

SECTION: SPECIFIC AIMS

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| LIABILITY IN THE DELIVERY OF PERSONALIZED MEDICINE:

DRIVER, IMPEDIMENT, OR BOTH?

SPECIFIC AIMS

Personalized medicine (PM) is widely expected to transform medicine and the health care system over the next decade. Yet, the emergence and implementation of PM has been slower than many anticipated. Scientific complexity and uncertainties, the need for validation of biomarkers, commercial unavailability of relevant diagnostic tests, economic costs, lack of reimbursement for diagnostic testing, regulatory approval barriers, structural problems in the existing health care delivery system, inadequate business models, physician educational gaps and resistance, and intellectual property issues have all been identified as potential factors impeding the implementation of PM. One factor that has not been subject to much attention to date, but is likely to play an increasingly significant role in the future, is the potential for liability. In particular, physicians, a key | gatekeeper in the uptake in PM, are most at risk of liability relating to PM due to their lack of available defenses, limited training in genetics, and legal doctrinal trends that will be further evaluated in this project. Indeed, the first PM lawsuits are already being pursued in the courts, and a rapid ramp-up of such litigation can be expected over the next few years, particularly if some of the initial lawsuits are successful. Uncertainties about the benefits, costs and standards for applying PM technologies and tests will further clinical adoption of some PM technologies and practices, while potentially deterring others, affecting the availability, safety and benefits of PM innovations for patients. Notwithstanding the major role that liability risks and uncertainties are likely to play in the implementation and direction of PM, relatively little doctrinal, empirical or policy research has been conducted on this issue to date. This project proposes to examine the nature and risks of potential PM-related liability for physicians, the key doctrinal and evidentiary issues that will determine the potential likelihood and success of such lawsuits, the likely impacts of liability risks on the development and direction of PM, and potential policy tools to better manage liability risks and uncertainties. It will then seek to

communicate the findings and implications of our research to key stakeholder groups. Specifically, this project aims to:

1. Identify the legal claims, defenses and doctrines, including current trends and changes in these key legal criteria, that will affect liability for physicians relating to PM;
2. Evaluate the risks of PM-related liability to physicians by integrating the doctrinal analysis with the fact patterns in four likely PM case studies, as well as by analyzing lessons from previous examples of physician liability relating to new medical technologies and procedures;
3. Explore the potential impacts of physician liability on the development and direction of PM, including physician practices and patient access to and benefit from PM;
4. Identify and evaluate potential policy options for better management of physician liability risks and uncertainties relating to PM; and
5. Conduct outreach on the findings and implications of our research to key stakeholder groups (including physicians, physician educators, patient groups, and legal practitioners (including judges)) to help them better prepare for and anticipate future liability trends and impacts.

SECTION: RESEARCH STRATEGY

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| LIABILITY IN THE DELIVERY OF PERSONALIZED MEDICINE:

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RESEARCH STRATEGY

]. Significance

There are many obstacles affecting the implementation of personalized medicine {PM}, including scientific complexity and uncertainty, the need for validation of biomarkers, economic costs, lack of reimbursement for diagnostic testing, regulatory approval barriers, structural problems in the existing health care delivery system, lack of physician training and motivation, inadequate business models, and intellectual property issues. One potentially important factor that has received less attention to date, but which could be enormously influential in the uptake and future direction of PM, is liability. While liability could potentially affect all actors in the PM lifecycle -- including drug and device manufacturers, test providers and testing labs, health care providers, third-party payors, and pharmacists -- physicians are at the greatest risk of liability and their behavior is most likely to be influenced by potential liability relating to PM (Marchant et al. 2011; Marchant et al 2006). This proposal will therefore focus on physicians and their patients, and the impact that liability may have on them in the context of PM.

Liability can be a powerful incentive for actors to take appropriate measures to protect public health and safety, or it can skew priorities and practices in socially disadvantageous ways. Thus, liability has the potential to have

| both beneficial and detrimental influences on whether and how physicians uptake PM. Liability may speed up the development and clinical use of some PM technologies and practices, while deterring others.

Notwithstanding the potential importance of liability in influencing the future direction and uptake of PM, relatively little is known about, and very little research has been conducted on, the liability risks associated with PM and their likely impacts. This proposed project seeks to fill that gap by providing legal doctrinal, empirical, | and policy research on the risks, impacts and possible policy approaches with regard to PM liability for physicians. The results of this project can help to better understand and predict the future course of PM, to

identify the key legal and policy levers that may be available to ensure that liability plays a beneficial rather than detrimental role in the implementation of PM, and to provide guidance to physicians, patients, attorneys and judges on PM liability issues .

In this section, we first provide a brief description of PM and its current status, followed by a more extensive discussion of potential liability risks to physicians and why the potential liability in the burgeoning field of PM is a unique and pressing issue that needs to be comprehensively analyzed and addressed.

1. Brief Description and Status of Personalized Medicine

The practice of medicine in the United States is on the verge of a profound paradigm shift from the “one size fits all” approach of the past to individualized care in which a new generation of molecular diagnostics will be used to target treatments to the unique genetic and molecular profile of individual patients and their diseases.

As NIH Director Francis Collins recently noted, “[t]he power of the molecular approach to health and disease has steadily gained momentum over the past several decades and is now poised to catalyze a revolution in medicine” (Collins, 2010). Notwithstanding the enormous potential and excitement about the dawning era of PM, the implementation of PM has turned out to be slower and more complex than many experts originally anticipated (SACGHS, 2008; The Royal Society, 2005).

Today, there is substantial uncertainty and disagreement about the appropriate use of genetics and other personalized medicine data in clinical care, giving rise to the types of disagreements and disputes that can spawn litigation. On one hand, some experts claim certain PM techniques are ready for clinical application today, and several leading medical institutions have begun to deploy such techniques (Personalized Medicine Coalition, 2009; Flockhart et al., 2009; Lesko, 2007). Experts with this perspective have expressed frustration that physicians and other stakeholders in the health care system have been too slow to uptake PM methods and tools (Lesko & Woodcock, 2004; Evans, 2006). Other experts, however, are more skeptical about the near-term deployment of PM, contending that such methods are not likely to benefit patient care and are not yet ready for widespread adoption (The Royal Society, 2005; Nebert & Vesell, 2004).

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We are currently at a critical and unsettled juncture in the implementation of PM, where much uncertainty and disagreement exists about which PM technologies and approaches are ready for use, what outcomes they will provide, and who will pay for them. In such a period of uncertainty, the potential for liability is at its greatest.

| 2. Liability Doctrines Affecting Personalized Medicine

One factor that may accelerate (appropriately or inappropriately) the widespread clinical use of personalized

medicine is liability (Marchant et al., 2011; SACGHS, 2008; Roth 2007; Marchant et al., 2006; Evans, 2006; Ossorio, 2001). A patient who suffers a serious adverse effect from a pharmaceutical for which he or she carries a genetic susceptibility or a patient whose treatment was adversely affected by the failure to use new genetic diagnostic techniques in a timely manner may bring a lawsuit against any number of entities across the PM lifecycle, including the physician who prescribed the drug, the drug manufacturer who produced the drug, the manufacturer who developed the diagnostic test, the testing lab that conducted the test, the insurer which may not have been willing to pay for a more appropriate genetic test, or the pharmacist that dispensed the drug. If and when one or more lawsuits are successful, the dynamics of litigation generally are such that news of the successful litigation will spread quickly among the legal community, and the number of such cases brought by trial attorneys will quickly skyrocket. If such a dynamic were to be unleashed in the context of PM, the impacts would be enormous. Even a relatively low number of lawsuits would have pervasive effects on how PM is delivered and implemented, since the economic and psychological consequences of liability for any individual at-risk party could be substantial. Physicians are likely to be the most at risk for liability relating to PM, mostly because other parties will be protected by various statutory and common law defenses such as the learned intermediary doctrine (Marchant et al., 2011; Marchant et al., 2006). This is not just a hypothetical issue. There has already been a smattering of PM-related lawsuits filed against physicians, including: (1) failing to recommend a genetic test before prescribing a drug or treatment; (e.g. Downey v. Dunnington, 2008 – physician performed prophylactic mastectomy on woman based on her family history of breast cancer, but was sued for failing to test her for a BRCA mutation first); (2) failing to timely diagnose genetic

condition, thereby leading to loss of chance to treat (e.g. Cardone v. Gunsberger, 2005 – physician liable for taking 3 weeks to diagnose a genetic disorder in an infant); (3) failing to recognize that family history indicates need for a given diagnostic or screening test (e.g. Bointy-Tsotigh v. U.S., 1996 – physician liable for not recommending early colonoscopy in patient with family history of cancer); (4) for providing an inaccurate diagnosis or prognosis based on genetic tests (e.g., Gallagher v. Duke University, 1988 – hospital erred in inaccurately reporting results of genetic tests to parents); (5) failure to warn family members about heritable conditions (e.g., Pafe v. Threikel, 1995 – doctor had duty to warn daughter of his patient of genetic risk for cancer);

These initial cases are likely to be just the tip of the iceberg. As the scientific knowledge, regulatory approval, and commercial availability of pharmacogenomic tests continues to expand, the potential and likelihood for liability will likewise continue to grow, especially if physicians are resistant to the uptake of these new technologies and procedures. Yet, there is considerable uncertainty about the prospects of a medical malpractice or other lawsuit brought by patients or other injured persons against their physician alleging that their injury was caused or exacerbated by the use or failure to employ PM technologies. The applicable legal scenarios, doctrines and evidentiary requirements relevant for PM liability for physicians are relatively uncharted, and are not fixed but rather are evolving due to shifting legal and policy trends. The first objective of this project will therefore be to identify and evaluate the relevant legal claims, defenses, and doctrines that will be applicable for potential liability lawsuits against physicians relating to PM, including recent doctrinal changes and trends that will significantly affect the liability exposure of physicians.

For example, to bring a successful medical malpractice case against a physician, a plaintiff must show that (i) the physician had a duty of care to the plaintiff, (ii) the physician breached that duty, (iii) the plaintiff incurred an injury, and (iv) the physician's breach caused the plaintiff's injury. The key element of liability exposure is the standard of care, which is undergoing rapid and significant doctrinal changes (Gostin & Jacobson, 2006). In some jurisdictions the standard of care is determined by local custom, and if few local physicians are currently using PM tests, a physician who is sued for failing to use adequate methods will not be held to have violated the applicable standard of care. However, some jurisdictions apply a more objective "risk based" test to

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determine the standard of care, where instead of looking to the common practices of the medical profession, the court looks to whether the physician's conduct was "reasonable" as determined by a judge or jury (Helling, 1974; Peters, 2000}. Under this standard, a physician may be held liable even if the medical community at large has not yet adopted the PM test that a patient claims should have been used. Additionally, some jurisdictions are now applying a national standard of care rather than a standard based on local practice and custom (Lewis et al., 2007). These shifting definitions of the standard of care, along with new claims {e.g., informed consent) brought against physicians to skirt medical malpractice defenses, are likely to create uncertainty and substantially affect liability risks for physicians relating to PM (Marchant et al. 2006), There are a number of other legal doctrinal trends and changes that will affect PM liability for physicians. New causes of action beyond medical malpractice are emerging in the context of genetics and PM. For example, physicians have been held liable in their handling of genetics by failing to obtain fully informed consent related to diagnostic and treatment procedures (Granata v. Fruiterman, 668 \$E.2d 127 (2008). These informed consent claims are increasingly powerful tools for patients, especially as courts transition to a patient-centered approach to this doctrine, which requires physicians to disclose all information that reasonable patients would consider material to their decision making (rather than the information that reasonable physicians would consider material, as the traditional doctrine required). Physicians have also been sued for failure to disclose genetic risks to family members of their patients who refuse to communicate the risk to their relatives, with mixed results (Pate v. Threlkel, 1995; Safer v. Pack, 1996; Molloy v. Meier, 2004). Other important doctrinal changes, such as those adopted by courts or legislatures affecting "loss of chance" (King, 1981; Renahan, 2009}, the learned intermediary doctrine (Calabro, 2004), and standards and procedures for medical malpractice cases (Kachalia & Mello, 2011) will also impact significantly the liability potential for physicians in the PM context.

3. Liability Risks in Personalized Medicine

While the number of lawsuits filed to date against physicians directly involving PM is limited, the number of cases will likely rise significantly in the next few years. However, little or no empirical analysis or in-depth research has been undertaken to date to try to evaluate the likelihood and magnitude of PM lawsuits being filed, the likely outcome of those lawsuits, and the impact that such outcomes will have on physician practice and the implementation of PM. Some important lessons can likely be learned from previous litigation episodes and experiences involving previous medical technologies. A general trend has been that new technologies, even if they improve overall health care, lead to a significant bump up in liability as expectations are increased and the gap in performance widens between early and slow adopters (Sage, 2003; De Ville, 1998). Such a dynamic can be expected with PM.

Yet, there are reasons to believe that personalized medicine may present unique liability issues for physicians compared to past medical technologies, although the project will seek to test this hypothesis. Reasons that PM may present unique liability dynamics include: (i) unlike other areas of medical practice where specialists with training and experience in the relevant specialty are applying a new technology or procedure, PM will involve the application of genetic information by physicians in virtually every type of practice, most of whom have no training or expertise in genetics; (ii) there are major uncertainties and disagreements within the medical and scientific communities about the appropriate use of personalized medicine tests at this time (Burke et al., 2010), and such uncertainty is known to be a major factor increasing liability risks (Craswell & Calfee, 1986); and (iii) the rapid pace of technology change in the personalized medicine results in constantly changing expectations and standards of care that can again greatly increase liability risk (SACGHS, 2008; Marchant et al., 2011).

In this present and unique environment, where much uncertainty exists about both the appropriate implementation of PM and the risks associated with implementing or not implementing specific PM methods, there is an important need for greater information and guidance on liability risks. Physicians, hospitals, malpractice insurers, and other PM stakeholders will be making important decisions that are currently based on incomplete or inaccurate impressions of their liability risks. Moreover, once liability has been established and starts to snowball, it will be too late to take appropriate measures

and safeguards to protect against liability. At this critical juncture in the rollout of PM, before widespread liability has taken hold, it would therefore be very

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important and useful to comprehensively study and make widely available the best information and projections of the risks and relevant factors for liability relating to PM. Because both the likelihood and outcome of PM lawsuits will be highly fact- and evidence-dependent, it will be necessary to evaluate liability risks in the context of specific examples in which the applicable legal and evidentiary information is assessed and integrated. This attempt to predict the risks of PM liability, integrating both legal doctrine and factual evidence, will be the second objective of this proposal.

4. Is Liability A Problem?

The third objective of this project will be to anticipate the potential impacts, both beneficial and detrimental, of physician liability in the PM arena. Personal injury liability, including liability for health care professionals, can serve an important social purpose to the extent that it induces actors to take appropriate actions to minimize unreasonable health risks (Gostin, 2000; Mello, 2006). If individuals are being harmed or denied the best health care because of the unreasonable failure of physicians to take full advantage of PM knowledge and technologies, the threat of liability can be an important driver for implementing sooner and more widely such beneficial personalized medicine technologies at the clinical level. On the other hand, problems are created by the enormous, and inevitably growing, uncertainties about the liability risks relating to personalized medicine. This uncertainty is caused by a number of factors including the lack of existing legal precedents in this specific area, the diverse state laws for determining the applicable standard of care, the lack of authoritative standards for practicing personalized medicine, the divergent expert opinions about the feasibility and effectiveness of existing PM tests, and the uncertainty about how lay jurors will evaluate claims relating to genetic testing. These pervasive uncertainties about PM liability risks present several potential policy problems. First, physicians may engage in defensive medicine and over-utilize genetic testing in order to protect against liability. Defensive medicine is

defined generally as a deviation from sound medical practice induced primarily by a threat of liability (OTA, 1994).

A physician may practice defensive medicine by performing extra tests or procedures to minimize potential liability, hoping that the additional testing will reduce adverse medical outcomes, deter patients from filing malpractice claims, and persuade the legal system that the appropriate standard of care was met. A number of studies have suggested that many physicians practice defensive medicine by ordering more diagnostic tests that would be warranted based on medical considerations alone (Studdert et al., 2005; Birbeck et al., 2004).

Uncertainty about applicable legal standards tends to increase the practice of defensive medicine (Studdert et al., 2005; Fenn et al., 2004). The resulting unnecessary diagnostic tests impose a significant cost on the medical system. The practice of defensive medicine has already been observed in the context of prenatal genetic testing, for which some commentators have argued that legal standards have over-ridden medical judgment in determining when prenatal genetic tests are appropriate (Young, 2003; Howlett et al., 2002;

Annas, 1985). In addition, the potential is there for some tests to do more harm than good. FVL is an example.

Patients and physicians may be compelled to take action (anticoagulation) that will result in more overall harm (bleeding complications) than benefit (clots prevented) because of not understanding the nature of absolute risk versus relative risk.

In addition to creating pressures for practicing defensive medicine, the uncertainty about applicable liability standards relating to PM will have other adverse effects. For example, the lack of any agreed standards for ordering personalized medicine tests will result in different standards of care, with some physicians being more proactive on ordering such tests and others being slower to adopt these new tools. Patients may thus be provided with inconsistent care if decisions are being influenced by legal concerns on an ad hoc basis.

Given these potential counter-productive consequences from the uncertainties and risks of PM liability, it is not too early to begin considering policy options – at either the private or public levels – to address these problems. Even less work has been done on solutions to the liability problem for PM than has been devoted to

identifying the risks of liability. The fourth objective of this project will be to identify potential policy initiatives to provide greater certainty to PM actors and thus to reduce liability risks and uncertainties. Almost no work has

been done on liability prevention in the PM context to date, but some of the ideas that will be explored include better business models to integrate drugs and companion diagnostic tests, clinical guidelines that recommend best practices, better training of physicians and other health professionals, regulatory changes and other

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possible solutions (Evans, 2007; Roth, 2007; Evans, 2006; Marchant et al., 2006).

Finally, there is an important need to educate affected stakeholders and policymakers about the potential risks and impacts of liability for PM. For example, physicians, PM policymakers, medical guidelines writers, regulators, and medical educators need to have realistic expectations about the potential for liability in this sphere as PM emerges as the dominant medical model of this century. Patients, the group who will potentially bring such lawsuits, and the stakeholders who could be most affected by both the beneficial and detrimental potential impacts of liability, need to be aware of liability issues and become proactive in the inevitable policy and legal battles relating to liability. Finally, the practitioners in the legal liability field, including lawyers, expert witnesses and judges, also would benefit from clear and informative information about liability. Thus, the fifth objective of the proposal will be to conduct outreach on the findings of this project to key stakeholder groups including physicians, patient groups and legal practitioners.

11. Innovation

Much research has been done on the scientific, medical, regulatory, economic, educational, intellectual property, ethical and public policy aspects of personalized medicine. In contrast, very little doctrinal, empirical or theoretical work has been done on the issue of liability in the PM field, notwithstanding frequent references to the importance of the issue for PM (e.g., SACGHS, 2008, p. 47; Sorrel, 2008, NRC, 2007). Only a handful of short, preliminary analyses emphasizing the potential importance of this subject have been published to date (Marchant, 2011; Roth, 2007; Marchant et al., 2006; Evans, 2007; Rothstein, 2005; Ossorio, 2001}. The risks, relevant key factors, impacts, and possible solutions relating to potential PM liability are largely unknown and have been under-studied to date. There is much that could be done to provide beneficial further information,

trends, predictions, and proposed policy interventions to address this largely uncharted subject that is likely to play a critical role in the implementation of PM over the next decade. The knowledge generated by research | on these issues would likely prove very useful in helping physicians, patient groups, legal practitioners and other various stakeholders in PM to make informed decisions relating to the risks and prevention of liability. The present proposal therefore addresses a conspicuous gap in the knowledge base and available literature on PM. To fill this gap, it is important to not only have a good knowledge of law and legal research, but also of the scientific, medical, economic, and policy dimensions of PM, because these integrate with the law in understanding, predicting and preventing liability. In this proposal, we have attempted to address the need for such an integrated and inter-disciplinary approach in two innovative ways. First, the research team incorporates a broad range of relevant training, experience and expertise necessary to address the multi-dimensional and complex issues of PM liability. The PI (Gary Marchant) is trained as both a geneticist and lawyer, and has worked on liability issues relating to genetics for the past decade, including publishing numerous articles on such issues and serving as lead organizer of three previous conferences and workshops on genetics liability issues. Co-Investigator Doug Campos-Outcalt is a medical school professor involved in training future physicians and who has worked and written on physician uptake of PM genetic tests, and has served on the CDC's EGAPP (Evidence based Genomics Applied in Practice and Prevention) group evaluating the clinical readiness of PM tests. Co-Investigator Amalia Issa is a scientist whose work focuses on how PM applications will be translated and integrated into clinical practice, health care delivery and health systems, including studying physician and patient perspectives on PM uptake. Consultant Scott Ramsey is a physician and health economist whose work examines economic factors affecting clinical uptake of new medical technologies and procedures. Consultant Paul Wicks is Director of Research and Development at PatientsLikeMe and works on new approaches and models for patient participation and engagement in their own healthcare. Consultant Rachel Lindor is a lawyer currently completing her MD training at Mayo Medical School who has conducted research on medical liability and reimbursement issues relating to PM, including a poster presentation on liability issues relating to PM at this year's American Society for Clinical Oncology

annual conference.

Second, we plan to directly engage key stakeholders in the project through our consultants and supporters on the project and using our extensive existing network of contacts in the PM field. The stakeholder engagement is discussed further in the Research Approach section (below).

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III. Research Approach

This project will proceed in three steps, roughly segmented by the three years of the proposal. The first year will be devoted to identifying relevant legal doctrine, including potential claims, criteria, and defenses for the wide variety of liability lawsuits that might be anticipated against physicians related to PM lifecycle.. In the second year, we will assess the risk of liability for physicians relating to PM, by integrating the doctrinal analysis with the specific factual and evidentiary data for four PM case studies. We will also look to previous examples of physician liability relating to new medical technologies for relevant lessons and projections for PM.

Finally, in the third year, we will address two objectives. First, we will investigate impacts of liability on physicians, patients and society more generally as well explore possible policy options for addressing the potential liability risks and uncertainties relating to PM. Second, we will adapt and customize our findings for relevant stakeholders groups and undertake outreach on our findings to those sectors, including physicians, patient groups, medical educators, and malpractice insurers.

| Year One: identifying Liability Claims and Doctrine

The first year will involve identifying and assessing the applicable legal claims and doctrines that may be applicable to PM lawsuits against physicians. As discussed above, the legal landscape applicable to such lawsuits has been undergoing significant change in recent years, with major potential implications for the chances of PM lawsuits against physicians being filed and succeeding. The first year of the project will be devoted to a comprehensive scoping of the legal landscape for PM liability of physicians. This work will include two lines of research.

The first line of research will be to identify, analyze and catalogue every reported case in the United States in which a physician was sued relating to PM or genetic testing in other medical contexts (e.g., prenatal genetic

testing). We anticipate finding 100–200 relevant judicial decisions. For each case, we will identify the relevant legal claims brought against the physician, as well as the outcome of the case and the key factual evidence, expert opinions, reliance on authoritative statements or professional guidelines, defenses, or other factors that led to the outcome. In addition to looking at the reported decision, we will also review court filings and briefs and expert opinions filed in significant cases when accessible. From this data set, we will distill some overall findings as to the range and dimensions of possible legal claims that could be brought against physicians in the PM context and the key factors likely to determine the outcome of those claims based on the historical legal precedents. The list and characterization of cases will be posted on a public website created to communicate the results of this project.

| The second line of research in year one will be to evaluate some of the key legal doctrinal issues that are likely to affect liability relating to PM. PM liability risks will be dependent on some key legal doctrines that are currently evolving and are in flux, including:

- a. Standard of care for medical malpractice: Medical malpractice is based on whether a physician breached the applicable standard for care. As discussed in more detail above, the standard of care for physicians is currently undergoing significant change. The standard of care has traditionally been defined by custom in the locality in which the physician practices, but in many jurisdictions the standard has been evolving from a local to a national standard, and from a duty based on custom to a more objective standard. These and other changes in how the standard of care is defined are likely to have significant impacts on PM liability risks for physicians (Lewis et al., 2007; Marchant et al., 2006; Peiers, 2000}. Moreover, important legislative and policy initiatives relating to medical malpractice are being implemented or considered across the nation (Kachalia & Mello, 2011), and these too could significantly affect the prospects for PM physician liability.
- b. Learned intermediary doctrine – The learned intermediary doctrine shifts responsibility (and associated liability) for failure to warn a patient from a drug or device manufacturer to the prescribing physician if the manufacturer included an appropriate warning in the product materials received by the physician (i.e., patient package insert for a pharmaceutical). The applicability and scope of this doctrine is currently being challenged, with two states (New Jersey and W.

Virginia) recently deciding to no longer recognize the defense, a trend which if it continues could have major implications for PM liability
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(Perez, 1999; Calabro, 2004).

c. Role of clinical guidelines – Various organizations have produced clinical guidelines to attempt to guide health care professionals to make appropriate clinical decisions. The role that such clinical guidelines should play in defining the standard of care in a medical malpractice case is still evolving.

The role and weight that judges and juries extend to clinical guidelines in medical malpractice cases will potentially play an important role in determining PM liability risks (SCGHS8, 2008; Evans, 2006).

d. Loss of chance – In most PM liability cases, a physician's negligence will not "cause" the plaintiff's injury, which will often be pre-existing to the doctor's treatment (e.g., cancer or cancer predisposition).

Rather than causing the plaintiff's illness, the physician's actions may have reduced the probability that the plaintiff might have been successfully treated. Notwithstanding the lack of causation per se, courts have gradually permitted recovery for the "loss of a chance" of survival under certain circumstances

(King 1981}. The recognition and criteria for allowing a plaintiff to receive compensation for loss of chance have been evolving in recent years (Renehan, 2009), and the availability and scope of this cause of action will be critical to the viability of many potential PM lawsuits.

The shifting status, application and criteria for these important legal doctrines affecting potential PM lawsuits will be analyzed through a review of key court decisions and secondary materials. The results of this doctrinal analysis will be integrated with the case law analysis and will be published in one or more journal manuscripts prepared at the end of year one of the project.

| Year Two: Evaluating PM Liability Risks

As discussed above, there has been no in-depth research or analysis on the level of risk that physicians are likely to face in the PM context – in terms of both the likelihood of facing a lawsuit and the probable outcome of such lawsuits. In the second year of the project, we will undertake two projects to help elucidate the risks of

liability and the key factors influencing such risks. The first task will analyze previous lawsuits against physicians relating to their failure to use, premature use, or faulty use of new medical technologies. We will examine the results and important factors in individual lawsuits, as well as the dynamics of the litigation relating to that technology as a class. In reviewing individual cases, we will evaluate why physicians were held liable in some cases and not in others, discerning the key factors, evidence and legal rules that influenced the outcome. In looking at classes of cases, we will seek to understand the dynamics of the litigation, investigating such questions as; What was the time line of the cases? How did a positive or negative outcome for the plaintiff affect the rate of new cases against that same technology? Were the cases brought by the same plaintiffs' lawyers, or were there a variety of lawyers? These types of trends can help provide insights on the dynamics of litigation – for example, is there likely to be a steady trickle of such cases, or will the cases come in clusters or bursts of lawsuits?

In choosing and undertaking this analysis of other litigation against physicians for their utilization (or lack thereof) of new medical technologies, we will start our research with some major secondary sources on the issue of technology and medical malpractice litigation (e.g., Sage, 2003; De Ville, 1998) to help us identify the most promising and informative technology precedents to analyze in depth. We will then pick 3–5 medical technologies that have been the subject of significant litigation against physicians and collect and analyze the primary cases involving those technologies. The objective will be to draw lessons from these previous examples (recognizing and addressing the various ways that PM litigation may differ because of its uniqueness) about the risks and dynamics of such litigation. In addition to this broader question, this comparative and historical analysis will enable us to focus in on specific factors that might affect liability. For example, one question that will be pursued is what impact does decisions by CMS and private insurers to cover or not cover a specific technology or procedure affect the potential liability of physicians with respect to their use (or non-use) of that technology or procedure (the difficulty in obtaining reimbursement for many genetic tests currently is an important impediment to the uptake of PM by physicians). We will publish our findings on the more general trends as well as specific factors that can affect liability (e.g., insurance coverage} in an academic journal.

The second task will be to look at four case studies involving different uses of PM technologies to evaluate the
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potential risks of physician liability. The risk of liability will depend in significant part on the factual and

scientific evidence about the effectiveness, safety, clinical utility and cost of the specific tests that the plaintiff

alleges the physician failed to use, used prematurely, or used incorrectly, combined with the applicable legal

doctrines discussed above. Because liability risks will be fact- and context-specific, the risks can best be

evaluated by using case studies to assess the potential for liability in specific contexts. We have identified the

following four case studies to evaluate, each involving a different type of PM test:

a. Warfarin (Coumadin): Warfarin is one of the most discussed drugs with respect to whether

physicians should require a genetic test before prescribing the drug {Wadelius & Pirmohamed, 2007}.

Warfarin has a very narrow therapeutic index and the safe dose for an individual patient can vary based

on a number of factors including polymorphisms in two genes (CYP2C9 and VKORC), If the initial dose

is too high for the individual patient, a serious bleeding event can result. The FDA revised the label for

warfarin in 2007 {and again in 2009} to give greater emphasis to the potential benefits of genetic testing

for initial dose determination, and a number of experts and organizations (e.g., CMS, Mayo/Medcc)

have offered inconsistent opinions on whether genetic testing is warranted {Epstein et al., 2010; Lenzini

et al. 2010; Kamali & Wynne, 2010; CMS, 2009; Roth, 2009). A number of other studies are underway,

including randomized clinical trials, so the evidentiary support for genetic testing may change over time.

The case for genetic testing prior to prescribing warfarin therefore remains uncertain and contested.

This case study will evaluate whether a physician who fails to genetically test a patient prior to

prescribing warfarin might be held liable if that patient suffers a serious or fatal reaction as a result of the failure to recommend genetic testing prior to initial dosing.

b. Gene expression diagnostic tests – A variety of diagnostic products using gene expression assays are available or being developed to profile tumors or infectious disease agents to predict prognosis or risk of recurrence. For example, the Oncotype Dx® diagnostic test used gene expression analysis to predict the risk of recurrence of breast cancer, which can then be used to make decisions about whether procedures such as chemotherapy are necessary {Snoo et al., 2009; EGAPP, 2009; Satiriou & Pusztai, 2009). It is possible that a physician could be sued either for using the test prematurely (before its use had been validated) or for not using the test at all.

c. BRCA testing – Among the strongest and best validated disease predisposition genes are the BRCA1/2 genes for breast cancer, as women carrying a mutation in either of these genes have a 50–85 percent risk of breast or ovarian cancer (Robson & Offit, 2007). Interventions such as prophylactic bilateral radical mastectomies and oophorectomies have been shown to substantially reduce the risk of cancer in asymptomatic women carrying a BRCA1/2 mutation (Robson & Offit, 2007). Various expert evidentiary reviews have recommended genetic testing of women who have certain risk factors for carrying one of these mutations, such as having two first-degree female relatives who have developed breast cancer. A physician could potentially be sued if he or she sees an asymptomatic patient with a strong family history of breast cancer, but does not recommend the patient undergo genetic counseling or BRCA testing. If that patient subsequently develops breast cancer, she or her surviving family members could bring a lawsuit alleging that the physician breached a duty to warn her of her potential genetic risk, and the failure to recommend genetic testing resulted in the patient's "loss of chance" to have prevented or successfully treated the disease.

d. Whole Genome Sequencing: The final case study involves a very recent type of genetic testing that is only in early research stages at this time but could become part of clinical care relatively quickly in at least some practices. The potential for rapid adoption of whole genome sequencing may fuel a discrepancy in care that could leave slower adopter physicians and provider institutions at risk of liability. This technique is already being used in the research

context, for example, to sequence the entire genome of a cancer patient's tumor and compare it to that same patient's inherited genome (Boneita, 2010; Ormend, et al., 2007). Genetic changes revealed in tumors using this comparative approach could be used to identify otherwise unexpected treatment regimes that target the particular molecular identity of the tumor. Although this method has only been used in research studies on a relatively small number of patients to date, the results today are promising and have generated significant interest in the method. While the technique is too expensive and experimental to be used in routine cancer care now, leading institutions and physicians may adopt the technology on selected