, for the observation i there are $\Sigma_t y_{it}$ outcomes of 1 in T periods. If we define the set $B_C = \{d_i \Sigma_t y_{it} = c\}$ to be the set of all possible 0s and 1s for which the sum of T binary outcomes is $\Sigma_t y_{it} = c$. If we condition on $\Sigma_t y_{it} = c$ and eliminate α_i, then

$$f(y_i|\Sigma_t y_{it} = c, x_i, \beta) = exp((\Sigma_t y_{it} x_{it'})\beta)/\Sigma_{d \in B_c} exp((\Sigma_t d_{it} x_{it})\beta)$$

(Cameron and Trivedi, 2005). This result is attributed to work done by Chamberlain in 1980. Conditioning on $\Sigma_{t=1}^{T_i}$ we can predict the probability of $y_i = (y_{i1}, y_{i2}...y_{iT_i})$.

Unfortunately, applying this methodology for fixed effects provided little information for low volume physicians, because there are many low volume physicains in the data set, and often there is variability in their results. It is impossible to condition on these cases, so they are dropped from the model. As can be seen from examining Table 26, 968 physicians with 9,284 cases were dropped from the sample. These physicians were primarily members of the low volume group. Their elimination rendered the analysis meaningless.

The random effects results are significant and similar to the pooled cross-sectional cluster robust model results, (also displayed in table 26). However, these results are only relevant if the we can rule out systematic bias. If a systematic bias exists, then the fixed effect model must be applied to control for the bias. We cannot perform testing on the fixed and variable models in this case, because the elimination of so many cases from the fixed effects model makes the models incomparable.

Table 26: Fixed and Random Effect Models: Independent Variable ln_Volume

Fixed Effects			
Mortality	OR	Z	p>Z
ln Op MD Volume	0.991	-0.10	0.917
ln Peer Group	0.967	-0.32	0.750
968 groups and 9,284 observations dropped because all positive or negative outcomes			
Random Effect Model			
Mortality	OR	Z	p>Z
ln Op MD Volume	0.901	-3.73	0.000
ln Peer Group	0.944	-1.38	0.167
$ln^2_\sigma \mu = -1.999226$ se = 0.2817383CI = -2.551423 to -1.447029			
$\sigma\mu = 0.3680291$ se = 0.0518429 CI = 0.2792323 to 0.4850447			
$\rho = 0.039541$ se = 0.106997 CI = 0.23515 to 0.0667402			
Likelihood ratio test of $\rho = 0$ $\bar{\chi}^2(01) = 24.93$ $Prob > \bar{\chi}^2 = 0.000$			
12 point quadrature			
Pooled Cross-Sectional			
Mortality	OR	Z	p>Z
ln Op MD Volume	0.899	-3.73	0.000
ln Peer Group	0.940	-1.62	0.106

5.3 Panel Data Model Alternatives

Because the fixed effects model discussed above inadequately addresses the volume outcome analysis, I reviewed the literature for more meaningful approaches. In 1987 Luft et al. suggest that the a mean variance approach can be taken to defining a mortality variable for analysis. For each patient case, mortality is predicted based on the patient's clinical risk. Then, the predicted outcome is subtracted from the actual mortality outcome (1 for a patient in-hospital death and 0 otherwise). For each case then, a variance calculation between expected mortality and actual mortality can be made. (Luft et al., 1987). Farley and Ozimkowski applied this approach in their 1992 panel data analysis of hospital referral effect. They calculated predicted variances for each case, and then applied a mean difference transformation for each physician (Farley and Ozminkowski, 1992). They then predicted in-Hospital mortality as a function of physician volume and other hospital factors and tested for the presence of fixed effects, using Hausman methodologies for detecting systematic bias. They were unable to identify such bias, for most of the diagnoses they tested. They concluded that for most diagnoses, referral bias does not exist. Barton Hamilton and Vivian Yo applied a similar approach when analyzing mortality of hip fracture patients in Canadian hospitals (Hamilton and Ho, 1998). However, they concluded that referral bias does exist. After consideration I decide not to use a mean transformation model, as to be applicable the model should be liner, with additive effects; and the model requires strong exogenous regressors. ((Cameron and Trivedi, 2005), Chapter 21.) The current model does not meet these criteria.

Next, I explore the possibility of defining larger clusters of physicians. Specifically, I considered grouping the physicians by the clinical risk of the patients they treated. In Chapter 1, I observed that patients admitted to lower volume physicians tended to be more likely to have serious complications than those admitted to higher volume. Generating physician groups with similar diagnoses partially addresses this concern. In addition, the concept of risk adjusting by patient is widely accepted. Risk adjustments are routinely applied and required to make adequate evaluations of resource use and quality outcomes for patients. Grouping physicians by their patients' clinical risk factors expands the size of all of the groups, but does not make use of any known innate quality of physicians that add bias to the analysis.

In 2000, Allan Donner and Neil Klar published Design and Analysis of Cluster Randomization Trials in Health Research. They have posted an educational presentation based on some of the concepts addressed on the internet (**?**) and (**?**). These works are primarily focused on design of randomized trials in field research. However, many of the same concepts apply to this analysis. Some of these concerns are as follows:

- Although the physicians are arranged in clusters, the inferences of the analysis are meant to apply to the individual physician. This can create problems because lack of independence among members of the same cluster. Positive correlations of characteristics of physicians who are members of the same cluster may exist.

- Application of clusters results in reduction in effective sample size, because of between-cluster variation. Therefore the standard approach for sample size estimations and power analyses are not applicable. Use of standard statistical method tend to bias p-values downward.

- All of the covariates in the analysis will be applied to all members of the cluster the same way. This may have unintended consequences, if a high level of variability exist among individual clustered group members for some variables;

- Patients may select physicians based on similarities, and this may result in increase similarities in characteristics among members of the clusters;

Since my goal is to develop mutually exclusive groups, I develop k-mean clusters of physicians including all the diagnostic variables used in the regressions for risk adjustment. (See Appendinx A.) I use the Jaccard measure, which groups binary measures with similar coefficients, such that the proportion of measures when at least one of the variables has a one are grouped; also, if both vectors are all 0, they are treated as similar and grouped together. Stata provides a program that finds similar groups using the Jaccard approach iteratively, given that the researcher identified the number of clusters desired.

Because the sample size is effectively reduced when using cluster analysis, I evaluate my cluster results, following a methodology suggested by Kerry and Bland in their Statistics Note published in the British Medical Journal in February 1998 (**?**). The focus of this article was to instruct researchers in study design when using cluster randomization. However, methodologies used are applicable to this situation.

- For a non-clustered design, we can calculate necessary sample size to assess the difference between two means, as $n = 21 \times s^2/d^2$, for power = 90 percent and a significance level = 5 percent.
- Our outcome measure is the proportion of in-hospital mortalities, based on the mean for all patients for all physicians, compared to the means for the clusters.
  - Let m = patients in a cluster and sw^2 = the variance of observations for one cluster.
  - Then sw^2/m is the variance of a single sample mean.
  - Let sc^2 = the true cluster mean variance. This will vary from cluster to cluster.
  - The observed variance of cluster means will be the sum of variance between clusters and within clusters:
    - $s^2 = sc^{@} + sw^2/m$

I analyze the available data to provide estimates.

- The mean mortality for the entire sample is 0.0155181, with variance by individual physician of 0.0005154.
- The mean mortality of cluster groups is 0.0155148 with 0.003267 variance by cluster group.
- The average patients per cluster is 1,956.8 with a range of 207 to 9,102.
- I estimate $s^2 = 0.003267 + 0.0005154/1,956.8 = 0.003268$
- Substituting into the original expression, $n = 21 \times s^2/d^2$, in order to detect a difference in mortality of 5 percent, from (1.55 percent to 1.62 percent, for example), we need a sample size of 28, ($n = 21 \times 0.003268/0.05^2$)

Using this logic, I conclude that the sample size for the 50 cluster analysis is more than adequate.

Jane F. Pendergast et al. published a survey of methods for analyzing clustered binary response data in the **International Statistics Review** in 1991 (**?**). In her review she recognizes valid methods for analyzing clustered panel data. The conditional logit model is equivalent to the Stata fixed effects model for Logit. I compare this with the random effects model using the 50 clustered groups, as opposed to using operating physicians as the group. These models control for intra-cluster correlation, which is a major concern of cluster modeling. In addition, the Stata programs allow for the creation of many clusters, with many variables per clusters. (The variables range from 207 to 9,102 per cluster.) The data characteristics reduce the likelihood of adverse impact from intra-cluster correlation. Results of the fixed and variable effects models for the cluster groups are displayed below in Table 27. We see that the fixed and random effects models yield similar results, which are also similar to the random effects model using operating physicians as the group. I now perform a Hausman test to determine whether the fixed effects model or the random effects should be utilized.

The Hausman test indicates that differences between the fixed and random effects for the clustered model are not significant. In addition, both models yield similar results that predict a strong inverse relationship between volume and outcome. The results are very consistent with the results derived from the pooled cross-sectional model and from the random effects model using operating physician groups.

5.4 Discussion and Conclusion

I have compared the results from the pooled-cross-sectional model and the panel data analysis. The models consistently demonstrate a volume-outcome effect. Implementation of a fixed effect model produces the same result, having eliminated possible systematic bias. The Hausman test does not detect significant differences between the fixed and random effects model. I therefore conclude that for patients receiving PCI as treatment for AMI, a referral bias does not exist. The cause of the volume outcome effect is physician learning. Given these robust and consistent results, along with the increased cost of operating smaller programs, serious consideration of implementing policies ensuring that physicians treating AMI patient with PCI should perform a minimum number of procedures to maintain reduced risk of patient mortality should be considered.

Table 27: Fixed and Random Effect Models: Independent Variable ln_Volume Using 50 groups Clustered by Patient Diagnoses

Fixed Effects Model: 50 Clustered Groups by Diagnoses			
Mortality	OR	Z	p>Z
ln Op MD Volume	0.900	-4.28	0.000
ln Peer Group	0.939	-1.75	0.080

Random Effect Model: 50 Clustered Group by Diagnoses			
Mortality	OR	Z	p>Z
ln Op MD Volume	0.899	-4.31	0.000
ln Peer Group	0.939	-1.75	0.081

$ln^2_{\sigma}\mu = -4,18118$ $se = 1.04738$CI = -6.23387 to -2.1285

$\sigma\mu = 0.123614$ $se = 0.064731$ CI = 0.044293 to 0.344987

$\rho = 0.0040623$ $se = 0.00482$ CI = 0.000596 to 0.034194

12 point quadrature

Random Effects Model: Group Operating MD			
Mortality	OR	Z	p>Z
ln Op MD Volume	0.901	-3.73	0.000
ln Peer Group	0.944	-1.38	0.167

$ln^2_{\sigma}\mu = -1.999226$ $se = 0.2817383$ CI = -2.551423 to -1.447029

$\sigma\mu = 0.3680291$ $se = 0.0518429$ CI = 0.2792323 to 0.4850447

$\rho = 0.039541$ $se = 0.106997$ CI = 0.23515 to 0.0667402

Likelihood ratio test of $\rho = 0$ $\bar{\chi}^2(01) = 24.93$ $Prob > \bar{\chi}^2 = 0.000$

12 point quadrature

Table 28: Hausman Test: Fixed and Random Effect Models: Using 50 Groups Clustered by Patient Diagnoses

	(b) Fixed Effects	(B) Random Effects	(b - B) Difference	(Sqrt(diag $(V_b - V_B)$)
ln Op MD Volume	-0.10474	-0.10614	-0.0013978	.
ln Peer Volume	-0.06335	-0.06301	-0.0003496	0.001419

B is inconsistent under H_a, efficient under H_0; obtained from xtlogit

Test: H_0 difference in coefficients not systematic

$\chi^2(54) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 30.66$

$Prob > \chi^2 = 0.9757$

$(V_b - V_B notpositivedefinite)$

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A Appendix 1 Complete Set of Regressions from Chapter 1

A.1 Independent Variable: Operator's Total PCI Volume

Table 29: Logit Regression Conventional Model Using All AMI Cases with Operator's Total PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVeryHigh	0.539	-4.72	0.000	0.418	0.697
opmdHigh	0.562	-5.07	0.000	0.450	0.702
opmdModerate	0.604	-3.88	0.000	0.469	0.780
PeerVeryHigh	0.963	-0.22	0.826	0.689	1.347
PeerHigh	0.872	-0.82	0.413	0.629	1.210
PeerModerate	1.373	2.01	0.044	1.008	1.872
Black	0.837	-1.30	0.193	0.641	1.094
Asian	1.298	1.20	0.229	0.849	1.985
Hispanic	1.139	1.16	0.247	0.913	1.422
OtherRace	1.106	0.86	0.390	0.878	1.394
UnknownRace	0.937	-0.65	0.518	0.770	1.141
ER	1.046	0.73	0.464	0.927	1.181
Female	1.820	1.63	0.103	0.887	3.737
Medicaid	1.160	1.26	0.208	0.921	1.463
Uninsured	1.385	1.76	0.079	0.963	1.993
PrivateInsurance	0.851	-1.72	0.085	0.708	1.022
OtherInsurancee	0.656	-1.47	0.142	0.374	1.152
AdmitLTC	1.306	1.53	0.126	0.927	1.840
meanage	1.042	10.19	0.000	1.033	1.050
AgeSex	0.995	-0.99	0.323	0.985	1.005
AnteriorInfarct	1.303	3.69	0.000	1.132	1.500
SubendInfarct	0.425	-11.74	0.000	0.368	0.490
CurrentSmoker	0.558	-5.23	0.000	0.448	0.694
HistSmoker	0.441	-5.16	0.000	0.323	0.601
CancerDx	0.820	-1.85	0.064	0.666	1.011
ChronCerebrovas	0.284	-3.84	0.000	0.150	0.540
ChronLiverDis	2.242	0.77	0.439	0.290	17.330
COPD	1.387	1.97	0.049	1.002	1.922
Cardiomyopathy	0.851	-1.01	0.313	0.621	1.165
HistPTCA	0.698	-2.81	0.005	0.543	0.897
HistCABG	0.877	-0.98	0.326	0.675	1.140
HistMI	0.720	-2.63	0.009	0.563	0.920
CHF	2.056	11.31	0.000	1.813	2.329
ValveDis	1.228	2.50	0.013	1.045	1.443

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Hypertension	0.659	-6.70	0.000	0.584	0.745
Paralysis	2.581	3.51	0.000	1.520	4.384
FluidDis	2.848	15.02	0.000	2.485	3.265
OtherNeuro	2.975	12.06	0.000	2.492	3.552
ChronPulmDis	0.826	-1.29	0.199	0.616	1.106
DiabeteswoCompl	1.098	1.41	0.157	0.965	1.250
DiabetesCompl	4.959	20.97	0.000	4.269	5.759
RenalFail	1.176	1.48	0.139	0.948	1.459
LiverDis	0.613	-0.47	0.638	0.079	4.721
HIV	0.595	-0.51	0.612	0.080	4.419
Coagulopathy	2.504	8.47	0.000	2.0249	3.098
WeekendAdmit	1.165	2.25	0.024	1.020	1.331
AdmitOff	1.132	1.98	0.048	1.001	1.2793
Year2002	0.962	-0.35	0.724	0.777	1.192
Year2003	0.842	-1.54	0.123	0.677	1.048
Year2004	0.907	-0.89	0.373	0.733	1.123
Year2005	0.787	-2.13	0.033	0.632	0.981
Year2006	0.811	-1.89	0.059	0.653	1.008
Year2007	0.879	-1.17	0.240	0.709	1.090

Table 30: Logit Regression One Year Lag Model Using All AMI Cases with Operator's Total PCI Volume as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVeryHigh	0.603	-3.99	0.000	0.470	0.773
opmdHigh	0.658	-3.77	0.000	0.529	0.818
opmdModerate	0.666	-3.33	0.001	0.524	0.846
PeerVeryHigh	0.688	-3.04	0.002	0.540	0.876
PeerHigh	0.771	-2.18	0.029	0.611	0.974
PeerModerate	0.795	-1.86	0.063	0.624	1.013
Black	0.815	-1.5	0.133	0.624	1.064
Asian	1.286	1.16	0.247	0.840	1.970
Hispanic	1.115	0.96	0.335	0.893	1.392
OtherRace	1.099	0.80	0.423	0.872	1.384
UnknownRace	0.916	-0.88	0.380	0.752	1.114
ER	1.018	0.30	0.766	0.903	1.149
Female	1.841	1.67	0.096	0.898	3.776
Medicaid	1.149	1.18	0.240	0.911	1.449
Uninsured	1.391	1.78	0.075	0.967	2.001
PrivateInsurance	0.853	-1.70	0.089	0.709	1.025
OtherInsurance	0.681	-1.35	0.177	0.390	1.190
AdmitLTC	1.233	1.20	0.228	0.877	1.734

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
meanage	1.041	10.18	0.000	1.033	1.050
AgeSex	0.995	-1.02	0.308	0.985	1.005
AnteriorInfarctt	1.319	3.86	0.000	1.146	1.518
SubendInfarctt	0.428	-11.66	0.000	0.371	0.493
CurrentSmoker	0.549	-5.37	0.000	0.441	0.683
HistSmoker	0.437	-5.21	0.000	0.321	0.597
CancerDx	0.824	-1.81	0.070	0.669	1.016
ChronCerebrovas	0.286	-3.84	0.000	0.151	0.542
ChronLiverDis	2.395	0.84	0.401	0.312	18.373
COPD	1.389	1.98	0.048	1.004	1.924
Cardiomyopathy	0.842	-1.07	0.282	0.614	1.153
HistPTCA	0.707	-2.71	0.007	0.551	0.909
HistCABG	0.874	-1.00	0.315	0.673	1.136
HistMI	0.720	-2.62	0.009	0.564	0.921
CHF	2.076	11.47	0.000	1.832	2.352
ValveDis	1.240	2.61	0.009	1.055	1.457
Hypertension	0.656	-6.79	0.000	0.580	0.741
Paralysis	2.530	3.44	0.001	1.490	4.296
FluidDis	2.840	14.97	0.000	2.477	3.256
OtherNeuro	2.953	11.96	0.000	2.473	3.526
ChronPulmDis	0.820	-1.33	0.183	0.613	1.098
DiabeteswoCompl	1.098	1.41	0.159	0.964	1.249
DiabetesCompl	4.955	20.95	0.000	4.266	5.755
RenalFail	1.171	1.44	0.150	0.945	1.452
LiverDis	0.568	-0.54	0.586	0.074	4.347
HIV	0.568	-0.55	0.581	0.076	4.239
Coagulopathy	2.488	8.39	0.000	2.011	3.078
WeekendAdmit	1.169	2.30	0.022	1.023	1.335
AdmitOff	1.138	2.06	0.039	1.006	1.286
Year2002	0.945	-0.51	0.607	0.763	1.171
Year2003	0.826	-1.71	0.087	0.664	1.028
Year2004	0.890	-1.07	0.285	0.719	1.102
Year2005	0.783	-2.18	0.029	0.628	0.975
Year2006	0.799	-2.02	0.043	0.643	0.993
Year2007	0.889	-1.07	0.284	0.717	1.102

Table 31: Logit Regression Most Recent 12 Month Lag Model Using All AMI Cases with Operator's Total PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVeryHigh	0.621	-4.13	0.000	0.496	0.779
opmdHigh	0.625	-4.70	0.000	0.513	0.760

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdModerate	0.648	-3.69	0.000	0.515	0.816
PeerVeryHigh	0.766	-2.74	0.006	0.633	0.927
PeerHighh	0.763	-2.87	0.004	0.634	0.918
PeerModerate	0.750	-3.11	0.002	0.626	0.899
Black	0.821	-1.45	0.148	0.629	1.072
Asian	1.277	1.13	0.260	0.834	1.956
Hispanic	1.132	1.10	0.272	0.907	1.413
OtherRace	1.088	0.72	0.474	0.864	1.370
UnknownRace	0.927	-0.75	0.451	0.762	1.129
ER	1.026	0.42	0.675	0.910	1.157
Female	1.838	1.66	0.097	0.896	3.768
Medicaid	1.157	1.23	0.218	0.917	1.458
SelfPay	1.394	1.79	0.073	0.970	2.005
PrivateInsurance	0.856	-1.66	0.096	0.712	1.028
OtherInsurance	0.674	-1.38	0.167	0.385	1.180
AdmitLTC	1.240	1.23	0.218	0.881	1.745
meanage	1.042	10.22	0.000	1.034	1.050
AgeSex	0.995	-1.02	0.307	0.985	1.005
AnteriorInfarctt	1.313	3.80	0.000	1.141	1.511
SubendInfarctt	0.426	-11.70	0.000	0.369	0.491
CurrentSmoker	0.552	-5.32	0.000	0.443	0.687
HistSmoker	0.438	-5.20	0.000	0.321	0.598
CancerDx	0.823	-1.83	0.068	0.667	1.014
ChronCerebrovas	0.284	-3.84	0.000	0.149	0.540
ChronLiverDiss	2.288	0.79	0.427	0.297	17.611
COPD	1.387	1.97	0.049	1.002	1.921
Cardiomyopathy	0.843	-1.06	0.287	0.616	1.154
HistPTCA	0.705	-2.73	0.006	0.549	0.906
HistCABG	0.873	-1.01	0.310	0.672	1.135
HistMI	0.721	-2.61	0.009	0.565	0.922
CHF	2.069	11.42	0.000	1.827	2.344
ValveDis	1.235	2.57	0.010	1.051	1.451
Hypertension	0.657	-6.76	0.000	0.581	0.742
Paralysis	2.584	3.50	0.000	1.519	4.394
FluidDis	2.841	14.97	0.000	2.478	3.257
OtherNeuro	2.966	12.01	0.000	2.484	3.541
ChronPulmDis	0.823	-1.31	0.191	0.615	1.102
DiabeteswoCompl	1.100	1.45	0.148	0.967	1.252
DiabetesCompl	4.973	21.01	0.000	4.282	5.776
RenalFail	1.174	1.46	0.144	0.947	1.456
LiverDis	0.587	-0.51	0.608	0.076	4.504
HIV	0.570	-0.55	0.585	0.076	4.268
Coagulopathy	2.501	8.44	0.000	2.021	3.093
WeekendAdmit	1.167	2.27	0.023	1.021	1.333

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
AdmitOff	1.137	2.06	0.040	1.006	1.285
Year2002	0.966	-0.32	0.752	0.780	1.197
Year2003	0.855	-1.41	0.159	0.687	1.063
Year2004	0.922	-0.75	0.456	0.745	1.141
Year2005	0.797	-2.02	0.044	0.640	0.994
Year2006	0.821	-1.79	0.074	0.661	1.019
Year2007	0.899	-0.98	0.328	0.725	1.113

A.2 Independent Variable: Operator's Total AMI with PCI Volume

Table 32: Logit Regression Conventional Model No Lag Using All AMI Cases with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmmHighAMI	0.864	(1.22)	0.222	0.683	1.093
opmdModerateAMI	0.936	(0.58)	0.560	0.748	1.170
PeerAMIVerHigh	0.617	(2.80)	0.005	0.441	0.865
PeerAMIHigh	0.755	(1.87)	0.062	0.562	1.014
PeerAMIModerate	0.984	(0.10)	0.918	0.721	1.343
Black	0.788	(1.69)	0.092	0.597	1.040
Asian	1.198	0.79	0.431	0.764	1.879
Hispanic	1.099	0.80	0.425	0.871	1.387
OtherRace	1.059	0.46	0.647	0.830	1.351
UnknownRace	0.868	(1.35)	0.177	0.706	1.066
ER	1.052	0.79	0.428	0.929	1.191
Female	2.164	2.03	0.043	1.026	4.563
Medicaid	1.144	1.10	0.273	0.899	1.455
SelfPay	1.410	1.79	0.074	0.967	2.054
PrivateInsurance	0.862	(1.52)	0.129	0.712	1.044
OtherInsurance	0.779	(0.87)	0.385	0.444	1.369
AdmitLTC	1.395	1.92	0.055	0.992	1.961
meanage	1.043	10.15	0.000	1.035	1.052
AgeSex	0.993	(1.37)	0.170	0.983	1.003
AnteriorInfarct	1.318	3.73	0.000	1.140	1.524
SubendInfarct	0.404	(11.97)	0.000	0.348	0.468
CurrentSmoker	0.571	(4.87)	0.000	0.456	0.716
HistSmoker	0.445	(4.93)	0.000	0.323	0.614
CancerDx	0.805	(1.97)	0.049	0.649	0.999
ChronCerebrovas	0.262	(3.85)	0.000	0.133	0.519
ChronLiverDis	2.345	0.83	0.408	0.311	17.686
COPD	1.370	1.84	0.066	0.980	1.915
Cardiomyopathy	0.820	(1.19)	0.234	0.591	1.137
HistPTCA	0.692	(2.79)	0.005	0.534	0.896
HistCABG	0.884	(0.90)	0.366	0.677	1.155
HistMI	0.711	(2.65)	0.008	0.552	0.915
CHF	2.031	10.74	0.000	1.785	2.312
ValveDis	1.235	2.47	0.013	1.045	1.461
Hypertension	0.649	(6.72)	0.000	0.572	0.736
Paralysis	2.887	3.79	0.000	1.669	4.994
FluidDis	3.022	15.40	0.000	2.625	3.478

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
OtherNeuro	2.902	11.31	0.000	2.413	3.490
ChronPulmDis	0.843	(1.11)	0.266	0.625	1.138
DiabeteswoCompl	1.127	1.75	0.080	0.986	1.288
DiabetesCompl	5.172	20.74	0.000	4.428	6.041
RenalFail	1.173	1.39	0.163	0.937	1.467
LiverDis	0.641	(0.43)	0.666	0.085	4.823
HIV	0.582	(0.52)	0.600	0.077	4.402
Coagulopathy	2.583	8.39	0.000	2.069	3.224
WeekendAdmit	1.163	2.14	0.032	1.013	1.335
AdmitOff	1.143	2.07	0.039	1.007	1.298
Year2002	0.954	(0.42)	0.677	0.765	1.190
Year2003	0.795	(1.97)	0.049	0.633	0.999
Year2004	0.898	(0.96)	0.337	0.720	1.119
Year2005	0.791	(2.03)	0.042	0.630	0.992
Year2006	0.772	(2.26)	0.024	0.617	0.967
Year2007	0.864	(1.29)	0.196	0.693	1.078

Table 33: Logit Regression One Year Lag Model Using All AMI Cases with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHighAMI	0.948	-0.50	0.620	0.769	1.169
opmdModerateAMI	0.865	-1.32	0.186	0.698	1.072
PeerAMIVeryHigh	0.524	-5.31	0.000	0.413	0.666
PeerAMIHigh	0.674	-3.79	0.000	0.550	0.827
PeerAMIModerate	0.813	-1.69	0.090	0.640	1.033
Black	0.773	-1.88	0.060	0.591	1.010
Asian	1.164	0.69	0.491	0.756	1.793
Hispanic	1.093	0.78	0.433	0.876	1.363
OtherRace	1.013	0.11	0.914	0.803	1.277
UnknownRace	0.915	-0.88	0.378	0.752	1.114
ER	1.045	0.72	0.471	0.927	1.179
Female	1.927	1.79	0.074	0.939	3.952
Medicaid	1.122	0.97	0.331	0.890	1.414
SelfPay	1.284	1.33	0.182	0.889	1.855
PrivateInsurance	0.850	-1.73	0.083	0.707	1.021
OtherInsurance	0.681	-1.34	0.180	0.389	1.194
AdmitLTC	1.293	1.48	0.138	0.921	1.816
meanage	1.041	10.01	0.000	1.033	1.049
AgeSex	0.994	-1.13	0.260	0.985	1.004
AnteriorInfarct	1.313	3.79	0.000	1.141	1.512
SubendInfarct	0.416	-12.03	0.000	0.360	0.479

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
CurrentSmoker	0.567	-5.08	0.000	0.455	0.705
HistSmoker	0.449	-5.05	0.000	0.329	0.613
CancerDx	0.829	-1.75	0.079	0.673	1.022
ChronCerebrovas	0.281	-3.87	0.000	0.148	0.535
ChronLiverDis	2.362	0.83	0.407	0.310	18.026
COPD	1.458	2.24	0.025	1.048	2.029
Cardiomyopathy	0.850	-1.01	0.312	0.621	1.164
HistPTCA	0.699	-2.80	0.005	0.544	0.898
HistCABG	0.852	-1.19	0.233	0.656	1.108
HistMI	0.712	-2.71	0.007	0.557	0.910
CHF	2.083	11.52	0.000	1.838	2.359
ValveDis	1.239	2.60	0.009	1.054	1.456
Hypertension	0.650	-6.92	0.000	0.575	0.734
Paralysis	2.533	3.42	0.001	1.487	4.317
FluidDis	2.878	15.14	0.000	2.510	3.300
OtherNeuro	2.960	11.98	0.000	2.478	3.535
ChronPulmDis	0.787	-1.58	0.113	0.585	1.059
DiabeteswoCompl	1.093	1.34	0.180	0.960	1.244
DiabetesCompl	5.085	21.28	0.000	4.378	5.907
RenalFail	1.160	1.35	0.176	0.935	1.438
LiverDis	0.563	-0.56	0.579	0.074	4.284
HIV	0.504	-0.67	0.506	0.067	3.798
Coagulopathy	2.517	8.49	0.000	2.034	3.116
WeekendAdmit	1.174	2.36	0.018	1.028	1.341
AdmitOff	1.135	2.03	0.042	1.004	1.284
Year2002	0.952	-0.45	0.652	0.768	1.180
Year2003	0.845	-1.50	0.133	0.679	1.053
Year2004	0.941	-0.55	0.579	0.760	1.166
Year2005	0.775	-2.27	0.023	0.621	0.966
Year2006	0.816	-1.84	0.066	0.656	1.013
Year2007	0.863	-1.34	0.180	0.696	1.070

Table 34: Logit Regression Most Recent 12 Month Lag Model Using All AMI Cases with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHighAMI	0.834	-1.75	0.080	0.681	1.022
opmdModerateAMI	0.830	-1.74	0.082	0.673	1.024
PeerAMIVveryHigh	0.639	-3.61	0.000	0.501	0.815
PeerAMIHigh	0.612	-4.13	0.000	0.485	0.772
PeerAMIModerate	0.721	-3.43	0.001	0.598	0.869
Black	0.776	-1.86	0.063	0.594	1.014

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Asian	1.244	1.01	0.312	0.814	1.901
Hispanic	1.091	0.77	0.442	0.874	1.360
OtherRace	1.014	0.12	0.905	0.804	1.279
UnknownRace	0.912	-0.92	0.360	0.749	1.111
ER	1.069	1.09	0.276	0.948	1.206
Female	1.886	1.73	0.083	0.920	3.865
Medicaid	1.124	0.99	0.324	0.891	1.417
SelfPay	1.328	1.53	0.126	0.923	1.910
PrivateInsurance	0.850	-1.73	0.083	0.707	1.022
OtherInsurance	0.686	-1.31	0.189	0.392	1.203
AdmitLTC	1.305	1.53	0.125	0.929	1.833
meanage	1.041	10.05	0.000	1.033	1.049
AgeSex	0.995	-1.08	0.280	0.985	1.004
AnteriorInfarct	1.317	3.85	0.000	1.145	1.516
SubendInfarct	0.417	-12.00	0.000	0.362	0.481
CurrentSmoker	0.567	-5.08	0.000	0.456	0.706
HistSmoker	0.450	-5.04	0.000	0.330	0.614
CancerDx	0.825	-1.80	0.072	0.670	1.017
ChronCerebrovas	0.285	-3.83	0.000	0.150	0.542
ChronLiverDis	2.225	0.77	0.442	0.289	17.121
COPD	1.392	1.99	0.046	1.006	1.926
Cardiomyopathy	0.844	-1.06	0.289	0.616	1.155
HistPTCA	0.693	-2.87	0.004	0.539	0.890
HistCABG	0.850	-1.21	0.225	0.654	1.105
HistMI	0.713	-2.70	0.007	0.558	0.911
CHF	2.082	11.54	0.000	1.838	2.359
ValveDis	1.231	2.53	0.011	1.048	1.447
Hypertension	0.654	-6.84	0.000	0.579	0.738
Paralysis	2.519	3.41	0.001	1.480	4.287
FluidDis	2.881	15.21	0.000	2.514	3.302
OtherNeuro	2.988	12.12	0.000	2.504	3.567
ChronPulmDis	0.825	-1.30	0.195	0.617	1.104
DiabeteswoCompl	1.093	1.34	0.179	0.960	1.244
DiabetesCompl	5.086	21.33	0.000	4.380	5.906
RenalFail	1.162	1.37	0.171	0.937	1.441
LiverDis	0.587	-0.51	0.608	0.076	4.501
HIV	0.507	-0.66	0.509	0.067	3.818
Coagulopathy	2.526	8.54	0.000	2.042	3.125
WeekendAdmit	1.167	2.27	0.023	1.021	1.332
AdmitOff	1.132	1.99	0.046	1.002	1.280
Year2002	0.968	-0.29	0.769	0.782	1.200
Year2003	0.842	-1.54	0.123	0.677	1.048
Year2004	0.909	-0.88	0.380	0.734	1.125
Year2005	0.780	-2.22	0.027	0.626	0.972

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Year2006	0.799	-2.03	0.042	0.644	0.992
Year2007	0.867	-1.30	0.192	0.700	1.074

Table 35: Logit Regression Conventional Model No Lag Using Primary PCI with AMI Cases Only with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHighAMI	0.784	-1.68	0.093	0.591	1.041
opmdModerateAMI	0.929	-0.53	0.596	0.707	1.220
PeerAMIVeryHigh	0.634	-2.13	0.033	0.417	0.963
PeerAMIHigh	0.754	-1.49	0.136	0.520	1.093
PeerAMIModerate	0.917	-0.43	0.667	0.617	1.363
Black	0.876	-0.78	0.434	0.628	1.222
Asian	1.105	0.36	0.716	0.646	1.888
Hispanic	1.039	0.26	0.797	0.779	1.385
OtherRace	1.006	0.04	0.969	0.746	1.356
UnknownRace	0.851	-1.23	0.219	0.658	1.101
ER	1.180	2.10	0.036	1.011	1.376
Female	2.663	2.20	0.028	1.113	6.370
Medicaid	1.261	1.53	0.126	0.937	1.697
SelfPay	1.752	2.70	0.007	1.167	2.632
PrivateInsurance	0.912	-0.79	0.427	0.728	1.144
OtherInsurance	0.881	-0.42	0.678	0.484	1.603
AdmitLTC	1.372	1.41	0.160	0.883	2.131
meanage	1.049	9.49	0.000	1.039	1.060
AgeSex	0.991	-1.54	0.124	0.979	1.003
AnteriorInfarct	1.253	2.71	0.007	1.064	1.476
SubendInfarct	0.456	-7.69	0.000	0.373	0.557
CurrentSmoker	0.621	-3.75	0.000	0.484	0.797
HistSmoker	0.399	-4.31	0.000	0.263	0.606
CancerDx	0.840	-1.27	0.206	0.640	1.101
ChronCerebrovas	0.288	-2.85	0.004	0.122	0.678
ChronLiverDis	3.390	0.79	0.430	0.164	70.158
COPD	1.261	1.09	0.276	0.831	1.914
Cardiomyopathy	0.616	-2.02	0.043	0.385	0.986
HistPTCA	0.600	-2.90	0.004	0.424	0.847
HistCABG	1.205	1.00	0.315	0.838	1.733
HistMI	0.819	-1.25	0.212	0.598	1.121
CHF	2.003	8.60	0.000	1.710	2.347
ValveDis	1.298	2.40	0.017	1.049	1.606
Hypertension	0.660	-5.38	0.000	0.568	0.768
Paralysis	3.024	3.21	0.001	1.540	5.937

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
FluidDis	3.108	12.80	0.000	2.612	3.697
OtherNeuro	3.140	10.06	0.000	2.512	3.923
ChronPulmDis	0.886	-0.64	0.520	0.612	1.281
DiabeteswoCompl	1.205	2.22	0.027	1.022	1.421
DiabetesCompl	5.664	17.99	0.000	4.689	6.841
RenalFail	1.103	0.58	0.560	0.793	1.533
LiverDis	0.564	-0.37	0.711	0.027	11.620
Coagulopathy	2.559	6.70	0.000	1.944	3.368
WeekendAdmit	1.328	3.20	0.001	1.116	1.581
AdmitOff	1.254	2.77	0.006	1.068	1.473
Year2002	0.832	-1.31	0.190	0.632	1.096
Year2003	0.631	-3.15	0.002	0.474	0.840
Year2004	0.750	-2.10	0.036	0.573	0.981
Year2005	0.690	-2.70	0.007	0.528	0.904
Year2006	0.641	-3.23	0.001	0.490	0.840
Year2007	0.669	-2.96	0.003	0.512	0.873

Table 36: Logit Regression One Year Lag Model Using Primary PCI with AMI Cases Only with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHighAMI	0.855	-1.21	0.226	0.663	1.102
opmdModerateAMI	0.838	-1.33	0.184	0.647	1.087
PeerAMIVeryHigh	0.585	-3.64	0.000	0.438	0.781
PeerAMIHigh	0.729	-2.47	0.014	0.568	0.937
PeerAMIModerate	0.886	-0.79	0.428	0.656	1.196
Black	0.879	-0.79	0.429	0.640	1.209
Asian	0.987	-0.05	0.961	0.579	1.682
Hispanic	1.020	0.14	0.887	0.775	1.343
OtherRace	0.946	-0.38	0.702	0.710	1.259
UnknownRace	0.890	-0.93	0.355	0.696	1.139
ER	1.192	2.32	0.021	1.027	1.384
Female	2.334	1.98	0.048	1.007	5.407
Medicaid	1.264	1.60	0.109	0.949	1.682
SelfPay	1.546	2.13	0.033	1.036	2.307
PrivateInsurance	0.888	-1.07	0.286	0.715	1.104
OtherInsurance	0.755	-0.92	0.355	0.416	1.370
AdmitLTC	1.272	1.07	0.283	0.820	1.974
meanage	1.046	9.32	0.000	1.036	1.056
AgeSex	0.992	-1.28	0.199	0.981	1.004
AnteriorInfarct	1.253	2.79	0.005	1.069	1.469
SubendInfarct	0.470	-7.65	0.000	0.388	0.571

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
CurrentSmoker	0.621	-3.86	0.000	0.488	0.791
HistSmoker	0.408	-4.35	0.000	0.273	0.611
CancerDx	0.870	-1.04	0.298	0.670	1.131
ChronCerebrovas	0.298	-2.90	0.004	0.131	0.675
ChronLiverDis	3.301	0.76	0.447	0.152	71.771
COPD	1.313	1.30	0.193	0.872	1.978
Cardiomyopathy	0.668	-1.78	0.074	0.429	1.040
HistPTCA	0.630	-2.74	0.006	0.453	0.877
HistCABG	1.155	0.79	0.429	0.808	1.651
HistMI	0.804	-1.39	0.163	0.591	1.093
CHF	2.016	8.96	0.000	1.729	2.350
ValveDis	1.282	2.37	0.018	1.044	1.575
Hypertension	0.654	-5.68	0.000	0.565	0.757
Paralysis	2.763	3.06	0.002	1.442	5.296
FluidDis	2.998	12.74	0.000	2.532	3.549
OtherNeuro	3.267	10.84	0.000	2.637	4.047
ChronPulmDis	0.846	-0.90	0.368	0.588	1.217
DiabeteswoCompl	1.171	1.94	0.053	0.998	1.375
DiabetesCompl	5.531	18.35	0.000	4.607	6.639
RenalFail	1.106	0.62	0.535	0.805	1.520
LiverDis	0.506	-0.43	0.665	0.023	10.983
Coagulopathy	2.391	6.42	0.000	1.832	3.120
WeekendAdmit	1.316	3.19	0.001	1.112	1.558
AdmitOff	1.216	2.45	0.014	1.040	1.421
Year2002	0.845	-1.23	0.220	0.646	1.106
Year2003	0.689	-2.64	0.008	0.523	0.908
Year2004	0.804	-1.64	0.102	0.619	1.044
Year2005	0.697	-2.69	0.007	0.536	0.907
Year2006	0.689	-2.78	0.005	0.530	0.896
Year2007	0.692	-2.77	0.006	0.534	0.898

Table 37: Logit Regression Most Recent 12 Month Lag Model Using Primary PCI with AMI Cases Only with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHighAMI	0.766	-2.14	0.033	0.600	0.978
opmdModerateAMI	0.806	-1.67	0.095	0.625	1.038
PeerAMIVeryHigh	0.677	-2.60	0.009	0.505	0.909
PeerAMIHigh	0.711	-2.36	0.018	0.536	0.944
PeerAMIModerate	0.781	-2.10	0.036	0.619	0.984
Black	0.889	-0.73	0.467	0.647	1.221
Asian	1.081	0.30	0.768	0.644	1.816

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
Hispanic	1.010	0.07	0.942	0.767	1.330
OtherRace	0.949	-0.36	0.718	0.713	1.263
UnknownRace	0.880	-1.01	0.312	0.688	1.127
ER	1.212	2.52	0.012	1.044	1.407
Female	2.325	1.97	0.049	1.005	5.377
Medicaid	1.247	1.51	0.131	0.936	1.660
SelfPay	1.596	2.31	0.021	1.074	2.372
PrivateInsurance	0.886	-1.09	0.277	0.713	1.102
OtherInsurance	0.764	-0.89	0.375	0.421	1.386
AdmitLTC	1.285	1.12	0.264	0.827	1.995
meanage	1.046	9.32	0.000	1.036	1.056
AgeSex	0.992	-1.29	0.196	0.981	1.004
AnteriorInfarct	1.258	2.85	0.004	1.074	1.474
SubendInfarct	0.469	-7.70	0.000	0.386	0.568
CurrentSmoker	0.620	-3.88	0.000	0.487	0.790
HistSmoker	0.408	-4.36	0.000	0.273	0.611
CancerDx	0.872	-1.03	0.303	0.671	1.132
ChronCerebrovas	0.306	-2.83	0.005	0.135	0.694
ChronLiverDis	3.294	0.75	0.453	0.147	73.845
COPD	1.275	1.18	0.240	0.850	1.911
Cardiomyopathy	0.657	-1.86	0.063	0.422	1.023
HistPTCA	0.625	-2.79	0.005	0.449	0.870
HistCABG	1.155	0.79	0.429	0.808	1.650
HistMI	0.803	-1.40	0.163	0.591	1.092
CHF	2.013	8.96	0.000	1.727	2.346
ValveDis	1.276	2.33	0.020	1.039	1.567
Hypertension	0.657	-5.62	0.000	0.568	0.761
Paralysis	2.708	3.00	0.003	1.414	5.188
FluidDis	3.020	12.87	0.000	2.552	3.573
OtherNeuro	3.291	10.95	0.000	2.659	4.074
ChronPulmDis	0.876	-0.72	0.469	0.612	1.254
DiabeteswoCompl	1.172	1.95	0.052	0.999	1.375
DiabetesCompl	5.550	18.40	0.000	4.624	6.662
RenalFail	1.111	0.65	0.516	0.809	1.526
LiverDis	0.495	-0.44	0.657	0.022	11.062
Coagulopathy	2.374	6.38	0.000	1.820	3.097
WeekendAdmit	1.308	3.12	0.002	1.105	1.548
AdmitOff	1.207	2.37	0.018	1.033	1.411
Year2002	0.850	-1.18	0.237	0.650	1.112
Year2003	0.680	-2.74	0.006	0.516	0.896
Year2004	0.774	-1.93	0.054	0.596	1.004
Year2005	0.690	-2.76	0.006	0.531	0.898
Year2006	0.671	-2.99	0.003	0.516	0.871
Year2007	0.692	-2.78	0.005	0.534	0.897

Table 38: Logit Regression Conventional Model No Lag Using Non-Primary PCI with AMI Cases Only with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHighAMI	1.038	0.17	0.864	0.676	1.595
opmdModerateAMI	1.001	0.00	0.997	0.670	1.495
PeerAMIVeryHigh	0.508	-2.26	0.024	0.282	0.915
PeerAMIHigh	0.652	-1.66	0.097	0.393	1.080
PeerAMIModerate	1.043	0.16	0.872	0.625	1.740
Black	0.629	-1.76	0.078	0.376	1.054
Asian	1.290	0.59	0.555	0.554	3.004
Hispanic	1.214	0.95	0.343	0.813	1.812
OtherRace	1.195	0.82	0.414	0.780	1.830
UnknownRace	0.941	-0.34	0.736	0.663	1.337
ER	0.891	-1.01	0.311	0.712	1.114
Female	1.202	0.24	0.811	0.267	5.414
Medicaid	0.974	-0.12	0.902	0.638	1.486
SelfPay	0.318	-1.58	0.114	0.077	1.318
PrivateInsurance	0.679	-1.99	0.047	0.464	0.995
OtherInsurance	0.276	-1.27	0.205	0.038	2.023
AdmitLTC	1.599	1.68	0.093	0.925	2.765
meanage	1.034	4.30	0.000	1.018	1.050
AgeSex	1.000	-0.01	0.989	0.980	1.020
AnteriorInfarct	1.478	2.29	0.022	1.058	2.066
SubendInfarct	0.636	-3.16	0.002	0.480	0.842
CurrentSmoker	0.387	-3.24	0.001	0.218	0.687
HistSmoker	0.584	-2.08	0.037	0.352	0.969
CancerDx	0.803	-1.17	0.241	0.556	1.159
ChronCerebrovas	0.263	-2.30	0.022	0.084	0.821
ChronLiverDis	1.816	0.37	0.708	0.080	41.301
COPD	1.494	1.38	0.168	0.844	2.645
Cardiomyopathy	1.233	0.90	0.370	0.780	1.949
HistPTCA	0.854	-0.78	0.437	0.574	1.271
HistCABG	0.759	-1.35	0.177	0.509	1.132
HistMI	0.598	-2.33	0.020	0.389	0.921
CHF	2.321	7.11	0.000	1.840	2.928
ValveDis	1.200	1.28	0.201	0.908	1.586
Hypertension	0.634	-3.81	0.000	0.502	0.802
Paralysis	2.807	2.07	0.038	1.059	7.443
FluidDis	2.768	7.99	0.000	2.156	3.553
OtherNeuro	2.560	5.32	0.000	1.810	3.620
ChronPulmDis	0.831	-0.70	0.486	0.493	1.399
DiabeteswoCompl	1.053	0.43	0.665	0.834	1.328

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
DiabetesCompl	3.973	9.80	0.000	3.015	5.236
RenalFail	1.414	2.10	0.035	1.024	1.952
LiverDis	0.740	-0.19	0.850	0.033	16.805
HIV	2.251	0.78	0.437	0.291	17.419
Coagulopathy	2.695	5.04	0.000	1.833	3.962
WeekendAdmit	1.090	0.70	0.482	0.857	1.386
AdmitOff	1.200	1.64	0.100	0.965	1.492
Year2002	1.209	0.97	0.330	0.825	1.773
Year2003	1.079	0.38	0.701	0.732	1.591
Year2004	1.014	0.07	0.945	0.683	1.506
Year2005	0.701	-1.59	0.113	0.452	1.087
Year2006	0.803	-1.02	0.307	0.527	1.223
Year2007	1.041	0.20	0.845	0.693	1.564

Table 39: Logit Regression One Year Lag Model Using Non-Primary PCI with AMI Cases Only with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHighAMI	1.193	0.91	0.360	0.818	1.739
opmdModerateAMI	0.933	-0.35	0.724	0.633	1.374
PeerAMIVerHigh	0.387	-4.33	0.000	0.252	0.595
PeerAMIHigh	0.575	-3.01	0.003	0.401	0.825
PeerAMIModerate	0.699	-1.73	0.084	0.466	1.049
Black	0.580	-2.09	0.037	0.347	0.967
Asian	1.527	1.11	0.265	0.725	3.214
Hispanic	1.221	1.03	0.302	0.836	1.784
OtherRace	1.146	0.67	0.504	0.768	1.710
UnknownRace	0.988	-0.07	0.943	0.708	1.378
ER	0.845	-1.53	0.126	0.681	1.049
Female	1.118	0.15	0.879	0.265	4.708
Medicaid	0.932	-0.34	0.732	0.622	1.396
SelfPay	0.447	-1.35	0.177	0.138	1.440
PrivateInsurance	0.703	-1.90	0.057	0.490	1.010
OtherInsurance	0.262	-1.32	0.187	0.036	1.915
AdmitLTC	1.499	1.46	0.144	0.871	2.579
meanage	1.032	4.33	0.000	1.018	1.048
AgeSex	1.000	0.04	0.966	0.981	1.020
AnteriorInfarct	1.515	2.54	0.011	1.100	2.088
SubendInfarct	0.654	-3.08	0.002	0.499	0.857
CurrentSmo r	0.358	-3.52	0.000	0.202	0.635
HistSmoker	0.565	-2.27	0.023	0.345	0.925
CancerDx	0.822	-1.08	0.281	0.575	1.174

Continued on Next Page

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
ChronCerebrovas	0.305	-2.21	0.027	0.106	0.875
ChronLiverDis	1.756	0.35	0.724	0.077	39.889
COPD	1.662	1.75	0.080	0.942	2.934
Cardiomyopathy	1.205	0.81	0.416	0.769	1.886
HistPTCA	0.828	-0.95	0.343	0.561	1.223
HistCABG	0.730	-1.57	0.116	0.494	1.081
HistMI	0.618	-2.27	0.023	0.409	0.936
CHF	2.510	8.09	0.000	2.008	3.136
ValveDis	1.209	1.39	0.165	0.925	1.580
Hypertension	0.663	-3.58	0.000	0.529	0.830
Paralysis	2.192	1.60	0.110	0.838	5.732
FluidDis	2.594	7.71	0.000	2.036	3.305
OtherNeuro	2.512	5.40	0.000	1.798	3.510
ChronPulmDis	0.741	-1.13	0.260	0.440	1.248
DiabeteswoCompl	1.002	0.02	0.986	0.801	1.254
DiabetesCompl	3.964	10.22	0.000	3.044	5.162
RenalFail	1.410	2.18	0.029	1.035	1.920
LiverDis	0.653	-0.27	0.789	0.029	14.807
HIV	2.013	0.67	0.502	0.261	15.557
Coagulopathy	2.800	5.55	0.000	1.946	4.029
WeekendAdmit	1.138	1.10	0.269	0.905	1.433
AdmitOff	1.241	2.03	0.042	1.008	1.527
Year2002	1.173	0.86	0.392	0.814	1.689
Year2003	1.108	0.55	0.584	0.767	1.601
Year2004	1.028	0.14	0.889	0.702	1.503
Year2005	0.660	-1.93	0.053	0.433	1.006
Year2006	0.842	-0.84	0.399	0.565	1.256
Year2007	0.994	-0.03	0.977	0.671	1.472

Table 40: Logit Regression Most Recent 12 Month Lag Model Using Non-Primary PCI with AMI Cases Only with Operator's Total AMI with PCI Volume as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHighAMI	1.008	0.04	0.967	0.697	1.458
opmdModerateAMI	0.917	-0.45	0.652	0.629	1.336
PeerAMIVeryHigh..	0.507	-3.02	0.003	0.326	0.788
PeerAMIHigh	0.442	-3.83	0.000	0.291	0.671
PeerAMIModerate	0.603	-3.05	0.002	0.436	0.834
Black	0.573	-2.13	0.033	0.343	0.956
Asian	1.556	1.17	0.244	0.740	3.271
Hispanic	1.250	1.16	0.247	0.857	1.823

Continued on Next Page

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
OtherRace	1.144	0.66	0.510	0.767	1.708
UnknownRace	0.995	-0.03	0.976	0.712	1.390
ER	0.871	-1.26	0.209	0.702	1.080
Female	1.046	0.06	0.951	0.248	4.412
Medicaid	0.950	-0.25	0.804	0.634	1.424
SelfPay	0.452	-1.33	0.184	0.140	1.459
PrivateInsurance	0.706	-1.88	0.059	0.492	1.014
OtherInsurance	0.255	-1.35	0.178	0.035	1.864
AdmitLTC	1.479	1.41	0.158	0.859	2.548
meanage	1.033	4.41	0.000	1.018	1.048
AgeSex	1.001	0.13	0.893	0.982	1.021
AnteriorInfarct	1.509	2.52	0.012	1.096	2.078
SubendInfarct	0.662	-2.99	0.003	0.505	0.867
CurrentSmoker	0.362	-3.48	0.000	0.204	0.642
HistSmoker	0.578	-2.18	0.029	0.354	0.945
CancerDx	0.809	-1.17	0.243	0.566	1.155
ChronCerebrovas	0.306	-2.22	0.027	0.107	0.872
ChronLiverDis	1.638	0.31	0.758	0.071	37.749
COPD	1.535	1.51	0.130	0.881	2.674
Cardiomyopathy	1.221	0.88	0.381	0.781	1.911
HistPTCA	0.823	-0.98	0.326	0.558	1.214
HistCABG	0.724	-1.61	0.107	0.490	1.072
HistMI	0.625	-2.23	0.026	0.413	0.945
CHF	2.508	8.10	0.000	2.008	3.133
ValveDis	1.195	1.31	0.192	0.915	1.561
Hypertension	0.665	-3.56	0.000	0.531	0.832
Paralysis	2.215	1.63	0.103	0.852	5.760
FluidDis	2.574	7.67	0.000	2.022	3.277
OtherNeuro	2.549	5.50	0.000	1.826	3.558
ChronPulmDis	0.791	-0.91	0.365	0.477	1.313
DiabeteswoCompl	1.002	0.02	0.985	0.801	1.254
DiabetesCompl	3.915	10.17	0.000	3.010	5.092
RenalFail	1.406	2.16	0.031	1.032	1.915
LiverDis	0.709	-0.22	0.829	0.031	16.282
HIV	2.026	0.68	0.498	0.263	15.579
Coagulopathy	2.845	5.66	0.000	1.980	4.087
WeekendAdmit	1.138	1.10	0.271	0.904	1.431
AdmitOff	1.244	2.06	0.039	1.011	1.530
Year2002	1.209	1.02	0.307	0.840	1.739
Year2003	1.113	0.57	0.568	0.771	1.606
Year2004	0.981	-0.10	0.921	0.671	1.434
Year2005	0.672	-1.85	0.065	0.441	1.025
Year2006	0.819	-0.98	0.329	0.549	1.222
Year2007	0.982	-0.09	0.927	0.664	1.453

A.3 Independent Variable: Operator's Total Non-AMI with PCI Volume

Table 41: Logit Regression Conventional Model No Lag Using All AMI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVHighNoAMI	0.638	(3.05)	0.002	0.477	0.852
opmdHighNoAMI	0.722	(2.65)	0.008	0.568	0.919
opmdModNoAMI	0.728	(2.65)	0.008	0.576	0.921
PeerNoAMIVHigh	0.626	(3.07)	0.002	0.464	0.844
PeerNoAMIHigh	0.608	(3.37)	0.001	0.455	0.812
PeerNoAMIMod	0.747	(2.05)	0.041	0.566	0.988
Black	0.803	(1.54)	0.124	0.607	1.062
Asian	1.307	1.21	0.228	0.846	2.017
Hispanic	1.141	1.13	0.258	0.908	1.434
OtherRace	1.089	0.70	0.483	0.858	1.383
UnknownRace	0.994	(0.06)	0.955	0.815	1.212
ER	1.023	0.36	0.719	0.904	1.157
Female	1.746	1.48	0.138	0.837	3.646
Medicaid	1.182	1.38	0.168	0.932	1.499
SelfPay	1.464	2.03	0.043	1.013	2.116
PrivateInsurance	0.887	(1.26)	0.209	0.735	1.070
OtherInsurance	0.667	(1.38)	0.169	0.374	1.188
AdmitLTC	1.255	1.28	0.200	0.887	1.774
meanage	1.041	9.93	0.000	1.033	1.050
AgeSex	0.995	(0.88)	0.380	0.985	1.006
AnteriorInfarct	1.307	3.65	0.000	1.132	1.509
SubendInfarct	0.416	(11.71)	0.000	0.359	0.482
CurrentSmoker	0.537	(5.42)	0.000	0.429	0.672
HistSmoker	0.441	(5.06)	0.000	0.321	0.605
CancerDx	0.799	(2.02)	0.043	0.643	0.993
ChronCerebrovas	0.296	(3.68)	0.000	0.155	0.566
ChronLiverDis	0.705	(0.34)	0.734	0.094	5.311
COPD	1.323	1.65	0.098	0.949	1.843
Cardiomyopathy	0.874	(0.83)	0.408	0.635	1.203
HistPTCA	0.712	(2.62)	0.009	0.552	0.918
HistCABG	0.894	(0.82)	0.411	0.685	1.167
HistMI	0.748	(2.30)	0.021	0.584	0.958
CHF	2.081	11.20	0.000	1.831	2.366
ValveDis	1.246	2.61	0.009	1.057	1.470
Hypertension	0.671	(6.26)	0.000	0.592	0.760
Paralysis	2.592	3.48	0.001	1.516	4.433

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
FluidDis	2.851	14.61	0.000	2.478	3.282
OtherNeuro	3.021	11.95	0.000	2.520	3.621
ChronPulmDis	0.865	(0.96)	0.338	0.643	1.164
DiabeteswoCompl	1.112	1.58	0.114	0.975	1.270
DiabetesCompl	4.969	20.50	0.000	4.263	5.792
RenalFail	1.227	1.83	0.068	0.985	1.528
LiverDis	1.487	0.42	0.674	0.235	9.399
HIV	0.614	(0.48)	0.634	0.082	4.576
Coagulopathy	2.468	8.03	0.000	1.980	3.078
WeekendAdmit	1.139	1.86	0.063	0.993	1.306
AdmitOff	1.136	1.99	0.046	1.002	1.288
Year2002	0.892	(1.02)	0.306	0.716	1.111
Year2003	0.795	(2.01)	0.045	0.636	0.995
Year2004	0.879	(1.16)	0.245	0.707	1.093
Year2005	0.743	(2.57)	0.010	0.593	0.932
Year2006	0.772	(2.28)	0.023	0.618	0.964
Year2007	0.865	(1.30)	0.194	0.696	1.076

Table 42: Logit Regression One year Lag Model Using All AMI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVHighNoAMI	0.552	-4.27	0.000	0.421	0.725
opmdHighNoAMI	0.661	-3.77	0.000	0.533	0.820
opmdModNoAMI	0.607	-4.37	0.000	0.485	0.759
PeerNoAMIVHigh	0.760	-2.22	0.026	0.597	0.968
PeerNoAMIHigh	0.815	-1.74	0.081	0.647	1.026
PeerNoAMIMod	0.774	-2.20	0.028	0.616	0.972
Black	0.828	-1.38	0.166	0.634	1.082
Asian	1.283	1.15	0.251	0.838	1.965
Hispanic	1.127	1.06	0.289	0.903	1.407
OtherRace	1.116	0.93	0.350	0.886	1.406
UnknownRace	0.932	-0.70	0.484	0.766	1.135
ER	1.032	0.52	0.603	0.916	1.164
Female	1.853	1.69	0.092	0.904	3.799
Medicaid	1.152	1.19	0.233	0.913	1.452
SelfPay	1.396	1.80	0.072	0.970	2.007
PrivateInsurance	0.851	-1.72	0.085	0.708	1.022
OtherInsurance	0.690	-1.31	0.191	0.395	1.204
AdmitLTC	1.279	1.41	0.160	0.908	1.801
meanage	1.041	10.15	0.000	1.033	1.050
AgeSex	0.995	-1.04	0.301	0.985	1.005

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
AnteriorInfarct	1.316	3.83	0.000	1.143	1.514
SubendInfarct	0.429	-11.62	0.000	0.371	0.494
CurrentSmoker	0.554	-5.28	0.000	0.445	0.690
HistSmoker	0.440	-5.19	0.000	0.322	0.600
CancerDx	0.824	-1.81	0.070	0.669	1.016
ChronCerebrovas	0.285	-3.84	0.000	0.150	0.541
ChronLiverDis	2.617	0.89	0.372	0.317	21.634
COPD	1.377	1.93	0.054	0.995	1.906
Cardiomyopathy	0.847	-1.04	0.299	0.618	1.159
HistPTCA	0.706	-2.73	0.006	0.550	0.907
HistCABG	0.873	-1.02	0.310	0.672	1.135
HistMI	0.718	-2.65	0.008	0.561	0.917
CHF	2.077	11.49	0.000	1.833	2.353
ValveDis	1.239	2.60	0.009	1.054	1.456
Hypertension	0.656	-6.77	0.000	0.581	0.741
Paralysis	2.571	3.49	0.000	1.513	4.369
FluidDis	2.842	14.98	0.000	2.479	3.259
OtherNeuro	2.974	12.04	0.000	2.490	3.551
ChronPulmDis	0.827	-1.28	0.202	0.618	1.107
DiabeteswoCompl	1.099	1.43	0.152	0.966	1.251
DiabetesCompl	4.974	21.01	0.000	4.282	5.777
RenalFail	1.169	1.42	0.154	0.943	1.450
LiverDis	0.533	-0.58	0.559	0.065	4.392
HIV	0.563	-0.56	0.576	0.075	4.223
Coagulopathy	2.492	8.39	0.000	2.013	3.084
WeekendAdmit	1.167	2.28	0.023	1.022	1.334
AdmitOff	1.140	2.10	0.036	1.009	1.289
Year2002	0.965	-0.32	0.745	0.779	1.196
Year2003	0.839	-1.57	0.116	0.674	1.044
Year2004	0.909	-0.88	0.379	0.734	1.125
Year2005	0.787	-2.13	0.033	0.631	0.981
Year2006	0.805	-1.96	0.050	0.648	1.000
Year2007	0.894	-1.03	0.305	0.721	1.108

Table 43: Logit Regression Most Recent 12 Month Lag Model Using All AMI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVHighNoAMI	0.632	-3.58	0.000	0.492	0.813
opmdHighNoAMI	0.695	-3.60	0.000	0.571	0.847
opmdModNoAMI	0.671	-3.85	0.000	0.548	0.822
PeerNoAMIVHigh	0.750	-2.77	0.006	0.611	0.919

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
PeeNoAMIHigh	0.754	-2.84	0.005	0.620	0.916
PeerNoAMIMod	0.746	-3.09	0.002	0.620	0.899
Black	0.834	-1.33	0.184	0.639	1.090
Asian	1.293	1.18	0.237	0.845	1.980
Hispanic	1.152	1.25	0.213	0.922	1.438
OtherRace	1.115	0.93	0.354	0.886	1.404
UnknownRace	0.934	-0.68	0.498	0.767	1.138
ER	1.025	0.40	0.687	0.909	1.156
Female	1.851	1.68	0.093	0.903	3.795
Medicaid	1.164	1.29	0.198	0.924	1.468
SelfPay	1.400	1.81	0.070	0.973	2.012
PrivateInsurance	0.859	-1.62	0.106	0.715	1.033
OtherInsurance	0.677	-1.37	0.172	0.387	1.185
AdmitLTC	1.207	0.28	0.857	1.700	
meanage	1.042	10.27	0.000	1.034	1.050
AgeSex	0.995	-1.05	0.295	0.985	1.005
AnteriorInfarct	1.315	3.82	0.000	1.143	1.513
SubendInfarct	0.429	-11.60	0.000	0.372	0.495
CurrentSmoker	0.549	-5.36	0.000	0.441	0.684
HistSmoker	0.436	-5.23	0.000	0.320	0.595
CancerDx	0.824	-1.82	0.069	0.668	1.015
ChronCerebrovas	0.291	-3.77	0.000	0.153	0.554
ChronLiverDis	2.288	0.79	0.428	0.296	17.708
COPD	1.379	1.94	0.052	0.997	1.909
Cardiomyopathy	0.843	-1.07	0.285	0.615	1.154
HistPTCA	0.702	-2.77	0.006	0.547	0.902
HistCABG	0.873	-1.01	0.311	0.672	1.135
HistMI	0.724	-2.58	0.010	0.567	0.925
CHF	2.074	11.46	0.000	1.831	2.350
ValveDis	1.235	2.57	0.010	1.051	1.451
Hypertension	0.655	-6.81	0.000	0.580	0.740
Paralysis	2.553	3.46	0.001	1.502	4.341
FluidDis	2.852	15.04	0.000	2.488	3.270
OtherNeuro	2.954	11.97	0.000	2.474	3.528
ChronPulmDis	0.826	-1.28	0.199	0.617	1.106
DiabeteswoCompl	1.100	1.45	0.147	0.967	1.252
DiabetesCompl	4.984	21.04	0.000	4.292	5.789
RenalFail	1.175	1.47	0.141	0.948	1.458
LiverDis	0.590	-0.51	0.613	0.076	4.557
HIV	0.586	-0.52	0.603	0.078	4.385
Coagulopathy	2.504	8.46	0.000	2.024	3.097
WeekendAdmit	1.162	2.21	0.027	1.017	1.327
AdmitOff	1.138	2.06	0.039	1.006	1.286
Year2002	0.950	-0.47	0.640	0.767	1.177

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Year2003	0.835	-1.62	0.104	0.671	1.038
Year2004	0.902	-0.94	0.345	0.729	1.117
Year2005	0.777	-2.25	0.025	0.624	0.969
Year2006	0.800	-2.02	0.043	0.644	0.993
Year2007	0.874	-1.23	0.219	0.706	1.083

Table 44: Logit Regression Conventional Model No Lag Using AMI with Primary PCI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVHighNoAMI	0.657	-2.24	0.025	0.455	0.949
opmdHighNoAMII	0.724	-2.09	0.037	0.535	0.980
opmdModNoAMI	0.755	-1.88	0.060	0.564	1.012
PeerNoAMIVHigh	0.697	-1.93	0.054	0.482	1.006
PeerNoAMIHigh	0.708	-1.91	0.057	0.496	1.010
PeerNoAMIMod	0.837	-1.02	0.307	0.595	1.178
Black	0.901	-0.61	0.540	0.645	1.258
Asian	1.094	0.33	0.741	0.641	1.869
Hispanic	1.047	0.32	0.752	0.789	1.389
OtherRace	1.009	0.06	0.954	0.751	1.355
UnknownRace	0.952	-0.38	0.702	0.741	1.223
ER	1.179	2.12	0.034	1.012	1.374
Female	2.066	1.66	0.098	0.875	4.880
Medicaid	1.313	1.82	0.069	0.979	1.761
SelfPay	1.769	2.78	0.005	1.184	2.644
PrivateInsurance	0.913	-0.81	0.420	0.731	1.140
OtherInsurance	0.729	-1.01	0.313	0.395	1.347
AdmitLTC	1.312	1.20	0.231	0.842	2.044
meanage	1.046	9.01	0.000	1.036	1.056
AgeSex	0.994	-1.00	0.317	0.982	1.006
AnteriorInfarct	1.258	2.77	0.006	1.070	1.479
SubendInfarct	0.464	-7.57	0.000	0.381	0.566
CurrentSmoker	0.576	-4.34	0.000	0.449	0.739
HistSmoker	0.384	-4.50	0.000	0.253	0.582
CancerDx	0.850	-1.18	0.239	0.649	1.114
ChronCerebrovas	0.325	-2.69	0.007	0.143	0.738
ChronLiverDis	3.111	0.66	0.508	0.108	89.254
COPD	1.254	1.06	0.287	0.827	1.900
Cardiomyopathy	0.675	-1.71	0.088	0.430	1.060
HistPTCA	0.646	-2.57	0.010	0.463	0.902
HistCABG	1.163	0.81	0.420	0.806	1.677
HistMI	0.832	-1.16	0.244	0.610	1.134

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
CHF	2.031	8.83	0.000	1.736	2.377
ValveDis	1.288	2.38	0.018	1.045	1.588
Hypertension	0.655	-5.52	0.000	0.564	0.761
Paralysis	2.696	2.97	0.003	1.401	5.189
FluidDis	2.961	12.28	0.000	2.490	3.521
OtherNeuro	3.301	10.70	0.000	2.652	4.109
ChronPulmDis	0.894	-0.60	0.552	0.619	1.292
DiabeteswoCompl	1.209	2.28	0.023	1.027	1.423
DiabetesCompl	5.444	17.77	0.000	4.516	6.563
RenalFail	1.181	1.02	0.310	0.857	1.627
LiverDis	0.416	-0.51	0.608	0.015	11.894
Coagulopathy	2.405	6.29	0.000	1.830	3.161
WeekendAdmit	1.278	2.77	0.006	1.075	1.520
AdmitOff	1.214	2.39	0.017	1.035	1.425
Year2002	0.774	-1.82	0.068	0.588	1.019
Year2003	0.635	-3.14	0.002	0.478	0.843
Year2004	0.755	-2.07	0.038	0.579	0.985
Year2005	0.655	-3.08	0.002	0.500	0.857
Year2006	0.656	-3.09	0.002	0.502	0.857
Year2007	0.682	-2.84	0.005	0.523	0.888

Table 45: Logit Regression One Year Lag Model Using AMI with Primary PCI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVer oAMI	0.606	-2.84	0.004	0.429	0.856
opmdHighNo I	0.738	-2.22	0.026	0.565	0.965
opmdMod oAMI	0.673	-2.81	0.005	0.510	0.887
PeerNoAMIV h	0.699	-2.38	0.017	0.520	0.938
PeerNoAMIH h	0.835	-1.26	0.206	0.632	1.104
PeerNoAMIM e	0.812	-1.45	0.146	0.613	1.075
Black	0.945	-0.35	0.728	0.689	1.298
Asian	1.136	0.48	0.631	0.675	1.913
Hispanic	1.037	0.26	0.797	0.787	1.366
OtherRace	1.035	0.24	0.814	0.778	1.377
UnknownRace	0.888	-0.94	0.345	0.694	1.137
ER	1.174	2.11	0.034	1.012	1.362
Female	2.307	1.96	0.051	0.998	5.332
Medicaid	1.301	1.80	0.072	0.977	1.732
SelfPay	1.699	2.62	0.009	1.144	2.524
PrivateIns e	0.897	-0.98	0.325	0.721	1.114
OtherInsur e	0.756	-0.93	0.353	0.419	1.365

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
AdmitLTC	1.207	0.84	0.403	0.776	1.878
meanage	1.047	9.45	0.000	1.037	1.057
AgeSex	0.992	-1.28	0.200	0.981	1.004
AnteriorIn t	1.264	2.90	0.004	1.079	1.481
SubendInfa t	0.486	-7.33	0.000	0.401	0.589
CurrentSmo r	0.593	-4.24	0.000	0.465	0.755
HistSmoker	0.396	-4.50	0.000	0.265	0.593
CancerDx	0.864	-1.09	0.274	0.666	1.122
ChronCereb s	0.307	-2.84	0.005	0.136	0.694
ChronLiver s	5.594	0.93	0.352	0.149	209.504
COPD	1.270	1.16	0.248	0.847	1.904
Cardiomyop y	0.662	-1.83	0.068	0.425	1.030
HistPTCA	0.636	-2.69	0.007	0.457	0.884
HistCABG	1.172	0.87	0.384	0.820	1.675
HistMI	0.817	-1.29	0.196	0.601	1.110
CHF	2.016	8.98	0.000	1.730	2.350
ValveDis	1.297	2.49	0.013	1.057	1.592
Hypertension	0.657	-5.64	0.000	0.567	0.760
Paralysis	2.753	3.06	0.002	1.438	5.271
FluidDis	2.977	12.68	0.000	2.515	3.524
OtherNeuro	3.242	10.78	0.000	2.618	4.015
ChronPulmDis	0.871	-0.76	0.449	0.608	1.246
Diabeteswo l	1.181	2.05	0.041	1.007	1.386
DiabetesCo l	5.449	18.19	0.000	4.539	6.542
RenalFail	1.100	0.59	0.557	0.800	1.512
LiverDis	0.317	-0.62	0.534	0.008	11.874
Coagulopathy	2.376	6.39	0.000	1.822	3.099
WeekendAdmit	1.306	3.11	0.002	1.104	1.546
AdmitOff	1.219	2.49	0.013	1.043	1.424
Year2002	0.851	-1.18	0.240	0.651	1.113
Year2003	0.672	-2.82	0.005	0.510	0.886
Year2004	0.770	-1.97	0.049	0.593	0.999
Year2005	0.691	-2.76	0.006	0.531	0.899
Year2006	0.672	-2.98	0.003	0.517	0.872
Year2007	0.720	-2.48	0.013	0.556	0.934

Table 46: Logit Regression Most Recent 12 Month Lag Model Using AMI with Primary PCI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVHighNoAMI	0.686	-2.33	0.020	0.500	0.942
opmdHighNoAMII	0.752	-2.28	0.022	0.589	0.960

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdModNoAMI	0.710	-2.68	0.007	0.553	0.912
PeerNoAMIVHigh..	0.709	-2.73	0.006	0.554	0.908
PeeNoAMIHigh	0.750	-2.38	0.017	0.592	0.950
PeerNoAMIMod	0.785	-2.12	0.034	0.627	0.982
Black	0.954	-0.29	0.772	0.695	1.310
Asian	1.131	0.46	0.643	0.672	1.904
Hispanic	1.056	0.38	0.700	0.801	1.392
OtherRace	1.034	0.23	0.819	0.777	1.375
UnknownRace	0.893	-0.90	0.369	0.697	1.143
ER	1.171	2.09	0.037	1.010	1.359
Female	2.313	1.96	0.050	1.000	5.349
Medicaid	1.310	1.85	0.064	0.984	1.745
SelfPay	1.710	2.66	0.008	1.151	2.539
PrivateInsurance	0.907	-0.88	0.380	0.730	1.128
OtherInsurance	0.751	-0.94	0.345	0.415	1.360
AdmitLTC	1.173	0.70	0.481	0.753	1.826
meanage	1.048	9.56	0.000	1.038	1.058
AgeSex	0.992	-1.30	0.195	0.981	1.004
AnteriorInfarct	1.266	2.92	0.003	1.081	1.484
SubendInfarct	0.485	-7.33	0.000	0.400	0.589
CurrentSmoker	0.594	-4.23	0.000	0.466	0.756
HistSmoker	0.392	-4.55	0.000	0.262	0.587
CancerDx	0.866	-1.07	0.282	0.667	1.125
ChronCerebrovas	0.318	-2.75	0.006	0.140	0.719
ChronLiverDis	3.647	0.79	0.427	0.150	88.853
COPD	1.257	1.11	0.268	0.839	1.885
Cardiomyopathy	0.663	-1.82	0.069	0.426	1.032
HistPTCA	0.632	-2.73	0.006	0.455	0.878
HistCABG	1.168	0.85	0.394	0.817	1.669
HistMI	0.821	-1.26	0.206	0.604	1.115
CHF	2.008	8.92	0.000	1.723	2.340
ValveDis	1.281	2.37	0.018	1.044	1.573
Hypertension	0.657	-5.63	0.000	0.568	0.761
Paralysis	2.721	3.02	0.003	1.421	5.213
FluidDis	2.987	12.73	0.000	2.524	3.535
OtherNeuro	3.223	10.73	0.000	2.603	3.991
ChronPulmDis	0.878	-0.71	0.477	0.614	1.257
DiabeteswoCompl	1.186	2.09	0.036	1.011	1.391
DiabetesCompl	5.473	18.24	0.000	4.560	6.570
RenalFail	1.104	0.61	0.540	0.804	1.518
LiverDis	0.468	-0.47	0.641	0.019	11.367
Coagulopathy	2.373	6.38	0.000	1.820	3.094
WeekendAdmit	1.302	3.08	0.002	1.101	1.541
AdmitOff	1.206	2.35	0.019	1.032	1.410

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Year2002	0.838	-1.29	0.197	0.641	1.096
Year2003	0.675	-2.79	0.005	0.513	0.889
Year2004	0.767	-2.00	0.046	0.590	0.995
Year2005	0.684	-2.83	0.005	0.526	0.889
Year2006	0.673	-2.97	0.003	0.518	0.874
Year2007	0.696	-2.74	0.006	0.537	0.902

Table 47: Logit Regression Conventional Model No Lag Using AMI with Non-Primary PCI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVHighNoAMI	0.594	-2.11	0.035	0.366	0.965
opmdHighNoAMI	0.666	-1.93	0.053	0.441	1.005
opmdModNoAMI	0.626	-2.23	0.026	0.415	0.945
PeerNoAMIVHigh	0.519	-2.40	0.016	0.304	0.887
PeerNoAMIHigh	0.466	-2.88	0.004	0.277	0.783
PeerNoAMIMod	0.624	-1.87	0.062	0.380	1.024
Black	0.629	-1.72	0.085	0.372	1.065
Asian	1.763	1.48	0.138	0.834	3.730
Hispanic	1.310	1.35	0.178	0.884	1.940
OtherRace	1.264	1.11	0.266	0.836	1.911
UnknownRace	1.081	0.45	0.649	0.774	1.509
ER	0.822	-1.72	0.086	0.657	1.028
Female	1.008	0.01	0.991	0.230	4.420
Medicaid	1.000	0.00	0.998	0.659	1.517
SelfPay	0.515	-1.11	0.267	0.159	1.663
PrivateInsurane	0.762	-1.45	0.147	0.528	1.100
OtherInsurance	0.278	-1.26	0.208	0.038	2.033
AdmitLTC	1.308	0.93	0.353	0.742	2.306
meanage	1.035	4.58	0.000	1.020	1.050
AgeSex	1.001	0.14	0.887	0.982	1.021
AnteriorInfarct	1.446	2.21	0.027	1.042	2.006
SubendInfarct	0.652	-3.04	0.002	0.495	0.859
CurrentSmoker	0.367	-3.43	0.001	0.207	0.651
HistSmoker	0.587	-2.11	0.035	0.359	0.962
CancerDx	0.766	-1.40	0.162	0.527	1.113
ChronCerebrovas	0.299	-2.21	0.027	0.102	0.874
ChronLiverDis	0.208	-1.22	0.222	0.017	2.588
COPD	1.374	1.12	0.264	0.787	2.398
Cardiomyopathy	1.271	1.03	0.301	0.807	2.002
HistPTCA	0.836	-0.89	0.376	0.563	1.242
HistCABG	0.806	-1.07	0.283	0.544	1.195

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HistMI	0.656	-1.99	0.046	0.433	0.993
CHF	2.425	7.56	0.000	1.927	3.051
ValveDis	1.199	1.29	0.198	0.910	1.580
Hypertension	0.731	-2.64	0.008	0.580	0.922
Paralysis	2.375	1.74	0.081	0.899	6.277
FluidDis	2.575	7.42	0.000	2.006	3.306
OtherNeuro	2.588	5.46	0.000	1.839	3.642
ChronPulmDis	0.885	-0.47	0.637	0.533	1.469
DiabeteswoCompl	0.997	-0.02	0.981	0.793	1.254
DiabetesCompl	3.822	9.71	0.000	2.916	5.010
RenalFail	1.505	2.50	0.012	1.093	2.074
LiverDis	4.173	1.34	0.179	0.520	33.510
HIV	2.366	0.83	0.408	0.307	18.207
Coagulopathy	2.624	4.94	0.000	1.789	3.848
WeekendAdmit	1.099	0.78	0.434	0.867	1.393
AdmitOff	1.232	1.91	0.056	0.995	1.525
Year2002	1.141	0.69	0.488	0.785	1.659
Year2003	1.077	0.39	0.699	0.740	1.567
Year2004	0.942	-0.30	0.765	0.637	1.393
Year2005	0.667	-1.83	0.067	0.432	1.029
Year2006	0.777	-1.19	0.234	0.512	1.178
Year2007	1.030	0.14	0.885	0.692	1.533

Table 48: Logit Regression One Year Lag Model Using AMI with Non-Primary PCI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVHighNoAMI	0.458	-3.39	0.001	0.292	0.719
opmdHighNoAMI	0.488	-3.78	0.000	0.337	0.708
opmdModNoAMI	0.456	-3.90	0.000	0.307	0.677
PeerNoAMIVHigh	0.934	-0.31	0.758	0.607	1.438
PeerNoAMIHigh	0.851	-0.76	0.446	0.562	1.288
PeerNoAMIMod	0.771	-1.27	0.204	0.517	1.151
Black	0.619	-1.84	0.066	0.372	1.032
Asian	1.572	1.19	0.235	0.746	3.314
Hispanic	1.277	1.27	0.205	0.875	1.865
OtherRace	1.301	1.30	0.194	0.875	1.933
UnknownRace	0.972	-0.16	0.869	0.697	1.357
ER	0.864	-1.32	0.186	0.695	1.073
Female	1.035	0.05	0.963	0.245	4.367
Medicaid	0.951	-0.24	0.807	0.634	1.426
SelfPay	0.468	-1.27	0.203	0.145	1.507

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
PrivateInsurance	0.701	-1.93	0.054	0.488	1.006
OtherInsurance	0.260	-1.33	0.185	0.036	1.901
AdmitLTC	1.567	1.59	0.112	0.901	2.724
meanage	1.033	4.37	0.000	1.018	1.048
AgeSex	1.002	0.16	0.877	0.982	1.021
AnteriorInfarct	1.472	2.36	0.018	1.068	2.029
SubendInfarct	0.659	-3.03	0.002	0.503	0.863
CurrentSmoker	0.365	-3.45	0.001	0.206	0.647
HistSmoker	0.564	-2.28	0.022	0.345	0.922
CancerDx	0.815	-1.12	0.261	0.571	1.164
ChronCerebrovas	0.303	-2.23	0.025	0.107	0.864
ChronLiverDis	1.702	0.35	0.730	0.083	34.840
COPD	1.520	1.48	0.139	0.873	2.649
Cardiomyopathy	1.221	0.87	0.383	0.780	1.912
HistPTCA	0.819	-1.00	0.316	0.555	1.210
HistCABG	0.753	-1.42	0.155	0.509	1.113
HistMI	0.612	-2.32	0.020	0.404	0.927
CHF	2.463	7.92	0.000	1.970	3.078
ValveDis	1.160	1.08	0.278	0.887	1.518
Hypertension	0.675	-3.42	0.001	0.539	0.845
Paralysis	2.252	1.67	0.095	0.868	5.843
FluidDis	2.533	7.50	0.000	1.987	3.229
OtherNeuro	2.549	5.47	0.000	1.823	3.565
ChronPulmDis	0.804	-0.84	0.399	0.484	1.335
DiabeteswoCompl	0.999	-0.01	0.990	0.798	1.250
DiabetesCompl	3.823	9.98	0.000	2.937	4.975
RenalFail	1.421	2.22	0.026	1.042	1.938
LiverDis	0.732	-0.20	0.839	0.036	14.944
HIV	2.146	0.73	0.464	0.278	16.581
Coagulopathy	2.726	5.39	0.000	1.893	3.926
WeekendAdmit	1.134	1.07	0.285	0.901	1.427
AdmitOff	1.225	1.91	0.056	0.995	1.507
Year2002	1.192	0.94	0.345	0.828	1.717
Year2003	1.125	0.63	0.530	0.779	1.626
Year2004	0.990	-0.05	0.958	0.677	1.447
Year2005	0.707	-1.61	0.107	0.464	1.078
Year2006	0.847	-0.81	0.416	0.567	1.264
Year2007	0.992	-0.04	0.970	0.668	1.475

Table 49: Logit Regression Most Recent 12 Month Lag Model Using AMI with Non-Primary PCI Cases with Operator's Total PCI Volume for Non-AMI Cases as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVHighNoAMI	0.546	-2.81	0.005	0.358	0.833
opmdHighNoAMII	0.551	-3.38	0.001	0.390	0.779
opmdModNoAMI	0.572	-3.06	0.002	0.399	0.818
PeerNoAMIVHigh..	0.809	-1.12	0.264	0.558	1.173
PeerNoAMIHigh	0.804	-1.21	0.227	0.564	1.145
PeerNoAMIMod	0.716	-1.93	0.054	0.509	1.006
Black	0.630	-1.77	0.076	0.378	1.050
Asian	1.629	1.28	0.199	0.773	3.433
Hispanic	1.328	1.47	0.143	0.909	1.939
OtherRace	1.298	1.29	0.198	0.872	1.930
UnknownRace	0.995	-0.03	0.978	0.712	1.391
ER	0.842	-1.55	0.121	0.677	1.047
Female	1.007	0.01	0.992	0.238	4.256
Medicaid	0.969	-0.15	0.878	0.646	1.452
SelfPay	0.462	-1.29	0.196	0.143	1.490
PrivateInsurance	0.703	-1.91	0.056	0.490	1.009
OtherInsurance	0.252	-1.36	0.174	0.035	1.839
AdmitLTC	1.394	1.18	0.237	0.804	2.416
meanage	1.033	4.41	0.000	1.018	1.048
AgeSex	1.002	0.18	0.854	0.983	1.021
AnteriorInfarct	1.470	2.36	0.018	1.067	2.026
SubendInfarct	0.664	-2.97	0.003	0.507	0.870
CurrentSmoker	0.354	-3.56	0.000	0.200	0.628
HistSmoker	0.561	-2.30	0.021	0.343	0.918
CancerDx	0.808	-1.17	0.240	0.566	1.154
ChronCerebrovas	0.305	-2.22	0.026	0.107	0.870
ChronLiverDis	1.641	0.32	0.750	0.078	34.537
COPD	1.547	1.54	0.123	0.888	2.696
Cardiomyopathy	1.201	0.80	0.423	0.767	1.878
HistPTCA	0.827	-0.96	0.338	0.560	1.220
HistCABG	0.755	-1.41	0.160	0.510	1.117
HistMI	0.621	-2.25	0.024	0.411	0.940
CHF	2.474	7.95	0.000	1.979	3.093
ValveDis	1.178	1.20	0.231	0.901	1.540
Hypertension	0.670	-3.49	0.000	0.535	0.839
Paralysis	2.237	1.65	0.098	0.861	5.809
FluidDis	2.546	7.56	0.000	1.998	3.244
OtherNeuro	2.529	5.43	0.000	1.810	3.533

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
ChronPulmDis	0.793	-0.90	0.369	0.477	1.316
DiabeteswoCompl	0.996	-0.03	0.973	0.796	1.246
DiabetesCompl	3.818	9.97	0.000	2.934	4.969
RenalFail	1.426	2.25	0.025	1.046	1.945
LiverDis	0.727	-0.21	0.837	0.035	15.262
HIV	2.245	0.78	0.437	0.292	17.277
Coagulopathy	2.797	5.56	0.000	1.946	4.021
WeekendAdmit	1.131	1.05	0.293	0.899	1.423
AdmitOff	1.250	2.10	0.035	1.015	1.538
Year2002	1.175	0.87	0.385	0.817	1.691
Year2003	1.108	0.55	0.583	0.769	1.597
Year2004	0.982	-0.10	0.924	0.672	1.434
Year2005	0.695	-1.70	0.090	0.457	1.058
Year2006	0.829	-0.92	0.357	0.556	1.236
Year2007	1.007	0.04	0.970	0.681	1.490

A.4 Peer-MD Interactions

Table 50: Logit Regression Conventional Model No Lag Peer-MD Interaction for Primary PCI Cases with Operator's Total PCI Volume Cases as Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
HighVeryHigh	0.640	-2.59	0.010	0.456	0.897
HighHigh	0.606	-2.72	0.006	0.422	0.869
HighModerate	0.855	-0.68	0.500	0.542	1.348
LowVeryHigh	0.788	-1.10	0.270	0.517	1.203
LowHigh	0.700	-1.68	0.093	0.462	1.061
LowModerate	1.494	1.97	0.049	1.002	2.228
Black	0.953	-0.30	0.765	0.694	1.308
Asian	1.133	0.47	0.639	0.674	1.904
Hispanic	1.062	0.43	0.667	0.806	1.400
OtherRace	1.010	0.07	0.945	0.759	1.345
UnknownRace	0.904	-0.80	0.426	0.706	1.158
ER	1.203	2.42	0.015	1.036	1.397
Female	2.255	1.90	0.058	0.973	5.226
Medicaid	1.296	1.78	0.076	0.973	1.726
SelfPay	1.669	2.53	0.011	1.123	2.480
PrivateInsance	0.898	-0.97	0.333	0.723	1.116
OtherInsurance	0.741	-0.99	0.324	0.408	1.344
AdmitLTC	1.271	1.06	0.289	0.816	1.979
meanage	1.047	9.45	0.000	1.037	1.057
AgeSex	0.993	-1.24	0.214	0.981	1.004
AnteriorInfarct	1.254	2.80	0.005	1.070	1.469
SubendInfarct	0.484	-7.36	0.000	0.399	0.587
CurrentSmoker	0.604	-4.09	0.000	0.474	0.769
HistSmoker	0.396	-4.50	0.000	0.264	0.592
CancerDx	0.865	-1.09	0.276	0.666	1.123
ChronCerebrovas	0.309	-2.82	0.005	0.137	0.698
ChronLiverDis	3.416	0.75	0.452	0.139	83.752
COPD	1.279	1.19	0.234	0.853	1.919
Cardiomyopathy	0.672	-1.76	0.078	0.431	1.046
HistPTCA	0.630	-2.74	0.006	0.453	0.876
HistCABG	1.153	0.78	0.436	0.806	1.648
HistMI	0.811	-1.34	0.181	0.597	1.103
CHF	2.016	8.98	0.000	1.730	2.349
ValveDis	1.281	2.37	0.018	1.044	1.574
Hypertension	0.659	-5.58	0.000	0.570	0.763
Paralysis	2.806	3.12	0.002	1.469	5.361
FluidDis	3.023	12.86	0.000	2.554	3.578
OtherNeuro	3.246	10.81	0.000	2.622	4.019

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
ChronPulmDis	0.872	-0.74	0.456	0.609	1.250
DiabeteswoCompl	1.176	1.99	0.047	1.002	1.380
DiabetesCompl	5.478	18.25	0.000	4.564	6.576
RenalFail	1.109	0.64	0.524	0.807	1.524
LiverDis	0.492	-0.43	0.664	0.020	12.038
Coagulopathy	2.362	6.35	0.000	1.812	3.080
WeekendAdmit	1.301	3.06	0.002	1.099	1.539
AdmitOff	1.195	2.24	0.025	1.022	1.397
Year2002	0.840	-1.27	0.203	0.642	1.099
Year2003	0.666	-2.89	0.004	0.505	0.877
Year2004	0.771	-1.95	0.051	0.594	1.001
Year2005	0.689	-2.78	0.005	0.529	0.896
Year2006	0.674	-2.95	0.003	0.519	0.876
Year2007	0.696	-2.73	0.006	0.536	0.903

Table 51: Logit Regression Most Recent 12 Month Lag Model Peer-MD Interaction for Primary PCI Cases with Operator's Total PCI Volume Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHigh	0.618	-4.22	0.000	0.494	0.773
HighHigh	0.678	-3.71	0.000	0.553	0.832
HighModerate	0.712	-3.21	0.001	0.578	0.876
HighLow	0.922	-0.58	0.559	0.703	1.210
LowVeryHigh	1.039	0.29	0.774	0.801	1.347
LowHigh	1.023	0.18	0.854	0.804	1.302
LowModerate	0.866	-1.05	0.294	0.663	1.132
Black	0.948	-0.33	0.741	0.690	1.302
Asian	1.150	0.53	0.598	0.684	1.931
Hispanic	1.047	0.33	0.745	0.795	1.379
OtherRace	0.995	-0.03	0.973	0.748	1.325
UnknownRace	0.889	-0.93	0.355	0.694	1.140
ER	1.199	2.40	0.016	1.034	1.391
Female	2.318	1.97	0.049	1.002	5.358
Medicaid	1.298	1.79	0.074	0.975	1.728
SelfPay	1.694	2.61	0.009	1.141	2.515
PrivateInsurance	0.901	-0.94	0.349	0.725	1.120
OtherInsurance	0.747	-0.96	0.335	0.413	1.352
AdmitLTC	1.201	0.81	0.417	0.772	1.867
meanage	1.047	9.53	0.000	1.037	1.057
AgeSex	0.992	-1.31	0.190	0.981	1.004
AnteriorInfarct	1.254	2.81	0.005	1.071	1.469
SubendInfarct	0.479	-7.48	0.000	0.395	0.581

Continued on Next Page

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
CurrentSmoker	0.589	-4.28	0.000	0.463	0.751
HistSmoker	0.395	-4.52	0.000	0.264	0.591
CancerDx	0.859	-1.14	0.254	0.662	1.115
ChronCerebrovas	0.303	-2.86	0.004	0.134	0.688
ChronLiverDis	3.534	0.78	0.436	0.147	84.863
COPD	1.261	1.12	0.261	0.842	1.889
Cardiomyopathy	0.660	-1.84	0.066	0.424	1.028
HistPTCA	0.636	-2.69	0.007	0.458	0.884
HistCABG	1.167	0.85	0.397	0.817	1.666
HistMI	0.813	-1.32	0.187	0.599	1.106
CHF	2.035	9.10	0.000	1.746	2.371
ValveDis	1.295	2.47	0.013	1.055	1.590
Hypertension	0.653	-5.72	0.000	0.565	0.756
Paralysis	2.782	3.09	0.002	1.452	5.328
FluidDis	3.001	12.80	0.000	2.536	3.551
OtherNeuro	3.238	10.81	0.000	2.617	4.008
ChronPulmDis	0.881	-0.69	0.489	0.616	1.261
DiabeteswoCompl	1.183	2.07	0.039	1.009	1.388
DiabetesCompl	5.513	18.32	0.000	4.593	6.618
RenalFail	1.106	0.62	0.533	0.806	1.519
LiverDis	0.467	-0.47	0.639	0.019	11.199
Coagulopathy	2.429	6.57	0.000	1.864	3.165
WeekendAdmit	1.292	2.99	0.003	1.092	1.529
AdmitOff	1.208	2.38	0.017	1.034	1.412
Year2002	0.836	-1.31	0.190	0.639	1.093
Year2003	0.680	-2.75	0.006	0.516	0.895
Year2004	0.777	-1.90	0.058	0.598	1.008
Year2005	0.693	-2.74	0.006	0.533	0.901
Year2006	0.683	-2.86	0.004	0.526	0.887
Year2007	0.699	-2.71	0.007	0.539	0.905

Table 52: Logit Regression Conventional Model No Lag Peer-MD Interaction for Non-Primary PCI Cases with Operator's Total PCI Volume Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHigh	0.424	-3.68	0.000	0.269	0.670
HighHigh	0.418	-3.47	0.001	0.255	0.684
HighModerate	0.472	-1.84	0.066	0.212	1.050
LowVeryHigh	0.443	-2.71	0.007	0.246	0.798
LowHigh	0.527	-2.24	0.025	0.301	0.923
LowModerate	1.212	0.70	0.485	0.706	2.080
Black	0.617	-1.85	0.064	0.370	1.029

Continued on Next Page

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
Asian	1.639	1.30	0.193	0.779	3.451
Hispanic	1.278	1.27	0.204	0.875	1.867
OtherRace	1.316	1.36	0.175	0.885	1.955
UnknownRace	1.020	0.12	0.905	0.734	1.419
ER	0.828	-1.70	0.089	0.666	1.030
Female	1.011	0.01	0.989	0.239	4.271
Medicaid	0.973	-0.13	0.893	0.649	1.457
SelfPay	0.470	-1.26	0.206	0.146	1.515
PrivateIns e	0.702	-1.92	0.055	0.489	1.007
OtherInsur e	0.252	-1.36	0.174	0.035	1.839
AdmitLTC	1.416	1.25	0.213	0.819	2.449
meanage	1.033	4.47	0.000	1.019	1.048
AgeSex	1.002	0.18	0.858	0.983	1.021
AnteriorIn t	1.466	2.34	0.019	1.064	2.020
SubendInfa t	0.664	-2.96	0.003	0.507	0.871
CurrentSmo r	0.354	-3.56	0.000	0.200	0.628
HistSmoker	0.559	-2.32	0.021	0.342	0.914
CancerDx	0.796	-1.25	0.210	0.557	1.137
ChronCereb s	0.293	-2.29	0.022	0.103	0.837
ChronLiver s	1.731	0.36	0.717	0.089	33.746
COPD	1.514	1.47	0.143	0.870	2.635
Cardiomyop y	1.226	0.89	0.371	0.784	1.918
HistPTCA	0.831	-0.93	0.352	0.563	1.227
HistCABG	0.752	-1.42	0.154	0.508	1.113
HistMI	0.619	-2.27	0.023	0.409	0.937
CHF	2.470	7.95	0.000	1.976	3.087
ValveDis	1.195	1.31	0.191	0.915	1.561
Hypertension	0.669	-3.50	0.000	0.534	0.838
Paralysis	2.249	1.67	0.096	0.867	5.834
FluidDis	2.547	7.57	0.000	2.000	3.244
OtherNeuro	2.539	5.47	0.000	1.818	3.545
ChronPulmDis	0.809	-0.82	0.412	0.488	1.342
Diabeteswo l	0.995	-0.04	0.968	0.796	1.245
DiabetesCo l	3.859	10.06	0.000	2.966	5.020
RenalFail	1.419	2.21	0.027	1.041	1.935
LiverDis	0.683	-0.25	0.801	0.035	13.264
HIV	2.165	0.74	0.458	0.282	16.626
Coagulopathy	2.829	5.63	0.000	1.970	4.065
WeekendAdmit	1.138	1.10	0.270	0.904	1.432
AdmitOff	1.249	2.10	0.036	1.015	1.536
Year2002	1.185	0.91	0.360	0.824	1.705
Year2003	1.106	0.54	0.588	0.767	1.595
Year2004	0.986	-0.07	0.942	0.675	1.440
Year2005	0.695	-1.69	0.090	0.457	1.059

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Year2006	0.829	-0.92	0.358	0.556	1.236
Year2007	1.009	0.04	0.964	0.682	1.493

Table 53: Logit Regression Most Recent 12 Month Lag Model Peer-MD Interaction for Non-Primary PCI Cases with Operator's Total PCI Volume Cases as Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHigh	0.669	-2.57	0.010	0.493	0.909
0. HighHigh	0.555	-3.89	0.000	0.412	0.746
HighModerate	0.624	-3.09	0.002	0.462	0.841
HighLow	0.476	-3.00	0.003	0.293	0.773
LowVeryHigh	0.811	-1.18	0.236	0.574	1.147
LowHigh	0.799	-1.25	0.213	0.561	1.137
LowModerate	0.708	-1.81	0.070	0.487	1.028
Black	0.625	-1.80	0.071	0.375	1.042
Asian	1.656	1.33	0.183	0.788	3.479
Hispanic	1.281	1.28	0.200	0.877	1.869
OtherRace	1.311	1.34	0.182	0.881	1.949
UnknownRace	1.000	0.00	0.998	0.715	1.398
ER	0.853	-1.43	0.153	0.687	1.061
Female	1.090	0.12	0.906	0.259	4.581
Medicaid	0.994	-0.03	0.976	0.663	1.490
SelfPay	0.462	-1.29	0.197	0.143	1.492
PrivateInsance	0.706	-1.89	0.059	0.492	1.014
OtherInsurance	0.261	-1.33	0.185	0.036	1.903
AdmitLTC	1.465	1.37	0.170	0.850	2.526
meanage	1.033	4.44	0.000	1.018	1.048
AgeSex	1.001	0.08	0.940	0.982	1.020
AnteriorInfarct	1.470	2.36	0.018	1.067	2.025
SubendInfarct	0.655	-3.06	0.002	0.500	0.859
CurrentSmoer	0.352	-3.57	0.000	0.199	0.624
HistSmoker	0.565	-2.27	0.023	0.346	0.924
CancerDx	0.804	-1.20	0.230	0.563	1.148
ChronCerebrovas	0.309	-2.20	0.028	0.108	0.882
ChronLiverDis	1.640	0.30	0.761	0.068	39.634
COPD	1.484	1.40	0.163	0.853	2.584
Cardiomyopathy	1.219	0.87	0.385	0.779	1.907
HistPTCA	0.804	-1.10	0.271	0.545	1.186
HistCABG	0.742	-1.49	0.136	0.502	1.099
HistMI	0.619	-2.27	0.023	0.409	0.937
CHF	2.485	8.01	0.000	1.989	3.105
ValveDis	1.183	1.23	0.219	0.905	1.546

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Hypertension	0.670	-3.50	0.000	0.535	0.838
Paralysis	2.242	1.66	0.097	0.863	5.825
FluidDis	2.584	7.69	0.000	2.029	3.292
OtherNeuro	2.535	5.45	0.000	1.815	3.541
ChronPulmDis	0.814	-0.80	0.426	0.491	1.351
DiabeteswoCompl	1.009	0.08	0.938	0.807	1.262
DiabetesCompl	3.856	10.05	0.000	2.964	5.017
RenalFail	1.420	2.22	0.026	1.043	1.935
LiverDis	0.715	-0.21	0.836	0.030	17.239
HIV	1.958	0.64	0.520	0.253	15.145
Coagulopathy	2.862	5.69	0.000	1.993	4.109
WeekendAdmit	1.124	1.00	0.317	0.894	1.414
AdmitOff	1.243	2.05	0.040	1.010	1.530
Year2002	1.184	0.91	0.363	0.823	1.703
Year2003	1.129	0.65	0.514	0.784	1.628
Year2004	1.002	0.01	0.991	0.686	1.464
Year2005	0.721	-1.53	0.127	0.474	1.097
Year2006	0.866	-0.71	0.478	0.581	1.290
Year2007	1.044	0.21	0.831	0.705	1.544

Table 54: Logit Regression Conventional Model No Lag Peer-MD Interaction for Primary PCI Cases with Operator's PCI with AMI Only Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHighAMI	0.496	-4.19	0.000	0.357	0.688
HighHighAMI	0.613	-2.09	0.037	0.387	0.971
LowVeryHigAMI	0.599	-2.79	0.005	0.418	0.858
LowHighAMI	0.725	-1.77	0.076	0.509	1.035
LowModAMI	0.909	-0.47	0.637	0.612	1.350
Black	0.874	-0.79	0.427	0.627	1.219
Asian	1.105	0.37	0.714	0.647	1.890
Hispanic	1.038	0.26	0.798	0.779	1.385
OtherRace	1.006	0.04	0.969	0.746	1.356
UnknownRace	0.850	-1.24	0.216	0.657	1.100
ER	1.175	2.06	0.039	1.008	1.371
Female	2.673	2.21	0.027	1.117	6.393
Medicaid	1.262	1.53	0.125	0.938	1.698
SelfPay	1.751	2.70	0.007	1.166	2.630
PrivateInsurance	0.913	-0.79	0.431	0.728	1.145
OtherInsurance	0.876	-0.43	0.666	0.481	1.596
AdmitLTC	1.367	1.39	0.164	0.880	2.124
meanage	1.049	9.50	0.000	1.039	1.060

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
AgeSex	0.990	-1.55	0.121	0.979	1.003
AnteriorInfarct	1.253	2.70	0.007	1.064	1.475
SubendInfarct	0.456	-7.69	0.000	0.373	0.557
CurrentSmoker	0.620	-3.75	0.000	0.483	0.796
HistSmoker	0.397	-4.32	0.000	0.262	0.604
CancerDx	0.839	-1.27	0.205	0.640	1.101
ChronCerebrovas	0.288	-2.85	0.004	0.122	0.678
ChronLiverDis	3.347	0.78	0.433	0.163	68.778
COPD	1.260	1.08	0.278	0.830	1.912
Cardiomyopathy	0.617	-2.02	0.044	0.386	0.986
HistPTCA	0.601	-2.89	0.004	0.425	0.848
HistCABG	1.206	1.01	0.312	0.839	1.735
HistMI	0.819	-1.25	0.213	0.598	1.121
CHF	2.007	8.62	0.000	1.713	2.351
ValveDis	1.300	2.41	0.016	1.050	1.608
Hypertension	0.660	-5.38	0.000	0.568	0.768
Paralysis	3.037	3.23	0.001	1.547	5.960
FluidDis	3.110	12.80	0.000	2.614	3.699
OtherNeuro	3.139	10.06	0.000	2.512	3.923
ChronPulmDis	0.887	-0.63	0.526	0.613	1.284
DiabeteswoCompl	1.203	2.20	0.028	1.021	1.419
DiabetesCompl	5.672	18.02	0.000	4.696	6.851
RenalFail	1.102	0.58	0.563	0.793	1.532
LiverDis	0.572	-0.36	0.716	0.028	11.685
Coagulopathy	2.559	6.70	0.000	1.944	3.368
WeekendAdmit	1.329	3.20	0.001	1.116	1.581
AdmitOff	1.254	2.76	0.006	1.068	1.472
Year2002	0.829	-1.33	0.182	0.630	1.092
Year2003	0.628	-3.18	0.001	0.472	0.837
Year2004	0.749	-2.10	0.035	0.573	0.980
Year2005	0.690	-2.70	0.007	0.527	0.903
Year2006	0.641	-3.23	0.001	0.489	0.839
Year2007	0.667	-2.97	0.003	0.511	0.871

Table 55: Logit Regression Most Recent 12 Month Lag Model Peer-MD Interaction for Primary PCI Cases with Operator's PCI with AMI Only Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHighAMI	0.547	-5.54	0.000	0.442	0.677
HighHighAMI	0.534	-5.35	0.000	0.425	0.672
HighModAMI	0.589	-3.14	0.002	0.424	0.820
HighLowAMI	0.987	-0.04	0.968	0.515	1.891

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
LowVeryHigAMI	0.489	-4.06	0.000	0.346	0.691
LowHighAMI	0.675	-2.71	0.007	0.508	0.897
LowModAMI	0.750	-2.45	0.014	0.596	0.944
Black	0.886	-0.74	0.457	0.645	1.218
Asian	1.077	0.28	0.778	0.642	1.809
Hispanic	1.009	0.06	0.950	0.766	1.329
OtherRace	0.953	-0.33	0.744	0.716	1.269
UnknownRace	0.873	-1.08	0.281	0.682	1.117
ER	1.201	2.41	0.016	1.035	1.394
Female	2.341	1.99	0.047	1.012	5.415
Medicaid	1.246	1.51	0.132	0.936	1.659
SelfPay	1.587	2.29	0.022	1.068	2.359
PrivateInsurance	0.890	-1.05	0.291	0.716	1.106
OtherInsurance	0.750	-0.94	0.346	0.413	1.363
AdmitLTC	1.287	1.12	0.261	0.829	1.999
meanage	1.046	9.35	0.000	1.037	1.056
AgeSex	0.992	-1.31	0.191	0.981	1.004
AnteriorInfarct	1.253	2.79	0.005	1.069	1.467
SubendInfarct	0.466	-7.74	0.000	0.385	0.566
CurrentSmoker	0.618	-3.90	0.000	0.485	0.787
HistSmoker	0.404	-4.40	0.000	0.270	0.605
CancerDx	0.873	-1.02	0.308	0.672	1.134
ChronCerebrovas	0.308	-2.83	0.005	0.136	0.697
ChronLiverDis	3.168	0.73	0.462	0.146	68.574
COPD	1.278	1.19	0.235	0.853	1.915
Cardiomyopathy	0.658	-1.85	0.064	0.423	1.024
HistPTCA	0.628	-2.76	0.006	0.451	0.874
HistCABG	1.151	0.77	0.440	0.806	1.644
HistMI	0.804	-1.39	0.164	0.591	1.093
CHF	2.023	9.03	0.000	1.736	2.358
ValveDis	1.278	2.34	0.019	1.041	1.569
Hypertension	0.657	-5.62	0.000	0.568	0.761
Paralysis	2.716	3.02	0.003	1.419	5.198
FluidDis	3.026	12.88	0.000	2.557	3.581
OtherNeuro	3.307	10.99	0.000	2.672	4.093
ChronPulmDis	0.877	-0.72	0.474	0.613	1.255
DiabeteswoCompl	1.169	1.91	0.056	0.996	1.372
DiabetesCompl	5.553	18.41	0.000	4.627	6.665
RenalFail	1.103	0.60	0.546	0.803	1.515
LiverDis	0.511	-0.43	0.668	0.024	11.019
Coagulopathy	2.382	6.40	0.000	1.827	3.107
WeekendAdmit	1.309	3.13	0.002	1.106	1.549
AdmitOff	1.204	2.33	0.020	1.030	1.406
Year2002	0.855	-1.15	0.252	0.653	1.118

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Year2003	0.685	-2.69	0.007	0.520	0.902
Year2004	0.782	-1.84	0.065	0.602	1.016
Year2005	0.697	-2.68	0.007	0.536	0.907
Year2006	0.678	-2.90	0.004	0.522	0.881
Year2007	0.706	-2.63	0.009	0.544	0.915

Table 56: Logit Regression Conventional Model No Lag Peer-MD Interaction for Non-Primary PCI Cases with Operator's PCI with AMI Only Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHighAMI	0.526	-2.86	0.004	0.339	0.817
HighHighAMI	0.694	-1.05	0.293	0.351	1.372
LowVeryHigAMI	0.511	-2.68	0.007	0.313	0.836
LowHighAMI	0.649	-1.78	0.075	0.402	1.045
LowModAMI	1.043	0.16	0.872	0.626	1.738
Black	0.630	-1.76	0.079	0.376	1.054
Asian	1.292	0.59	0.553	0.555	3.010
Hispanic	1.215	0.95	0.341	0.814	1.814
OtherRace	1.195	0.82	0.411	0.781	1.829
UnknownRace	0.942	-0.34	0.737	0.663	1.337
ER	0.890	-1.02	0.308	0.712	1.113
Female	1.202	0.24	0.811	0.267	5.414
Medicaid	0.974	-0.12	0.903	0.639	1.486
SelfPay	0.318	-1.58	0.114	0.077	1.317
PrivateInsurance	0.679	-1.99	0.047	0.464	0.995
OtherInsurance	0.275	-1.27	0.204	0.038	2.018
AdmitLTC	1.598	1.68	0.093	0.925	2.761
meanage	1.034	4.30	0.000	1.018	1.050
AgeSex	1.000	-0.01	0.988	0.980	1.020
AnteriorInfarct	1.478	2.29	0.022	1.058	2.066
SubendInfarct	0.636	-3.16	0.002	0.480	0.842
CurrentSmoker	0.387	-3.24	0.001	0.218	0.687
HistSmoker	0.584	-2.08	0.037	0.352	0.969
CancerDx	0.803	-1.17	0.241	0.556	1.159
ChronCerebrovas	0.263	-2.30	0.022	0.084	0.821
ChronLiverDis	1.824	0.38	0.706	0.080	41.331
COPD	1.494	1.38	0.168	0.844	2.644
Cardiomyopathy	1.233	0.90	0.369	0.780	1.949
HistPTCA	0.855	-0.78	0.438	0.575	1.271
HistCABG	0.759	-1.35	0.177	0.509	1.133
HistMI	0.599	-2.33	0.020	0.389	0.921
CHF	2.321	7.11	0.000	1.840	2.928

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
ValveDis	1.200	1.28	0.200	0.908	1.586
Hypertension	0.634	-3.81	0.000	0.502	0.802
Paralysis	2.806	2.07	0.038	1.058	7.441
FluidDis	2.767	7.99	0.000	2.156	3.552
OtherNeuro	2.561	5.32	0.000	1.811	3.621
ChronPulmDis	0.831	-0.70	0.486	0.493	1.400
DiabeteswoComl	1.053	0.43	0.666	0.834	1.328
DiabetesCompl	3.973	9.80	0.000	3.015	5.235
RenalFail	1.414	2.11	0.035	1.024	1.953
LiverDis	0.738	-0.19	0.849	0.033	16.709
HIV	2.251	0.78	0.437	0.291	17.414
Coagulopathy	2.695	5.04	0.000	1.833	3.962
WeekendAdmit	1.090	0.71	0.481	0.857	1.387
AdmitOff	1.200	1.64	0.100	0.966	1.493
Year2002	1.210	0.97	0.330	0.825	1.773
Year2003	1.078	0.38	0.705	0.731	1.590
Year2004	1.014	0.07	0.945	0.683	1.506
Year2005	0.700	-1.59	0.112	0.451	1.087
Year2006	0.803	-1.02	0.306	0.527	1.223
Year2007	1.040	0.19	0.850	0.692	1.563

Table 57: Logit Regression Most Recent Lag Model Peer-MD Interaction for Non-Primary PCI Cases with Operator's PCI with AMI Only Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
HighVeryHighAMI	0.554	-6.68	0.000	0.466	0.659
HighHighAMI	0.507	-7.24	0.000	0.422	0.609
HighModAMI	0.562	-4.18	0.000	0.429	0.737
HighLowAMI	0.913	-0.31	0.758	0.513	1.627
LowVeryHighAMI	0.469	-5.13	0.000	0.351	0.626
LowHighAMI	0.553	-4.98	0.000	0.438	0.698
LowModAMI	0.702	-3.79	0.000	0.584	0.843
Black	0.772	-1.89	0.058	0.591	1.009
Asian	1.235	0.97	0.330	0.808	1.886
Hispanic	1.087	0.74	0.459	0.871	1.356
OtherRace	1.012	0.10	0.917	0.803	1.276
UnknownRace	0.901	-1.04	0.301	0.740	1.098
ER	1.064	1.01	0.313	0.944	1.199
Female	1.898	1.75	0.080	0.926	3.889
Medicaid	1.119	0.95	0.343	0.887	1.410
SelfPay	1.319	1.49	0.136	0.917	1.897
PrivateInsurance	0.851	-1.72	0.085	0.708	1.023

Continued on Next Page

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
OtherInsurance	0.686	-1.31	0.190	0.391	1.204
AdmitLTC	1.305	1.53	0.125	0.929	1.834
meanage	1.041	10.06	0.000	1.033	1.049
AgeSex	0.995	-1.10	0.273	0.985	1.004
AnteriorInfarct	1.314	3.81	0.000	1.142	1.512
SubendInfarct	0.416	-12.04	0.000	0.361	0.480
CurrentSmoker	0.568	-5.07	0.000	0.456	0.707
HistSmoker	0.450	-5.04	0.000	0.330	0.614
CancerDx	0.826	-1.80	0.072	0.670	1.018
ChronCerebrovas	0.288	-3.80	0.000	0.151	0.547
ChronLiverDis	2.236	0.78	0.437	0.294	16.987
COPD	1.395	2.01	0.045	1.008	1.930
Cardiomyopathy	0.843	-1.07	0.286	0.615	1.154
HistPTCA	0.694	-2.85	0.004	0.541	0.892
HistCABG	0.849	-1.23	0.220	0.653	1.103
HistMI	0.713	-2.70	0.007	0.558	0.911
CHF	2.088	11.58	0.000	1.843	2.365
ValveDis	1.232	2.54	0.011	1.049	1.448
Hypertension	0.653	-6.84	0.000	0.578	0.738
Paralysis	2.513	3.40	0.001	1.476	4.277
FluidDis	2.889	15.24	0.000	2.521	3.311
OtherNeuro	3.001	12.17	0.000	2.515	3.582
ChronPulmDis	0.825	-1.30	0.195	0.617	1.104
DiabeteswoCompl	1.091	1.32	0.187	0.959	1.242
DiabetesCompl	5.088	21.33	0.000	4.381	5.908
RenalFail	1.164	1.38	0.167	0.939	1.443
LiverDis	0.588	-0.51	0.607	0.078	4.456
HIV	0.514	-0.65	0.518	0.068	3.872
Coagulopathy	2.530	8.55	0.000	2.045	3.130
WeekendAdmit	1.167	2.28	0.023	1.022	1.333
AdmitOff	1.130	1.96	0.050	1.000	1.278
Year2002	0.968	-0.30	0.765	0.781	1.199
Year2003	0.845	-1.51	0.130	0.679	1.051
Year2004	0.914	-0.82	0.411	0.738	1.132
Year2005	0.782	-2.19	0.028	0.627	0.974
Year2006	0.804	-1.97	0.049	0.647	0.999
Year2007	0.878	-1.19	0.234	0.708	1.088

B Appendix 2 Complete Set of Regressions from Chapter 2

Table 58: Logit Regression Most Recent Lag Model MDs Cardiology Specialists Only for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVeryHigh	0.535	-4.02	0.000	0.394	0.726
opmdHigh	0.514	-4.89	0.000	0.393	0.671
opmdModerate	0.590	-3.29	0.001	0.431	0.808
PeerVeryHigh	0.992	-0.07	0.946	0.786	1.251
PeerHigh	0.886	-1.02	0.307	0.703	1.117
PeerModeratee	0.965	-0.32	0.748	0.778	1.198
Black	0.742	-1.46	0.144	0.497	1.107
Asian	1.341	0.96	0.337	0.737	2.441
Hispanic	1.341	1.90	0.057	0.991	1.816
OtherRace	1.041	0.23	0.820	0.738	1.468
UnknownRace	0.986	-0.11	0.915	0.757	1.284
ER	1.060	0.71	0.475	0.904	1.242
Female	1.513	0.87	0.386	0.593	3.864
Medicaid	1.042	0.24	0.811	0.746	1.454
SelfPay	1.557	1.84	0.065	0.973	2.492
PrivateInsurance	0.814	-1.67	0.095	0.639	1.037
OtherInsurance	1.003	0.01	0.993	0.547	1.837
AdmitLTC	1.539	2.16	0.031	1.041	2.275
meanage	1.041	7.78	0.000	1.031	1.052
AgeSex	0.997	-0.45	0.653	0.984	1.010
AnteriorInfarct	1.289	2.76	0.006	1.076	1.545
SubendInfarct	0.419	-9.11	0.000	0.347	0.505
CurrentSmoker	0.638	-3.41	0.001	0.492	0.826
HistSmoker	0.466	-4.02	0.000	0.321	0.677
CancerDx	0.732	-2.19	0.028	0.553	0.967
ChronCerebrovas	0.439	-2.01	0.045	0.197	0.981
ChronLiverDis	12.308	2.33	0.020	1.486	101.918
COPD	1.556	1.91	0.056	0.989	2.447
Cardiomyopathy	1.135	0.65	0.517	0.773	1.666
HistPTCA	0.823	-1.25	0.213	0.606	1.118
HistCABG	0.795	-1.27	0.205	0.557	1.134
HistMI	0.724	-2.00	0.045	0.527	0.993
CHF	1.893	7.65	0.000	1.608	2.229
ValveDis	1.210	1.78	0.075	0.981	1.493
Hypertension	0.691	-4.58	0.000	0.590	0.810

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Paralysis	2.027	2.01	0.044	1.019	4.032
FluidDis	3.496	14.17	0.000	2.940	4.156
OtherNeuro	3.180	10.02	0.000	2.536	3.988
ChronPulmDis	0.746	-1.38	0.168	0.493	1.131
DiabeteswoCompl	1.140	1.50	0.133	0.961	1.352
DiabetesCompl	4.775	15.76	0.000	3.931	5.800
RenalFail	1.362	2.13	0.033	1.025	1.810
LiverDis	0.139	-1.68	0.092	0.014	1.380
Coagulopathy	2.373	5.73	0.000	1.765	3.189
WeekendAdmit	1.141	1.48	0.138	0.958	1.359
AdmitOff	1.164	1.84	0.066	0.990	1.368
Year2002	0.851	-1.16	0.248	0.648	1.118
Year2003	0.700	-2.45	0.014	0.527	0.931
Year2004	0.836	-1.29	0.199	0.636	1.099
Year2005	0.756	-1.96	0.050	0.571	1.001
Year2006	0.799	-1.59	0.111	0.606	1.053
Year2007	0.922	-0.59	0.557	0.703	1.209

Table 59: Logit Regression Most Recent Lag Model MDs Cardiology Specialists Only with Quality Characteristics for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdVeryHigh	0.543	-3.88	0.000	0.399	0.739
opmdHigh	0.514	-4.85	0.000	0.393	0.673
opmdModerate	0.589	-3.28	0.001	0.429	0.808
PeerVeryHigh	0.995	-0.04	0.968	0.788	1.257
PeerHigh	0.877	-1.10	0.273	0.695	1.108
PeerModerate	0.958	-0.39	0.696	0.771	1.189
Black	0.737	-1.49	0.135	0.494	1.100
Asian	1.310	0.88	0.378	0.719	2.388
Hispanic	1.330	1.84	0.065	0.982	1.801
OtherRace	1.023	0.13	0.895	0.725	1.444
UnknownRace	0.971	-0.22	0.828	0.745	1.265
ER	1.059	0.70	0.483	0.903	1.241
Female	1.496	0.84	0.400	0.585	3.826
Medicaid	1.055	0.31	0.754	0.755	1.475
SelfPay	1.559	1.85	0.065	0.973	2.495
PrivateInsurance	0.814	-1.66	0.096	0.639	1.038
OtherInsurance	1.002	0.01	0.996	0.547	1.836
AdmitLTC	1.540	2.16	0.031	1.041	2.279
meanage	1.042	7.78	0.000	1.031	1.052

Continued on Next Page

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
AgeSex	0.997	-0.43	0.669	0.984	1.010
AnteriorInfarct	1.287	2.73	0.006	1.074	1.542
SubendInfarct	0.418	-9.12	0.000	0.347	0.504
CurrentSmoker	0.637	-3.42	0.001	0.491	0.825
HistSmoker	0.464	-4.04	0.000	0.320	0.674
CancerDx	0.728	-2.22	0.026	0.551	0.963
ChronCerebrovas	0.440	-2.00	0.046	0.196	0.985
ChronLiverDis	12.843	2.37	0.018	1.551	106.347
COPD	1.565	1.94	0.053	0.995	2.461
Cardiomyopathy	1.138	0.66	0.511	0.775	1.670
HistPTCA	0.824	-1.24	0.216	0.607	1.120
HistCABG	0.794	-1.27	0.203	0.556	1.133
HistMI	0.719	-2.04	0.041	0.524	0.987
CHF	1.899	7.69	0.000	1.612	2.236
ValveDis	1.207	1.75	0.080	0.978	1.490
Hypertension	0.690	-4.60	0.000	0.589	0.808
Paralysis	2.025	2.00	0.045	1.016	4.035
FluidDis	3.489	14.14	0.000	2.934	4.149
OtherNeuro	3.176	10.00	0.000	2.532	3.984
ChronPulmDis	0.745	-1.39	0.165	0.492	1.129
DiabeteswoCompl	1.140	1.50	0.132	0.961	1.352
DiabetesCompl	4.780	15.76	0.000	3.935	5.806
RenalFail	1.368	2.16	0.031	1.029	1.818
LiverDis	0.133	-1.72	0.085	0.013	1.318
Coagulopathy	2.372	5.72	0.000	1.764	3.189
WeekendAdmit	1.142	1.49	0.136	0.959	1.360
AdmitOff	1.165	1.85	0.065	0.991	1.369
Year2002	0.855	-1.12	0.261	0.651	1.123
Year2003	0.699	-2.46	0.014	0.526	0.930
Year2004	0.837	-1.28	0.202	0.637	1.100
Year2005	0.755	-1.96	0.050	0.570	1.000
Year2006	0.797	-1.61	0.107	0.604	1.050
Year2007	0.921	-0.60	0.551	0.702	1.208
OpBoardCert	1.277	0.72	0.474	0.654	2.495
MissingOpBdCert	1.497	1.10	0.270	0.731	3.068
OpFMG	0.954	-0.32	0.746	0.717	1.269
MissingOpFMG	0.894	-0.73	0.465	0.663	1.207
opmdExperience	1.000	0.04	0.968	0.985	1.016
MissingopmExp	0.974	-0.12	0.905	0.635	1.495

Table 60: Logit Regression Most Recent Lag Model MDs Cardiology Specialists Only with Quality Characteristics for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVeryHigh	0.541	-3.90	0.000	0.397	0.736
opmdHigh	0.513	-4.81	0.000	0.391	0.673
opmdModerate	0.579	-3.38	0.001	0.421	0.795
PeerVeryHigh	1.026	0.20	0.838	0.799	1.319
PeerHigh	0.893	-0.94	0.346	0.705	1.130
PeerModerate	0.967	-0.31	0.759	0.778	1.201
Black	0.732	-1.53	0.127	0.490	1.093
Asian	1.293	0.84	0.403	0.708	2.361
Hispanic	1.332	1.85	0.064	0.983	1.805
OtherRace	1.008	0.05	0.963	0.713	1.425
UnknownRace	0.980	-0.15	0.881	0.749	1.282
ER	1.058	0.70	0.487	0.902	1.241
Female	1.511	0.86	0.389	0.591	3.864
Medicaid	1.058	0.33	0.740	0.757	1.480
SelfPay	1.539	1.79	0.073	0.961	2.465
PrivateInsurance	0.813	-1.67	0.094	0.638	1.036
OtherInsurance	1.002	0.01	0.994	0.547	1.837
AdmitLTC	1.551	2.20	0.028	1.048	2.296
meanage	1.042	7.80	0.000	1.031	1.052
AgeSex	0.997	-0.44	0.657	0.984	1.010
AnteriorInfarct	1.283	2.70	0.007	1.071	1.537
SubendInfarct	0.417	-9.15	0.000	0.345	0.502
CurrentSmoker	0.638	-3.40	0.001	0.492	0.827
HistSmoker	0.465	-4.03	0.000	0.320	0.674
CancerDx	0.725	-2.25	0.024	0.548	0.959
ChronCereb s	0.437	-2.01	0.045	0.195	0.981
ChronLiver s	12.261	2.30	0.021	1.453	103.489
COPD	1.561	1.93	0.054	0.992	2.455
Cardiomyopathy	1.127	0.61	0.542	0.767	1.656
HistPTCA	0.823	-1.25	0.212	0.606	1.118
HistCABG	0.797	-1.25	0.212	0.559	1.138
HistMI	0.722	-2.02	0.044	0.525	0.991
CHF	1.897	7.67	0.000	1.610	2.234
ValveDis	1.217	1.83	0.067	0.986	1.503
Hypertension	0.692	-4.56	0.000	0.591	0.811
Paralysis	2.021	2.00	0.046	1.014	4.029
FluidDis	3.505	14.17	0.000	2.947	4.169
OtherNeuro	3.185	10.02	0.000	2.540	3.995

Continued on Next Page

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
ChronPulmDis	0.747	-1.38	0.168	0.493	1.132
DiabeteswoCompl	1.140	1.50	0.133	0.961	1.352
DiabetesCompl	4.794	15.78	0.000	3.946	5.825
RenalFail	1.378	2.21	0.027	1.036	1.832
LiverDis	0.137	-1.69	0.092	0.014	1.382
Coagulopathy	2.372	5.71	0.000	1.764	3.191
WeekendAdmit	1.140	1.47	0.141	0.957	1.358
AdmitOff	1.166	1.86	0.063	0.992	1.371
Year2002	0.857	-1.11	0.268	0.652	1.126
Year2003	0.697	-2.48	0.013	0.524	0.927
Year2004	0.834	-1.30	0.194	0.635	1.097
Year2005	0.754	-1.97	0.049	0.569	0.999
Year2006	0.794	-1.63	0.102	0.602	1.047
Year2007	0.914	-0.65	0.516	0.696	1.199
OpBoardCert	1.277	0.72	0.474	0.653	2.497
MissingOpBdCert	1.547	1.19	0.235	0.754	3.174
OpFMG	0.935	-0.46	0.648	0.702	1.247
MissingOpFMG	0.902	-0.67	0.501	0.669	1.217
opmdExperience	1.002	0.24	0.810	0.986	1.018
MissingopmdExp	0.992	-0.04	0.970	0.646	1.524
teaching	0.798	-1.36	0.174	0.577	1.105
system	1.013	0.14	0.889	0.844	1.216

Table 61: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with $\rho = 0.2$ and $\kappa = 0.13$ for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHigh	0.559	-2.81	0.005	0.373	0.838
opmdModerate	0.622	-2.32	0.020	0.417	0.929
PeerVeryHigh	0.723	-1.65	0.100	0.491	1.064
PeerHigh	0.747	-1.49	0.137	0.508	1.098
PeerModerate	0.826	-0.97	0.333	0.561	1.216
Black	1.028	0.15	0.883	0.711	1.487
Asian	1.580	1.56	0.119	0.888	2.810
Hispanic	1.122	0.71	0.479	0.815	1.545
OtherRace	0.823	-0.90	0.366	0.539	1.255
UnknownRace	0.992	-0.04	0.966	0.678	1.451
ER	1.097	0.96	0.339	0.908	1.325
Female	1.943	1.20	0.229	0.659	5.727
Medicaid	1.122	0.59	0.558	0.763	1.650
SelfPay	1.473	1.48	0.140	0.881	2.463

Continued on Next Page

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
PrivateInsurance	0.707	-2.30	0.021	0.527	0.950
OtherInsurance	0.926	-0.21	0.834	0.453	1.893
AdmitLTC	2.071	2.75	0.006	1.233	3.480
meanage	1.033	5.14	0.000	1.020	1.046
AgeSex	0.995	-0.64	0.525	0.980	1.010
AnteriorInfarct	1.401	2.96	0.003	1.120	1.751
SubendInfarct	0.410	-7.75	0.000	0.328	0.514
CurrentSmoker	0.478	-4.60	0.000	0.349	0.655
HistSmoker	0.380	-4.16	0.000	0.241	0.600
CancerDx	1.031	0.20	0.843	0.760	1.398
ChronCerebrovas	0.141	-3.45	0.001	0.046	0.429
ChronLiverDis	1.681	0.41	0.680	0.142	19.891
COPD	1.335	1.17	0.240	0.824	2.162
Cardiomyop y	0.517	-2.39	0.017	0.301	0.887
HistPTCA	0.607	-2.44	0.015	0.406	0.907
HistCABG	0.826	-0.86	0.391	0.534	1.279
HistMI	0.976	-0.14	0.892	0.685	1.390
CHF	1.979	6.79	0.000	1.625	2.411
ValveDis	1.032	0.24	0.813	0.796	1.338
Hypertension	0.654	-4.29	0.000	0.539	0.794
Paralysis	5.062	4.01	0.000	2.289	11.193
FluidDis	2.917	10.12	0.000	2.371	3.589
OtherNeuro	3.021	7.76	0.000	2.285	3.993
ChronPulmDis	0.914	-0.41	0.680	0.594	1.404
DiabeteswoCompl	0.947	-0.52	0.606	0.771	1.164
DiabetesCompl	4.937	12.57	0.000	3.849	6.333
RenalFail	1.058	0.33	0.741	0.758	1.476
LiverDis	0.893	-0.09	0.929	0.075	10.638
HIV	1.114	0.10	0.919	0.141	8.805
Coagulopathy	2.706	6.06	0.000	1.961	3.735
WeekendAdmit	1.063	0.57	0.567	0.862	1.312
AdmitOff	0.901	-1.03	0.302	0.739	1.098
Year2006	1.035	0.30	0.762	0.829	1.292
Year2007	1.131	1.08	0.281	0.904	1.414

Table 62: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with $\rho = 0.2$ and $\kappa = 0.13$ for Cardiologist Only Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHigh	0.367	-4.69	0.000	0.241	0.558
opmdModerate	0.404	-3.82	0.000	0.254	0.644

Continued on Next Page

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
PeerVeryHigh	1.033	0.16	0.870	0.698	1.530
PeerHigh	0.845	-0.85	0.395	0.573	1.246
PeerModerate	1.142	0.65	0.519	0.763	1.709
Black	0.887	-0.41	0.682	0.499	1.576
Asian	1.587	1.15	0.250	0.723	3.486
Hispanic	1.624	2.33	0.020	1.079	2.444
OtherRace	0.841	-0.54	0.586	0.449	1.572
UnknownRace	1.050	0.19	0.847	0.640	1.721
ER	1.123	0.92	0.355	0.878	1.436
Female	1.301	0.36	0.719	0.311	5.439
Medicaid	1.167	0.57	0.572	0.683	1.992
SelfPay	2.115	2.28	0.023	1.110	4.030
PrivateInsurance	0.729	-1.63	0.102	0.498	1.065
OtherInsurance	1.188	0.42	0.673	0.533	2.648
AdmitLTC	2.156	2.40	0.016	1.151	4.039
meanage	1.040	4.91	0.000	1.024	1.056
AgeSex	0.999	-0.06	0.949	0.980	1.019
AnteriorInfarct	1.306	1.85	0.065	0.984	1.734
SubendInfarct	0.402	-6.13	0.000	0.300	0.538
CurrentSmoker	0.473	-3.72	0.000	0.319	0.702
HistSmoker	0.336	-3.67	0.000	0.188	0.602
CancerDx	0.925	-0.38	0.707	0.618	1.386
ChronCerebrovas	0.287	-1.93	0.053	0.081	1.016
ChronLiverDis	11.336	2.08	0.038	1.150	111.705
COPD	1.764	1.62	0.105	0.889	3.501
Cardiomyopathy	0.770	-0.84	0.400	0.419	1.414
HistPTCA	0.716	-1.33	0.185	0.437	1.173
HistCABG	0.612	-1.52	0.129	0.325	1.153
HistMI	0.933	-0.30	0.765	0.593	1.469
CHF	1.828	4.64	0.000	1.417	2.359
ValveDis	1.142	0.81	0.419	0.828	1.575
Hypertension	0.686	-3.00	0.003	0.536	0.877
Paralysis	3.048	2.18	0.029	1.120	8.295
FluidDis	3.282	8.85	0.000	2.523	4.270
OtherNeuro	3.264	6.64	0.000	2.302	4.629
ChronPulmDis	0.756	-0.87	0.386	0.402	1.423
DiabeteswoCompl	1.068	0.49	0.626	0.819	1.393
DiabetesCompl	4.526	9.43	0.000	3.307	6.194
RenalFail	1.114	0.48	0.631	0.717	1.732
LiverDis	0.110	-1.42	0.156	0.005	2.312
Coagulopathy	2.875	4.86	0.000	1.878	4.401
WeekendAdmit	1.049	0.35	0.727	0.801	1.374
AdmitOff	0.946	-0.42	0.675	0.731	1.225
Year2006	1.077	0.51	0.608	0.811	1.432

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Year2007	1.208	1.30	0.192	0.909	1.606

Table 63: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with No Discounting for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHigh	0.718	-1.27	0.204	0.430	1.197
opmdModerate	0.799	-0.87	0.382	0.483	1.322
PeerVeryHigh	0.610	-2.60	0.009	0.420	0.886
PeerHigh	0.633	-2.42	0.016	0.437	0.917
PeerModerate	0.770	-1.32	0.185	0.523	1.134
Black	1.034	0.18	0.858	0.715	1.497
Asian	1.615	1.64	0.102	0.909	2.868
Hispanic	1.152	0.87	0.385	0.837	1.586
OtherRace	0.845	-0.78	0.433	0.555	1.287
UnknownRace	1.000	0.00	0.999	0.684	1.464
ER	1.083	0.83	0.408	0.897	1.308
Female	1.960	1.22	0.222	0.666	5.774
Medicaid	1.122	0.59	0.558	0.763	1.649
SelfPay	1.465	1.46	0.145	0.876	2.451
PrivateInsurance	0.713	-2.26	0.024	0.531	0.956
OtherInsurance	0.895	-0.30	0.762	0.437	1.832
AdmitLTC	2.018	2.66	0.008	1.203	3.386
meanage	1.033	5.18	0.000	1.020	1.046
AgeSex	0.995	-0.65	0.513	0.980	1.010
AnteriorInfarct	1.414	3.05	0.002	1.131	1.767
SubendInfarct	0.411	-7.73	0.000	0.328	0.515
CurrentSmoker	0.472	-4.68	0.000	0.345	0.646
HistSmoker	0.380	-4.17	0.000	0.241	0.599
CancerDx	1.030	0.19	0.848	0.760	1.397
ChronCerebrovas	0.139	-3.48	0.001	0.046	0.423
ChronLiverDis	1.733	0.44	0.660	0.149	20.174
COPD	1.323	1.14	0.255	0.817	2.141
Cardiomyopathy	0.519	-2.38	0.018	0.302	0.892
HistPTCA	0.606	-2.44	0.015	0.406	0.906
HistCABG	0.831	-0.83	0.406	0.537	1.286
HistMI	0.969	-0.17	0.862	0.680	1.380
CHF	1.991	6.85	0.000	1.635	2.425
ValveDis	1.040	0.30	0.767	0.802	1.348
Hypertension	0.650	-4.36	0.000	0.536	0.789
Paralysis	5.036	3.99	0.000	2.277	11.139

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
FluidDis	2.921	10.15	0.000	2.375	3.593
OtherNeuro	3.028	7.78	0.000	2.291	4.003
ChronPulmDis	0.926	-0.35	0.724	0.603	1.422
DiabeteswoCompl	0.942	-0.56	0.572	0.767	1.158
DiabetesCompl	4.970	12.62	0.000	3.875	6.375
RenalFail	1.054	0.31	0.756	0.755	1.472
LiverDis	0.855	-0.12	0.901	0.073	10.028
HIV	1.136	0.12	0.904	0.143	9.022
Coagulopathy	2.718	6.08	0.000	1.969	3.751
WeekendAdmit	1.066	0.60	0.551	0.864	1.315
AdmitOff	0.902	-1.03	0.305	0.740	1.099
Year2006	1.036	0.31	0.757	0.829	1.294
Year2007	1.130	1.07	0.283	0.904	1.412

Table 64: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with No Discounting for Cardiologist Only Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHigh	0.412	-4.04	0.000	0.268	0.634
opmdModerate	0.597	-2.22	0.026	0.378	0.941
PeerVeryHigh	1.045	0.22	0.827	0.706	1.546
PeerHigh	0.838	-0.90	0.369	0.569	1.233
PeerModerate	1.181	0.81	0.417	0.790	1.766
Black	0.890	-0.40	0.688	0.502	1.576
Asian	1.601	1.18	0.239	0.732	3.506
Hispanic	1.585	2.20	0.028	1.052	2.389
OtherRace	0.825	-0.60	0.546	0.443	1.539
UnknownRace	1.063	0.24	0.807	0.649	1.743
ER	1.113	0.86	0.392	0.871	1.424
Female	1.270	0.33	0.743	0.304	5.299
Medicaid	1.196	0.66	0.512	0.701	2.040
SelfPay	2.116	2.28	0.023	1.111	4.030
PrivateInsurance	0.744	-1.53	0.126	0.509	1.087
OtherInsurance	1.168	0.38	0.705	0.523	2.611
AdmitLTC	2.133	2.37	0.018	1.141	3.987
meanage	1.040	4.94	0.000	1.024	1.057
AgeSex	1.000	-0.03	0.977	0.980	1.019
AnteriorInfarct	1.329	1.97	0.048	1.002	1.763
SubendInfarct	0.403	-6.12	0.000	0.301	0.539
CurrentSmoker	0.467	-3.78	0.000	0.315	0.694
HistSmoker	0.338	-3.66	0.000	0.189	0.604

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
CancerDx	0.916	-0.43	0.668	0.612	1.370
ChronCerebrovas	0.272	-2.01	0.044	0.076	0.967
ChronLiverDis	12.326	2.16	0.030	1.267	119.917
COPD	1.730	1.57	0.116	0.873	3.428
Cardiomyopathy	0.767	-0.86	0.391	0.418	1.406
HistPTCA	0.716	-1.32	0.186	0.437	1.174
HistCABG	0.612	-1.52	0.129	0.325	1.153
HistMI	0.937	-0.28	0.778	0.596	1.473
CHF	1.864	4.79	0.000	1.445	2.404
ValveDis	1.161	0.91	0.362	0.842	1.601
Hypertension	0.680	-3.07	0.002	0.532	0.870
Paralysis	3.118	2.25	0.024	1.159	8.392
FluidDis	3.281	8.86	0.000	2.523	4.267
OtherNeuro	3.298	6.70	0.000	2.326	4.676
ChronPulmDis	0.777	-0.78	0.434	0.414	1.460
DiabeteswoCompl	1.058	0.42	0.677	0.811	1.380
DiabetesCompl	4.566	9.49	0.000	3.336	6.249
RenalFail	1.099	0.42	0.675	0.707	1.707
LiverDis	0.092	-1.53	0.125	0.004	1.940
Coagulopathy	2.849	4.81	0.000	1.860	4.363
WeekendAdmit	1.044	0.31	0.756	0.797	1.367
AdmitOff	0.949	-0.40	0.689	0.733	1.228
Year2006	1.090	0.59	0.552	0.820	1.448
Year2007	1.204	1.28	0.201	0.906	1.599

Table 65: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with $\rho = 0.8$ and $\kappa = 0.65$ for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHigh	0.693	-1.40	0.162	0.415	1.158
opmdModerate	0.777	-0.98	0.328	0.469	1.287
PeerVeryHigh	0.618	-2.51	0.012	0.425	0.900
PeerHigh	0.641	-2.34	0.019	0.441	0.930
PeerModerate	0.775	-1.29	0.198	0.526	1.143
Black	1.034	0.17	0.861	0.714	1.496
Asian	1.609	1.62	0.105	0.906	2.857
Hispanic	1.150	0.86	0.392	0.835	1.583
OtherRace	0.845	-0.78	0.434	0.555	1.288
UnknownRace	1.000	0.00	0.998	0.684	1.464
ER	1.084	0.84	0.400	0.898	1.310
Female	1.956	1.22	0.223	0.664	5.762

Continued on Next Page

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
Medicaid	1.122	0.58	0.559	0.763	1.648
SelfPay	1.464	1.45	0.146	0.875	2.448
PrivateInsurance	0.712	-2.27	0.023	0.530	0.955
OtherInsururance	0.897	-0.30	0.766	0.438	1.835
AdmitLTC	2.020	2.66	0.008	1.204	3.390
meanage	1.033	5.17	0.000	1.020	1.046
AgeSex	0.995	-0.65	0.515	0.980	1.010
AnteriorInfarct	1.412	3.03	0.002	1.130	1.765
SubendInfarct	0.411	-7.74	0.000	0.328	0.515
CurrentSmoker	0.472	-4.68	0.000	0.345	0.647
HistSmoker	0.380	-4.17	0.000	0.241	0.599
CancerDx	1.030	0.19	0.851	0.759	1.396
ChronCerebrovas	0.139	-3.48	0.001	0.046	0.423
ChronLiverDis	1.723	0.43	0.664	0.148	20.025
COPD	1.324	1.14	0.254	0.818	2.142
Cardiomyopathy	0.518	-2.38	0.017	0.301	0.889
HistPTCA	0.606	-2.44	0.015	0.406	0.906
HistCABG	0.831	-0.83	0.405	0.537	1.285
HistMI	0.969	-0.17	0.862	0.681	1.380
CHF	1.991	6.85	0.000	1.635	2.425
ValveDis	1.040	0.30	0.765	0.803	1.348
Hypertension	0.650	-4.36	0.000	0.536	0.789
Paralysis	5.038	3.99	0.000	2.278	11.144
FluidDis	2.922	10.15	0.000	2.376	3.595
OtherNeuro	3.026	7.78	0.000	2.289	4.001
ChronPulmDis	0.925	-0.36	0.720	0.602	1.420
DiabeteswoCompl	0.942	-0.57	0.572	0.767	1.158
DiabetesCompl	4.968	12.62	0.000	3.873	6.373
RenalFail	1.054	0.31	0.756	0.755	1.472
LiverDis	0.859	-0.12	0.904	0.073	10.059
HIV	1.134	0.12	0.906	0.143	9.005
Coagulopathy	2.715	6.08	0.000	1.967	3.747
WeekendAdmit	1.067	0.60	0.546	0.865	1.316
AdmitOff	0.902	-1.03	0.305	0.740	1.099
Year2006	1.036	0.31	0.757	0.829	1.294
Year2007	1.129	1.07	0.284	0.904	1.411

Table 66: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with $\rho = 0.8$ and $\kappa = 0.65$ for Cardiologist Only Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHigh	0.435	-3.77	0.000	0.282	0.670
opmdModerate	0.642	-1.90	0.058	0.406	1.014
PeerVeryHigh	1.035	0.17	0.865	0.699	1.531
PeerHigh	0.832	-0.93	0.351	0.565	1.225
PeerModerate	1.186	0.83	0.406	0.793	1.774
Black	0.891	-0.39	0.693	0.503	1.579
Asian	1.608	1.19	0.234	0.735	3.518
Hispanic	1.582	2.19	0.029	1.049	2.385
OtherRace	0.825	-0.61	0.545	0.443	1.538
UnknownRace	1.070	0.27	0.788	0.653	1.754
ER	1.109	0.83	0.409	0.867	1.418
Female	1.283	0.34	0.732	0.307	5.361
Medicaid	1.193	0.65	0.518	0.699	2.036
SelfPay	2.102	2.26	0.024	1.104	4.004
PrivateInsurance	0.745	-1.52	0.129	0.510	1.089
OtherInsurance	1.135	0.31	0.757	0.508	2.540
AdmitLTC	2.125	2.36	0.018	1.137	3.972
meanage	1.041	4.97	0.000	1.024	1.057
AgeSex	1.000	-0.05	0.962	0.980	1.019
AnteriorInfarct	1.328	1.97	0.049	1.001	1.761
SubendInfarct	0.403	-6.12	0.000	0.301	0.539
CurrentSmoker	0.466	-3.79	0.000	0.314	0.692
HistSmoker	0.338	-3.66	0.000	0.189	0.603
CancerDx	0.920	-0.40	0.686	0.615	1.377
ChronCerebrovas	0.269	-2.03	0.042	0.076	0.957
ChronLiverDis	12.146	2.17	0.030	1.270	116.146
COPD	1.729	1.57	0.116	0.873	3.425
Cardiomyopathy	0.772	-0.84	0.403	0.421	1.415
HistPTCA	0.717	-1.32	0.187	0.437	1.175
HistCABG	0.607	-1.54	0.123	0.322	1.145
HistMI	0.936	-0.29	0.774	0.595	1.472
CHF	1.866	4.80	0.000	1.447	2.407
ValveDis	1.165	0.93	0.353	0.845	1.606
Hypertension	0.678	-3.10	0.002	0.530	0.867
Paralysis	3.141	2.27	0.023	1.169	8.434
FluidDis	3.291	8.88	0.000	2.530	4.280
OtherNeuro	3.308	6.72	0.000	2.334	4.690
ChronPulmDis	0.776	-0.79	0.429	0.413	1.456

Continued on Next Page

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
DiabeteswoCompl	1.058	0.42	0.675	0.812	1.380
DiabetesCompl	4.575	9.50	0.000	3.343	6.260
RenalFail	1.096	0.41	0.682	0.706	1.703
LiverDis	0.094	-1.53	0.126	0.005	1.939
Coagulopathy	2.841	4.80	0.000	1.855	4.350
WeekendAdmit	1.046	0.33	0.742	0.799	1.370
AdmitOff	0.948	-0.41	0.685	0.732	1.227
Year2006	1.093	0.61	0.540	0.823	1.452
Year2007	1.204	1.28	0.200	0.906	1.599

Table 67: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with $\rho = 0.5$ and $\kappa = 0.37$ for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHigh	0.624	-2.00	0.046	0.393	0.991
opmdModerate	0.750	-1.25	0.210	0.478	1.176
PeerVeryHigh	0.683	-1.92	0.055	0.462	1.008
PeerHigh	0.702	-1.79	0.073	0.477	1.034
PeerModerate	0.813	-1.02	0.307	0.548	1.208
Black	1.031	0.16	0.871	0.712	1.492
Asian	1.595	1.59	0.111	0.898	2.832
Hispanic	1.140	0.80	0.422	0.828	1.569
OtherRace	0.833	-0.85	0.397	0.547	1.270
UnknownRace	0.998	-0.01	0.993	0.682	1.460
ER	1.092	0.91	0.362	0.904	1.319
Female	1.943	1.20	0.228	0.659	5.728
Medicaid	1.123	0.59	0.556	0.764	1.650
SelfPay	1.459	1.44	0.150	0.872	2.442
PrivateIns e	0.710	-2.28	0.022	0.529	0.953
OtherInsur e	0.915	-0.24	0.807	0.447	1.872
AdmitLTC	2.054	2.72	0.006	1.224	3.447
meanage	1.033	5.13	0.000	1.020	1.046
AgeSex	0.995	-0.63	0.526	0.980	1.010
AnteriorIn t	1.410	3.02	0.003	1.128	1.762
SubendInfa t	0.410	-7.75	0.000	0.328	0.514
CurrentSmo r	0.476	-4.62	0.000	0.348	0.652
HistSmoker	0.382	-4.14	0.000	0.242	0.602
CancerDx	1.031	0.20	0.844	0.760	1.398
ChronCereb s	0.139	-3.48	0.001	0.046	0.424
ChronLiver s	1.702	0.42	0.673	0.144	20.122
COPD	1.331	1.16	0.244	0.822	2.156

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Cardiomyop y	0.516	-2.40	0.016	0.300	0.886
HistPTCA	0.604	-2.46	0.014	0.404	0.903
HistCABG	0.832	-0.83	0.408	0.537	1.287
HistMI	0.969	-0.17	0.862	0.680	1.380
CHF	1.984	6.82	0.000	1.629	2.417
ValveDis	1.036	0.27	0.790	0.799	1.343
Hypertension	0.653	-4.32	0.000	0.538	0.792
Paralysis	5.047	4.00	0.000	2.282	11.162
FluidDis	2.928	10.17	0.000	2.381	3.602
OtherNeuro	3.025	7.77	0.000	2.288	3.999
ChronPulmDis	0.916	-0.40	0.690	0.596	1.408
Diabeteswo l	0.944	-0.55	0.585	0.769	1.160
DiabetesCo l	4.952	12.59	0.000	3.861	6.352
RenalFail	1.059	0.34	0.734	0.759	1.479
LiverDis	0.873	-0.11	0.915	0.073	10.397
HIV	1.102	0.09	0.927	0.138	8.776
Coagulopathy	2.710	6.06	0.000	1.963	3.741
WeekendAdmit	1.063	0.57	0.572	0.861	1.311
AdmitOff	0.901	-1.03	0.303	0.740	1.098
Year2006	1.037	0.32	0.751	0.830	1.295
Year2007	1.128	1.06	0.290	0.903	1.409

Table 68: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 with $\rho = 0.5$ and $\kappa = 0.37$ for Cardiologists Only Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
opmdHigh	0.374	-4.60	0.000	0.246	0.568
opmdModerate	0.476	-3.18	0.001	0.302	0.752
PeerVeryHigh	1.051	0.25	0.803	0.710	1.557
PeerHigh	0.844	-0.86	0.391	0.574	1.243
PeerModerate	1.171	0.77	0.442	0.782	1.754
Black	0.883	-0.42	0.671	0.497	1.568
Asian	1.589	1.16	0.248	0.724	3.488
Hispanic	1.606	2.27	0.023	1.066	2.417
OtherRace	0.829	-0.59	0.556	0.443	1.548
UnknownRace	1.046	0.18	0.857	0.638	1.715
ER	1.117	0.88	0.378	0.873	1.428
Female	1.301	0.36	0.718	0.312	5.434
Medicaid	1.183	0.61	0.539	0.693	2.019
SelfPay	2.111	2.27	0.023	1.108	4.024
PrivateInsurance	0.742	-1.54	0.123	0.507	1.084

Continued on Next Page

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
OtherInsurance	1.199	0.44	0.658	0.537	2.675
AdmitLTC	2.131	2.37	0.018	1.138	3.989
meanage	1.040	4.96	0.000	1.024	1.057
AgeSex	0.999	-0.06	0.952	0.980	1.019
AnteriorInfarct	1.313	1.89	0.059	0.989	1.743
SubendInfarct	0.402	-6.13	0.000	0.300	0.538
CurrentSmoker	0.472	-3.73	0.000	0.318	0.700
HistSmoker	0.337	-3.67	0.000	0.188	0.602
CancerDx	0.918	-0.41	0.680	0.613	1.375
ChronCerebrovas	0.281	-1.96	0.050	0.079	0.999
ChronLiverDis	11.552	2.10	0.036	1.179	113.189
COPD	1.744	1.59	0.111	0.879	3.460
Cardiomyopathy	0.771	-0.84	0.402	0.420	1.415
HistPTCA	0.714	-1.33	0.182	0.436	1.171
HistCABG	0.614	-1.51	0.131	0.326	1.157
HistMI	0.934	-0.29	0.768	0.594	1.470
CHF	1.847	4.72	0.000	1.432	2.383
ValveDis	1.147	0.83	0.405	0.831	1.581
Hypertension	0.684	-3.03	0.002	0.534	0.874
Paralysis	3.024	2.17	0.030	1.113	8.217
FluidDis	3.276	8.84	0.000	2.518	4.262
OtherNeuro	3.297	6.69	0.000	2.325	4.676
ChronPulmDis	0.767	-0.82	0.411	0.408	1.442
DiabeteswoCompl	1.064	0.45	0.650	0.815	1.387
DiabetesCompl	4.545	9.46	0.000	3.321	6.219
RenalFail	1.114	0.48	0.631	0.717	1.731
LiverDis	0.099	-1.49	0.136	0.005	2.075
Coagulopathy	2.886	4.88	0.000	1.886	4.417
WeekendAdmit	1.047	0.34	0.736	0.800	1.371
AdmitOff	0.947	-0.41	0.680	0.732	1.226
Year2006	1.082	0.54	0.588	0.814	1.438
Year2007	1.206	1.29	0.197	0.907	1.603

Table 69: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 Decay Only with $\rho = 0.2$ and $\kappa = 0.13$ for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHigh	0.768	-1.38	0.169	0.527	1.119
opmdModerate	0.826	-0.96	0.336	0.559	1.220
PeerVeryHigh	0.591	-2.74	0.006	0.406	0.861
PeerHigh	0.593	-2.68	0.007	0.404	0.869

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
PeerModerate	0.729	-1.51	0.130	0.484	1.097
Black	1.018	0.09	0.929	0.690	1.503
Asian	1.744	1.88	0.060	0.977	3.112
Hispanic	1.188	1.03	0.303	0.856	1.647
OtherRace	0.813	-0.91	0.363	0.520	1.270
UnknownRace	0.965	-0.17	0.862	0.644	1.445
ER	1.100	0.96	0.337	0.906	1.335
Female	1.935	1.14	0.252	0.625	5.989
Medicaid	1.080	0.37	0.708	0.722	1.615
SelfPay	1.260	0.81	0.419	0.719	2.210
PrivateInsrance	0.697	-2.32	0.020	0.514	0.946
OtherInsurance	0.891	-0.31	0.753	0.434	1.829
AdmitLTC	1.815	2.08	0.038	1.034	3.185
meanage	1.036	5.44	0.000	1.023	1.049
AgeSex	0.995	-0.67	0.500	0.979	1.010
AnteriorInfarct	1.439	3.11	0.002	1.144	1.810
SubendInfarct	0.417	-7.36	0.000	0.331	0.527
CurrentSmoker	0.492	-4.32	0.000	0.357	0.679
HistSmoker	0.374	-4.14	0.000	0.234	0.595
CancerDx	1.021	0.13	0.899	0.746	1.396
ChronCerebrovas	0.187	-2.96	0.003	0.062	0.568
ChronLiverDis	1.776	0.46	0.648	0.151	20.963
COPD	1.221	0.81	0.419	0.752	1.984
Cardiomyopathy	0.462	-2.62	0.009	0.259	0.823
HistPTCA	0.583	-2.50	0.013	0.382	0.891
HistCABG	0.818	-0.86	0.389	0.519	1.291
HistMI	0.912	-0.49	0.627	0.628	1.324
CHF	1.936	6.38	0.000	1.580	2.371
ValveDis	1.053	0.38	0.703	0.808	1.372
Hypertension	0.635	-4.48	0.000	0.520	0.774
Paralysis	3.685	3.03	0.002	1.585	8.568
FluidDis	3.029	10.26	0.000	2.451	3.742
OtherNeuro	3.190	7.98	0.000	2.400	4.242
ChronPulmDis	1.025	0.11	0.909	0.667	1.576
DiabeteswoCompl	0.976	-0.22	0.825	0.790	1.206
DiabetesCompl	4.753	12.00	0.000	3.685	6.131
RenalFail	0.987	-0.07	0.943	0.697	1.399
LiverDis	0.871	-0.11	0.913	0.073	10.374
HIV	1.192	0.16	0.869	0.148	9.593
Coagulopathy	2.991	6.55	0.000	2.154	4.152
WeekendAdmit	1.040	0.35	0.724	0.836	1.294
AdmitOff	0.884	-1.18	0.238	0.721	1.085
Year2006	1.052	0.43	0.670	0.833	1.328
Year2007	1.154	1.22	0.221	0.917	1.452

Table 70: Logit Regression Grid Search with One Year Lag for years 2005, 2006 and 2007 Decay Only with $\rho = 0.2$ and $\kappa = 0.13$ for Cardiologists Only AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdHigh	0.445	-3.51	0.000	0.283	0.699
opmdModerate	0.605	-1.98	0.048	0.368	0.996
PeerVeryHigh	1.015	0.07	0.942	0.685	1.502
PeerHigh	0.813	-1.05	0.292	0.553	1.195
PeerModerate	1.155	0.70	0.486	0.770	1.733
Black	0.925	-0.26	0.791	0.521	1.643
Asian	1.675	1.30	0.195	0.768	3.653
Hispanic	1.650	2.39	0.017	1.095	2.487
OtherRace	0.828	-0.59	0.554	0.443	1.548
UnknownRace	1.099	0.38	0.707	0.670	1.803
ER	1.095	0.72	0.472	0.855	1.402
Female	1.447	0.50	0.614	0.345	6.074
Medicaid	1.139	0.47	0.640	0.661	1.961
SelfPay	2.115	2.27	0.023	1.107	4.039
PrivateInsurance	0.737	-1.56	0.118	0.503	1.080
OtherInsurance	1.128	0.29	0.770	0.503	2.527
AdmitLTC	1.964	2.05	0.041	1.030	3.746
meanage	1.041	4.92	0.000	1.024	1.057
AgeSex	0.998	-0.20	0.842	0.979	1.018
AnteriorInfarct	1.356	2.10	0.036	1.021	1.801
SubendInfarct	0.406	-6.02	0.000	0.302	0.544
CurrentSmoker	0.453	-3.88	0.000	0.304	0.676
HistSmoker	0.337	-3.66	0.000	0.189	0.603
CancerDx	0.931	-0.35	0.730	0.622	1.395
ChronCerebrovas	0.281	-1.97	0.048	0.079	0.992
ChronLiverDis	11.407	2.11	0.035	1.190	109.334
COPD	1.750	1.60	0.109	0.882	3.470
Cardiomyop y	0.719	-1.03	0.304	0.383	1.348
HistPTCA	0.644	-1.66	0.096	0.383	1.081
HistCABG	0.632	-1.42	0.156	0.335	1.191
HistMI	0.923	-0.34	0.735	0.581	1.466
CHF	1.803	4.51	0.000	1.396	2.329
ValveDis	1.167	0.94	0.348	0.845	1.611
Hypertension	0.665	-3.23	0.001	0.519	0.852
Paralysis	3.142	2.27	0.023	1.169	8.443
FluidDis	3.373	9.02	0.000	2.590	4.393
OtherNeuro	3.309	6.69	0.000	2.331	4.697
ChronPulmDis	0.785	-0.75	0.451	0.418	1.475

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
DiabeteswoCompl	1.075	0.53	0.595	0.824	1.403
DiabetesCompl	4.597	9.45	0.000	3.350	6.308
RenalFail	1.086	0.37	0.715	0.698	1.689
LiverDis	0.111	-1.42	0.155	0.005	2.290
Coagulopathy	2.891	4.87	0.000	1.886	4.432
WeekendAdmit	1.030	0.22	0.829	0.785	1.353
AdmitOff	0.943	-0.44	0.659	0.727	1.223
Year2006	1.084	0.55	0.581	0.813	1.446
Year2007	1.215	1.34	0.181	0.913	1.617

C Appendix 3 Complete Set of Regressions from Chapter 3

Table 71: Logit Regression Cluster Robust Pooled Cross-Sectional Model: Most recent 12 Months Lagged for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
opmdVeryHigh	0.620	-3.74	0.000	0.483	0.797
opmdHigh	0.623	-4.52	0.000	0.508	0.765
opmdModerate	0.647	-3.62	0.000	0.512	0.819
PeerVeryHigh	0.766	-2.56	0.011	0.625	0.940
PeerHigh	0.764	-2.59	0.010	0.623	0.936
PeerModerate	0.751	-2.83	0.005	0.616	0.915
Black	0.821	-1.37	0.171	0.619	1.089
Asian	1.277	1.21	0.227	0.859	1.897
Hispanic	1.133	1.03	0.302	0.894	1.437
OtherRace	1.088	0.72	0.474	0.864	1.369
UnknownRace	0.928	-0.73	0.462	0.761	1.132
ER	1.026	0.39	0.695	0.901	1.169
Female	1.838	1.56	0.120	0.853	3.958
Medicaid	1.157	1.21	0.227	0.913	1.467
SelfPay	1.395	1.81	0.070	0.973	2.002
PrivateInsurance	0.856	-1.55	0.121	0.703	1.042
OtherInsurance	0.674	-1.44	0.150	0.394	1.153
AdmitLTC	1.240	1.27	0.204	0.890	1.727
meanage	1.042	9.29	0.000	1.033	1.051
AgeSex	0.995	-0.96	0.339	0.984	1.005
AnteriorInfarct	1.313	3.89	0.000	1.145	1.505
SubendInfarct	0.426	-11.15	0.000	0.367	0.495
CurrentSmoker	0.552	-5.70	0.000	0.450	0.677
HistSmoker	0.438	-4.81	0.000	0.313	0.613
CancerDx	0.823	-1.68	0.092	0.655	1.033
ChronCerebrovas	0.284	-3.49	0.000	0.140	0.576
ChronLiverDis	2.287	0.59	0.555	0.147	35.633
COPD	1.387	1.79	0.074	0.969	1.985
Cardiomyopathy	0.843	-0.91	0.364	0.583	1.219
HistPTCA	0.706	-2.63	0.008	0.545	0.915
HistCABG	0.873	-1.03	0.305	0.673	1.132
HistMI	0.721	-2.59	0.010	0.563	0.924
CHF	2.069	10.89	0.000	1.816	2.359
ValveDis	1.235	2.46	0.014	1.044	1.461
Hypertension	0.657	-6.83	0.000	0.582	0.741

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
Paralysis	2.583	3.01	0.003	1.391	4.796
FluidDis	2.840	14.16	0.000	2.458	3.281
OtherNeuro	2.965	11.89	0.000	2.479	3.547
ChronPulmDis	0.824	-1.19	0.235	0.598	1.135
DiabeteswoCompl	1.100	1.45	0.148	0.967	1.252
DiabetesCompl	4.973	20.23	0.000	4.257	5.809
RenalFail	1.175	1.46	0.143	0.947	1.458
LiverDis	0.587	-0.38	0.705	0.037	9.320
HIV	0.570	-0.55	0.579	0.078	4.153
Coagulopathy	2.500	8.04	0.000	1.999	3.126
WeekendAdmit	1.167	2.20	0.028	1.017	1.338
AdmitOff	1.137	1.96	0.050	1.000	1.293
Year2002	0.965	-0.33	0.742	0.783	1.190
Year2003	0.855	-1.35	0.178	0.681	1.074
Year2004	0.922	-0.75	0.452	0.745	1.140
Year2005	0.797	-1.83	0.067	0.626	1.016
Year2006	0.820	-1.68	0.094	0.651	1.034
Year2007	0.898	-0.94	0.349	0.717	1.125

Table 72: Logit Panel Data Fixed Effects Model Grouped by Operating Physician: Most Recent 12 Months Lagged for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
968 groups 9284 obs dropped because of all positive or all negative outcomes					
$ln_{L}ag12$	0.991	-0.10	0.917	0.829	1.184
$ln_{P}eerGroup$	0.967	-0.32	0.750	0.789	1.186
Black	0.728	-2.01	0.045	0.534	0.992
Asian	1.270	1.00	0.317	0.795	2.029
Hispanic	0.956	-0.33	0.742	0.732	1.248
OtherRace	0.975	-0.18	0.857	0.743	1.280
UnknownRace	0.809	-1.62	0.106	0.625	1.046
ER	1.107	1.39	0.165	0.959	1.277
Female	1.678	1.32	0.188	0.776	3.627
Medicaid	1.216	1.51	0.131	0.943	1.568
SelfPay	1.350	1.52	0.129	0.916	1.989
PrivateInsurance	0.852	-1.58	0.115	0.698	1.040
OtherInsurance	0.729	-1.07	0.285	0.408	1.301
AdmitLTC	1.459	1.91	0.056	0.990	2.150
meanage	1.041	9.38	0.000	1.032	1.050
AgeSex	0.997	-0.63	0.531	0.986	1.007
AnteriorInfarct	1.342	3.81	0.000	1.154	1.560

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
SubendInfarct	0.400	-11.48	0.000	0.342	0.468
CurrentSmoker	0.597	-4.37	0.000	0.474	0.752
HistSmoker	0.486	-4.22	0.000	0.347	0.679
CancerDx	0.840	-1.53	0.126	0.672	1.050
ChronCerebrovas	0.286	-3.47	0.001	0.141	0.580
ChronLiverDis	0.769	-0.24	0.807	0.093	6.375
COPD	1.296	1.49	0.136	0.922	1.824
Cardiomyopathy	0.896	-0.61	0.544	0.630	1.276
HistPTCA	0.748	-2.14	0.033	0.573	0.976
HistCABG	0.863	-1.03	0.303	0.652	1.142
HistMI	0.763	-2.01	0.045	0.587	0.993
CHF	2.069	10.52	0.000	1.807	2.369
ValveDis	1.286	2.75	0.006	1.075	1.538
Hypertension	0.669	-6.01	0.000	0.587	0.763
Paralysis	2.658	3.28	0.001	1.482	4.767
FluidDis	2.913	13.90	0.000	2.506	3.387
OtherNeuro	3.046	11.25	0.000	2.509	3.699
ChronPulmDis	0.916	-0.56	0.573	0.675	1.243
DiabeteswoCompl	1.102	1.36	0.173	0.958	1.266
DiabetesCompl	5.162	20.01	0.000	4.395	6.061
RenalFail	1.229	1.70	0.090	0.969	1.558
LiverDis	1.489	0.40	0.687	0.215	10.315
HIV	0.482	-0.70	0.483	0.063	3.697
Coagulopathy	2.448	7.18	0.000	1.918	3.126
WeekendAdmit	1.144	1.83	0.067	0.991	1.320
AdmitOff	1.111	1.54	0.123	0.972	1.269
Year2002	0.881	-1.06	0.291	0.696	1.115
Year2003	0.758	-2.21	0.027	0.593	0.969
Year2004	0.829	-1.51	0.132	0.651	1.058
Year2005	0.720	-2.55	0.011	0.560	0.927
Year2006	0.781	-1.93	0.054	0.608	1.004
Year2007	0.839	-1.34	0.179	0.650	1.084

Table 73: Logit Panel Data Random Effects Model Grouped by Operating Physician: Most Recent 12 Months Lagged for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
ln_Lag12	0.901	-3.73	0.000	0.853	0.952
$ln_PeerGroup$	0.943	-1.40	0.162	0.870	1.024
Black	0.797	-1.58	0.114	0.601	1.056
Asian	1.253	0.99	0.325	0.800	1.964

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Expired	Odds Ratio	Z	p>Z	[95% Conf.	Interval]
Hispanic	1.048	0.38	0.700	0.824	1.334
OtherRace	1.064	0.50	0.617	0.834	1.358
UnknownRace	0.903	-0.93	0.352	0.730	1.119
ER	1.065	0.96	0.339	0.936	1.211
Female	1.829	1.59	0.111	0.871	3.842
Medicaid	1.227	1.66	0.097	0.964	1.562
SelfPay	1.444	1.93	0.053	0.995	2.096
PrivateIns e	0.880	-1.31	0.189	0.727	1.065
OtherInsur e	0.733	-1.08	0.281	0.417	1.289
AdmitLTC	1.341	1.61	0.107	0.939	1.915
meanage	1.042	9.88	0.000	1.033	1.050
AgeSex	0.995	-0.93	0.352	0.985	1.005
AnteriorIn t	1.324	3.79	0.000	1.145	1.531
SubendInfa t	0.405	-11.84	0.000	0.349	0.471
CurrentSmo r	0.553	-5.14	0.000	0.442	0.694
HistSmoker	0.435	-4.99	0.000	0.314	0.603
CancerDx	0.831	-1.67	0.094	0.669	1.032
ChronCereb s	0.285	-3.61	0.000	0.144	0.563
ChronLiver s	0.742	-0.29	0.776	0.095	5.768
COPD	1.300	1.55	0.121	0.933	1.811
Cardiomyop y	0.817	-1.18	0.239	0.584	1.143
HistPTCA	0.700	-2.68	0.007	0.540	0.909
HistCABG	0.877	-0.94	0.346	0.669	1.151
HistMI	0.731	-2.42	0.015	0.567	0.942
CHF	2.067	10.95	0.000	1.815	2.353
ValveDis	1.281	2.87	0.004	1.082	1.517
Hypertension	0.656	-6.52	0.000	0.578	0.745
Paralysis	2.610	3.36	0.001	1.492	4.563
FluidDis	2.896	14.54	0.000	2.509	3.342
OtherNeuro	2.996	11.56	0.000	2.487	3.608
ChronPulmDis	0.891	-0.77	0.443	0.663	1.197
Diabeteswo l	1.113	1.56	0.119	0.973	1.273
DiabetesCo l	5.130	20.67	0.000	4.393	5.991
RenalFail	1.190	1.50	0.133	0.948	1.493
LiverDis	1.402	0.35	0.724	0.215	9.143
HIV	0.586	-0.52	0.606	0.077	4.451
Coagulopathy	2.453	7.74	0.000	1.955	3.079
WeekendAdmit	1.157	2.06	0.039	1.007	1.329
AdmitEvening	1.055	0.83	0.407	0.929	1.199
AdmitNight	1.028	0.30	0.766	0.856	1.235
Year2002	0.933	-0.61	0.539	0.746	1.165
Year2003	0.815	-1.75	0.079	0.649	1.024
Year2004	0.888	-1.04	0.300	0.710	1.111
Year2005	0.773	-2.18	0.029	0.614	0.974

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
Year2006	0.828	-1.64	0.101	0.660	1.038
Year2007	0.908	-0.84	0.401	0.726	1.137

$lnsig^2(u)$ = -2.000185 se= .2818895 ci = -2.552678 to -1.447692
$sigma(u)$ = .3678454 se= .0518459 ci = .279057 to .4848839
rho = .0395046 se = .010696 ci = .0231232 to .0666989
Likelihood-ratio test of rho=0: $chibar^2(01)$ = 24.89
Prob >= chibar2 = 0.000

Table 74: Logit Panel Data: 50 Clusters: Fixed Effects Model Operating Physicians Grouped by Patient Risk: Most Recent 12 Months Lagged for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
ln_Lag12	0.901	-4.26	0.000	0.858	0.945
$ln_PeerGroup$	0.939	-1.75	0.080	0.874	1.007
Black	0.812	-1.48	0.140	0.615	1.071
Asian	1.306	1.18	0.237	0.839	2.032
Hispanic	1.088	0.71	0.477	0.862	1.375
OtherRace	1.083	0.66	0.510	0.854	1.374
UnknownRace	0.921	-0.79	0.428	0.753	1.128
ER	1.025	0.39	0.697	0.905	1.161
Female	1.727	1.45	0.147	0.826	3.611
Medicaid	1.191	1.44	0.151	0.938	1.511
SelfPay	1.494	2.13	0.033	1.032	2.162
PrivateInsurance	0.894	-1.16	0.245	0.739	1.080
OtherInsurance	0.755	-0.99	0.325	0.432	1.320
AdmitLTC	1.265	1.33	0.184	0.894	1.789
meanage	1.041	9.80	0.000	1.033	1.050
AgeSex	0.996	-0.82	0.412	0.986	1.006
AnteriorInfarct	1.329	2.35	0.019	1.048	1.684
SubendInfarct	0.423	-9.03	0.000	0.351	0.510
CurrentSmoker	0.486	-3.28	0.001	0.316	0.748
HistSmoker	0.422	-5.15	0.000	0.303	0.586
CancerDx	0.732	-2.60	0.009	0.578	0.926
ChronCerebrovas	0.347	-2.74	0.006	0.163	0.740
ChronLiverDis	0.767	-0.26	0.796	0.103	5.696
COPD	2.077	2.22	0.026	1.090	3.958
Cardiomyopathy	0.783	-1.45	0.148	0.562	1.091
HistPTCA	0.641	-2.97	0.003	0.478	0.859
HistCABG	0.848	-0.84	0.401	0.577	1.246
HistMI	0.659	-2.11	0.035	0.448	0.970
CHF	1.728	5.31	0.000	1.412	2.114

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
ValveDis	1.252	2.35	0.019	1.038	1.509
Hypertension	0.671	-4.34	0.000	0.561	0.804
Paralysis	2.621	3.35	0.001	1.492	4.604
FluidDis	2.688	12.60	0.000	2.305	3.135
OtherNeuro	2.957	11.53	0.000	2.459	3.555
ChronPulmDis	0.969	-0.17	0.866	0.671	1.399
DiabeteswoCompl	0.942	-0.58	0.563	0.768	1.154
DiabetesCompl	3.685	9.26	0.000	2.796	4.856
RenalFail	1.161	0.90	0.366	0.840	1.605
LiverDis	1.313	0.29	0.771	0.211	8.180
HIV	0.564	-0.56	0.578	0.075	4.239
Coagulopathy	2.410	7.46	0.000	1.912	3.036
WeekendAdmit	1.154	2.04	0.041	1.006	1.323
AdmitOff	1.143	2.07	0.038	1.007	1.297
Year2002	0.940	-0.55	0.583	0.754	1.172
Year2003	0.829	-1.63	0.103	0.661	1.039
Year2004	0.895	-0.98	0.326	0.718	1.116
Year2005	0.789	-2.04	0.041	0.629	0.991
Year2006	0.826	-1.69	0.091	0.661	1.031
Year2007	0.913	-0.81	0.418	0.733	1.138

Table 75: Logit Panel Data: 50 Clusters: Random Effects Model Operating Physicians Grouped by Patient Risk: Most Recent 12 Months Lagged for All AMI PCI Cases with Operator's Total PCI Cases Key Independent Variable

Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
ln_Lag12	0.899	-4.31	0.000	0.857	0.944
$ln_PeerGroup$	0.939	-1.75	0.081	0.875	1.008
Black	0.819	-1.41	0.158	0.621	1.081
Asian	1.296	1.15	0.251	0.833	2.016
Hispanic	1.083	0.67	0.506	0.857	1.368
OtherRace	1.081	0.64	0.523	0.852	1.371
UnknownRace	0.932	-0.69	0.492	0.761	1.140
ER	1.030	0.46	0.644	0.909	1.166
Female	1.790	1.55	0.122	0.855	3.747
Medicaid	1.201	1.51	0.131	0.947	1.525
SelfPay	1.474	2.06	0.039	1.019	2.132
PrivateInsurance	0.884	-1.27	0.203	0.731	1.069
OtherInsururance	0.751	-1.00	0.315	0.430	1.313
AdmitLTC	1.264	1.32	0.186	0.893	1.788
meanage	1.042	9.99	0.000	1.034	1.050
AgeSex	0.995	-0.90	0.366	0.985	1.005

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Expired	**Odds Ratio**	**Z**	**p>Z**	**[95% Conf.**	Interval]
AnteriorInfarct	1.306	3.14	0.002	1.106	1.542
SubendInfarct	0.411	-11.22	0.000	0.352	0.480
CurrentSmoker	0.529	-5.13	0.000	0.414	0.674
HistSmoker	0.425	-5.16	0.000	0.307	0.588
CancerDx	0.817	-1.82	0.069	0.657	1.016
ChronCerebrovas	0.295	-3.52	0.000	0.150	0.583
ChronLiverDis	0.738	-0.29	0.769	0.098	5.576
COPD	1.328	1.62	0.106	0.941	1.875
Cardiomyopathy	0.793	-1.36	0.173	0.569	1.107
HistPTCA	0.697	-2.70	0.007	0.536	0.906
HistCABG	0.888	-0.79	0.427	0.663	1.190
HistMI	0.711	-2.55	0.011	0.547	0.924
CHF	2.011	9.38	0.000	1.738	2.327
ValveDis	1.273	2.76	0.006	1.072	1.512
Hypertension	0.665	-5.77	0.000	0.579	0.764
Paralysis	2.566	3.34	0.001	1.477	4.458
FluidDis	2.800	13.70	0.000	2.417	3.245
OtherNeuro	2.985	11.64	0.000	2.483	3.589
ChronPulmDis	0.898	-0.71	0.479	0.666	1.210
DiabeteswoCompl	1.078	0.93	0.352	0.921	1.262
DiabetesCompl	4.988	18.15	0.000	4.193	5.934
RenalFail	1.201	1.46	0.144	0.939	1.536
LiverDis	1.376	0.34	0.735	0.217	8.725
HIV	0.596	-0.50	0.615	0.079	4.485
Coagulopathy	2.398	7.60	0.000	1.914	3.004
WeekendAdmit	1.152	2.01	0.044	1.004	1.321
AdmitOff	1.145	2.11	0.035	1.009	1.300
Year2002	0.937	-0.58	0.564	0.751	1.169
Year2003	0.821	-1.71	0.088	0.655	1.029
Year2004	0.889	-1.04	0.296	0.713	1.108
Year2005	0.779	-2.15	0.032	0.621	0.978
Year2006	0.827	-1.67	0.095	0.662	1.033
Year2007	0.913	-0.82	0.415	0.733	1.137
lnsig2u	-4.181	se =1.04		-6.234	-2.128
sigma u	0.124	se= 0.064		0.044	0.345
rho	0.005	0.00482		0.001	0.035