Electronic Discovery and the Adoption of Information Technology

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Abstract

After firms adopt electronic information and communication technologies, their decision-making leaves a trail of electronic information that may be more extensive and accessible than a paper trail. We ask how the threat of litigation affects decisions to adopt technologies that leave more of an electronic trail, by exploring the case of electronic medical records (EMRs). EMRs allow hospitals to document electronically both patient symptoms and health providers' reactions to those symptoms. We find evidence that hospitals are one-third less likely to adopt EMRs if there are state rules that facilitate the use of electronic records in court.

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1 Introduction

When firms adopt new information and communication technologies (ICTs), they hope to increase profits by reducing communication and archiving costs. However, they may incur hidden costs, among which is an increased likelihood of detrimental evidence being uncovered from an electronic 'paper trail'. In United States v. Microsoft, CA No. 98-1232, federal prosecutors used e-mails sent between Microsoft executives as evidence of anti-competitive intent towards Netscape. In this paper, we study whether changes in the risks and costs of litigation stemming from the existence of an electronic document trail influence firms in their decisions to adopt new technologies.

We focus on the specific question of how the prospect of electronic data being used in court affects the decisions of US hospitals to adopt Electronic Medical Record (EMR) systems. EMRs allow health providers to store and exchange information about their patients' medical and treatment histories electronically rather than using paper. EMR systems can improve patient care and reduce administrative costs, but their effect on malpractice litigation is ambiguous.

On the one hand, by automating documentation of a patient's care, EMR systems can help protect health providers in a malpractice case, by documenting that hospital protocols were followed. EMRs may provide better and more legible documentation with an audit trail. By helping to prevent medical mistakes, such as dosage errors, EMRs may actually reduce the risk of a malpractice lawsuit being launched.

On the other hand, EMRs include more detailed information about patient care than traditional paper records. Therefore, plaintiff attorneys may make extensive discovery requests for 'relevant' electronic information in medical malpractice litigation. In a case described in Vigoda and Lubarsky (2006) and Dimick (2007), surgery left a patient quadriplegic. The patient's lawsuit initially focused on the surgeon's competence, but it switched to focusing

on the anesthesiologist's competence after pretrial discovery, which released EMRs to the patient's attorneys. These records contained an electronic time-stamp that cast doubt on whether the anesthesiologist was present for the entire procedure. This anecdote illustrates the risk to health providers of EMRs being released during discovery. An increase in information can improve patient care and aid rebuttal in court, but it can also increase the chance that the plaintiffs' lawyers will find evidence of wrongdoing.

To analyze whether this threat of increased medical malpractice litigation deters adoption of EMRs, we use panel data on EMR adoption by hospitals from 1994-2007. To measure the likelihood that electronic data will be used in medical malpractice trial proceedings, we exploit differences over time in state court procedural rules governing the scope and depth of general electronic document discovery, or 'e-Discovery', in pretrial proceedings. E-discovery refers to the use of electronic materials in the discovery stage of court proceedings. These laws increase the likelihood of extensive electronic metadata being preserved, such as potentially damaging evidence of time-stamps when records were accessed and modified in court. We find that the enactment of such state rules decreases the propensity of hospitals to adopt EMRs by one-third. We check the robustness of this result by adding controls to the main model and by employing a set of falsification tests.

We then examine which hospitals were most deterred by these procedural rules. First, we find that e-Discovery rules hinder adoption more in states with more malpractice litigation stemming from allegations that could be bolstered with data from EMRs. Second, we find evidence that it was smaller hospitals who were most deterred by these e-Discovery rules. This result may suggest that small hospitals find it harder to cover the fixed cost associated with maintaining electronic records if they face or expect a malpractice suit. To comply with most e-Discovery requests, hospitals need to have implemented policies and procedures to address potential IT systems risks, such as special systems that can accurately record corrections or additions to the electronic record.

We contribute to three literatures. By documenting evidence of the role of electronic data in court cases in inhibiting diffusion of healthcare IT, we contribute a growing information systems literature that examines the determinants of the use and diffusion of healthcare IT in the US (Kim and Michelman, 1990; Menon et al., 2000; Devaraj and Kohli, 2000, 2003; Angst et al., 2008; Miller and Tucker, 2009, 2011b). Medical researchers have examined the association of malpractice risk and the adoption of healthcare IT, the literature has so far been either anecdotal or empirically ambiguous. Feldman (2004) quotes survey evidence that shows that in 41 malpractice cases, there were no reported cases where an "automated record" hindered the defense process. He also discusses quotes from survey participants that suggest positive legal outcomes, such as "I know of three cases where the anesthesia record directly contributed to the anesthesiologist being dismissed (from the suit)." Lane (2005) points out that it would be unwise to conclude from anecdotal evidence that electronic systems do not increase practice exposure, because Feldman (2004) ignores the additional risk created by additional data stored in the electronic record. To try to understand how 'malpractice risk' and adoption of EMRs may correlate, Virapongse et al. (2008) sent surveys to 1140 physicians in Massachusetts. 6.1 percent of physicians with an EMR system had a history of paid malpractice claims, compared to 10.8 percent of physicians who did not use EMRs. However, after controlling for sex, race, year of medical school graduation, speciality and practice size, this difference was no longer statistically significant. We are able to add to the precision and identification of this survey research, by using shifts in state rules and procedures governing electronic data to separately identify changes in the use of electronic data in court cases that might affect adoption.

Our paper also contributes to a new literature that relates the increasing interconnection between the practice of law and technology. Korin and Quattrone (2007) emphasize that to meet electronic document discovery challenges, attorneys will need to 'become familiar with systems and processes that are used to create, transmit and store health care information

electronically; electronic information availability; how routine computer operations in health care institutions may change or alter electronically stored information (ESI); and what is entailed in producing requested electronic documents.' As emphasized by Ward et al. (2009), new legal rules and procedures have severely complicated the management and use of various information systems. There is also an active policy debate about the costs of electronic disclosure in court systems (Losey, 2008; Dimick, 2007; Korin and Quattrone, 2007). While the focus so far has been on the complexity and costs that e-Discovery adds to the litigation process, our research suggests that policymakers should also consider whether potential adopters are being deterred from adopting welfare-enhancing technology.

Finally, this work relates to the literature in health economics that attempts to assess how the risk of malpractice litigation affects health care provider choices. The bulk of this research concerns physician responses to the malpractice environment, and considers location (Matsa, 2007) and treatment decisions. For example, Kessler and McClellan (1996) show that medical malpractice tort reforms affect how doctors treat heart disease patients. Dubay et al. (1999) study the effects on caesarean section rates while Currie and MacLeod (2008) study birth outcomes. Avraham et al. (2010) provide an overview of the cost impact by relating tort reforms to changes in health insurance premiums. This study considers how malpractice concerns may affect hospitals' decisions regarding technology adoption. In our robustness analysis, we control for the major tort reforms studied in the previous papers, such as payment caps and joint and several liability rules. However, our focus is on the impact of the rules of evidence, which has not previously been explored.

The finding that the use of electronic data in court appears to deter hospitals from adopting EMRs has particular policy relevance now, because the 2009 HITECH Act offers incentives of roughly $44,000 per physician to promote EMR adoption.

Our findings imply that there are costs to EMR adoption from allowing electronic discovery in court. However, this does not mean that they imply there should be no electronic

discovery. That would be true only if the policy goal were simply increasing EMR adoption. Instead, it is important to recognize that there may be important benefits from electronic discovery for the strength and usefulness of the medical malpractice system. For example, there may be benefits to electronic discovery in terms of discerning and penalizing truly negligent care. However, given the general lack of information about the use of electronic records in electronic discovery cases, there may be clear benefits to clarifying the procedures surrounding the use of electronic medical records in court cases. It may be advantageous for medical professionals to be well-informed about how much additional risk they will expose themselves to rather than having them perceive those risks as unquantifiable.

2 Background

2.1 State Electronic Discovery Laws

In order to determine if the use of electronic data in court proceedings deters or encourages the adoption of EMRs by health providers, we exploit variation in the legal environment that shifts the likelihood that EMRs will be used in malpractice cases. This variation is from state rules governing the use of electronic information in the discovery stage of litigation in state courts. We focus on state court rules governing the use of electronic information in this discovery phase because most medical negligence cases are filed in state courts.

The discovery phase of a medical malpractice case starts after the plaintiff files the lawsuit. During discovery, both the defense and the plaintiff have the opportunity to obtain relevant information and documents from the other parties in the lawsuit. The standard for discovery for paper records is generally very broad. Documents are 'discoverable' if they are likely to lead to the uncovering of admissible evidence. They do not have to be necessarily admissible at trial. Requests for discovery are generally statutorily predetermined requests that must be produced without objection. Therefore, all parties in a lawsuit must respond to discovery

requests or face being found in contempt.

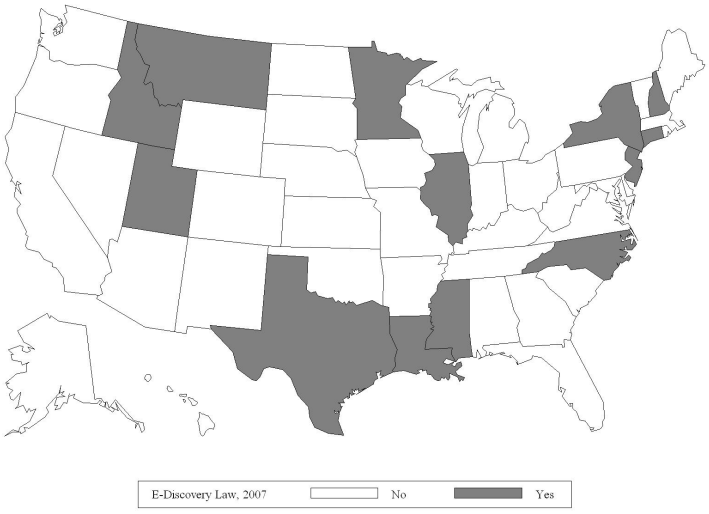
The extent to which the use of electronic data in courts is seen as a burden is demonstrated by the evolution of new 'E-Discovery' insurance products. ProAssurance Insurance Company, for example, has a product it advertises to medical providers as follows: 'If your private practice or facility's practice of medicine stores any portion of medical records electronically, producing required information (e-Discovery) for a formal legal or regulatory proceeding can be costly - not including the pitfalls of compliance [...] Sophisticated plaintiffs' attorneys are beginning to understand the potentially fertile ground for this method of legal discovery in health care.' Their services offer immediate intercession on the receipt of an electronic discovery request - 'helping to identify secure data limited to what's requested instead of opening additional doors of risk.' This description for healthcare providers and their legal teams illustrates that the discovery phase requires extensive time and effort. Conversations with industry specialists suggest that the costs of employing appropriate IT and forensic experts increase the established costs of assembling a legal team for defending a medical malpractice suit by 50 percent.[1]

In the past decade, many states have adopted rules that govern 'e-Discovery,'. As shown by Figure 1, these rules are geographically diverse. The rules originate both from statutes and courts. Table 1 summarizes the rules that have been enacted.

These rules generally add electronic documents as an additional class of documents that are governed by existing rules on discovery in pretrial proceedings. This means that such materials fall, without any room for dispute, into the class of materials that must be automatically produced without objection in pretrial proceedings. Without such a legal guarantee

[1] As an illustration of the perceptions of legal experts, a recent conference on medical malpractice included a session that described electronic discovery as "an aggressive enemy lurking at the door of every hospital in the United States" and "a friend of the plaintiff's bar," explaining that "a wealth of digital information can accumulate about a patient that is housed outside an organizations' legal medical record. Attorneys in search of additional information pertinent to a lawsuit may view this data as digital Easter eggs waiting to be discovered."

Figure 1: Distribution of state e-Discovery rules in 2007



in place, the plaintiff's and defendant's teams of lawyers must hash out the use of electronic materials between themselves. Interviews with medical malpractice attorneys to provide evidence on this informal and undocumented process suggest that they often reach an agreement with the other party to exclude electronic evidence from the discovery process. This practice of excluding electronic materials has been broadly criticized by authors such as Weiss (2006), who says "Lawyers have tended to avoid filing e-Discovery requests, primarily out of fear." Lawyers rationalize such behavior by pointing out that without clarification from the courts about how e-Discovery should be conducted, e-Discovery becomes costly and may not produce worthwhile evidence that offsets these costs.[2]

The rules also recognize some distinctive features of electronic information. For example, the rules often allow requests for electronically stored information ("ESI") to specify the format in which the information should be delivered. Rather than accepting hard-copy printouts containing relevant information, lawyers can request that information be provided

[2]This anecdotal evidence was backed up by a recent '2008 Litigation Survey of Fellows of the American College of Trial Lawyers' (ACTL and IAALS (2009)). This suggested that nearly 77 percent of courts did not understand the difficulties associated with e-Discovery and that 87 percent of trial lawyers said that e-Discovery increases the costs of litigation.

electronically in the 'native form' in which it was produced. Blumenthal et al. (2006) also discusses the concern that widespread use of ESI in medical malpractice cases introduces ambiguity in the definition of a legal 'medical record' and extends the scope of discovery. This extension goes beyond the medical record information that hospitals are required to provide to patients upon request under the Privacy Rule of the 1996 Health Insurance Portability and Accountability Act (HIPAA).[3]

A problem for defendants about requests for 'ESI' is that metadata contained in the electronic record can give the impression that medical records have been tampered with. This is a particular point of vulnerability for defendants in court. One example, given to us by an industry insider, was the case of radiologist in Arizona who prior to a deposition accessed the patient's record to review its contents. By doing so, they inadvertently created a time-stamp which suggested that the record had been 'modified' just prior to the deposition. In Arizona, the absence of clear rules meant that this inadvertent electronic data was not admitted as evidence, but legal experts say that under new state rules that this potential electronic evidence of possible 'tampering' could be used effectively by the plaintiff to have medical evidence dismissed.

In our regressions, we use an indicator variable to signal the existence of a state rule: We do not exploit the variation in the wording of the rule. We did check the robustness of our results to the exclusion of Texas, which appears to have the least 'plaintiff-friendly' rules for e-Discovery of the states in our sample, and obtained similar, if marginally higher, estimates of the effects of e-Discovery rules than before.

In the last year of the time period that we study, there were sweeping changes to the Federal Rules of Civil Procedure (effective December 2006) that broadened the reach of the electronic data health providers may have to release in malpractice cases, to include

[3]See, for example, AHIMA e-HIM Work Group on Defining the Legal Health Record (2005) and AHIMA e-HIM Work Group on e-Discovery (2006).

Table 1: State rules governing e-Discovery

State	Law	Date	Source	Description
CT	Connecticut Practice Book, Superior Court - Procedures in Civil Matters Sec. 13-9. Requests for Production, Inspection and Examination; In General (see subsection (d), at p. 192 of 259-page .pdf document)	Effective 1/1/2006	Court	Amendments creating a procedure to address how e-Discovery will take place
ID	Idaho R. Civ. P. 34	Effective 7/1/2006	Court	Amendments add ESI to existing rules relating to discovery of documents
IL	Illinois Supreme Court Rules 201(b)(1) and 214	Effective 1/1/1996	Court	Adds "retrievable" ESI to existing rules on discovery; requires provision in printed form of such ESI, and that they produce those documents organized in the order in which they are kept in the usual course of business, or organized and labeled to correspond with the categories in the request.
LA	CCP 1424 - Scope of discovery; trial preparation; materials: CCP 1460 - Option to produce business records: CCP 1461 - Production of documents and things; entry upon land; scope: CCP 1462 - Production of documents and things; entry upon land; procedure	Approved 6/25/2007, Effective October 2007	Statute	Adds ESI to definition of "writing" in a clause excluding discovery for materials prepared in advance of litigation or in preparation for trial. Allows interrogatories to be answered by specifying the ESI from which the answer may be obtained. Adds ESI to existing rules covering production of documents. Adds ESI to existing rules covering production of documents; requires ESI to be produced in the form in which it is "ordinarily maintained" or in reasonably usable form.
MN	Amendments to Rules of Civil Procedure 16, 26, 33, 34, 37, 45	Effective 7/1/2007	Court	Adds as a valid matter for pretrial conferences the reaching of agreements on e-Discovery
MS	Miss. R. Civ. P. 26(b)(5)	Effective 5/29/2003	Court	Requires that "To obtain discovery of data or information that exists in electronic or magnetic form, the requesting party must specifically request production of electronic or magnetic data and specify the form in which the requesting party wants it produced. The responding party must produce the electronic or magnetic data that is responsive to the request and is reasonably available to the responding party in its ordinary course of business."
MT	Mont. R. Civ. P. 16(b). Scheduling and planning, 26(b). Discovery scope and limits, 26(f). Discovery conference, 33(c). Option to produce business records, 34(a). Scope, 34(b). Procedure, 37(e). Electronically stored information, 45(a). Form issuance, 45(c). Protection of persons subject to or affected by subpoenas, 45(d). Duties in responding to subpoena	Effective 2/28/2007	Court	Adds as a valid matter for pretrial conferences the reaching of agreements on e-Discovery, Limits discovery of ESI that would be "unreasonably burdensome or expensive", or "unreasonably cumulative or duplicative", Adds as a valid matter for pretrial conferences the reaching of agreements on e-Discovery. Allows interrogatories to be answered by specifying the ESI from which the answer may be obtained. Adds ESI to existing rules covering production of documents. Adds an exemption from normal sanctions for failure to cooperate in discovery, for ESI "lost as a result of the routine, good faith operation of an electronic information system" Adds ESI to language governing subpoenas. Allows subpoenas to cover sampling of ESI. ESI must be provided as "kept in the usual course of business" or organized and labeled "to correspond with the categories in the demand." If subpoena does not specify form, ESI must be provided "in a form or forms in which the person ordinarily maintains it, or in a form or forms that are reasonably usable." Exempts ESI from sources that are not accessible because of "undue burden or cost"
NC	Rules for Superior Court Judicial District 15B: Rule 6 - Discovery	Effective 7/1/2006	Court	Requires ESI to be provided in a "reasonably usable" form
NH	Superior Court Rule 62. (I) Initial Structuring Conference (see subsection (C)(4))	Effective 3/1/2007	Court	Adds as a valid matter for pretrial conferences the reaching of agreements on e-Discovery
NJ	Part IV Rules Governing Civil Practice in the Superior Court, Tax Court and Surrogates Courts, Rule 1:9. Subpoenas, Rule 4:5B. Case Management; Conferences, Rule 4:10. Pretrial Discovery, Rule 4:17. Interrogatories to Parties, Rule 4:18. Discovery and Inspection of Documents and Property; Copies of, Rule 4:23. Failure to Make Discovery; Sanctions Documents	Effective 9/1/2006	Court	Allows subpoenas for ESI that is not "unreasonable or oppressive", Adds as a valid matter for pretrial conferences the reaching of agreements on e-Discovery, Allows claims that ESI is not reasonably accessible if party pre-specifies the sources that are not accessible, Allows interrogatories to be answered by specifying the ESI from which the answer may be obtained., Adds ESI to existing rules covering production of documents. Specifies that the ESI must be in a form or forms in which it is ordinarily maintained or in a form or forms that are reasonably usable., Adds an exemption from normal sanctions for failure to cooperate in discovery, for ESI "lost as a result of the routine, good faith operation of an electronic information system"
NY	Uniform Civil Rules of the Supreme and County Courts, 202.70 Commercial Division of the Supreme Court, Rule 8. Consultation prior to Preliminary and Compliance Conferences	Effective 1/17/2006	Court	Requires meeting of counsel before preliminary conference to address e-Discovery, including "(i) implementation of a data preservation plan; (ii) identification of relevant data; (iii) the scope, extent and form of production; (iv) anticipated cost of data recovery and proposed initial allocation of such cost; (v) disclosure of the programs and manner in which the data is maintained; (vi) identification of computer system(s) utilized; (vii) identification of the individual(s) responsible for data preservation; (viii) confidentiality and privilege issues; and (ix) designation of experts."
TX	Tex. R. Civ. P. 196.4 Electronic or Magnetic Data	Effective 1/1/1999	Court	ESI must be specifically requested and its form pre-specified; limited to ESI "reasonably available to the responding party in its ordinary course of business"
UT	Utah R. Civ. P. 26. General provisions governing discovery: P. 33. Interrogatories to parties: . P. 34. Production of documents and things and entry upon land for inspection and other purposes: P. 37. Failure to make or cooperate in discovery; sanctions	Effective 11/1/2007	Court	Limits discovery of ESI that poses an "undue burden or cost"; Adds provisions covering inadvertent disclosure of privileged information. Allows interrogatories to be answered by specifying the ESI from which the answer may be obtained. Adds ESI to existing rules covering production of documents. Adds an exemption from normal sanctions for failure to cooperate in discovery, for ESI "lost as a result of the routine, good faith operation of an electronic information system."

Source for dates of enactment of laws/rules: K&L Gates LLP,E-Discovery Analysis & Technology Group "Current Listing of States That Have Enacted E-Discovery Rules" October 2008. Description of each rule based on actual rule or statute text.

electronic metadata such as creation dates and modification dates. Since these rules apply to federal courts, they are unlikely to apply to malpractice cases prosecuted in state courts. However, because some of the 2007 state rules incorporate language from the Federal Rules, we estimated an alternative version of our main specification excluding 2007 data, with similar results.

In all cases, we focus on the dates the laws became effective. Since these rules are generally changes to the court code of civil procedure, there is not a large gap between the enactment date and the effective date as sometimes occurs with changes in state law. Furthermore, while these state laws often formalize and codify the procedures that have been followed in a prior case, they do represent a discontinuity in terms of legal practice. First, before such rules are enacted, it is not clear whether in that state practices that have been followed in complex corporate civil cases apply to all civil procedure. Second, while lawyers who specialize in such areas of corporate law may be well aware of the issues of electronic discovery, the enactment of such rules are ordinarily attended by both publicity and offers of workshops and training in matters of e-Discovery by the state bar association, which improve the ability of the broad spectrum of the legal profession to take advantage of electronic data mining techniques.

In any investigation of the effect of changes in state laws, it is important to know the origin and background behind the changes. For example, we would be faced by a severe endogeneity problem, if these rules came about because of activity by large hospitals or medical malpractice litigation experts in that state. Most of these laws have been prompted to an extent by court cases where e-Discovery became a crucial issue at trial and there were no rules to govern the fallout. However, our study of the origin of these rules suggests that rather than reflecting activity in the health sector, they instead reflect litigation practices in the financial sector. Banks and other financial firms were the first industrial sector to embrace a large number of ICT-type technologies that store electronic data. For example,

Merrill Lynch's Jonathan Eisenberg noted that in his experience, 98% of the records in discovery cases involving Merrill Lynch are ESI (Losey, 2008). The financial sector also has the 'deep pockets' to enable lawyers involved in these cases to take on the substantial cost and complexity of reviewing electronic documents as part of the discovery process. An example of this relationship between the presence of financial firms and the enactment of state-level e-Discovery rules is New York's Zubulake v. UBS Warburg, 2004 WL 1620866 decision, where UBS had to pay $29.2 million, partly because they failed to store data properly. Conversations with e-Discovery experts suggest that it was the holes in the existing discovery trial procedure guidelines that were exposed by the Zubulake case that prompted the New York courts to issue clarifying procedural rules in 2006.

2.2 Effects of E-Discovery on Malpractice Litigation

The effects of making it easier for plaintiffs to access electronic data in malpractice cases are ambiguous. The majority of the EMR policy literature emphasizes that EMRs can document that hospital protocols were followed, and consequently provide a more complete and easily 'provable' paper trail for the defense. However, it also means that if there are informal practices in a hospital that go against official protocol, they will also be recorded.[4] EMRs may prevent mistakes by standardizing care and patient histories, and make it easy to document that an alleged violation of procedure did not occur. However, the presence of electronic data makes it more likely that a mistake, if it were made, would be recorded. It also opens the possibility that even if the initially alleged error or negligence did not occur, the plaintiff could data-mine the electronic information until it found another potential

[4]Anecdotal evidence indicates that when nurses are called away in an emergency from making regular checks on patients recovering from surgery, they can "correct" paper records after the fact to indicate that they had made the checks. That is not possible with EMRs. Similarly, Williams (2009) reports a case where the focus of a medical malpractice suit was the fact that a nurse made entries to an electronic record *after* the patient had died. If the patient records had been paper, there would have been no way of assessing knowing for sure when these entries were made.

mistake, or at least some evidence of questionable actions that could be open to medical interpretation.

There are other specific ways EMRs could affect malpractice litigation. There is the potential for legal sanction as the result of for data loss or destruction. There is also the potential that inappropriate corrections to a medical record that would be revealed by electronic data stamps, inaccurate data entry and unauthorized access. Errors may also occur during the transition period from paper to EMRs, such as those documented by Han et al. (2005). EMRs make it easier to refer to a patient history, so courts may judge physicians more harshly who make errors because of not referring to a patient history, and it will be easier to tell when they have not referred to it.[5] Also, the use of inappropriate standardized templates (for example using an adult neurological template in a pediatric case, Kern (2009)) could be used as evidence against health providers in court. Hospitals may also fear that in the course of discovery for a single malpractice case, the electronic information will reveal a system-wide error in the EMR system's clinical guidelines and alerts that would affect a large class of patients, thereby amplifying the risk relative to paper documents. Finally, electronic information also increases the potential for data mining (Terry, 2001).

We focus on how the risk of malpractice litigation affects hospital adoption decisions, because the EMR system is hospital-wide. However, malpractice cases may not be hospital-wide. Litigation resulting from hospital care may be directed at the hospital; at the physician and other members of the medical team as well as the hospital; or at individual members of the medical team. Therefore, the hospital adoption decision may reflect not only its direct perception of the negative consequences of electronic data being used in court for itself but also the negative consequences faced by its physicians, if the hospital worries that this could interfere with employing physicians of high-caliber.

[5]This is a change from the current paper-based systems, where failure to obtain past clinical history has had to be judged based on a comprehensive review of the individual case files.

3 Data

We use technology data from the 2008 release of the Healthcare Information and Management Systems Society (HIMSS) Analytics^{TM} Database (HADB). The 2004 release of this data has been used to study the diffusion of EMR technology in three RAND studies (Fonkych and Taylor, 2005; Hillestad et al., 2005; Bower, 2005). To control for time-varying hospital characteristics, we matched the HADB data with the American Hospital Association (AHA) survey from 1994-2007, and were left with data on the timing of technology adoption decisions of 3,712 hospitals. The hospitals in our data were generally larger than the hospitals we could not match in the AHA data. For example, they had on average 7,988 annual admissions compared to 2,717 average annual admissions for the hospitals for whom the HADB data did not contain information on IT adoption. The HADB database covers the majority of US hospitals, including about 90 percent of non-profit, 90 percent of for-profit, and 50 percent of government-owned (non-federal) hospitals. However, it excludes hospitals that have fewer than 100 beds that are not members of healthcare systems. Also, we do not have information on hospitals that were in operation during the sample period but that closed before 2007, but this represents less than 1 percent of the AHA sample. Therefore, our estimates should be taken as representative only of the larger, more urban, and non-freestanding hospitals for which we have data. Looking ahead, in Section 5 we show that smaller and poorer hospitals respond more negatively to the presence of e-Discovery laws. Thus, it seems likely that by omitting smaller community hospitals, we are understating the average impact of the potential for the use of electronic data in court on EMR adoption.

Table 1 describes the main variables in our regressions, including the multiple controls that we use to control for hospital-level heterogeneity. Table A-1 reports summary statistics for the initial year of the sample, separately for hospitals in states that did and did not adopt e-Discovery rules by 2007. On average, the two sets of hospitals appear quite similar along

the observed dimensions.

We measure adoption of EMRs by whether a hospital has installed or has entered into a contract installing an "enterprise EMR" system. Installing EMRs in a hospital setting is a large undertaking that may span more than one year, so we define adoption by whether or not the hospital has contracted with a EMR vendor to set up an EMR system. It makes sense that it is the decision to choose to install an EMR which will be influenced by the potential of electronic data in litigation rather than the EMRs' completion date. Enterprise EMR software provides the software skeleton that underlies other potential add-ins such as clinical decision support, a clinical data repository, and order entry. EMR software can therefore provide the electronic metadata, such as time-stamps, file modification dates and user access details, that increase the amount of information available to lawyers in a medical malpractice case compared to paper records. The 1,394 hospitals who adopted EMRs during the sample period between 1994 and 2007, and the 2,174 hospitals who have not adopted by the end of 2007, provide the key variation in our data.[6] The average annual adoption rate of EMRs among hospitals who had not previously adopted the technology was 3.3 percent.

4 Results

We first examine the aggregate impact of laws that clarify the use of e-Discovery in the pretrial stages of medical malpractice suits on adoption of EMRs. As described in Section 2.1, these laws increase how much electronic information a plaintiff's lawyer may receive automatically as part of pretrial disclosure. As such, the laws are expected to magnify the impact of electronic information on the litigation process.

We model hospitals as maximizing an objective function that includes net revenues and patient outcomes, including potential costs associated with malpractice lawsuits. Hospitals

[6]These values exclude hospitals who reported IT adoption dates before the sample period and those who did not report the timing of their adoption.

Table 2: Summary Statistics for Full Sample

	Mean	Std Dev	Min	Max	Observations
Adopt EMR	0.033	0.18	0	1	42106
Adopt Business Intelligence Software	0.0083	0.091	0	1	42106
Adopt Financial Data Warehousing Software	0.0067	0.082	0	1	42106
E-Discovery Law	0.11	0.31	0	1	42106
Years Opened	34.3	34.4	0	190	42106
Staffed Beds	182.9	174.9	3	1875	42106
Admissions (000)	7.53	8.12	0.0030	98.2	42106
Inpatient Days (000)	42.7	48.2	0.0040	582.0	42106
Medicare Inpatient Days (000)	19.2	21.1	0	476.9	42106
Medicaid Inpatient Days (000)	8.43	14.3	0	302.8	42106
Births	896.9	1257.0	0	16463	42106
Total Inpatient Operations (000)	2.26	2.87	0	83.1	42106
Total Operations (000)	5.88	6.64	0	213.4	42106
Emergency Outpatient Visits (000)	23.5	21.8	0	290.1	42106
Total Outpatient Visits (000)	112.5	147.2	0	2935.9	42106
Total Payroll Expenses (USDm)	35.7	52.1	0.037	1116.5	42106
Employee Benefits (USDm)	8.19	12.7	0	294.5	42106
Total Expenses (USDm)	85.0	125.2	0.095	2393.8	42106
Length of Stay	1.01	0.078	1	2	42106
No. Doctors	15.5	65.0	0	2067	42106
No. Nurses	219.4	279.2	0	3325	42106
No. Trainees	19.0	82.2	0	1347	42106
Non-Medical Staff	608.7	769.2	0	12054	42106
PPO	0.64	0.48	0	1	42106
HMO	0.56	0.50	0	1	42106
Member Hospital System	0.48	0.50	0	1	42106
Speciality Hospital	0.036	0.19	0	1	42106
Non-Profit	0.60	0.49	0	1	42106
Gross State Product (USDtr)	0.38	0.37	0.014	1.81	42106
Gross State Product Per Capita (USD000)	32.5	4.99	20.9	58.8	42106
EMR Prevent Malp. Payouts (USDm)	0.23	0.10	0.029	0.97	42106
EMR Document Malp. Payouts (USDm)	0.26	0.11	0.022	0.92	42106
EMR Unrelated Malp. Payouts (USDm)	0.18	0.072	0.041	0.81	42106
Cap Punitive	0.55	0.50	0	1	42106
Cap Non Economic	0.36	0.48	0	1	42106
Joint+Several Liability	0.79	0.41	0	1	42106
Contingency Fee	0.39	0.49	0	1	42106

choose to adopt EMRs if the net benefits are positive. We model adoption of EMRs as an irreversible, absorbing state and exclude hospitals who have previously adopted from the sample. Examining past years of HADB data confirms that there are no observations where a hospital divests itself of an EMR system without seeking a replacement. We use a discrete-time hazard model since our survival time data is discrete (the year of adoption). Discrete survival time models can be estimated using standard binary choice methods, if the panel is limited to time periods for each firm when it is still at risk of the event (Allison, 1982). We use a probit specification to model new adoption decisions among hospitals who have not previously adopted EMRs. This means that we exclude observations of hospitals that have already adopted EMR from our regressions, in effect treating it as an irreversible decision.

Our results are robust to using a linear probability model, a logit specification, or a Cox proportional hazards model.[7] Robust standard errors are clustered at the state level. This allow for the potential correlation within states over time and between hospitals. This robustness is especially important for our study because the policy variation occurs at the state level (Bertrand et al., 2004).[8]

Table 3 reports our initial results. Column (1) reflects the results of our initial panel specification that includes the full set of state and year fixed effects. Here, the presence of a law that facilitates e-Discovery is associated with a statistically significant 0.24 reduction in the latent variable capturing the net value of adoption of EMRs. At the sample mean, this translates to a marginal effect of e-Discovery rules lowering the likelihood of adopting EMRs by 0.011 each year. This represents a large (one-third) decrease relative to the average propensity to adopt of 0.033 each year. These estimates are identified from within-state variation in adoption rates around the time that state e-Discovery rules are put in place.

[7]See Table A-3 in the appendix for the main estimates in these models.

[8]Column (3) of appendix table 6 reports results with standard errors clustered at the hospital level. The standard errors are generally similar to those clustered at the state level, but they are somewhat smaller for the main variable of interest. This suggests that clustering at the state level provides a more conservative and appropriate test for the impact of the state level policies we study.

Table 3: How e-Discovery laws affect hospital adoption of EMRs

	(1)	(2)	(3)	(4)	(5)	(6)
E-Discovery Law	-0.239**	-0.236**	-0.233**	-0.235**	-0.234***	-0.191**
	(0.114)	(0.117)	(0.110)	(0.109)	(0.0711)	(0.0818)
Cap Punitive			-0.0894	-0.0842	-0.0863	-0.0862
			(0.0963)	(0.0936)	(0.0679)	(0.0680)
Cap Non Economic			-0.0245	-0.0278	-0.0206	-0.0183
			(0.0804)	(0.0751)	(0.0525)	(0.0524)
Joint+Several Liability			-0.0564	-0.0568	-0.0476	-0.0577
			(0.0592)	(0.0584)	(0.0805)	(0.0812)
Contingency Fee			0.0103	0.0115	0.00934	0.00496
			(0.140)	(0.145)	(0.164)	(0.165)
Lagged Installed Base				0.00769*	0.00789**	0.00768**
				(0.00404)	(0.00363)	(0.00362)
State Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Hospital Controls	No	Yes	Yes	Yes	Yes	Yes
Privacy Laws	No	No	No	No	Yes	Yes
Linear Trend	No	No	No	No	No	Yes
Observations	42106	42106	42106	42106	42106	42106
Log-Likelihood	-5766.2	-5575.3	-5573.9	-5571.9	-5571.6	-5571.1

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Sample includes hospitals that have not previous adopted EMRs.

In Column (2) we add a full set of hospital and state level controls to capture differences in hospital characteristics over time. This means that we can control explicitly for changes in hospital characteristics that may be correlated with the rules. For example, if states that were more likely to enact an electronic discovery rule also had hospitals that were likely to adopt earlier, because they were larger, then the potential for only small hospitals to have not adopted after the enactment of the rule could give rise to a spurious negative correlation between the enactment of the law and adoption in the state. However, adding all of these controls leaves the key effect of the electronic discovery law largely unchanged.

Due to space constraints, we omit the full set of coefficient estimates from the main table, and instead report them in Column (1) of Table 6 in the appendix. Many of the controls are insignificant. Being a speciality hospital, a non-profit hospital, a member of a hospital system, having higher employee benefits, having longer average patient length of stays, more emergency room visits, and relatively fewer trainees and nurses are all linked with hospitals who are more likely to adopt EMR.[9]

As with any study that analyzes the effect of a legal rule, there is a question as to whether we can interpret our main relationship in a causal manner, given potential for the rule to be endogenous. Specifically, the concern is that the enactment of the rule that facilitates e-Discovery could be related to other factors that in turn deter adoption of EMRs and are not controlled for by the state or year fixed effects or the hospital-level controls. Many of the factors that one might expect to be correlated with inclusion of electronic documents in pretrial proceedings (for example, increases in unobserved technological sophistication that are not captured by our state GDP controls) would also be correlated with adoption of EMRs. These omitted factors lead us to understate the effect of e-Discovery rules on adoption. However, there are also alternative confounds that would lead us to overstate the

[9]Given that we employ several controls that capture different measures of a hospital's size, the overall relationship between size and adoption is not obvious from the estimates. In fact, larger hospitals are more likely to adopt EMRs.

impact of e-Discovery. One possible alternative would be that the enactment of e-Discovery laws is associated with an increase in consumer protection sentiment at the state level, which also gives hospitals problems in collecting unpaid medical bills from consumers, in turn leaving hospitals with less money to invest in technology.

We deal with this potential for endogeneity initially by adding direct controls for the medical malpractice environment. We then in Tables 4 and 5 conduct falsification tests, confirming the absence of significant associations between technology adoption and e-Discovery rules if we incorrectly specify the date of enactment or if we study the adoption of an alternative healthcare technology that does not produce metadata that can be used in court.

Column (3) of Table 3 reports the results of a specification where we control directly for changes in laws surrounding medical malpractice. We measure the tendency of states to adopt reforms to their court rules by using state level malpractice tort reforms. Our data on state-level tort reforms is from Avraham (2006), who documents changes in state level regulations that affected caps on medical malpractice payouts, the use of contingency fees and the allocation of liability. We include separate controls for limits on punitive and economic damages. However, we omit the control for limits on total damages because it does not vary over time during our sample period and is not identified. We supplemented the data for 2007 by manually reviewing whether there had been changes to these regulations. We also include controls that capture the price that lawyers are charged for paper records in that state, according to the price guidelines set out by that state's medical board. The addition of tort reform has an insignificant impact on the estimated coefficient for e-Discovery rules. The e-Discovery coefficient is -0.235. The marginal effect at the sample mean is -0.011, or a one-third decrease in the propensity to adopt, as in Columns 1 and 2. Interestingly, the reforms themselves are generally unrelated to adoption of EMRs.[10]

Column (4) of Table 3 further reports the results of a specification in which we control for

[10]The full set of coefficients is in Column (2) of Table 6.

differences in the level of the installed base of EMR in the previous year for that state. This directly addresses the concern that our results are an artifact of states that pass these laws having many early adopters, meaning that after the law is passed there are few hospitals left who actually would benefit from adopting EMRs. Although the lagged installed base variable itself has a positive and significant relationship with EMR adoption, its inclusion has a negligible impact on the main estimate of interest.

Two additional robustness checks are reported in the last two Columns. Miller and Tucker (2009) and Miller and Tucker (2011a) document the importance of privacy regulation as a driver of electronic medical record adoption. Column (5) shows that controlling for the presence of state-level privacy laws limiting the disclosure of personal medical information by hospitals does not alter the estimated impact of e-Discovery. Column (6) shows that the main effect also remains negative and significant after allowing for separate linear time trends in EMR adoption for states that pass e-Discovery rules during the sample period.

4.1 Timing of Laws

In Table 4, we report results from a falsification exercise in which we use a 'false' adoption date for state e-Discovery rules. For each state with an e-Discovery law, we create three 'false' e-Discovery laws passed 1, 2 and 3 years before the actual enactment date. The idea of doing such a falsification test is that if our estimates are reflecting some change in the time-trend of adoption behavior in states that enact laws but that is not related to the actual law, then the placebo will pick up some of this time-trend. We first repeat the estimate from our main model (from Column 4 of Table 3) in Column (2). In the next Column, we report estimates from a model that includes the true e-Discovery adoption date, as well as the false dates in each of the 3 preceding years. The lack of a relationship with the false law suggests

Table 4: Dynamic effects and timing of laws

	Main	Placebo laws	Placebo laws	Exclude early laws
	(1)	(2)	(3)	(4)
Adopt EMR				
False E-Discovery Law: 3 year before		-0.0242	-0.0234	
		(0.102)	(0.101)	
False E-Discovery Law: 2 year before		-0.0206	-0.0206	
		(0.144)	(0.145)	
False E-Discovery Law: 1 year before		0.124	0.124	
		(0.112)	(0.112)	
E-Discovery Law	-0.235**	-0.301**	-0.313***	-0.273*
	(0.109)	(0.131)	(0.112)	(0.162)
False E-Discovery Law: 1 year after			0.0617	
			(0.190)	
False E-Discovery Law: 2 year after			-0.151	
			(0.173)	
False E-Discovery Law: 3 year after			0.111	
			(0.0967)	
State Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Hospital Controls and Lagged Base	Yes	Yes	Yes	Yes
Tort Law controls	Yes	Yes	Yes	Yes
Observations	42106	42106	42106	36814
Log-Likelihood	-5571.9	-5570.9	-5570.5	-4935.9

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Sample includes hospitals that have not previous adopted the technology.

that the changes in adoption followed e-Discovery rules rather than preceding them.[11]

Column (3) of Table 4 builds on these estimates to investigate the dynamic impact of e-Discovery rules on EMR adoption. The main finding of Column (2) is repeated in that there are no significant pre-trends leading up to the law. There are also no significant differential trends following e-Discovery rules either. The lack of any significant coefficient for laws starting 1, 2 or 3 year after the actual enactment date suggests that the longer-term effects of the law on adoption rates resemble the immediate effects. This implies that the total impact on adoption accumulates over time, but the annual reduction shows no systematic pattern of increasing or decreasing magnitude. Column (4) provides additional evidence for the constancy of the incremental impact by reporting the estimated impact of the e-Discovery rules on a sample that excludes data from Illinois and Texas, the 2 states with e-Discovery laws in place by 2000.[12]

4.2 Different Technologies

Table 5 investigates how e-Discovery rules affects different types of technology. The first Column repeats the previously reported main estimate for adoption of EMRs. The second shows a similar negative impact of e-Discovery rules on the adoption of a related technology, Computerized physician order entry (CPOE) systems. These systems can record and disseminate instructions for patient treatments and often include safety features such as error-checking and clinical decision support tools (such as automated warnings for potential drug interactions). As with EMRs, the increased record-keeping associated with CPOEs has

[11] In other estimation, when we measure separate impacts of each of the false laws in isolation, we obtain negative point estimates that are smaller than the main estimate (ranging from -0.0395 to -0.0562) and statistically insignificant.

[12] The immediate negative impact of the e-Discovery rule on adoption is consistent with anecdotal evidence from changes in medical malpractice insurance premiums for physicians in Illinois around the time its rule was enacted, as reported in the Medical Liability Monitor. Premiums increased for one insurer by 28 to 40% (depending on specialty and region) over the two years that ended after enactment, but by only 8 to 12% over the following two years.

Table 5: Effects on different hospital information technologies

	EMR	CPOE	Financial Datawarehouse	Business Intelligence
	(1)	(2)	(3)	(4)
main				
E-Discovery Law	-0.235**	-0.258**	0.150	0.191
	(0.109)	(0.119)	(0.159)	(0.196)
State Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Hospital Controls and Lagged Base	Yes	Yes	Yes	Yes
Tort Law Controls	Yes	Yes	Yes	Yes
Observations	42106	46252	46180	47252
Log-Likelihood	-5571.9	-4267.7	-2024.1	-2231.9

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Sample includes hospitals that have not previous adopted the technology.

been identified as a potential risk in malpractice cases where electronic discovery is present (Greenberg and Ridgely, 2011). The reduction in CPOE adoption provides further evidence of a decline in clinical IT adoption following the enactment of e-discovery rules.

In contrast, in the spirit of our previous falsification tests, in the next two columns of the table we report estimates from different placebo test using alternative technologies that are unlikely to affect pre-trial discovery: Financial Data Management Software and Business Intelligence Software. These technologies, while used in hospital record-keeping, do not produce data that is part of a legal medical record. We found no significant effects from state e-Discovery rules on these technologies and the point estimate are positive. This suggests the main result in Table 3 is not being driven by a spurious negative correlation between e-Discovery rules and healthcare IT adoption more generally.

5 Heterogeneous Effects of E-Discovery Rules

5.1 E-Discovery and Different Types of Malpractice Cases

In this section we explore how the effect of e-Discovery rules may be affected by the types of medical malpractice lawsuits a hospital faces. Specifically, we examine how the effect of the

law is mediated by the size and nature of the medical malpractice payments associated with practitioners working in that state. Our hypothesis is that higher malpractice payments by practitioners translate into greater financial risk to hospitals from malpractice, either because hospitals themselves face increased financial exposure in medical malpractice suits or because hospitals compete for physicians and would need to compensate them for increasing their exposure to electronic data in malpractice cases. We use data from the national practitioner databank of all medical malpractice payments. The files are the universe of all claims paid in the United States, but do not include information on complaints and litigation that did not result in a payment.[13] We use payments from the previous year to predict new adoption, avoiding the potential reverse causality that could otherwise run from adoption of EMRs to malpractice payments.

Using the 3-digit allegation claim category code, we determine if each payment is potentially related or unrelated to EMRs. Claims related to EMRs are from mistakes that might be prevented or documented by EMRs. An example of a claim that could be theoretically supported by electronic metadata in an electronic medical record is a 'failure to monitor' a patient sufficiently. An example of a claim that could be theoretically prevented by an electronic medical record is a claim of a 'wrong dosage' being administered by a nurse, since electronic medical records theoretically remove the uncertainties introduced by a physician's handwriting and idiosyncratic use of unit abbreviations. Other claims in the first category include a 'failure to diagnose,' where easy access to a patient's previous medical history may make diagnosis easier, but a failure to use the history would also be documented and could be used in court. The second category of claims are those that are not likely to be affected by EMRs. An example is 'Surgical or Other Foreign Body Retained'. It is unlikely that

[13]The practitioner databank is the most comprehensive source of malpractice payments, with full coverage of practitioners and inclusion of both settlements and verdicts. The Jury Verdict Research data exclude settlements and the Physician Insurer Association of America Data Sharing Project contains only about 12 percent of claims.

the presence of an electronic medical record would affect the likelihood of a surgeon leaving behind a piece of operating equipment within a patient.

The results in Table 6 show how the presence of an e-Discovery law is mediated by the average payment in that state for a medical case for each of these claims classes. In each case, to ensure comparability, we use a mean standardized and centered measure of the average payment data. The average size of claims that are associated with practices that might be related to EMRs has a statistically significant negative interaction with the presence of a law. The sizes of the estimates imply that increasing the value of EMR-related claims from its mean to a value one standard deviation above the mean increases the e-Discovery coefficient by about 50 percent (from -0.214 to -0.325). In contrast, unrelated claims have statistically insignificant effects on the estimated impact of an e-Discovery law. This suggests that when a hospital is in a state where there are large medical malpractice payouts for lawsuits that would be documented by electronic medical records, a law facilitating e-Discovery would be incrementally negatively correlated with adoption. These separate effects are confirmed in Column (3) where a single model is estimated with both types of payouts and interactions. As pointed out by Ai and Norton (2003), care is needed when evaluating the significance of interaction terms in non-linear models. Results from a linear probability model, however, are reassuringly similar.

Column (1) reports both a positive correlation between malpractice payments and adoption of EMRs in that Column and a negative estimate of the effect of the interaction between with E-discovery rules malpractice payments. Though this is just a correlation which may be subject to the usual confounds, one interpretation is that having an EMR system in place can be an advantage for hospitals in documenting their compliance with standard practices. However, this benefit is eliminated when e-Discovery rules put all electronic information by default in the hands of plaintiffs. The potential for a downside to the use of electronic data for hospitals with extensive electronic documentation increases directly when the control over

Table 6: Different types of medical malpractice claims mediate the effect of e-Discovery laws on hospital adoption of EMRs

	(1)	(2)	(3)
Adopt EMR			
E-Discovery Law	-0.214**	-0.200**	-0.208**
Law*EMR Related Malp. Payouts	-0.111***		-0.102*
EMR Related Malp. Payouts	0.0458**		0.0489**
Law *EMR Unrelated Malp. Payouts		-0.0777	-0.0120
EMR Unrelated Malp. Payouts		-0.00987	-0.0219
State Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Hospital Controls and Lagged Base	Yes	Yes	Yes
Tort Law controls	Yes	Yes	Yes
Observations	42106	42106	42106
Log-Likelihood	-5567.9	-5570.7	-5567.3

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Sample includes hospitals that have not previous adopted EMRs.

that information shifts to plaintiffs through greater ease of e-Discovery. There is anecdotal evidence that some hospitals with EMRs attempt to gain control over this risk by engaging in costly activities, such as retaining duplicate paper records or employing third-party document storage systems or expensive customized software modules to limit the content included in the legal medical record.

In Columns (2) and (3), the interaction terms between e-Discovery rules and other types of malpractice payments are statistically insignificant. However, consistent with the relationship in Column (1), there is a positive relationship between EMR adoption and malpractice cases stemming from allegations that might have been prevented by EMRs. In Column (3), for unrelated allegations, there is no such association.

5.2 Which Hospitals Are Affected by E-Discovery Laws?

We now consider how hospital characteristics may affect the correlations between hospital EMRs adoption and the presence of e-Discovery laws. We find evidence that the most statistically significant moderator along various dimensions is hospital size. Table 7 provides a summary of our results. The three columns summarize specifications that include interactions with an indicator variable that measures whether or not the hospital has a

below-median number of total admissions, expenses and non-medical staff. In all cases we find a negative interaction with whether a hospital is small by that measure and whether a state has an e-Discovery law in place. The largest interaction by size is the interaction with the size of the support staff. To control for the Ai and Norton (2003) critique, we also estimated a linear probability model with similar results.

We speculate that this result may reflect the costs and difficulties associated with preparing electronic data for discovery for civil trial. Hospitals that do not employ large enough legal and IT teams may be therefore placed at a relative disadvantage if electronic medical records are brought into the discovery process. Losey (2008) urges institutions who face substantial e-Discovery risks to establish an internal e-Discovery preparedness and response team, consisting of one or more outside attorneys who specialize in e-Discovery as well as representatives from the legal team, IT department, key business departments as well as records and compliance units. Such costly and complex organizational requirements may deter smaller hospitals more. In addition, hospitals who face the prospect of e-Discovery would need to invest in additional storage and IT management systems to prevent unintentional data loss.

6 Conclusion

This paper documents how the presence of state e-Discovery laws affects the adoption of electronic medical records. On the one hand, it seemed possible that the use of electronic records might facilitate a hospital's defense, by providing a broader and more robust standard of documentation. On the other hand, it seemed possible that the increase in the breadth of evidence and the possibility of 'data-mining' by the plaintiff's lawyers might increase hospitals' perception of the potential for negative consequences of electronic medical data being used in court.

Table 7: Which hospitals' adoption is affected by e-Discovery laws?

	(1)	(2)	(3)
Adopt EMR			
E-Discovery Law	-0.153	-0.159	-0.149
	(0.103)	(0.107)	(0.121)
Law*Low Admissions	-0.221***		
	(0.0853)		
Law*Low Total Budget		-0.196**	
		(0.0779)	
Law*Low Non-Medical Staff			-0.228**
			(0.0925)
State Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Hospital Controls and Lagged Base	Yes	Yes	Yes
Tort Law controls	Yes	Yes	Yes
Observations	42106	42106	42106
Log-Likelihood	-5568.4	-5569.1	-5568.2

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Sample includes hospitals that have not previous adopted EMRs.

Our empirical analysis suggests that state laws that clarify the use of electronic evidence in discovery are associated with a 33 percent decrease in adoption of EMRs by hospitals. The implication of this finding is that there may be previously ignored welfare effects from the risk of litigation on the spread of certain new technologies that store electronic data. Although we have focused on the adoption of health IT, this deterrence effect may be present in other sectors of the economy where companies make choices about converting records from paper to electronic methods of storage.

There has been a substantial federal push to ensure widespread adoption of EMRs, providing financial incentives of approximately $44,000 per physician under the 2009 HITECH Act. However, such policies have as of yet not addressed this issue of the potential of the use of electronic data in malpractice cases when designing incentives. Our research suggests that hospitals' concerns about the use of electronic data in malpractice cases may limit the effectiveness of such financial subsidies. If the efforts to promote adoption of EMRs are to be effective, they should be coupled with efforts to streamline and guide the use of elec-

tronic data in court proceedings, to reduce hospitals' perceived costs from malpractice claims enabled by EMRs.

Several limitations are worth noting. First, we study adoption of a simple, bare-bones EMR system, rather than additional functionality such as computerized practitioner order entry and integration with radiology information systems. Second, we only study the effect of e-Discovery laws on the adoption of EMRs, not how they are actually used. It is possible that hospitals who fear litigation end up not fully using their electronic medical records, for fear of future data mining. If this is the case, then our estimates may understate the extent of the problem. Last, when a state enacts an e-Discovery rule, the local medical and legal press commonly publish articles that address issues of e-Discovery and the potential costs they entail. We recognize that therefore our regressions measure the effect of the enactment of an e-Discovery law (and the attention that surrounds the enactment) as opposed to the pure causal effect of an unpublicized change in the wording of the law.

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Table A-1: Summary Statistics in 1994 by E-Discovery Rule in 2007

	No Rule		Rule	
	Mean	Std Dev	Mean	Std Dev
Adopt EMR	0.011	0.10	0.017	0.13
E-Discovery Law	0	0	0	0
Years Opened	35.2	34.6	37.2	36.7
Staffed Beds	189.1	168.3	206.4	198.2
Admissions (000)	6.89	6.89	7.07	7.49
Inpatient Days (000)	42.5	44.5	50.1	58.0
Medicare Inpatient Days (000)	19.3	20.1	22.3	24.8
Medicaid Inpatient Days (000)	7.99	13.3	10.7	20.2
Births	875.9	1205.0	920.3	1226.6
Total Inpatient Operations (000)	2.24	2.67	2.28	2.82
Total Operations (000)	5.29	5.86	5.09	5.58
Emergency Outpatient Visits (000)	20.5	18.8	20.5	18.9
Total Outpatient Visits (000)	83.7	100.5	86.8	110.5
Total Payroll Expenses (USDm)	25.8	32.6	29.4	42.5
Employee Benefits (USDm)	5.83	8.00	6.55	10.1
Total Expenses (USDm)	60.0	78.6	64.6	91.4
Length of Stay	1.01	0.086	1.01	0.100
No. Doctors	10.2	42.3	13.7	51.3
No. Nurses	198.1	234.3	205.4	256.4
No. Trainees	16.1	70.3	22.7	87.1
Non-Medical Staff	559.7	642.9	612.7	783.0
PPO	0.57	0.50	0.59	0.49
HMO	0.45	0.50	0.49	0.50
Member Hospital System	0.40	0.49	0.36	0.48
Speciality Hospital	0.030	0.17	0.046	0.21
Non-Profit	0.63	0.48	0.61	0.49
Gross State Product (USDtr)	0.27	0.27	0.34	0.21
Gross State Product Per Capita (USD000)	28.1	2.92	30.4	4.19
EMR Prevent Malp. Payouts (USDm)	0.16	0.043	0.17	0.049
EMR Document Malp. Payouts (USDm)	0.18	0.065	0.20	0.057
EMR Unrelated Malp. Payouts (USDm)	0.12	0.049	0.16	0.052
Cap Punitive	0.35	0.48	0.52	0.50
Cap Non Economic	0.37	0.48	0.042	0.20
Joint+Several Liability	0.64	0.48	0.92	0.28
Contingency Fee	0.40	0.49	0.40	0.49

Table A-2: Estimates with Full Set of Coefficients

	S.E. Clustered at State Level			S.E. Clustered at Hospital level
	(1)	(2)	(3)	(4)
E-Discovery Law	-0.236**	-0.233**	-0.235**	-0.235***
	(0.117)	(0.110)	(0.109)	(0.0712)
Years Opened	0.00196***	0.00196***	0.00196***	0.00196***
	(0.000333)	(0.000330)	(0.000330)	(0.000383)
Staffed Beds	0.0000854	0.0000913	0.0000917	0.0000917
	(0.000306)	(0.000307)	(0.000307)	(0.000298)
Admissions (000)	0.00731	0.00736	0.00718	0.00718
	(0.00847)	(0.00845)	(0.00831)	(0.00683)
Inpatient Days (000)	0.00111	0.00108	0.00107	0.00107
	(0.00116)	(0.00117)	(0.00118)	(0.00137)
Medicare Inpatient Days (000)	-0.00245	-0.00245	-0.00237	-0.00237
	(0.00216)	(0.00216)	(0.00215)	(0.00174)
Medicaid Inpatient Days (000)	0.000999	0.00102	0.00103	0.00103
	(0.00140)	(0.00140)	(0.00140)	(0.00170)
Births	-0.00000784	-0.00000786	-0.00000763	-0.00000763
	(0.0000207)	(0.0000207)	(0.0000206)	(0.0000157)
Total Inpatient Operations (USD000)	-0.0129	-0.0132	-0.0133	-0.0133
	(0.0126)	(0.0126)	(0.0125)	(0.0116)
Total Operations (USD000)	0.00353	0.00350	0.00348	0.00348
	(0.00430)	(0.00432)	(0.00430)	(0.00355)
Emergency Outpatient Visits (000)	0.00201*	0.00200*	0.00201*	0.00201**
	(0.00119)	(0.00118)	(0.00117)	(0.000941)
Total Outpatient Visits (000)	0.000101	0.000102	0.000100	0.000100
	(0.000121)	(0.000121)	(0.000122)	(0.000111)
Total Payroll Expenses (USDm)	0.000453	0.000454	0.000454	0.000454
	(0.000890)	(0.000884)	(0.000887)	(0.00126)
Employee Benefits (USDm)	0.00545**	0.00533**	0.00528**	0.00528*
	(0.00254)	(0.00246)	(0.00246)	(0.00282)
Total Expenses (USDm)	-0.000186	-0.000176	-0.000166	-0.000166
	(0.000507)	(0.000507)	(0.000508)	(0.000516)
Length of Stay	0.464**	0.462**	0.461**	0.461***
	(0.191)	(0.192)	(0.191)	(0.169)
No. Doctors	0.0000215	0.0000235	0.0000144	0.0000144
	(0.000212)	(0.000213)	(0.000211)	(0.000259)
No. Nurses	-0.000243**	-0.000242*	-0.000243*	-0.000243*
	(0.000124)	(0.000125)	(0.000125)	(0.000144)
No. Trainees	-0.000771***	-0.000770***	-0.000765***	-0.000765***
	(0.000264)	(0.000264)	(0.000263)	(0.000246)
Non-Medical Staff	0.0000307	0.0000311	0.0000317	0.0000317
	(0.0000472)	(0.0000471)	(0.0000471)	(0.0000505)
PPO	0.0262	0.0256	0.0267	0.0267
	(0.0412)	(0.0409)	(0.0406)	(0.0428)
HMO	0.00527	0.00590	0.00578	0.00578
	(0.0481)	(0.0480)	(0.0480)	(0.0417)
Member Hospital System	0.123***	0.125***	0.124***	0.124***
	(0.0374)	(0.0373)	(0.0373)	(0.0287)
Speciality Hospital	0.155**	0.155**	0.156**	0.156**
	(0.0783)	(0.0784)	(0.0787)	(0.0677)
Non-Profit	0.312***	0.312***	0.312***	0.312***
	(0.0408)	(0.0409)	(0.0409)	(0.0330)
Gross State Product (USDm)	-0.249	-0.257	-0.330*	-0.330
	(0.203)	(0.192)	(0.181)	(0.210)
Gross State Product Per Capita (USD000)	0.0209	0.0179	0.0198	0.0198
	(0.0244)	(0.0235)	(0.0229)	(0.0152)
Cap Punitive		-0.0894	-0.0842	-0.0842
		(0.0963)	(0.0936)	(0.0680)
Cap Non Economic		-0.0245	-0.0278	-0.0278
		(0.0804)	(0.0751)	(0.0516)
Joint+Several Liability		-0.0564	-0.0568	-0.0568
		(0.0592)	(0.0584)	(0.0794)
Contingency Fee		0.0103	0.0115	0.0115
		(0.140)	(0.145)	(0.164)
Lagged Installed Base			0.00769*	0.00769**
			(0.00404)	(0.00362)
State Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Observations	42106	42106	42106	42106
Log-Likelihood	-5575.3	-5573.9	-5571.9	-5571.9

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A-3: Robustness to alternative estimation models

	LPM	Logit	Cox
	(1)	(2)	(3)
E-Discovery Law	-0.0157***	-0.526***	-0.498*
	(0.00457)	(0.169)	(0.256)
Observations	42106	42106	43492

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The sample in Columns (1) and (2) includes hospitals that have not previous adopted EMRs. The outcome is an indicator for new EMR adoption. Column (1) estimates a Linear Probability Model using ordinary least squares and Column (2) uses a Logit model. Column (3) estimates a Cox Proportional Hazards model for initial EMR adoption.