HAS THE MALPRACTICE CRISIS IN FLORIDA REALLY AFFECTED ACCESS TO CARE?*

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Abstract

In this paper, we examine the effects of the recent malpractice "crisis" in Florida on access to care and physician activity levels at three intervals over a six year period, namely 1997, 2000 and 2003. We focus on two specialties particularly hard hit by malpractice insurance increases, neurosurgery and obstetrics and we compare access to care and activity levels before and after 2000 when the large premium increases begin. Within each specialty we define a high risk group that we compare to other procedures in the specialty as well as an unrelated set of lower risk diagnoses. We find that travel times for craniotomies have increased by approximately five minutes. This increase is statistically significant but economically small. Travel times for high risk deliveries increase by one minute, but the increase is not significant compared to changes for low risk treatments. The number of surgeons who perform only a handful of procedures has fallen during the crisis. Case studies show that markets respond to the exit of physicians in a variety of ways.

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I. Introduction

According the American Medical Association, 20 states are currently in "full-blown crisis" due to escalating medical malpractice premiums.[1] There is much speculation as to whether the "crisis" is causing significant changes in access to health care services. This speculation is fueled by anecdotal accounts of specialty physicians moving out of crisis states and, allegedly, leaving their patients without a convenient, alternative source of care. A recent GAO report suggests that access effects have been relatively limited, whereas the AMA and other provider organizations have questioned this finding [GAO, 2003]. Skeptics argue that the GAO study does not adequately measure physician migration or service reductions and fails to extend beyond 2002, about the time when the anecdotes of physician migration begin to emerge.

In this paper, we examine whether high malpractice premiums have forced specialty physicians to abandon or curtail their practices and the resulting impact on patients. We use detailed hospital utilization data from Florida and focus on two specialties -- obstetrics and neurology -- that have been especially hard hit by malpractice premium increases. We examine Florida for three reasons. Florida is one of the early crisis states. The state also has some of the highest levels of premiums in the country, very large premium increases and some of the highest rates of litigation.[2] Finally, the state of Florida makes available nearly current data on hospital utilization that includes physician identifiers. Thus, we are able to look for systematic effects of the crisis on access through 2003, identify physicians who sharply limit their inpatient practice, find patients who may have been affected by such occurrences, and observe the resulting impact on their access to care.

We find no evidence of reductions in the incidence of craniotomies (and did not consider incidence of high risk deliveries, deeming this to be out of the control of physicians). We do find large (5+ minute or over 13% of the mean travel time) and statistically significant increases in one way travel times for all patients receiving craniotomies in 2003 relative to 1997, well above the contemporaneous trend for other low risk diagnoses and above the prior trend for craniotomies. However, we estimated that the economic impact of this increase is very small relative to the cost of care. We also found a significant increase in travel times for high risk deliveries in 2003 relative to 1997, but the magnitude is small (less than a minute and about 1.5% of the mean travel time) and the finding is not significant when compared to the change the period before or the change for other deliveries or other low risk treatments.[3]

We also examine changes in physician activity levels. We find a reduction in the number of surgeons who perform only a handful of procedures in 2003 relative to prior years. There is also a slight increase in the exit rates of physicians performing high risk deliveries. We conclude that there is some evidence that the malpractice crisis is affecting access and physician activity levels, but the evidence is not overwhelming at this point. We wrap up with case studies of several zip codes with significant rural populations that have experienced substantial physician exit. These are the types of communities that might be disproportionately affected due the lack of proximate alternative providers. In some cases, the slack from exiting physicians is picked up by one or two who remain at the same hospital; in other cases the difference is made up by a number of physicians spread across a number of hospitals.

II. Background on the Current Malpractice Crisis

There is little doubt that there are substantial affordability and availability problems in the medical malpractice marketplace. Numerous publications confirm that premiums, or the price of the insurance contract, have risen dramatically in the past few years. For example, National Association of Insurance Commissioners' data show that the national medical malpractice premium volume (total medical malpractice revenue) has increased by 18.3% and 26.7% from 2000-2001 and 2001-2002 respectively whereas the average annual increase in premium volume for the prior 6 years (1995-2000) was 0.8%.[4] Other data show significant variation in premium increases for a specific policy contract both by location and specialty. The Medical Liability Monitor's survey of 'base rate' premiums for a typical policy by state and medical specialty showed overall increases between 2001 and 2003 from 43-60% for the five states with highest increases. Appendix I reports data from this survey showing that the rate of increase in Florida from 2000-2003 greatly exceeded the national median. Finally, a number of medical malpractice insurers have recently left the marketplace or greatly reduced their volume of business, increasing availability problems.[5]

While there is no argument that premiums are increasing substantially, there is considerable debate as to why. Some observers cite rising litigation rates and higher jury awards.[6] Other observers focus on the large decline in investment income since the late 1990s associated with a decline in stock valuations; insurers are raising prices now, they contend, to recover these losses. Still others view the recent increase in medical malpractice (and other) insurance premiums in the context of the insurance industry's historical dynamic. The property casualty insurance industry has experienced a series of rapid premium increases and limited availability periods during the past 30 years and longer. Medical malpractice insurance experienced similar malpractice crises during the mid 1970s and the mid 1980s. Research has linked these episodes to temporary capital shortages resulting in temporarily reduced capacity and supply for the industry.[7] These explanations are not mutually exclusive; elements of each may occur simultaneously. In any event, our intention here is not to engage in the debate as to which of these explanations dominates, but rather to document the effects of premium increases on doctor participation and patient care.

The conventional wisdom is that increases in malpractice premiums directly reduce physician incomes. This does not have to be the case. If physician fees are market-based and the demand for physician services is perfectly inelastic, then the increase in rates would be passed along to patients in the form of higher fees. Most physicians are paid on the basis of a "Resource-based Relative Value Scale" (RBRVS) developed by Medicare but copied by most private insurers. The RBRVS is a sort of "comparable worth" scheme in which fees are based on inputs including time, training, and liability expense. The liability adjuster is lagged several years, however, forcing physicians to endure lower incomes during the adjustment period. Moreover, higher premiums may be indicative of a more litigious environment in which physicians spend more time in legal imbroglios and less time practicing medicine. Thus, it is reasonable to expect that physicians would experience a loss in utility when premiums increase.

Physicians in "crisis states" might respond by choosing to curtail those activities that drive up their premiums, such as performing high risk procedures, or moving to another, less litigious state.

There is no shortage of anecdotes regarding physician responses to the crisis. For example, in an address to the Subcommittee on Wellness and Human Rights, Dr. John C. Nelson of the AMA began his remarks saying,

> "Escalating jury awards and the high cost of defending against lawsuits, even meritless ones, have caused medical liability insurance premiums to reach unprecedented levels. As insurance becomes unaffordable or unavailable, physicians are being forced to relocate, close their practices, or drop vital services—all of which seriously impeded patient access to care." [AMA 2003]

Publications by the Insurance Information Institute expressed similar views. A survey of member companies by BlueCross BlueShield [BCBS 2002] revealed that over half the plans in crisis states reported doctors refusing to perform some high risk procedures and that more doctors are leaving practices or retiring. Numerous accounts can also be found in the general press. However, as noted above, a recent General Accounting Office report investigated many of these anecdotes and found no evidence of a mass exodus of physicians from several crisis states examined. While acknowledging that many physicians are moving across state lines, the GAO report questioned whether the rate of physician migration has increased.

III. Data and Methods

A. Data

We use hospital inpatient utilization data from Florida for the years 1997, 2000, and 2003. The data contain details about every admission to every hospital in the state, including the patient's primary and secondary diagnoses, treatment, demographics, and residence zip code. The data also include a surgeon identifier that can be linked across years. To our knowledge, the state of Florida offers the only publicly available data that is up to date within one year *and* provides surgeon identifiers.

We use diagnostic and procedure codes to identify inpatient procedures that would normally be performed by obstetricians or neurosurgeons. We further break these down into "high risk" and "normal risk" procedures. We do not have a way to identify those procedures most likely to result in lawsuits, so we base this categorization on simple rules of thumb. In particular, for neurosurgery, we selected the three diagnoses (of nine available) with either the highest mortality rate, or the highest incidence among children.[8] It turns out that all three diagnoses involved craniotomies,[9] which is consistent with anecdotal reports of the riskiest procedures. For deliveries, we selected patients with complications.[10]

We use the Mapquest travel time calculator to compute travel times from each patient's zip code centroid to the centroid of each hospital's zip code.[11]

B. Methods

Our basic methodology for all of our regression analyses is to compare observed changes in high risk surgery markets between 2000 and 2003 with contemporaneous changes in markets for low risk hospital treatments and with prior trends (1997-2000) that occurred in the same high risk surgery market.[12] We also compute the "triple difference" to determine if the change in trends in high risk surgery differed from the change in trends for other diagnoses. Our low risk comparison group includes low risk procedures offered by the same specialty. In the travel time analysis, we also consider a wider range of low risk admissions. Specifically, we consider five common, low risk diagnoses that, like craniotomy, underwent relatively minimal technological advancement and only nominal changes in volume during the period studied.[13] Finally, we sometimes restrict attention to rural markets as they may have been disproportionately affected by physician exit, due to the lack of nearby alternative providers.

Our justification for using the 1997-2000 time period to control for underlying trends unrelated to malpractice is that premiums did not begin their meteoric climb until 2000-2001. We implicitly assume that physicians during the period 1997-2000 either did not anticipate the looming malpractice crisis or, if they did, were slow to respond. We also assume that other factors that may affect physician and patient decisions regarding high risk procedures did not change appreciably between 2000 and 2003.[14]

We start by examining incidence. For this analysis, we focus on craniotomies, as we do not believe that the incidence of deliveries is likely to be affected by malpractice.[15] We measure incidence by taking the total number of procedures done on patients residing in a zip code and divide by the zip code population using 2000 census data. The unit of observation is the zip code/DRG/year and we estimate the following equation:

(1) $I_{dzt} = \alpha_0 + \alpha_Z D_Z + \alpha_{DRG} D_{DRG} + \alpha_1 T + \alpha_2 D_{2003} + \alpha_3(\text{HighRisk*T}) + \alpha_4(\text{HighRisk*}D_{2003}) + \varepsilon_{dzt}$[16]

where

I_{dzt} is the incidence of drg d in time t in zip code z,

D_Z is a vector of zip code dummies,

D_{DRG} is a vector of DRG dummies,

T is an discrete variable for a time trend (T=0 if year = 1997, T=1 if year = 2000; T = 2 if year = 2003),

D_{2003} is a dummy variable for 2003

HighRisk is a dummy variable for the risk level (HighRisk = 1 if high risk).

ε_{dzt} is a normally distributed error term.

This specification allows us to assess whether the incidence trend for craniotomies for the 2000/2003 differed from the 2000/2003 trend for low risk diagnoses ($\alpha_3 + \alpha_4$) or whether it differed from the 1997/2000 trend for craniotomies ($\alpha_2 + \alpha_4$).[17] We can also assess whether the change in time trend for craniotomies differed from that for low risk diagnoses (the triple difference α_4.).

We next turn our attention to access. In this analysis, the unit of observation is the individual patient and the dependent variable is travel time. We measure access by computing travel times from each patient's zip code to the zip code of the hospital where they receive treatment. We estimate the following equation for both neurosurgeries and deliveries. Because we have repeated observations for each zip code, we cluster standard errors by zip code to account for possible lack of independence.

$$(2) \quad M_{idzt} = \beta_0 + \beta_x X_i + \beta_Z D_Z + \beta_{DRG} D_{DRG} + \beta_1 T + \beta_2 D_{2003} + \beta_3(HighRisk*T) + \beta_4(HighRisk*D_{2003}) + \nu_{idzt}$$

where

M_{izdt} is the minutes of travel time of patient i with drg d residing in zip code z in period t,

X_i are a set of patient characteristics including age, race, and insurance coverage, and D_Z, D_{DRG}, T, D_{2003}, and HighRisk are defined as above. We assume the error term, ν_{izdt}, is normally distributed.

As with incidence, we can compute difference in differences and triple difference effects, the calculations are analogous to those for incidence.

C. Sample Overview

Tables I and II report summary statistics for physician activity and incidence and travel times for neurosurgeries and deliveries. As seen in Table I, a great number of physicians performing neurosurgeries performed only one or two procedures during a given year, and many did not perform any craniotomies. Only about 20% of physicians performing neurosurgeries performed craniotomies, and it appears that a larger fraction of these physicians perform a large number of procedures than neurosurgeons as a whole, as evidenced by the procedures per physician at the 75th and 90th percentiles. From 1997 to 2000 there is an increase in the number of physicians doing any neurosurgery and craniotomies in particular; that increase levels off from 2000 to 2003 for all neurosurgeons while the number of physicians performing craniotomies declines. There is also an increase in the number of craniotomy procedures per physician at the 90th percentile, while that number declines slightly for neurosurgeons as a whole.

In contrast to neurosurgeons, approximately 75% of obstetricians perform high risk deliveries (HRDs) as well as non-HRDs.[18] In addition, most obstetricians in this group perform a significant number of procedures annually. As with neurosurgeons, we observe an increase in the number of physicians from 1997 to 2000 and a leveling off or decrease from 2000 to 2003, although in the case of deliveries we need to be careful interpreting this result due to the large number of missing or resident coded practitioners in 1997, and the significant decline in subsequent years. There is no evidence of increasing activity levels at the 90th percentile by physicians performing HRDs, although it appears that physicians at the 75th and 90th percentiles are performing more procedures over the sample period.

Table II provides summary statistics on incidence and travel times. Incidence is calculated at the zip code level. We report both the mean and median incidence levels across zip codes. As indicated by the difference in the number of procedures, the incidence of neurosurgery and craniotomy in particular in the population is much lower than that of deliveries and HRDs. The mean and median incidence numbers show that there is some variance in mean the median incidence, particularly for the less common neurosurgery categories. However, while there appears to be a slight increase in incidence of some procedures over time in the aggregate statistics, there does not seem to be a consistent increase in high risk procedures—either for craniotomies or HRDs.

Average annual travel time is significantly higher for craniotomies than other neurosurgeries—over 40% higher—and the difference is increasing over time in the statewide sample.[19] In rural areas it appears that a large increase in travel time occurs from 1997 to 2000 with a smaller increase from 2000 to 2003. For deliveries we observe travel times for HRD and other deliveries that are much closer, less than a minute different for the full sample. While travel times for both groups increase over the period, the increases are small, under a minute. For patients living in rural zipcodes the travel time for HRD is again slightly greater than for other deliveries, and the difference is increasing slightly over the sample period. Once more the greatest increase occurs from 1997 to 2000 and the mean travel time for rural HRDs actually drops from 2000 to 2003.

IV. Results: Incidence and Travel Times

A. Incidence: Neurosurgeries

Table III reports estimates of incidence equation (1) for craniotomy patients. The first two columns examine incidence in the full state. The first column does not include zip code fixed effects; the second does. The last two columns focus on rural zip codes, again with the latter model including zip code fixed effects.[20] Because the model specification includes a series of interacted dummy variables, interpreting individual coefficients requires a bit of algebraic manipulation. Table IV reports the estimated incidence trends for craniotomies and other neurosurgeries, using the results from the fixed effects model for the full state and rural only regressions (columns (2) and (4) in Table III.)

While the departures from the 1997 baseline are statistically significant, the magnitudes of changes are small and fail to reveal any obvious reductions in incidence of craniotomies in the crisis year of 2003. There is no difference between the change in craniotomy incidence from 2000-2003 compared with the change in incidence of other neurosurgeries from 2000-2003. Likewise, we find no significant change in craniotomy incidence from 2000 to 2003 versus the change in craniotomy incidence from 1997 to 2000. Lastly, the triple difference (the change in trends for craniotomies versus that for other neurosurgeries) is insignificant. The rural data show no significant changes in incidence regardless of the comparison made.

B. Travel Times: Neurosurgeries

Table V presents the estimates of the travel time equation (2) for neurosurgery where we use other neurosurgeries as the low risk comparison group. As with the incidence results, we report regressions without and with fixed effects, and for the entire state and rural patients only. Table VIa reports the implied travel times from the full state and rural fixed effects regressions. The estimates of equation (2) using other low risk diagnoses as the comparison group are similar to those presented in Table V and are omitted for brevity. Table VIb reports the corresponding implied estimated trends. [21]

The most notable finding is a large and statistically significant increase in travel times for all craniotomy patients between 2000 and 2003. The 5+ minute increase (from 37 to 42 minutes) is much larger than the increases reported for other neurosurgeries and other low-risk diagnoses, both in absolute and percentage terms. The difference in differences (based on nominal differences) is statistically significant at $p < .001$. Turning to other comparisons, we find that the 2000-2003 increase for craniotomy patients is also significantly larger than the 1997-2000 increase for these patients. Lastly, the triple difference is statistically significant, regardless of whether we use other neurosurgeries or other low risk diagnoses as the comparison group.

We can assess the economic importance of the increase in travel time by noting first that there are about 9,000 craniotomies performed annually in Florida. The 5+ minute increase per one way trip implies a total increase in round trip travel times of about 1600 hours. If we allow for travel by loved ones visiting the hospital, this could plausibly increase to 10,000-20,000 hours (the typical length of stay for craniotomy patients is about 8 days.) The transportation literature gives a range of values for the cost of travel of $7.00 to $20.00 per hour.[22] Valuing travel time at a generous $20 per hour, we put the cost associated with additional travel for craniotomies at no more than $400,000 annually. A typical craniotomy costs about $15,000, making the extra travel time cost about 0.25% of total cost of all craniotomies.

Not surprisingly, rural patients travel much longer than the average patient. Travel times for rural craniotomy patients increase by over 2 minutes between 1997 and 2000, versus less than one minute from 2000 to 2003. The difference in differences is not significant. Nor are there significant differences between craniotomy trends and trends for other neurosurgeries or other diagnoses.

Coefficients on control variables indicate that blacks, Hispanics, older patients, and Medicare patients travel shorter distances for care even after we control for general location with zip code fixed effects. Patients that use HMOs have shorter commutes when we do not control for location, but that this is because these patients tend to live in zip codes where all patients have shorter commutes (compare the results without fixed effects to those with fixed effects).

C. Travel Times: Deliveries

Table VII presents the estimates of the travel time equation (2) for deliveries (where we use low risk deliveries as the comparison group). Tables VIIIa and VIIIb report the implied estimated trends. There is a 0.28 minute increase in travel times for HRDs from 2000 to 2003. This increase is comparable to that for other deliveries, however, and the .063 minute difference in differences is not significant. Travel times for other diagnoses did not increase during this period, however, and .24 minute difference in differences is significant. Triple differences are not significant for either comparison group.

There is no significant increase in travel times for rural HRD patients; if anything travel times fall relative to prior trend for HRDs and relative to trends for low risk deliveries.[23] Using estimates from the regression where the comparison group is other diagnoses, the fall in travel times relative to prior trend is -2.53 minutes and is significant at p=.067. The triple difference is roughly -3 minutes and significant at p=.030.

Examining covariates in Table VII, we note that Black, Hispanic, Medicaid, and older maternity patients appear to have shorter commutes, but only the Black and Medicaid findings survive when we include zip code fixed effects. With fixed effects included, older maternity patients appear to travel further.

D. Incidence and Travel Times Summary

Our regression results suggests that doctors in Florida are performing about the same number of craniotomies in 2003 as they did as in prior years, but that patients are traveling further to get them. There has been no similar increase in travel times for patients having other neurosurgeries. Travel times for high risk deliveries statewide not change much at all both in absolute terms and relative to other diagnoses and past trends. Travel times for rural high risk deliveries actually decreased relative to trend and relative to other diagnoses, though the decline is only significant in some specifications.

V. Physician Activity Levels

We next consider whether the malpractice crisis is causing some doctors to reduce their level of high risk surgeries, leaving other doctors to pick up the slack. This could occur, for example, if low volume doctors feel that the cost of carrying malpractice insurance for high risk activities is excessive relative to the revenue they expect for a small number of procedures.[24] They may drop from the market, leaving higher volume physicians to pick up their surgical load.

To determine whether craniotomies and HRDs are becoming more concentrated among high volume providers, we first compute GINI coefficients for both procedures.[25] For any given year, we restrict the computation of the GINI to those surgeons who performed at least one intervention. Table IX reports the GINI coefficients. The increase in the craniotomy GINI between 1997 and 2000 suggests some increased concentration of procedures among high volume providers during this period. This levels off in 2003. The GINI for HRDs does not seem to change much over time.

The GINI may be too coarse to capture reductions in effort and/or outright exit by very low volume providers. It will also mask such trends if departing providers are replaced by entrants. Thus, we supplement the GINI analysis by looking directly at exit and entry. There is no way to be certain whether a physician has curtailed a practice or flat out exited the market; nor is there necessarily a meaningful distinction between the two. Similarly, we cannot fully distinguish entry from expansion. Thus, our definitions of exit and entry are necessarily arbitrary. Table X lists our definitions of different exit and entry types. We obtain similar findings when we try different definitions.

Table XI presents the exit and entry rates for craniotomies and HRDs based on the definitions in Table X. We note first that the rate of exit of very low volume craniotomy

providers is high (nearly 50%) and steady. Apparently, some physicians perform the occasional craniotomy out of happenstance (e.g., an experienced neurosurgeon is unavailable to operate on an emergency patient) and the malpractice crisis has done little to increase the rate at which such doctors abandon the practice. However, the crisis may have reduced entry of very low volume providers – entrants represent a smaller percentage of physicians in 2003 than they did in 2000 (43% versus 49%).[26]
Overall there are fewer total physicians performing craniotomies in 2003 than in 2000, in part because of the relative decline of entrants versus exiters. This may explain some of the increase in travel times. At the opposite end of the spectrum, there is little change over time in the exit or entry rates of high volume craniotomy providers.

The results for HRDs are slightly different. Here, the exit rate of very low volume providers has increased (from 13% to 16%). However, due to changes in coding over time, one cannot be sure that the change in exit is significant.[27] There is also an increase in exit rates for providers at other levels, though the magnitude is small. Entry rates appear to be unchanged over time, with the result that the total number of providers of HRDs declines slightly from 2000 to 2003.

VI. Case Studies of Zip Codes Facing High Exit

Although we have not documented substantial provider exit as of 2003, continued rate increases may eventually hasten the exit of more physicians. Our data allow us to explore what happens to communities that have experienced the loss of key providers, thus shedding insight as to what might happen if the rate of exit were to increase. In this section, we explore in some detail the impact of exit on select markets.

We selected markets for case study where patients were most likely to be adversely affected. These are markets where a significant provider or providers left a market without a close substitute available—a description also fitting the "classic" media exit story. The goal was then to compare the distribution and travel times of patients in the periods before and after significant exit, and make any other observations we could about how and from whom these patients obtained their care.

We first identified high volume providers who significantly reduced their practices. For craniotomies and HRDs, we looked at high volume providers who reduced their number of procedures by 80% or more; except in the case of 2000 to 2003 HRDs where we broadened our criteria to include high volume providers with 75% declines and medium volume providers with 80% declines. We then looked at zip codes where exiting physicians together accounted for at least 40% of the procedures for that zip code in the period prior to exit. We further restricted our sample to zip codes with at least 12 procedures in the period prior to exit in order to ensure that the observed reduction in physician activity was not due to random fluctuations. Finally, we study only the zip codes with nontrivial rural populations (over 30%), as urban residents have closer substitutes in nearby providers. Using these criteria, we identify seven candidate zip codes (25 zip codes including those with more urban populations). From these, we selected four zip codes that are representative of the wide range of outcomes observed. We do not report the zip code numbers so as to preserve confidential information about patients and providers in those zips.

A. Case Study 1: Neurosurgery 1997/00

Craniotomies were performed on 13 residents of this zip code in 1997. All were performed at the same hospital located 45 minutes away[28] The physicians who exited this zip code performed 10 of the 13 craniotomies. The number of craniotomies for this zip code fell to 8 in 2000 but increased to 15 in 2003. A physician who was new to serving patients from this market performed 2 craniotomies in 2000 and 5 in 2003, picking up some of the slack. He operated at a different hospital, also located 45 minutes away. The remaining slack was picked up by several other doctors, including some who had previously served the zip code. Most operated in the hospitals that are 45 minutes away. However, by 2003, 4 of the 15 craniotomies were performed in a hospital 180 minutes away

B. Case Study 2: Neurosurgery 2000/03

Residents of this zip code received 17 craniotomies in 2000. These were performed at three hospitals, located 40-50 minutes away. An exiting doctor accounted for 8 of the 17 craniotomies and operated at two different hospitals. In 2003, there were 19 craniotomies. These were performed in five hospitals: the three mentioned above and two more located 160 and 200+ minutes away. (6 of the procedures are at the 200+ minute hospital.) The slack was picked up by several doctors at several hospitals.

C. Case Study 3: HRDs 1997/2000

There were 64 HRDs performed in 1997. These occurred at six different hospitals from 5 to 50 minutes away. One exiting doctor accounted for 30 HRDs at a hospital 20 minutes away with an 80% share of HRD patients from this zip code. There were 56

HRDs in 2000 and 49 in 2003. These were done in eight hospitals up to 55 minutes away. One new physician picked up nearly all the slack. He operated out of the same hospital as the exiting doctor.

D. Case Study 4: HRDs 2000/2003

There were 20 HRDs in 2000, performed at four hospitals located 40-95 minutes away.[29] Exiting doctors accounted for 8 HRDs altogether; two of them performed a total of 7 HRDs at a hospital 40 minutes away. There were 21 HRDs in 2003, done at seven hospitals located 40-95 minutes away. Another hospital located 40 minutes away performed one HRD in 1997, none in 2000, but increased that to five in 2003.

E. What the Case Studies Tell Us

Exiting doctors leave a void in the market, but there is no consistent pattern as to how the void is filled. In some markets, one or two physicians replace those who depart. In others, patients see several different physicians at the same set of hospitals or perhaps see new physicians in new hospitals. While some affected craniotomy patients travel quite far, obstetrics patients stay close to home. In this way, the case study findings mirror the travel time findings in our regression analyses. Also, while the rate of craniotomies appears more constant over time, there do appear to be markets in which the rate of births, and HRDs in particular, are declining. This reminds us that there may be other reasons for physicians to exit besides increases in medical malpractice premiums.

VII. Discussion

In this paper we provide a detailed look at changes in patient access and physician activity levels for the high risk procedures in two high malpractice premium specialties, neurosurgery and obstetrics. We examine the changes in the state of Florida, providing a 'before' period (1997-2000) to compare with the period of rapidly rising malpractice rates (2000-2003) in a state that has been highly affected by the current malpractice premium increases. We find evidence of significantly increased travel times for craniotomies relative to other neurosurgery procedures and relative to low risk admissions in other diagnostic categories. We do not find similar evidence of increases in travel times in our examination of HRDs. If anything rural travel times are falling relative to trends. While we caution that it is difficult to precisely identify HRDs with the available data, we obtain similar negative results using several alternative definitions.

We also document a decrease in the participation of low volume providers of craniotomies and HRDs. This may be good news for patients, to the extent that there is a positive relationship between volume and outcomes. The literature has documented correlations between volume and outcome for these procedures, but causality has not been resolved.[30]

Our case studies both reinforce our travel times results and highlight a number of other considerations, with the caveat that these cases are not a scientific study. They also provide some indication of why we might not see large changes in rural travel times, even though most of the media accounts focus on the effects of the malpractice insurance problems on rural communities. First and foremost, rural populations already travel significant distances for their services. If one provider leaves the market there may be another provider at the same hospital or a provider at a different hospital of equal distance (perhaps in another direction) who takes up the slack. Moreover, many of these rural areas have relatively few high risk procedures a year. Low demand makes it more costly to provide specialized services. If demand is declining, increasing malpractice premiums may be just one more reason providers do not locate close to these communities.

Overall, our findings give a mixed account of the effects of the malpractice crisis in Florida. While we find evidence of decreased access to care for craniotomy patients statewide, we do not find the same when we focus on rural zip codes in particular, nor do we find similar evidence in high risk deliveries. It remains to be seen whether there will be larger effects in the coming years. A lot depends upon whether insurance premium increases level off (or become decreases), whether physician reimbursements catch up with rising costs, and whether other providers of malpractice insurance come into the market to increase available coverage (and perhaps bringing down price as well). Since it is very costly for a physician to build a practice anew, physicians might wait awhile before pulling up stakes. Our 2003 data may simply be too early to observe the full impact of the crisis.

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Appendix I

Trends in Malpractice Premiums

	Median Increase Nationwide		Median Increase Florida	
Year	ObGyn	General Surgery	ObGyn	General Surgery
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	7%	10%	5%	10%
2001	9%	15%	15%	18%
2002	20%	29%	21%	45%
2003	12%	15%	12%	17%

*Source: *Medical Liability Monitor*, various years.

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Table I: Physician Summary Statistics

	Number of phys.	Mean procedures per phys.	Median procedures per phys.	75th percentile for proc. Per phys.	90th percentile for proc. Per phys.	max procedures per phys.
NEUROSURGERY SAMPLE						
All Neurosurgeries						
1997	2324	10.96	2	7	37	243
2000	2523	10.71	2	7	36	286
2003	2557	10.61	2	6	34	303
Craniotomies Only						
1997	474	18.41	2	30	52	185
2000	530	18.09	2	27	52.5	264
2003	497	20.45	2	29	61	287
OBSTETRICS SAMPLE						
All Deliveries						
1997	2006	82.83	62	131	202	578
2000	2120	86.93	63	137.5	206	714
2003	2118	92.21	64	147	231	813
High Risk Deliveries Only						
1997	1551	19.42	13	28	43	174
2000	1622	19.90	15	27	44	200
2003	1580	20.03	15	27	44	188

*Physicians with missing identifiers or resident identifiers have been dropped from the sample.

Table II: Incidence and Travel Time Summary Statistics

	INCIDENCE*			Travel Times**		
	Number of observations	mean	p50	Number of observations	mean	p50
NEUROSURGERY SAMPLE						
1997						
non craniotomy	872	1.23	0.91	15171	24.80	17
craniotomy	872	0.55	0.47	7768	34.71	21
2000						
non craniotomy	870	1.42	0.97	16093	24.76	18
craniotomy	870	0.70	0.54	8690	36.50	22
2003						
non craniotomy	871	1.27	0.98	15508	26.08	18
craniotomy	871	0.75	0.57	9187	40.74	24
RURAL ONLY						
1997						
non craniotomy	229	1.42	0.93	1570	49.69	43
craniotomy	229	0.56	0.43	685	64.92	55
2000						
non craniotomy	228	2.09	1.01	1643	48.93	41
craniotomy	228	1.01	0.54	854	68.88	57
2003						
non craniotomy	230	1.75	1.08	1773	50.38	42
craniotomy	230	0.92	0.51	843	69.41	57
OBSTETRICS SAMPLE						
1997						
non HRD	898	9.21	8.08	134721	20.59	17
HRD	898	1.90	1.58	29999	21.01	17
2000						
non HRD	892	10.25	8.99	149832	20.85	17
HRD	892	2.06	1.67	31607	21.27	18
2003						
non HRD	905	10.92	9.42	156723	21.16	18
HRD	905	2.00	1.67	30207	21.74	18
RURAL ONLY						
1997						
non HRD	247	10.62	8.02	12576	42.46	39
HRD	247	1.93	1.47	2592	43.28	39
2000						
non HRD	240	11.74	8.74	14194	42.14	38
HRD	240	2.17	1.55	2725	45.15	40
2003						
non HRD	256	12.55	9.21	14768	41.96	37
HRD	256	1.88	1.50	2683	44.28	39

* incidence is calculated on a zipcode-year-category basis.
**travel times are truncated at 200, travel time for patients going to hospitals in the same zipcode is .99.

Table III: Incidence Regression Results-Neurosurgery[a]
(std errors in parentheses)

Predictor	**Full State**	**Full State**	**Rural Only**	**Rural Only**
T: Time Trend	0.037 (0.040)	0.0098 (0.012)	0.133 (0.152)	0.024 (0.037)
D_{2003}: Year 2003 Dummy	-0.067 (0.079)	-0.024 (0.019)	-0.201 (0.299)	-0.028 (0.069)
HighRisk*T	0.014 (0.022)	0.014 (0.023)	0.020 (0.078)	0.020 (0.080)
HighRisk*D_{2003}	0.031 (0.044)	0.031 (0.045)	0.016 (0.161)	0.016 (0.165)
DRG dummies	Included	Included	Included	Included
Zip code dummies	Excluded	Included	Excluded	Included
Constant	0.38*	0.42*	0.37*	0.53*
N	20904	20904	5496	5496
Adjusted R^2	.07	.29	.04	.28

[a]Note: Incidence is reported as number of procedures per 1000 population
* = sig at p<.01; ** = sig at p<.05; *** = sig at p<.10

Table IV: Estimated Trends in Neurosurgery Incidence

With zipcode fixed effects:

	All Patients		Rural Only	
Year	Craniotomy Incidence	Other Neurosurgery Incidence	Craniotomy Incidence	Other Neurosurgery Incidence
1997	.22	.26	.28	.35
2000	.24 P = .09[a]	.27 P = .41 [a]	.32 P = .37 [a]	.36 P = .75 [a]
2003	.27 P = .00 [a]	.26 P = .75 [a]	.36 P = .10 [a]	.38 P = .55 [a]
Diff in Diff$_{03-00}$: [2003-2000]$_{Craniotomy}$ -- [2003-2000]$_{oth\_ neurosurg}$	.045 P=.106		.036 P=.718	
Diff in Diff$_{Craniotomy}$: [2003-2000]$_{Craniotomy}$ – [2000-1997]$_{Craniotomy}$	.008 P=.79		-.012 P=.91	
Diff in Diff$_{Craniotomy}$ – Diff in Diff$_{oth. neurosurg}$	.031 P=.48		.016 P=.92	

[a]F-test of difference from baseline year 1997

Table V
Travel Time Regression Results-Neurosurgery[a]
(std errors in parentheses)

Predictor	Full State	Full State	Rural Only	Rural Only
T: Time Trend	-0.489 (0.367)	-0.283 (0.308)	-1.416 (1.105)	-0.367 (1.111)
D_{2003}: Year 2003 Dummy	2.109*** (0.588)	1.163** (0.512)	2.753 (1.846)	2.345 (1.728)
HighRisk*T	2.008*** (0.729)	1.272* (0.655)	5.212** (2.478)	4.228* (2.361)
HighRisk*D_{2003}	1.185 (1.262)	2.283** (1.117)	-5.578 (4.189)	-3.699 (3.889)
Medicare	0.163 (0.500)	-1.443*** (0.426)	1.504 (1.364)	-1.230 (1.098)
Medicaid	0.068 (0.914)	0.130 (0.745)	6.433** (2.827)	3.314 (2.411)
HMO	-5.032*** (0.594)	-0.646 (0.455)	-6.537*** (1.687)	-0.381 (1.447)
Age	-0.341*** (0.015)	-0.276* (0.014)	-0.333*** (0.050)	-0.328*** (0.046)
Black	-12.782*** (1.123)	-5.662*** (0.647)	-9.526*** (2.526)	-10.245*** (2.014)
Hispanic	-11.926*** (0.905)	-1.508** (0.609)	-6.782* (3.887)	-3.885 (2.816)
DRG dummies	Included	Included	Included	Included
Zip code dummies	Excluded	Included	Excluded	Included
Constant	54.31***	50.89***	78.30***	78.83***
N	72417	72417	7368	7368
Adjusted R^2	.087	.305	.098	.372

*** = sig at p<.01; ** = sig at p<.05; * = sig at p<.10

Table VIa: Estimated Trends in Neurosurgery Travel Times

(comparison with low-risk neurosurgeries)

With zipcode fixed effects:

	All Patients		**Rural Only**	
Year	Craniotomy Travel Times	Other Neurosurgery Travel Times	Craniotomy Travel Times	Other Neurosurgery Travel Times
1997	37.48	25.20	67.93	49.68
2000	38.47 P= .10	24.92 P=.36	71.79 P=.05	49.31 P=.74
2003	42.90 P=.00	25.80 P= .06	74.30 P=.004	51.29 P=.15
Diff in Diff$_{03-00}$: [2003-2000]$_{Craniotomy}$ -- [2003-2000]$_{oth\_neurosurg}$	3.56 P=.000		.528 P=.810	
Diff in Diff$_{Craniotomy}$: [2003-2000]$_{Craniotomy}$ – [2000-1997]$_{Craniotomy}$	3.45 P=.001		-1.35 P= .15	
Diff in Diff$_{Craniotomy}$ – Diff in Diff$_{oth.\ neurosurg}$	2.28 P=.04		-3.70 P= .34	

Table VIb: Estimated Trends in Neurosurgery Travel Times

(comparison with other low-risk diagnoses)

With zipcode fixed effects:

	All Patients		**Rural Only**	
Year	Craniotomy Travel Times	Other Low-risk Diagnoses Travel Times	Craniotomy Travel Times	Other Low-risk Diagnoses Travel Times
1997	37.48	15.42	67.93	32.17
2000	38.69 P=.059	15.22 P=.000	70.92 P=.178	31.87 P=.28
2003	42.75 P=.000	15.16 P=.001	71.71 P=.127	32.22 P=.9
Diff in Diff$_{03-00}$: [2003-2000]$_{Craniotomy}$ -- [2003-2000]$_{oth\_diagnoses}$	4.127 P=.000		.447 P=.842	
Diff in Diff$_{Craniotomy}$: [2003-2000]$_{Craniotomy}$ – [2000-1997]$_{Craniotomy}$	2.853 P=.010		-2.187 P=.550	
Diff in Diff$_{Craniotomy}$ – Diff in Diff$_{oth.diagnoses}$	2.727 .015		-2.841 P=.450	

Table VII
Travel Time Regression Results-High Risk Deliveries
(std errors in parentheses)

Predictor	**Full State**	**Full State**	**Rural Only**	**Rural Only**
T: Time Trend	0.434***	-0.005	-0.211	0.271
	(0.106)	(0.077)	(0.500)	(0.459)
D_{2003}: Year 2003 Dummy	-0.111	0.231**	-0.201	-0.276
	(0.166)	(0.122)	(0.707)	(0.572)
HighRisk*T	0.014	0.040	2.321**	0.818
	(0.199)	(0.132)	(0.943)	(0.688)
HighRisk*D_{2003}	0.074	0.023	-3.227**	-1.024
	(0.312)	(0.216)	(1.288)	(1.025)
Medicare	1.109	0.035	-0.859	-2.299*
	(0.685)	(0.479)	(2.100)	(1.338)
Medicaid	-0.638***	-1.321***	0.436	-2.187***
	(0.237)	(0.119)	(0.816)	(0.408)
HMO	-1.753***	-0.140	-3.125**	0.779**
	(0.280)	(0.107)	(1.252)	(0.351)
Age	-0.085***	0.040***	-0.120**	0.106***
	(0.019)	(0.005)	(0.052)	(0.020)
Black	-5.468***	-0.904***	-3.259**	-1.981***
	(0.502)	(0.159)	(1.631)	(0.503)
Hispanic	-3.097***	0.048	-1.188	-1.253**
	(0.529)	(0.144)	(2.770)	(0.758)
DRG dummies	Included	Included	Included	Included
Zip code dummies	Excluded	Included	Excluded	Included
Constant	25.91***	21.56***	46.41***	42.56***
N	533089	533089	49538	49538
Adjusted R^2	.019	.50	.008	.56

*** = sig at p<.01; ** = sig at p<.05; * = sig at p<.10

Table VIIIa: Estimated Trends in High Risk Delivery Travel Times

(comparison with non-HRDs)

With zipcode fixed effects:

	All Patients		**Rural Only**	
Year	HRD Travel Times	Other Delivery Travel Times	HRD Travel Times	Other Delivery Travel Times
1997	21.34	20.88	44.25	42.17
2000	21.38 P=.80	20.88 P=.95	45.34 P=.21	42.44 P=.56
2003	21.66 P=.03	21.08 P=.017	45.13 P=.30	42.44 P=.59
Diff in Diff$_{03\text{-}00}$: [2003-2000]$_{HRD}$-- [2003-2000]$_{nonHRD}$	.063 P=.610		-.21 P=.670	
Diff in Diff$_{HRD}$: [2003-2000]$_{HRD}$ – [2000-1997]$_{HRD}$	.25 P=.25		-1.30 P=.27	
Diff in Diff$_{HRD}$ – Diff in Diff$_{nonHRD}$	.02 P=.92		-1.02 P=.32	

Table VIIIb: Estimated Trends in High Risk Delivery Travel Times

(comparison with other low-risk diagnoses)

With zipcode fixed effects:

	All Patients		**Rural Only**	
Year	HRD Travel Times	Other Low-risk Diagnoses Travel Times	HRD Travel Times	Other Low-risk Diagnoses Travel Times
1997	21.34	15.57	44.26	32.31
2000	21.47 P=.421	15.27 P=.000	45.83 P=.123	31.85 P=.104
2003	21.71 P=.030	15.269 P=.000	44.89 P=.529	31.87 P=.288
Diff in Diff$_{03\text{-}00}$: [2003-2000]$_{HRD}$ -- [2003-2000]$_{oth\_diagnoses}$	.241 P=.100		-.963 P=.145	
Diff in Diff: [2003-2000]$_{HRD}$ – [2000-1997]$_{HRD}$	.114 P=.626		-2.525 P=.067	
Diff in Diff$_{HRD}$ – Diff in Diff$_{oth_diagnoses}$	-.185 P=.457		-2.999 P=.030	

Table IX: GINI Coefficients for Craniotomies and HRDs

Year	GINI-Craniotomies	GINI-HRDs
1997	.675	.491
2000	.696	.496
2003	.693	.493

Table X: Exit and Entry Definitions

Type of Entry/Exit	Initial Year Volume	Volume 3 years later
Very Low Volume Exit	1-3 procedures	0 procedures
Low Volume Exit	4-10	0-1 procedures
Medium Volume Exit	11-24	At least 67% reduction
High Volume Exit	25+	At least 50% reduction
Low Volume Entrant	0	1-3 procedures
Small Entrant	0-1	4-10 procedures
Medium entrant	0-4	11-24 procedures
Large entrant	0-11	25+

Table XI: Exit and Entry Rates

PHYSICIANS PERFORMING BRAIN OPERATIONS*		
Type of Entry/Exit	**% from 1997 to 2000**	**% from 2000 to 2003**
Very Low Volume Exit	47.47	46.42
Low Volume Exit	1.90	2.26
Medium Volume Exit	2.74	2.83
High Volume Exit	5.06	4.91
Low Volume Entrant	48.49	42.66
Small Entrant	3.21	3.22
Medium entrant	3.21	2.01
Large entrant	5.09	5.23
# phys. Operating in beg. year	474	530
# phys. Operating in end year	530	497
PHYSICIANS PERFORMING HRDS		
Type of Entry/Exit	**% from 1997 to 2000**	**% from 2000 to 2003**
Very Low Volume Exit	12.57	15.78
Low Volume Exit	5.80	6.41
Medium Volume Exit	7.22	9.06
High Volume Exit	7.80	8.57
Low Volume Entrant	14.92	14.37
Small Entrant	5.43	6.33
Medium entrant	8.32	7.34
Large entrant	6.47	6.27
# phys. Operating in beg. year	1551	1622
# phys. Operating in end year	1622	1580

*exits are presented as the percent of all physicians in the base year, entrants are presented as the percent of all physicians in the end of period year.

[1] See AMA 2005. This was up from 12 states reported by the AMA in mid 2002. The 19 states determined to be in crisis in October 2003 include: Arkansas, Connecticut, Florida, Georgia, Illinois, Kentucky, Mississippi, Missouri, New Jersey, Nevada, New York, North Carolina, Ohio, Oregon, Pennsylvania, Texas, Washington, West Virginia and Wyoming. In June 2004 the AMA added Massachusetts to the list of states in crisis.

[2]The Insurance Information Institute reports that Florida doctors are sued twice as often as those in other states [Hartwig and Wilkinson, 2003].

[3]We examine several definitions of high risk deliveries and lower-risk comparison sets. None display a significant increase in travel times in 2003 compared to trend.

[4] Data are from the National Association of Insurance Commissioners (NAIC): Historical Direct Premiums written (available at www.naic.org/research/Research_Division/Stats/2002_pc_stat_compHISTORY.pdf). Premium volume, or total revenue, reflects changes in both price and quantity so, to the extent some physicians have reduced the amount of insurance purchased (higher deductibles, lower limits, or switching from occurrence to claims made policies), or have found themselves without coverage, increases in premium volume are likely to under report the actual change in price. Not all medical malpractice premiums are reported to insurance departments who in turn report to the NAIC, however, there is no other national source and the trends in these data are largely recognized as representative of the national market.

[5]The St. Paul Companies announced their withdrawal from the market in December 2001, as did Frontier, Clarendon, and Washington Casualty. Legion was placed in 'rehabilitation' and PHICO was placed in run-off (where no additional policies are written) by the Pennsylvania Insurance Department. Other companies reported to be reducing the number of policies written include CAN and MIIX [Medical Liability Monitor, October 2002.]

[6]See for example, Hartwig and Wilkinson [2003] cite significant increases in the median medical malpractice jury award over the period 1995-2001 and within the time period of 1999-2001.

[7]In this explanation, both unexpected increases in claims costs and unexpected declines in insurers' capital and investment returns may lead to higher prices as both reduce insurer capacity and increase the likelihood of a capacity shortage.

[8] Specifically, we designated patients in diagnosis related groups (DRGs) 1-3 as "high risk", and patients with DRGs 4-9 as normal risk.

[9] A craniotomy is a temporary opening of the skull and is performed for several reasons, including removal of lesions and blood clots, repairing aneurysms, removing abnormal collections of blood vessels, and draining abscesses.

[10] Specifically, we selected patients with DRGs 370 and 372, which are caesarian deliveries with complications and vaginal deliveries with complications. We originally selected deliveries with *preexisting* complications based on International Classification of Disease codes 64000-64999. However, we observed a sharp increase in the number of patients reported to have these diagnostic codes, creating concerns of "diagnosis creep." The DRG coding does not display the same "creep," though it necessarily includes some patients whose complications arose during the delivery. In footnote 21, we describe our results when we try alternative definitions of high risk deliveries. The qualitative results are identical.

[11] For patients who receive care in their own zip code, we set travel time equal to 1 minute. To limit the role of outliers, we set the maximum travel time to 200 minutes. These assumptions improve the precision of our estimates with changing the qualitative conclusions. As with the incidence analysis, we cluster standard errors by zipcode.

[12] It is a bit speculative to compare trends in incidence for two different diagnostic categories as these may be driven by change in technology as much as changes in malpractice. Thus, we only compare incidence for craniotomies and other neurosurgeries, rather than with other clinical areas.

[13] These were selected in consultation with Dr. Joel Shalowitz, an internist and Director of the Kellogg Health Industry Management Program. The diagnoses are: chronic obstructive pulmonary disease, simple pneumonia, gastrointestinal bleeding, nutritional and miscellaneous metabolic disorders, and septicemia. A search of the popular press coverage of the malpractice crisis found no references to any of these diagnoses.

[14] During this time, there were several key changes in payer markets, including a shift away from tightly managed care and a reduction in Medicare reimbursements. But these were nationwide trends, and it is difficult to see how they would cause physicians to migrate from Florida or affect at-risk patients more than other patients.

[15] While few craniotomies would be considered "elective", some of the conditions treated with this procedure could instead be treated with watchful waiting. Thus, the incidence of craniotomies is not necessarily independent of malpractice considerations. We were hard pressed to argue that the incidence of childbirths would be affected by malpractice considerations.

[16] We cluster the standard errors by zip code.

[17] Our approach is immune to the concerns about serial correlation raised by Bertrand et al. [2004], as we do not have multiple repeated observations in pre and post periods.

[18] It is generally the case that only neurosurgeons perform craniotomies. Most, but not all deliveries are performed by obstetricians. For the latter, we use the terms obstetrician and physician interchangeably.

[19] By way of contrast, we computed travel times for neurosurgeries in California, a state that has not experienced a spike in malpractice premiums and is considered a non-crisis state by the AMA. We observed that travel times in 2003 were comparable to those in 1997, with a slight dip in 2000. This is suggestive that there was not some general trend towards higher travel times.

[20] Rural is defined by zip codes having more than 40% rural population.

[21] The estimated values for 2000 and 2003 in Tables 6a and 6b are not identical because the coefficients on control variables are not identical.

[22] For example, see Small, Winston, and Yan [2002].

[23] We also performed the analysis with an alternative definition of high risk delivery and low risk delivery based upon diagnostic codes and found similar results. Specifically we identified a number of diagnoses that indicated *ex ante* higher risk at delivery and which did not exhibit significant upcoding over the period. These were: antepartum Hemorrhage, abruption placentae and placenta previa (641); hypertension complicating pregnancy, childbirth and the puerperium (642); infections and parasitic conditions in the mother classifiable elsewhere but complicating pregnancy, childbirth or the puerperium (647); multiple gestation (651); malposition and malpresentation of fetus (652); disproportion in pregnancy, labor and delivery (653); polyhydramnios/ hydramnios (657); and other problems associated with amniotic cavity and membranes (658). We compared these to patients with the diagnosis "normal delivery" (650).

[24] Malpractice premiums are generally nonlinear in high volume procedures performed..

[25] For a particularly clear discussion of how to measure the GINI, see http://william-king.www.drexel.edu/top/prin/txt/factors/dist4.html (visited 10/1/2004). We estimated the GINI by computing the areas of ten equal height trapezoids, representing deciles of the surgical volume distribution.

[26]Malpractice premiums are usually nonlinear in the number of high risk procedures performed. Hence, a physician performing a small number of procedures Physicians doing relatively small numbers of procedures that increase malpractice insurance premiums significantly are most likely to curtail those activities associated with the higher premiums since the additional income is less likely to be greater than the additional malpractice insurance premiums. However, the litigation risk and associated costs are more likely to impact physicians doing larger numbers of procedures related to the higher malpractice insurance premiums if the risk of being sued is increasing in the number of procedures performed.

[27] A number of observations in the data do not have the physician id, it is either missing or coded as resident (RES000). The number of observations without physician codes is changing over time, it is most common in the 1997 data and almost nonexistent in the 2003 data with the 2000 data in between. The procedures with missing or resident identifiers may be performed by physicians providing a small number of procedures, if so the increased exit *might* be the result of having more physicians precisely identified in the later period. This issue is unlikely affect neurosurgery results, where physicians with missing or resident codes accounted for 8 high risk procedures in 1997, 2 in 2000, and 0 in 2003. However, for obstetrics data are less clear, there are 1157 HRDs in 1997 that have missing or resident physician codes, 293 such observations in 2000 and 50 in 2003.

[28] All travel times are rounded to nearest 5 minutes to protect anonymity.

[29]As noted above, no market with significant rural population met our criteria for significant exit, although one zipcode with less than 10% rural population did. We broadened the criteria to include

physicians in the medium volume category (10 to 25 HRDs per year) and experienced a decline greater than 80% in addition to the criteria used earlier, then identified zipcodes with exit as above, and selected one.

[30] For example, see *AHRQ Quality Indicators—Guide to Inpatient Quality Indicators: Quality of Care in Hospitals—Volume, Mortality, and Utilization*. Rockville, MD: Agency for Healthcare Research and Quality, 2002. AHRQ Pub. No. 02-RO204.. Revision 2 (September 4, 2003)