ITIF
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EXPLAINING INTERNATIONAL IT APPLICATION LEADERSHIP:

Health IT

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Executive Summary

Greater use of information technology (IT) in health care can help achieve many health care reform goals. Health IT can improve the effectiveness and efficiency of health care by reducing costs, improving the quality of care, and increasing access to health care services and information. Health IT also contributes to broader health care goals such as creating a more patient-centric health care system by empowering individuals to better manage their own health care and enabling them to communicate more easily with their health care providers. Finally, health IT increasingly serves as the foundation for medical research, opening up new pathways for drug discovery and enabling comparative effectiveness research. However, progress in the adoption of health IT varies significantly between nations, suggesting that progress is not limited by the costs, quality or usefulness of the technology, but rather by other factors that nations can influence.

Perhaps no factor is more important in explaining why some countries lead in health IT adoption than strong national-level leadership.

The purpose of this report is to identify which countries are leading in the deployment of health IT and to draw lessons that might be useful for other countries. The first section of the report gives an overview of the current state of and trends in health IT adoption in the United States and several other developed countries. Our analysis of available literature and data indicate that three countries—Denmark, Finland, and Sweden—are definitively ahead of the United States and most other countries in moving forward with their health IT systems. These three Nordic countries have nearly universal usage of electronic health records (EHRs) among primary care providers, high rates of adoption of EHRs in hospitals, widespread use of health IT applications, including the ability to order tests and prescribe medicine electronically, advanced telehealth programs, and portals that provide online access to health information. All three countries have embraced IT as the foundation for reforming their health care systems and have successfully implemented changes that reach every patient. These nations show the transformations possible in health care today through the greater use of IT. Any nation that is not at or ahead of this level is missing substantial opportunities.

The second section of the report identifies the factors that have led to success in these countries and the lessons that can be learned by other nations to drive health IT adoption. These factors include the following:

- **National leadership to promote health IT adoption.** Perhaps no factor is more important in explaining why some countries lead in health IT adoption than strong national-level leadership. Implementing health IT involves a complex set of relationships among individuals and organizations with competing goals and priorities. The global leaders—Denmark, Finland, and Sweden—have all implemented national-level strategies to drive and coordinate health IT adoption. In contrast, the de facto strategy in the United States has focused on building the network from the bottom up by establishing regional health information organizations (RHIOs) or health information exchanges (HIEs). The U.S. approach, including its lack, up until now, of national-level executive leadership, has failed to produce a nationwide system of interoperable EHR systems. For example, the majority of these regional initiatives are not yet operational, with only 57 HIEs operational out of 193 active HIEs nationwide.[1] Without strong national-level leadership, progress will likely continue to be incremental at best.

- **Health care system organization and financing.** The organization of a country's health care system and health care financing

can have a significant impact on health IT adoption. In Denmark, Finland, and Sweden, and other countries with single-payer health care systems, the costs and benefits of investing in health IT systems are better aligned than they are in countries such as the United States, where multiple governmental and nongovernmental entities pay for health care. Moreover, in these nations governments can afford to take a longer term view and make investments that might not pay off fully in the short term. More government involvement in health care also leads to more accountability. One of the reasons that Finland and Denmark have achieved significantly higher rates of EHR adoption in hospitals than other countries is that their hospital systems are government-run. Thus, political leaders have direct accountability for the quality of the care delivered at these institutions, and the government can prioritize needed upgrades and recoup public investment in hospital IT systems.

Adoption of health IT in the United States is made more difficult by the fact that over two-thirds of physicians work in solo or small group practices.

- **Financial incentives for health IT.** Researchers consistently identify the high initial cost of EHR systems as a barrier to more widespread health IT adoption.[2] Financial incentives for health IT adoption by health care providers therefore can be an effective policy tool, and they have been used effectively in Australia, Denmark, the Netherlands, and the United Kingdom, among others, to spur the use of health IT.

- **Government mandates to spur health IT.** Many countries use government mandates to achieve broad or universal health IT adoption. Governments can mandate either the use of specific functionality or the use of specific technology. Denmark and Norway, for example, have achieved high rates of e-prescribing by making e-prescribing mandatory for primary care providers.[3]

- **Size of a country's population.** Large countries with a diverse group of stakeholders appear to be at a disadvantage when deploying health IT. Arguments can be made for both a positive and a negative correlation between a country's population size and health IT adoption. On the one hand, economies of scale would suggest that deploying health IT in larger countries would be cheaper and thus larger countries would be more likely to have higher rates of health IT adoption. Conversely, smaller countries may be more likely to lead in health IT adoption because their smaller size allows easier coordination between various stakeholders. Indeed, a significant challenge with health IT is the difficulty of coordinating and bringing together various stakeholders to work towards a shared vision and overcome obstacles such as interoperability. Coordination is often easier in smaller countries in part because the ability to collaborate is closely related to the number of competing stakeholders, such as the number of health IT vendors. Some mid-sized nations, like the United Kingdom, have also been able to achieve a level of success coordinating the deployment of health IT because they have a more centralized health care system.

- **Structural issues in the health care sector.** Several structural issues in the health care sector can have a significant impact on technology adoption including the average size of medical practices (larger practices make it easier to adopt health IT), the number of vendors for health IT systems (fewer vendors make it easier to adopt health IT), and the number of competing pharmacies (fewer pharmacies make it easier to adopt health IT). Consolidation to achieve economies of scale generally facilitates deployment of health IT. For example, Sweden was able to more easily introduce a national e-prescribing system because of the existing state monopoly on pharmacies. Adoption of health IT in the

United States is made more difficult by the fact that over two-thirds of physicians work in solo or small group practices.[4]

- **Societal and cultural factors related to health IT.** A number of factors, including the level of technological sophistication of the population, peer influences, and cultural norms, have a significant impact on health IT adoption. Denmark, Finland and Sweden all have a relatively technologically sophisticated population, a fact which contributes to high expectations from patients to have their doctors use IT in health care. In Denmark, for example, as early as 1998, patients would consider their doctor "second-rate" if he or she did not have a personal computer in the office.[5] Peer pressure from other doctors to adopt health IT has also contributed to the mostly voluntary adoption of health IT in countries like Denmark and Sweden.

- **Privacy issues related to health IT systems.** Concerns about medical privacy should not be used to impede adoption of health IT. Deploying EHR systems with robust technical controls, including encryption, electronic identification, and audit logs can improve the privacy and security of personal medical data. In Denmark, for example, patients have access to health information through the official Danish e-health portal Sundhed.dk and can control many privacy functions through this portal, including monitoring who has accessed or modified their personal medical records. As a result, privacy advocates generally supported efforts to implement health IT. In the United States, health privacy advocates have often opposed efforts to implement health IT and have succeeded in advocating for overly restrictive laws and rules that have limited implementation of health IT. In general, privacy regulations are most effective when they strike a balance by reassuring citizens that their privacy is being protected while not implementing restrictive measures that reduce data sharing and result in lower quality care.

- **Policies to support telehealth.** Many nations have enacted policies designed to either encourage or impede the use of telemedicine including funding mechanisms, licensing and regulatory barriers. To support telemedicine, medical insurance reimbursement schedules need to include appropriate funding for telemedicine applications, interstate and international licensing standards should be promoted, and regulatory barriers should be minimized**.**

- **Common health IT infrastructure.** Building shared IT infrastructure—that is, technology that can be used by multiple health care providers—helps lower costs and increase interoperability by creating a shared platform for health care organizations to use. Examples of common health IT infrastructure include shared EHR systems, online authentication services, electronic billing systems, secure e-mail, online portals, and health data networks. For example, Sweden has developed Sjunet, a national broadband network for the secure exchange of health information connecting all hospitals, primary care centers, and many other health centers. Sjunet is used for multiple clinical and administrative purposes in Sweden, including video-conferencing, teleradiology, secure e-mail, electronic data interchange, and e-learning in medical education.

- **Robust standards to support health IT.** Robust standards are critical to the effective application of health IT and play an important role in spurring the use of new technology. To facilitate the standard-setting process, many governments actively engage with all stakeholders, including those from the private sector, to coordinate the development of standards. In Denmark, for example, MedCom, the Danish health care organization responsible for setting standards for health IT systems, acts as a coordinating body to bring together health care providers, laboratories, vendors, and others to develop interoperable standards.

- **Use of unique patient identifiers.** Unique patient identifiers help facilitate data sharing between different health care organizations and benefits of their use include reduced risk of medical error, improved efficiency, and better privacy protections for patients. The use of unique patient identifiers is common in many of the global leaders in health IT, including Denmark, Finland and Sweden. Notably, the United States has not adopted a system of unique patient identifiers—in large part because of unwarranted fears about a loss of privacy—a fact that has been identified as being a hindrance to using data from EHRs for research.[6]

Although there is no one-size-fits-all set of rules for achieving widespread health IT adoption, government policymakers can learn many lessons from the global health IT leaders about how to spur progress in modernizing their health care systems. Some of the factors that influence health IT, including the type of health care system, are entrenched in the nation and not likely to change. Yet other factors, including organizational challenges, technical hurdles, and societal issues, are more amenable to change by national policy. Our analysis demonstrates that national government policies can play an important role in shaping and facilitating a country's health IT adoption and use, regardless of the structure and organization of that nation's health care system. For example, the United States does not need to adopt a single-payer system to make more robust progress in health IT.

Congress could fund the deployment and evaluation of next-generation hospital IT applications, including robotics, wireless mobile technology, and RFID, in select hospitals within the Veterans Health Administration.

The United States has many opportunities to improve its use of health IT by learning from the global leaders in the field. Some of these lessons mentioned have already been implemented in the health IT provisions of the American Recovery and Reinvestment Act of 2009. Further actions for policymakers to spur use and maximize benefits of health IT include the following:

- **Provide strong national-level leadership on health IT.** Every nation leading in health IT has a comprehensive national strategy for e-health, with clear metrics and goal posts to measure progress. Strong national leadership is needed for the United States to break through existing barriers on health IT adoption and make progress towards a future of interconnected health data systems.

- **Provide sufficient funding for health IT adoption.** The American Recovery and Reinvestment Act of 2009 has provided a needed boost in funding for deploying EHR systems in the United States; however, additional funding may be necessary. If necessary, Congress should consider providing additional financial incentives, including entitlement spending and direct grants, or the use of mandates and penalties, to spur adoption of qualified EHR systems. Congress should also continue to fund pilot programs and demonstration projects for innovative, new applications of health IT, including telemedicine, health record data banks and "smart" hospitals. For example, Congress could fund the deployment and evaluation of next-generation hospital IT applications, including robotics, wireless mobile technology, and RFID, in select hospitals within the Veterans Health Administration.

- **Build and share tools for health IT.** Although the United States has pursued a decentralized approach to building a nationwide system of interoperable EHRs, as other nations have demonstrated, policymakers should support efforts to build common infrastructure to spur more widespread adoption of health IT systems. In particular, the United States would likely benefit from the development of common infrastructure for routine tasks, such as electronic authentication for patients, which should be performed by

every health care information system. In cases where de facto national tools have been developed by the private sector, the federal government can support these tools by actively using them.

- **Encourage the creation of health record data banks.** Many countries appear to be moving towards a centralized repository for health information. Given the resistance to a government-run solution in the United States, health record data banks run by the private sector may offer a compelling, and perhaps even more effective, alternative. Health record data banks would help create the necessary market incentives to spur adoption of EHR systems and provide patients with a single portal through which they could get access to and manage their medical records. They would also allow patients to maintain control over their medical records.

- **Encourage personal health records with data sharing.** A personal health record is a health record that is initiated and maintained by an individual. Individuals need access to their EHRs, maintained by health care providers, to use personal health record systems such as Microsoft HealthVault and Google Health, which help empower patients to make better health care decisions. To encourage the use of personal health records, Congress should require doctors to provide patients with a no-cost electronic copy of their health information upon request.[7] In addition, the Office of the National Coordinator for Health Information Technology in the U.S. Department of Health and Human Services should include the ability to export data to personal health record managers as part of the definition of "meaningful use" used to determine which EHR systems qualify for stimulus funding.

- **Address legitimate privacy concerns.** Privacy advocates have raised many objections to health IT initiatives that have slowed progress with this technology in the United States. U.S. policymakers need to recognize that some privacy objections have more to do with general issues concerning medical privacy than with specific technology. Taking a lesson from some of the global leaders in health IT, U.S. policymakers should encourage the use of technical controls to ensure privacy, such as the use of electronic identification, authentication and audit trails in health IT systems. In addition, a national discussion is needed so that policymakers and the public fully understand the costs that certain privacy measures impose on society and the benefits that come from a more liberal data-sharing environment, such as better use of decision support systems and improved medical research.

- **Eliminate barriers to health IT adoption.** Policymakers in the United States must work to identify and overcome existing barriers to the adoption and use of health IT—including legislative, regulatory, and societal obstacles. Thus, for example, policy leaders must continue to work with the Drug Enforcement Administration to pass regulations to allow physicians to prescribe controlled substances electronically. In addition, the Centers for Medicare and Medicaid Services should be directed to ensure that it develops fair reimbursement regulations for telemedicine.

- **Leverage federal resources to support health IT initiatives.** Congress should use the federal government's substantial buying power to support health IT initiatives. For example, to help spur the adoption and use of health IT, Congress should cover the monthly access fees to participate in a health record data bank for all Medicare, Medicaid, and CHIP enrollees. In addition, Congress should require that health plan insurers for federal employees include access to health record data banks as part of their covered services. Because supporting broader use of health IT will lead to cost savings for health care payers, in this case the federal government, this strategy will help ensure a positive return on investment for federal health care dollars.

- **Encourage "in silico" health research.** Ultimately health IT has the potential to dramatically improve the quality of medical research as more and more medical data is digitized. To benefit from the full potential of health informatics, the United States should develop the capability to share medical data for authorized research in a timely and efficient manner.[8] This includes developing a comprehensive legal framework to address challenges to sharing research data, such as the appropriate use of de-identified medical data. Policymakers should also consider functional requirements for EHR systems to allow the secondary-use of medical data for research. Finally, health care leaders should work to develop a national data-sharing infrastructure to support health informatics research, including the development of rapid-learning health networks, rather than relying on the current system of isolated, project-specific research databases.[9]

- **Collaborate and partner with all stakeholders.** Stronger federal leadership in health IT in the United States should not come at the expense of a collaborative relationship with other health care stakeholders. The federal government should work to bring together health care providers, insurers, and the health IT industry to spur meaningful use of e-health applications. The U.S. government must partner with the private sector to continue to develop standards and certification criteria for health IT systems. Health care providers must be involved throughout the planning and implementation stages to ensure widespread acceptance from physicians and health care workers. In addition, the United States should seek out more international partnerships to engage in the development of global standards for health IT and to continue to learn from the insights and experiences of the global leaders in health IT.

Introduction

Countries all over the world, large and small, rich and poor, have embraced health information technology (IT) as a critical component of health care reform. It has become increasingly clear to governments and health care leaders that IT is central to delivering high-quality health care, improving patient outcomes, and controlling health care costs. Health care around the world is entering the digital age, with applications of IT ranging from the use of IT to train nurses in Kenya to advanced telemedicine applications in Sweden.[10] Although many countries have made progress in deploying health IT on a national level, a few developed countries have emerged as global leaders. The global leaders in health IT not only have a high rate of usage of critical health IT applications such as electronic health records (EHRs) but also look to utilize IT at every step in the health care system.

The purpose of this report is to identify which countries are leading in the deployment of health IT and to draw lessons that might be useful for other countries. The report begins with an overview of the current state of and trends in health IT adoption in the United States and several other developed countries. The basis for any country's e-health system is a robust system of EHRs. An EHR is a longitudinal electronic record of patient health information generated by one or more encounters in any health care delivery setting.[11] An EHR is a critical and necessary component of many advanced health care applications. The adoption of EHR systems generally occurs along two separate trajectories—one for primary care providers and one for hospitals. To identify the countries that are leading in health IT adoption, we analyze available data to see which nations are furthest along in both of these adoption paths. We also analyze several other indicators of progress in the adoption of health IT, including the adoption of computerized physician order entry (CPOE) systems that enable physicians to directly enter orders for medication and other medical care into a computer, electronic prescribing, online health portals, and the use of telecommunication for health care or "telehealth" (also referred to as "telemedicine").

Our analysis of available English-language literature and data indicate that three developed countries—Denmark, Finland, and Sweden—are definitively ahead of the United States and most other countries in moving forward with their health IT systems. These three Nordic countries have nearly universal usage of EHRs among primary care providers, high rates of adoption of EHRs in hospitals, widespread use of health IT applications, including the ability to order tests and prescribe medicine electronically, advanced telehealth programs, and portals that provide online access to health information. All three of these countries have embraced IT as the foundation for reforming their health care systems and have successfully implemented changes that reach every patient. Other developed countries, including Australia, the Netherlands, New Zealand, Norway, Singapore, and the United Kingdom, also have advanced health IT platforms. In addition, some countries, such as Spain and Italy, have regional health IT projects that rival the scope and complexity of some national projects.

To be sure, no country has all of the answers or a perfect health care system. Neither does any one country lead across every metric. But all nations can learn from the leaders. The second half of the report analyzes the policies implemented by the Nordic and other developed countries that lead in health IT and evaluates factors that may have contributed to their success. The factors discussed include national leadership, health care system financing, financial incentives, government mandates, health IT infrastructure, and others. The report concludes with recommendations for the United States to learn from other nations' successes in adopting and using health IT. The global leaders in health IT provide useful lessons for the United States and other nations that aspire to implement world-class health IT applications.

Part I: Health IT in Different Countries

In this section, we present our analysis, based on existing literature and data, of the United States' and other developed countries' progress with respect to several metrics of the adoption and use of health IT:

- **Adoption of electronic health record (EHR) systems.** EHRs are critical and necessary components of many advanced health care applications, and EHR systems are the fundamental building blocks of any national health information system. Widely deployed EHR systems can provide population-level health information that can be used by epidemiologists and other researchers. Thus, a robust system of EHRs makes it feasible to use clinical data to improve health care.

- **Adoption of computerized physician order entry (CPOE) systems**. CPOE systems are systems that enable physicians to enter orders for medication and other medical care (e.g., laboratory, microbiology, pathology, radiology tests) directly into a computer. Directly entering orders into a computer has the benefit of reducing errors by minimizing the ambiguity of hand-written orders, and the combination of CPOE and clinical decision support tools offers additional benefits.

- **Use of electronic prescribing.** Electronic prescribing, or "e-prescribing," is the computer-based generation of a prescription for medication, taking the place of paper and faxed prescriptions. Some e-prescribing systems allow a health care provider not only to enter the prescription electronically but also to transmit it electronically to the pharmacy.

- **Availability of online health portals.** The development of patient-centric, online portals is in line with a broader trend in health care to use IT to create a more patient-centric approach to health care. Online health portals range from basic portals that provide patients with basic medical information on illnesses and drugs, to more advanced portals that provide online access to health care services, to even more advanced portals that provide access to personalized medical information.

- **Applications of telehealth.** Health care applications delivered via telecommunications, or "telehealth," have great potential to facilitate the provision and receipt of high quality health care by reducing geographic barriers to care. Telehealth can be applied to almost any medical field from telepathology to telesurgery to teledermatology.

Comparing the progress of different countries with respect to health IT is challenging. Levels of health IT adoption are always changing, albeit gradually, and the publication of survey results typically lags data collection by a few months to a year or more. Moreover, direct comparisons between countries, even when data are available, are often complicated by divergent methodologies used to derive national statistics on the usage of certain technologies. The rate of adoption and use of the various technologies only tell part of the story—these numbers do not reflect the varying levels of quality of the information systems in use. Survey methods and definitions used in different studies may vary, making direct comparison inaccurate, and sometimes, even misleading. In addition, the quality of the data varies. Numerous studies analyzing the level of health IT adoption and usage throughout various countries have been published, and no single study can definitively capture the state of e-health systems in a nation.

Nonetheless, our analysis indicates that Denmark, Finland, and Sweden are definitively ahead of the United States and other countries in the deployment and use of health IT. It also shows that no single country leads or lags across every metric of success in health IT just as no single country leads or lags across every metric of success in its health care system (e.g., the United States has a high 5-year cancer survival rate but a low 5-year kidney transplantation survival rate).[12] Countries that do well on one metric of progress in health IT

do not always do well on others (e.g., Finland has one of the highest rates of adoption of EHRs yet has no system in place for transmitting prescriptions electronically from physicians to pharmacies).

Adoption of Electronic Health Record Systems

The adoption of EHR systems generally occurs along two separate trajectories—one for primary care providers and one for hospitals. To identify the leaders in health IT adoption for this report, we analyzed available data to see which nations were furthest along in both of these adoption paths. Some EHR systems are far more sophisticated than others.

As early as 1991, the Institute of Medicine envisioned an EHR as "an electronic patient record that resides in a system specifically designed to support users through availability of complete and accurate data, practitioner reminders and alerts, clinical decision support systems, links to bodies of medical knowledge, and other aids."[13] More recently, a study commissioned by the principal federal entity charged with coordination of nationwide efforts to implement and use the most advanced health IT in the United States—the Office of the National Coordinator for Health Information Technology (ONC) in the U.S. Department of Health and Human Services (HHS)—identified four functional criteria for EHR systems: (1) collecting patient demographic and clinical information; (2) displaying and managing laboratory test results; (3) allowing health care providers to enter orders for medication and other medical care (e.g., laboratory, microbiology, pathology, radiology tests) and (4) supporting clinical decisions (e.g., through computer reminders and alerts to improve the diagnosis and care, including screening for correct drug selection and dosing, preventive health reminders for vaccinations and screenings, and clinical guidelines for treatment).[14]

The adoption of EHR systems generally occurs along two separate trajectories—one for primary care providers and one for hospitals.

Not all EHR systems currently in existence include all of these capabilities. Thus, for example, some EHR systems allow a provider to record patients' demographic and clinical information electronically but do not offer clinical decision support at the point of care. EHR systems also vary as to whether they store data centrally or distribute data across multiple information systems. Finally, the level of interoperability and portability of the electronic records stored in EHR systems varies greatly from one system to another.

Adoption of EHR Systems by Primary Care Providers

Our analysis of the use of EHR systems by primary care providers in Australia, Canada, Denmark, Finland, Germany, Japan, the Netherlands, New Zealand, Sweden, the United Kingdom, and the United States is based on data drawn from multiple sources. For seven countries—Australia, Canada, Germany, the Netherlands, New Zealand, the United Kingdom, and the United States—the primary source of data is a survey of primary care providers on their use of IT in their practices that was conducted on behalf of the Commonwealth Fund by Harris Interactive between February and July 2006. That survey yielded a comprehensive, multinational data set on the use of EHR systems by primary care providers in these seven countries.[15] For Denmark, Finland, Sweden, and Japan, four countries that were not included in that survey, we used other data sources.[16]

As shown in Table 1, the global leaders in the adoption and use of EHR systems by primary care physicians in our analysis were Sweden, Finland, the Netherlands, and Denmark, where EHRs were used, respectively, by 100 percent, 99 percent, 98 percent, and 95 percent of primary care physicians. Other countries leading in the adoption of EHR systems by primary care physicians were New Zealand, and the United Kingdom, all with EHR adoption rates among primary care physicians of close to 90 percent.

The United States was far behind the global leaders. In 2006, only 28 percent of primary care doctors in the United States reported using an EHR system. Measurements of the level of adoption of EHRs among primary care providers in the United States vary based on a variety of factors such as size of practice (small or large) or setting (outpatient or inpatient care). The 2005 National Ambulatory Medical Care Survey, for example, found that EHR adoption rates among primary care physicians in the United States for at least partial use of an EHR ranged from 16 percent for solo practitioners to 46 percent among physicians in practices with more than 10 physicians. When an EHR system was defined as a more comprehensive system that provides "health information and data, results management, order entry and support, and decision support," EHR adoption rates by primary care physicians in the United States in 2006 dropped to 4 percent in solo practices and 21 percent in practices with 11 or more physicians.[17]

Table 1: Use of EHR Systems by Primary Care Physicians

Country	Percent of Primary Care Physicians Using EHR Systems
Australia	79
Canada	23
Denmark	95
Finland	99
Germany	42
Japan	10
The Netherlands	98
New Zealand	92
Sweden	100
United Kingdom	89
United States	28

Adoption of EHR Systems by Hospitals

As shown in Table 2, our analysis indicates that Finland, Sweden, and Denmark are clearly among the global leaders in adoption of EHR systems by hospitals. In Finland, 100 percent of hospitals have adopted EHR systems.[18] In Sweden, 88 percent of all medical records in hospitals are digital, far surpassing the progress of most other countries.[19] In Denmark, 35 percent of hospitals use EHR systems.[20] Finland has shown perhaps the most remarkable success in deploying EHR systems in hospitals. In 1999, only 4 of the 21 hospital administrative districts in Finland had deployed any EHR systems; as of 2007, EHR systems were in use in all 21 of Finland's hospital districts. More impressively, 19 of the hospital districts reported that the intensity of usage was over 90 percent. The intensity measures the degree to which actions are electronic; in this case 9 out of every 10 patient records were recorded electronically.[21]

In most countries, the rates of adoption of EHR systems by hospitals have been much lower than EHR adoption rates among primary care physicians. Even in the Netherlands where 98 percent of primary care physicians use EHR systems, the EHR adoption rate in hospitals is below 5 percent. A 2008 assessment of health IT use in seven nations by Jha et al. found that none of the countries reviewed—the United States, Canada, the United Kingdom, Germany, the Netherlands, Australia, and New Zealand—had hospital-based EHR use greater than 10 percent.[22] The study noted two primary reasons for this slow progress: first, policymakers in most of these countries have shown little interest in modernizing hospitals; second, hospitals often have legacy systems that must be integrated, often with much expense, with newer EHR systems.

Japan has also had little success deploying EHR systems in hospitals. A 2008 study in Japan found that 10 percent of hospitals had adopted an EHR system, but the rate of adoption was much higher at public hospitals and university hospitals.[23] Public hospitals and university hospitals both tend to be larger institutions. It is unclear whether the size of the institution or the type was a determining factor.

The lack of progress in modernizing hospitals can certainly be seen in the United States. A study released in 2009 found that 7.6 percent of acute care hospitals in the United States had EHRs present in at least one clinical unit and that only 1.5 percent of acute care hospitals in the United States had implemented EHRs in all clinical units.[24] That study also found that "hospitals were

more likely to report having an electronic-records system if they were larger institutions, major teaching hospitals, part of a larger hospital system, or located in urban areas and if they had dedicated coronary care units."[25] It found no correlation between hospitals' rate of adopting EHRs and whether the hospitals were public or privately owned.

Table 2: Use of EHR Systems in Hospitals

Country	Percent of Hospitals Using EHR Systems
Australia	< 10
Canada	< 10
Denmark	35
Finland	100
Germany	< 5
Japan	10
The Netherlands	< 5
New Zealand	< 1
South Korea	9
Sweden	88
United Kingdom	3
United States	8

Adoption of Computerized Physician Order Entry Systems

One potential benefit of using IT in health care is reducing medical errors. In 1999, a study by the Institute of Medicine estimated that between 44,000 to 98,000 people in the United States die every year as a result of medical errors.[26] This statistic has since been disputed, but there is little question that more progress is needed to improve patient safety.[27] A variety of IT-based applications can improve patient safety by providing feedback to medical providers on potential hazards and best practices. Among these are computerized physician order entry (CPOE) systems. As noted earlier, CPOE systems enable physicians to enter orders for medical care ranging from prescription medicine to orders for medical tests into a computer rather than on paper; these orders are then integrated with patient information, including laboratory and prescription information.[28] CPOE systems can help reduce medical errors by improving the legibility of medical orders, increasing access to on-demand medical information, and warning of potential adverse drug effects. In many developed countries, the adoption rate of CPOE in primary care practices corresponds to the adoption rate of EHR systems for the simple reason that that many EHR systems include this functionality.

The use of CPOE to improve patient care has been endorsed by a variety of organizations in the United States, including the Institute of Medicine and the Leapfrog Group.[29] The Leapfrog Group, for example, identifies CPOE use as the top priority safety initiative for hospitals and estimates 522,000 serious medical errors could be avoided annually in the United States if all non-rural hospitals used CPOE.[30] Clinical decision support systems in CPOE systems can integrate patient information to indicate, for example, if a new prescription will likely interfere with other medications or conditions. In addition to improving patient safety, CPOE can help reduce costs and increase operational efficiency. Although the level of adoption of CPOE provides a good indicator of progress, the effectiveness of CPOE systems depends on the skill with which the system has been integrated into a medical practice's workflow and procedures. Indeed, a CPOE system should not be thought of as a "plug-and-play" technology, but instead a health care tool that is only as effective as those wielding it.

Adoption of CPOE Systems by Primary Care Physicians

One indicator of a successful implementation of CPOE systems among primary care providers is the ability of primary care physicians to place orders for medical tests (e.g. laboratory, microbiology, pathology, radiology tests) electronically. (Another indicator of the successful implementation of CPOE use, electronic prescribing, is discussed in a separate section below.) As shown in Table 3, using the ability of primary care physicians to order medical tests electronically as a proxy for the use of CPOE among primary care providers, we find that Denmark leads in this area. Approximately 80 percent of primary care providers in Denmark report being able to order medical tests electronically.[31]

Finland has not published data on primary care doctors' ability to order laboratory tests electronically, but 72 percent of primary health care centers in that country have the capability to receive laboratory results electronically.[32] For Sweden, we were unable to locate data on the ability of primary care doctors to order laboratory tests electronically; however, one scholar notes that "most GPs receive laboratory results from hospitals over local networks but few are sending their lab requests electronically."[33] Other developed countries that rank high in the routine use of computers to order medical tests among primary care providers include Australia and New Zealand, with adoption rates of 65 percent and 62 percent, respectively.[34] The United States lags these nations in the ability of primary care physicians to order medical tests electronically, as it does in the adoption of EHR systems. Only 22 percent of primary care providers use CPOE systems to order medical tests.[35]

Table 3: Use of Electronic Ordering of Laboratory Tests by Primary Care Physicians

Country	Percent of Primary Care Physicians Using Electronic Ordering of Laboratory Tests
Australia	65
Canada	8
Denmark	80
Finland	n/a*
Germany	27
The Netherlands	5
New Zealand	62
Sweden	n/a
United Kingdom	20
United States	22

* Although Finland has not published data on the ability of primary care doctors to order laboratory tests electronically, 72 percent of primary health care centers in that country have the capability to receive laboratory results electronically.

Other nations where the use of electronic ordering of laboratory results is low include Germany and Canada, with adoption rates of 27 percent and 8 percent respectively.[36] Interestingly, the Netherlands, a leader in the use of EHR systems, ranks low in this category too, with only 5 percent of primary care providers reporting the ability to order medical tests electronically. One explanation for this situation is that many laboratories in the Netherlands did not see the short-term value of implementing a system that would enable primary care physicians to order medical tests electronically because in most cases a physical transfer would still need to occur—i.e., either a patient or a sample would have to be sent to the laboratory. Instead, laboratories in the Netherlands invested in information systems to share data. Given that 72 percent of primary care providers in the Netherlands report the ability to receive laboratory results electronically, this program appears to have been a successful one. At present, however, a new laboratory program is under development in the Netherlands that includes the electronic ordering of medical tests.[37]

Adoption of CPOE Systems in Hospitals

Although the value of CPOE systems is likely to be amplified in a hospital setting where patients interact with multiple caregivers, Table 4 shows that most countries' progress in deploying CPOE systems in hospitals has been slow. The exception is South Korea, which reports that CPOE systems are available in 81 percent of hospitals—an unexpectedly high rate given the low level of EHR adoption in hospitals in that country.[38] In contrast, six of the countries reviewed in a 2008 study by Jha et al.—Australia, Canada, Germany, the Netherlands, New Zealand, and the United Kingdom—did not have hospital CPOE adoption rates above 5 percent; the United States had a slightly higher hospital CPOE adoption rate, in the range of 5 percent to 10 percent.[39] A 2009 survey of the literature from seven countries similarly found that Australia, France, Germany, Switzerland, and the United Kingdom had hospital CPOE adoption rates of less than 5 percent; but it found that the United States had a hospital CPOE adoption rate of approximately 15 percent; and the Netherlands had a hospital CPOE adoption rate of 20 percent.[40]

Other surveys of CPOE use in U.S. hospitals have reached similar conclusions. A 2002 survey of U.S. hospitals found that 9.6 percent of hospitals reported full availability of a CPOE system and 6.5

percent reported partial availability. More striking was that of the hospitals that had implemented a CPOE system, only 46.2 percent of them required physicians to use the systems. The remainder of the hospitals either encouraged, but did not require its use, or made usage optional.[41] A more recent study in 2009 found that CPOE for medication had been implemented in 17 percent of hospitals.[42]

One factor contributing to the low level of adoption of CPOE systems by hospitals in most countries is that integrating CPOE systems in the hospital environment, which typically already has some information systems, is complex.[43] Explanations for the low levels of adoption of CPOE in American hospitals have centered primarily on the high cost of such systems. In fact, some studies have concluded that a CPOE system does not pay for itself, although it does lead to better patient outcomes, more hospital efficiency, and other potential benefits, including reduced malpractice costs.[44] Cost alone, however, does not explain the low levels of CPOE adoption in hospitals in the United States. One study found that the primary determinant of whether a hospital invested in a CPOE system in the United States was hospital ownership. Government hospitals in the United States were "three times as likely as nonprofit hospitals and seven times as likely as for-profit hospitals to satisfy the requirements for a 'good early-stage effort.'"[45] CPOE use is not a federal requirement for hospitals, but various states have implemented patient safety mandates requiring hospitals to take steps to reduce medical errors, which can include implementing CPOE. Further progress in the United States will likely require additional financial incentives for CPOE systems, increasing doctor acceptance of such systems and a renewed focus by hospitals on patient safety.

The use of CPOE in hospitals appears to be higher in the Nordic countries of Denmark, Finland, and Sweden than in many other countries, although we could not find comparable data for each country. Denmark ranks high in hospitals' use of CPOE, as evidenced by the high proportion of electronic messages exchanged between hospitals and laboratories in that country. As of early 2009, the percentage of messages exchanged by all Danish health care providers (hospitals, primary care providers, dentists, specialists, etc.) ranged from 68 percent of messages in the lowest ranked region to 99 percent of messages in the highest ranked region.[46] In addition, by 2004, virtually all hospitals had laboratory information systems in place.[47] Finland, too, has widespread use of CPOE. In Finland, laboratory information systems allow physicians to order laboratory tests electronically and receive test results. These systems not only provide feedback on the usage of the test but also provide information to physicians about the performance of the laboratories. Laboratory information systems are in use in all 21 of the hospital districts in Finland.[48] In Sweden, we could not find any data on the adoption of CPOE systems in hospitals, but the adoption of CPOE systems in Sweden is reported as being "very common" by experts.[49]

Table 4: Use of CPOE Systems in Hospitals

Country	Percent of Hospitals Using CPOE
Australia	< 5
Denmark	n/a
Finland	100
France	< 5
Germany	< 5
The Netherlands	20
South Korea	81
Sweden	n/a
Switzerland	< 5
United Kingdom	< 5
United States	15

Use of Electronic Prescribing

Electronic prescribing, or "e-prescribing," is an important component of many CPOE systems and often includes decision support features. Instead of using the pen-and-paper prescriptions of the past, doctors can now use desktop computers, tablet personal computers, personal digital assistants, or even mobile phones to generate a prescription electronically. Some e-prescribing systems simply have a doctor generate a paper-based prescription print-out for the patient to take to a pharmacy, but more advanced e-prescribing systems have the capability to send prescriptions

directly to the pharmacy of the patient's choice, including online pharmacies.

By reducing the need for paper prescriptions, e-prescribing can improve efficiency in the delivery of care. Paper-based prescriptions cost pharmacists and doctors substantial time and money—in fact, using faxes and the telephone to communicate with pharmacists accounts for up to 20 percent of the time of the staff at a doctor's office and 25 percent of the time of pharmacists. One study found that the administrative cost of filling a paper prescription for a Medicaid patient in California was $13.18 per prescription.[50] Moreover, the transmission of prescriptions directly to a pharmacy may save time and money for patients.

Perhaps more importantly, e-prescribing has the potential to improve the safety and quality of medical care by reducing medication errors, some of which are due to illegible handwriting. Decision support features in e-prescribing systems can allow doctors and pharmacies to have access to proper dosage information at their fingertips and alert them to possible drug interactions or warnings. Access to a comprehensive profile of a patient's medical history is necessary, however, for decision support tools to be most effective. In e-prescribing systems with formulary decision support, generic alternatives can be presented to the doctor and patient at the time of prescribing, giving patients access to lower cost medicine. Formulary decision support has been found to increase the use of generics among doctors who use e-prescribing. One study found the average annual savings of formulary decision support to be $8.45 per patient.[51]

Moreover, e-prescribing has the potential to enable a whole host of additional benefits in health care. As an example, doctors who use e-prescribing can easily generate a list of their patients receiving a certain drug if a more effective product comes on the market. Pharmacists can use electronic prescription information to improve patient safety when dispensing medicine by checking for incorrect dosing and warning of possible drug interactions. Similarly, drug manufacturers may be able to alert their customers if a drug needs to be recalled or if new risks emerge. E-prescribing might even be a tool in stemming the abuse of prescription drugs. For drug enforcement agents, the possibility of monitoring physicians' prescribing patterns or receiving alerts if patients are seen filling multiple prescriptions for the same drug at different pharmacies in a short period of time may improve their ability to prevent prescription fraud and drug abuse.

As shown in Table 5, primary care providers in Denmark, Finland, and Sweden routinely prescribe drugs electronically, with e-prescribing adoption rates at nearly 100 percent in each country.[52] E-prescribing rates among primary care providers in the seven countries included in the 2006 Harris Interactive/Commonwealth Fund survey—Australia, Canada, Germany, the Netherlands, New Zealand, the United Kingdom, and the United States—varied widely. The Netherlands, with 85 percent of primary care physicians routinely prescribing medicine electronically, had the highest rate of e-prescribing among primary care providers, followed by Australia at 81 percent and New Zealand at 78 percent.[53] The United States lagged significantly behind these countries in 2006, with only 20 percent of primary care providers reporting that they routinely prescribe medicine electronically.[54]

Table 5: Use of Electronic Prescribing by Primary Care Physicians

Country	Percent of Primary Care Physicians Using E-Prescribing
Australia	81
Canada	11
Denmark	100
Finland	100
Germany	59
The Netherlands	85
New Zealand	78
Sweden	100
United Kingdom	55
United States	20

The electronic transmission of prescriptions from the physician at the point of care to the dispensing pharmacy requires connectivity between the

provider's office, the pharmacy, and sometimes other intermediaries (e.g., pharmacy benefit manager, health plan). In many countries, the progress with respect to the electronic transmission of prescriptions to the pharmacy lags behind the use of computers to order prescriptions. In Germany, for example, 59 percent of doctors reported the ability to order prescriptions electronically, but the electronic transmission of prescriptions to the pharmacy in that country is uncommon.[55]

Table 6 compares three Nordic countries, the United Kingdom, and the United States with respect to the routine electronic transmission of prescriptions by primary care physicians. In the United Kingdom where 55 percent of primary care physicians surveyed reported e-prescribing capabilities, only 24 percent of daily prescription messages are transmitted through the United Kingdom's Electronic Prescription Service.[56]

Denmark and Sweden rank high in the electronic transmission of prescriptions to pharmacies. In Denmark, 85 percent of prescriptions were transmitted electronically as of 2003 and today virtually every doctor transmits prescriptions electronically.[57] Sweden has rapidly deployed e-prescribing throughout the country. In 2004, only 25 percent of prescriptions in Sweden were transmitted electronically; as of October 2008, 75 percent of all prescriptions were being transmitted electronically directly to a pharmacy.[58] Finland ran an e-prescribing pilot project between 2004 and 2006 but discontinued the project. Thus, although Finnish physicians almost universally have access to an EHR system that allows prescription entry at present, they cannot transmit prescriptions electronically to the pharmacy.[59]

The number of prescriptions transmitted electronically in the United States has been growing rapidly in recent years, but still represents only a small fraction of all the prescriptions written. In 2007, 35 million prescriptions in the United States were transmitted electronically (2 percent); in 2008, the number increased to 100 million (7 percent).[60] In addition, health care providers in the United States have transitioned from the use of standalone e-prescribing systems to the use of integrated EHR systems with e-prescribing capabilities. In 2004, 95 percent of e-prescriptions in the United States were created using a standalone application; in 2008, 40 percent of prescriptions were created using a standalone system and 60 percent were created using an EHR system.

Table 6: Electronic Transmission of Prescriptions by Primary Care Physicians

Country	Percent of Primary Care Physicians Using Electronic Transmission of Prescriptions
Denmark	100
Finland	0
Sweden	75
United Kingdom	24
United States	7

Availability of Online Health Portals

Online health portals provide individuals a single online destination to access web-based applications and services to manage their various health care needs. Health portals range from basic portals that provide patients with basic medical information on illnesses and drugs, to more advanced portals that provide online access to health care services, to even more advanced portals that provide access to personalized medical information. The development of e-health portals is in line with a broader trend in health care to use IT to create a more patient-centric approach to health care. Patient-centric e-health portals help empower individuals and others to make good medical decisions.

Several developed countries have government-run e-health portals that provide individuals with access to information related to medicine and health care. A 2009 survey of European countries found that Denmark, Estonia, Finland, Portugal, Sweden, and the United Kingdom provided 24/7 access to Web or phone-based health care information. Other countries, including Germany, the Netherlands, and Norway, provided less access

Box 1: Technologies for Reducing Medication Errors in Hospitals

According to the Institute of Medicine, medication errors are among the most common medical errors, harming at least 1.5 million people in the United States every year.[61] In hospitals, errors are common during every step of the medication process—procuring the drug, prescribing it, dispensing it, administering it, and monitoring its impact—but they occur most frequently during the prescribing and administering stages. These medication errors are undoubtedly costly—to patients, their families, their employers, and to hospitals, health-care providers, and insurance companies.

To improve patient safety by reducing medication errors, some U.S. hospitals have invested in technologies that rely on health IT for dispensing and administering medications. As of 2006, 61.8 percent of hospitals in the United States used automated dispensing machines, 7 percent used robots, and 26.1 percent relied on barcoding to help prevent medication errors. The goal of these initiatives is to eliminate some forms of human error, such as misreading a medication label of similarly named drugs or misreading dosage information while dispensing or administering medications.

In 2004, the U.S. Food and Drug Administration (FDA) mandated that all human medications have machine-readable National Drug Code-format barcodes on their labels by 2006. It has been estimated that this change will prevent almost 500,000 adverse events and errors over 20 years and save $93 billion.[62] Automated dispensing machines and robots can function because pharmaceutical companies place bar codes on the drugs they manufacture.

Automated dispensing machines can help hospitals ensure accurate medication dispensing to prevent medication errors; can help ensure medication is available to doctors and nurses in an emergency or when the pharmacy is closed; and can make hospital billing and inventory maintenance more efficient and accurate.

A drug-dispensing robot can similarly help prevent medication errors. St. Francis Hospital and Medical Center in Hartford, Connecticut, implemented such a robot in 2003. As described by one reporter, "each vial of medicine moves along a kind of production line until the machine spits out the finished syringe. Load the device with vials of the most prescribed medicines, and it begins filling a prescription by grabbing the appropriate drug vial and reading the bar code. The machine then shoots four digital photographs of the vial label, removes the cap and swabs the vial with alcohol. If the drug is a powder or concentrated liquid, the machine will mix in the correct amount of liquid. Then the device inserts a needle into the vial, extracts the needed amount of medicine and fills an intravenous syringe."[63]

To reduce errors when administering drugs to hospitalized patients (e.g., when a nurse gives medication to a patient), hospitals use barcoding at medication administration and electronic medication administration records. Studies have found that using barcoding at medication administration can reduce errors by 65 percent to 85 percent.[64] A 2006 study found few hospitals use barcoding at medication administration with adoption levels at only 4.7 percent. The 2006 study found higher rates of use of electronic medication administration records with adoption at 25.9 percent of U.S. hospitals.[65] Providing prepackaged, patient-specific medication with barcodes, for example, allows a nurse to use a computer to verify that the right patient is receiving the right medicine at the right dosage at the right time.[66] Using this technology also reduces the workload on nurses allowing them to focus on other care-giving tasks. In Canada, Centre hospitalier de l'Université de Montréal (CHUM) estimates that the robotics system it implemented has allowed nurses to devote 30 more minutes per day to other patient-care activities.[67]

to such information.[68] The range of functions available on government-sponsored health portals varies from country to country, depending on factors that include the types of health services provided by the government.

Denmark has the most advanced government-run e-health portal. Denmark's online health portal—called Sundhed.dk ("sundhed" means "health" in Danish)—provides a public destination for exchanging health information between patients and health care providers. The portal was launched in 2003 with the purpose of bringing together electronic communication between patients and the health care service, and the portal is part of the common infrastructure in the health care sector in Denmark. The portal is designed to provide patients access to various services (e.g., viewing an individual's hospital records, booking appointments, sending e-mail to health care providers, ordering medication and renewing prescriptions, and registering for organ donation).[69] Each patient in Denmark has a custom webpage with information relevant to his or her own medical history. Thus, for example, Danish patients who have diabetes might participate in a diabetes management system that allows them to better understand their medical history, treatment options, and self-care regimen. Danish citizens can also use the portal to check hospital quality ratings and discover where they can find the shortest waitlists for specific treatments.[70] The e-health portal Sundhed.dk has long been popular with Danish citizens, with analysts reporting that as early as 2004 it captured approximately 40 percent of the health care related Internet traffic in Denmark.[71]

The e-health portal Sundhed.dk has long been popular with Danish citizens, with analysts reporting that as early as 2004 it captured approximately 40 percent of the health care related Internet traffic in Denmark.

Sweden's national e-health portal—called 1177.se (the portal's name, 1777, refers to the number that individuals can call for 24/7 access to expert health information)—was designed by Swedish Healthcare Direct (SVR AB) to provide a government-sponsored outlet for trusted health information. The online portal was launched in 1998, reflecting Sweden's early start in developing health IT applications designed to improve the experience for patients. Sweden's e-health portal does not link to patients' EHRs the way Denmark's national portal does and is not as rich in content as the health portals in some other nations. Nevertheless, Sweden's 1177.se portal received over 1 million visitors per month in 2008.[72] The Swedish government plans to introduce additional online services in 2009 to allow users to complete common tasks such as scheduling medical appointments and renewing prescriptions.

Finland's national e-health portal—called TerveSuomi (HealthFinland)—is being developed to provide citizens with online access to timely and relevant health care information. This online portal does not offer access to patients' electronic health records or to online health services, although these functionalities may be added at a later date. Finland's government is designing TerveSuomi to use semantic Web technology to solve many problems with publishing health information online, such as difficulty in finding the right information, duplication of effort, and a lack of quality control. All of the content created for TerveSuomi is designed to be shared and reused by any third-party website or application. In addition, Finland's government is developing common metadata standards and ontologies so that data can be easily aggregated from multiple publishers. Finally, developers are including intelligent search capabilities in TerveSuomi to help ensure that citizens can locate desired health information without needing to know medical jargon.[73]

The United Kingdom's National Health Service (NHS) has a national e-health portal— called NHS Direct—that was designed to point people in the right direction for the most appropriate form of treatment and encourage the best use of health

services.[74] The NHS Direct portal provides a variety of options for giving citizens health advice and information. It provides a 24/7 telephone number for health information, and individuals in the United Kingdom can submit health care questions online and receive a response by e-mail or on a secure website for patients with shared e-mail accounts.

Moreover, NHS Direct hosts a website called NHS Choices, which provides in-depth information on medical conditions, treatment options, and drug information. Individuals can use NHS Choices to look up answers to common medical questions, use an online self-help guide, or get help on first aid. In addition, NHS Choices provides extensive resources for finding health care providers such as GPs, dentists, pharmacies, and opticians. Many of these tools promote patient empowerment—from guides that teach citizens about their health care rights with the NHS to health guides that provide flow charts for health care encounters so patients will know what to expect for treatment of various conditions.

The NHS has also created an online service called Choose and Book, which lets patients create and manage appointments with specialists at registered hospitals and clinics. With Choose and Book, patients are able to choose the specialist and appointment time that is most convenient to their own schedule. In the past, the hospital received a referral letter from a primary care provider and then booked a patient for any available slot. The new service also helps ensure that the NHS can guarantee that no patient must wait longer than 13 weeks to see a specialist.[75] Currently, more than 90 percent of primary care providers in the United Kingdom use the service (at least part of the time), and 50 percent of all NHS referral activity goes through this application.[76]

In the United States, the federal government is one of the top sources of health information. Some government websites, such as Cancer.gov or AIDS.gov, provide first-rate resources for information on specific diseases and conditions. The U.S. National Institutes of Health also hosts PubMed, a database of biomedical research, and MedlinePlus, an online resource for health and drug information. In contrast to some European countries, however, the U.S. government has not

Box 2: Nationally Standardized Machine-Readable Patient ID Cards in the United States

In contrast to many European and Asian countries which use smart cards as electronic identification for health care encounters or to store medical information, most patient ID cards issued by health insurers in the United States today are not standardized and cannot be read by machines the way credit cards can be. Thus, health care providers have to waste time and money in making copies of the cards or manually entering patients' data from the cards. This process is administratively inefficient. It is also prone to errors, which frequently result in denied insurance claims that must be resubmitted.

The Medical Group Management Association (MGMA), which represents physician group practice administrators in the United States, estimates that widespread adoption of interoperable, machine-readable patient ID cards in U.S. hospitals and providers' offices could save up to $1 billion annually in administrative costs.[77] Although standards for patient ID cards were developed as early as 1997, most health insurers in the United States, including Medicare, have not implemented them.[78]

In 2009, MGMA launched Project SwipeIT—a nationwide campaign to get all major health insurers, including government insurers such as Medicare and Medicaid, to commit to using a single machine-readable standard for patient ID cards by 2010. An increasing number of private health care insurers and providers are supporting the development of a standardized, machine-readable patient ID card. One large private insurer, UnitedHealth, announced plans to provide 25 million machine-readable patient ID cards by the end of 2009.[79]

Box 3: Self-Serve Computer Kiosks in Hospitals

Self-serve computer kiosks can be used by hospitals to automate a number of patient interactions. They can be used to facilitate patient management activities such as patient admission, discharge, and transfer. Kiosks can also be used to process copayments, receive patient consent forms, collect demographic data, perform clinical prescreening, and perform satisfaction surveys. Another common application of kiosks in hospitals is for way-finding (i.e., patients getting directions to their appointments). Finally, kiosks can offer all of these services in multiple languages. Kiosks benefit hospitals by freeing nurses and hospital staff from routine activities and allowing them to work more efficiently. Patients benefit from kiosks by experiencing shorter waiting times, more convenience, and more privacy.[82]

Currently, only a small percentage of U.S. hospitals have such kiosks. A 2008 survey of hospitals found no more than 5 percent of hospitals had adopted kiosks for most patient management activities. The same survey found that 13 percent of hospitals had a patient kiosk for way-finding.[83]

developed a single comprehensive e-health portal, and some government-sponsored online health portals that aspire to be patient-centric really are not user friendly. To take just a few examples, healthfinder.gov bills itself as "Your Source for Reliable Health Information" and provides numerous links to both government and nongovernment health resources. The bare-bones website health.gov calls itself "a portal to the Web sites of a number of multi-agency health initiatives and activities" but it is underdeveloped and lacks much content. And finally USA.gov, with the tagline "Government Made Easy," simply provides a directory of links to other resources.

Some private sector companies in the United States are developing patient-centric online health portals, including ones that maintain personal health records (e.g., Revolution Health, WebMD, and Microsoft HealthVault). Moreover, several hospitals and health insurers in the United States are using online patient portals to provide access to a variety of services they offer. The use of patient portals in hospitals in the United States has been growing, from approximately 32 percent of hospitals in 2006 to 37 percent of hospitals in 2008.[80] Kaiser Permanente, the largest not-for-profit health plan, launched an online portal to give patients access to laboratory results, scheduled appointments, and tools to communicate with their providers. As of April 2009, 3 million Kaiser Permanente members had signed up for online access.[81]

Online portals are also a component of health record data banks, which have been proposed as an alternative to health information exchanges. To date, no health record data bank has been fully implemented at the state level, but the proposed model would function along the following lines.[84] An individual selects a health record data bank entity to be a secure repository of his or her health information and opens an account with that entity. The individual's doctors submit to the health record data bank an electronic record of any health care encounter, including any clinical notes, test results, and prescriptions in a standard electronic data format. The individual uses an online portal to access his or her medical records online in the health record bank and is able to control who is permitted to access his or her personal information. By creating a central repository for all of a patient's medical information that is controlled by the patient rather than the provider, health record data banks eliminate many interoperability and privacy challenges associated with health information exchanges.[85] Health record data banks also create a sustainable business model: patients or health insurers pay health record data banks a fee to manage their electronic health information, and health record data banks, in turn, pay health care providers to electronically transmit their updates after every health care encounter. Various state and city-level projects, including projects in Washington, Oregon, Louisville, and Kansas City, are exploring the use

of health record data banks as an alternative to health information exchanges.[86]

Implementation of Telehealth

The degree to which a country has embraced health IT may be reflected in part in the extent to which the country has embraced health care applications delivered via telecommunications or "telehealth" (also referred to as "telemedicine"). Telehealth can be applied to almost any medical field from telepathology to telesurgery to teledermatology to help eliminate geography as a barrier to receiving quality health care services. Although countries with large rural populations may be more likely to promote telehealth applications to bring quality medical care to rural residents, all health care systems can benefit when patients can use telecommunications to more easily receive care and health care providers can use telecommunications to facilitate the provision of care.

In 1965, one of the first applications of COMSAT's first satellite "Early Bird" was to demonstrate the possibility of global telemedicine by broadcasting an open-heart surgery from the United States to Geneva, Switzerland.

The idea of telemedicine is not new. In 1965, one of the first applications of COMSAT's first satellite "Early Bird" was to demonstrate the possibility of global telemedicine by broadcasting an open-heart surgery from the United States to Geneva, Switzerland.[87] Much of the initial research on telemedicine was conducted by the National Aeronautics and Space Administration for monitoring the health of astronauts in space and to provide them care when a specialist could not treat them in person. Today telehealth encompasses a variety of applications and services including rural e-health care centers, in-home patient monitoring, electronic intensive care units (eICUs), and telesurgery. In addition, broadband Internet connections allow doctors and patients to interact and communicate over video links and participate in remote consultations with health care providers.

Unlike many of the technologies discussed above, telehealth is a tool to increase access to care and save time and money rather than a best practice. There are no clear metrics to measure the level of telehealth adoption. Nevertheless, it appears that many countries have been active in fostering telehealth, although many projects are still in the early stages.

Sweden has long been a pioneer with telehealth applications. In 1922, it launched a "sea-to-shore" program to provide medical consultations to Swedish ships from Sahlgren University Hospital, a service that is still in use today.[88] In addition, using Sjunet, the national health care network, Sweden has implemented telehealth applications such as teleradiology, telepathology, and video-conferencing services.

Denmark, too, has used its national health care network to implement various telehealth programs from remote consultations to in-home therapy. The goal of these programs is to improve the quality of health care available to Danish citizens and make health care available closer to the patient's home. The Danish Centre for Health Telematics, which has been integrated into MedCom, has sponsored multiple programs to build useful telehealth applications. Among these are a national teledermatology project that allows patients to receive online consultations for skin conditions and a tele-alcohol-abuse-treatment program to improve participation rates for patients who do not, or cannot, attend in-person meetings.[89]

Finland was also an early adopter of telehealth applications, for example, the use of video teleconferencing in health care. Video teleconferencing is used to provide patients with consultations from specialists. Patients in regional health care centers in Finland can attend a video-conference session with their primary care provider and a nurse; at another location at a hospital, the specialist and a nurse provide the consultation. Specialists can provide consultation through video conferencing in 14 of Finland's 21

Box 4: Remote Electronic Intensive Care Units

The provision of around-the-clock care to critically ill patients in ICUs by physicians who specialize in their care (intensivists) is considered key to improving outcomes for critically ill patients, but some hospitals cannot provide such care because of a shortage of intensivists. Recently, some hospitals have used telemedicine to improve care for critically ill patients via remote electronic intensive care units (eICUs). Remote eICUs allow a team of intensivists to monitor critically ill patients in the hospital continuously using streaming video, EHRs, and remote sensors, so that they can coordinate care with the physicians and nurses who are caring for these patients in the hospital.

A health system in Kansas City, for example, implemented an eICU to leverage its limited intensivists and standardize clinical practices and processes in its seven hospitals. Researchers found that this initiative reduced the health system's ICU and hospital mortality rates.[93] In addition, it reduced the length of stay for patients in the ICU and hospital, a factor that strongly influences hospital costs.[94] A study of the first major eICU installation similarly found that the hospital reduced mortality by 27 percent and reduced the costs per ICU case by 25 percent.[95] In the United States, hospital adoption of eICUs is still low—fewer than 50 hospitals had implemented eICUs by late 2007.[96]

hospital districts, and patients can participate at 17 percent of the health care centers nationwide.

Australia and New Zealand showed an early commitment to telehealth by creating the Australian New Zealand Telehealth Committee (ANZTC) in 1997. ANTZC operated until 2001 working to devise a joint national telehealth strategy. In Australia, the activities of ANTZC were later assumed by the Australian HealthConnect office, which in 2007 was integrated by the Australian Department of Health and Aging. Between 1997 and 2000 the number of telehealth applications more than doubled. Approximately 42 percent of the telehealth programs focused on clinical applications with the second most common application (37 percent) being for professional education and training. Within clinical telehealth applications, the largest single disciplines in 2000 were for mental health (32 percent) and radiology (14 percent).[90] A survey in 2000 found that most public hospitals in New Zealand had video-conferencing capabilities but these capabilities were limited primarily to nonclinical applications, such as conducting meetings or interviewing overseas job applicants. Between 2000 and 2003, the number of telemedicine applications in New Zealand grew slowly, from 10 projects in 2000 to 22 projects in 2003. The most common of these projects were teleradiology and telepsychiatry projects.[91]

A 2007 study found that Japan has implemented over 1,000 telemedicine projects. These projects have principally focused on teleradiology (37 percent) and home telecare (33 percent). In the past 10 years, Japan has also made a fourfold increase in the number of telepathology projects. Researchers suggest that one reason for Japan's growth in teleradiology and telepathology is that these specialists tend to be located in a few academic locations.[92]

Japan's home telecare initiatives are most common in rural areas, where 70 percent of the projects have been implemented.[97] Home telecare projects provide an important alternative to hospital-based care for Japan's aging population. Home telemonitoring allows patients to submit test results from their residence to their care provider over the Internet. To take one chronic illness as an example, patients with diabetes in Japan can use home telecare programs to automatically send in updates to their caregiver about their personal health. Electronic devices can transmit a patient's daily blood glucose measurements, and doctors can remotely monitor the patient's health and manage the patient's care without requiring as many office visits. Not only is this a convenience to the patient, it also leads to better medical outcomes. A recent study found diabetes patients' participation in a telecare program resulted in significantly fewer deaths.[98]

In the United States, telehealth programs will likely continue to grow in importance as a tool for providing quality of care for patients with chronic conditions. Currently, for example, one out of every four patients receiving care in the U.S. Department of Veterans Affairs has diabetes. As shown in Table 7, some U.S. hospitals already are focusing on using telehealth for patients with chronic conditions like diabetes, congestive heart failure, and heart disease.

Table 7: Use of Internet-Enabled Monitoring Devices in U.S. Hospitals, by Condition[99]

Condition	Percentage of U.S. Hospitals that Have Patients Submit Self-Test Results Online
Asthma	5
Diabetes	12
Cancer	2
Chronic obstructive pulmonary disease (COPD)	6
Congestive heart failure	10
Heart disease	11

Teleradiology

Teleradiology—the use of high-speed networks to deliver medical images, such as radiographs or computed tomography (CT) scans, to radiologists working at another location—is one indicator of a nation's progress in the realm of telehealth. With teleradiology patients can receive better, more efficient care. The radiologists viewing the medical images may be located at home, in another building or perhaps even in another country. The ease with which medical images can be shared means that physicians can request a consult or second opinion from a specialist. Teleradiology has revolutionized the field of radiology by making access to such services available to even the smallest practices. In addition, hospitals can use teleradiology to provide on-call or overnight radiology services. Mobile teleradiology also allows doctors to bring higher quality care to rural patients.

Denmark has launched various teleradiology programs to give physicians more flexible access to diagnostic images. The Department of Neurology at the Odense University Hospital, for example, implemented a teleradiology program so that a specialist could determine if patients from neighboring hospitals needed priority admittance to receive treatment from neurosurgeons at the Odense University Hospital. Using this program, patients with less serious cases can receive treatment locally and avoid an unnecessary transfer.[100] Teleradiology is now common in much of Denmark. As of 2006, 7 of the 14 counties in Denmark had linked together their Radiography Information Systems (RIS) or Picture Archiving and Communication Systems (PACS).[101] Denmark also participates in Baltic eHealth, a joint project with Sweden and Norway, designed to improve cross-border resource sharing between hospitals. In this project, Danish doctors send medical images for analysis to Estonia and Lithuania.

Finland was an early promoter of teleradiology, and by 1994, all five university hospitals in the country had implemented teleradiology services.[102] By 2005, 18 hospital districts out of the 21 such districts in Finland had implemented at least a regional teleradiology program. Finland has also seen rapid adoption of PACS. In 2003, only 6 of the 21 Finnish hospital districts reported heavy usage of PACS. By 2007, all 21 Finnish hospital districts had implemented PACS and were producing over 90 percent of their medical images digitally. Moreover, all 21 hospital districts also provided some form of electronic distribution for digital radiological images.[103] In addition, many primary care physicians have access to digital images stored at regional hospitals. Approximately half (49 percent) of the Finnish regional health care centers use PACS. Rather than develop their own PACS, most of the regional health care centers work with the existing system at a regional hospital.[104]

Sweden, too, has widely implemented teleradiology. In 2003, the Sollefteå and Borås hospitals implemented teleradiology programs to cut costs, reduce waiting times, and respond to a shortage of radiologists in Sweden. By establishing a teleradiology program with Telemedicine Clinic in Barcelona, Spain, these Swedish hospitals could

send nonurgent magnetic resonance imaging (MRI) and CT images to remote specialists for analysis, thereby reducing the need for the hospitals to hire additional radiologists. The hospitals also received immediate financial benefits with the cost per scan analysis decreasing by approximately 35 percent. Patients have also benefited, with waiting times reduced by almost half.[105] By 2004, most Swedish hospitals had access to teleradiology. Many Swedish hospitals also use teleradiology to provide radiologists access to medical images at home or between departments.[106]

The implementation of teleradiology has also been growing in Australia and the United Kingdom. As of 2004, 30 percent of public Australian hospitals (representing about 65 percent of the national total hospital beds) had implemented PACS.[107] The growth of PACS technology in Australia has been largely driven by a combination of the benefits of such systems and the government mandate that adult images be stored for 5 years to 7 years and children's images stored for 21 years to 25 years. In the United Kingdom, the National Health Service (NHS) implemented PACS to create a completely filmless electronic medical imaging system for nationwide use. PACS creates a number of benefits including cost savings from film and film storage and more flexibility in capturing, storing and distributing medical images. PACS is a centralized system developed so that the NHS can manage the security and privacy features governing the image database. The NHS has implemented role-based security features that limit access to private medical information based on each individual's role in the health care process.[108] As of December 2007, the NHS has deployed PACS to every acute care hospital in the United Kingdom.[109]

In the United States, a 2003 study found that 78 percent of all radiologists reported using teleradiology. The most commonly reported use of teleradiology in this study was to enable radiologists to work from home. Despite a few popular stories to the contrary, offshore teleradiology services are not common in the United States, accounting for less than 0.1 percent of the teleradiology workforce.[110] Various factors contribute to the low levels of offshoring of teleradiology services, including stringent licensing requirements, a shortage of qualified radiologists overseas, and the refusal of Medicare and Medicaid to provide reimbursements for medical services performed overseas.[111]

Part II: Lessons from Global Leaders in Health IT

As discussed in the previous section, three Nordic countries—Denmark, Finland, and Sweden—have an advanced, patient-centric health care system that uses IT to improve the quality and efficiency of the care provided to its citizens. To recap, an electronic health record (EHR) system is the foundation of more advanced health care applications, and in this regard, all of these countries lead their peers. Denmark, Finland, and Sweden have near universal usage of EHR systems among primary care providers. Most hospitals in Finland and Sweden also have EHR systems in place. Denmark has an above-average rate of adoption of EHR systems in hospitals, and adoption should be near universal in the next few years.[112] Moreover, these three Nordic countries lead in the use of other health IT applications, including the use of CPOE to order medical tests, the electronic prescribing of medicine, the use of telehealth applications, including teleradiology, and online health portals. Finally, Denmark, Finland, and Sweden have significant efforts in-place and in-development to facilitate the electronic exchange of clinical data including prescriptions, laboratory results, medical images, and hospital orders.

The global leaders—Denmark, Finland, and Sweden—have all implemented national-level strategies to drive and coordinate health IT adoption.

The degree of success or failure a country experiences with health IT depends on many factors. Although no single approach to deploying health IT will work in all countries, many lessons can be learned from the global leaders. In this section, we analyze various factors that have the potential to affect health IT adoption among countries. These factors include organizational (e.g., leadership, health care system organization and financing), political (e.g., incentives, mandates), institutional (e.g., population size, structure of the health care sector, cultural factors, privacy issues), and technological factors (e.g., common infrastructure, standards, unique patient identifiers). We focus our analysis on the global leaders in health IT—Denmark, Finland, and Sweden—but also use examples from other countries with demonstrated success in health IT, including the Netherlands, New Zealand, and the United Kingdom.

National Leadership to Promote Health IT Adoption

Perhaps no factor is more important in explaining why some countries lead in health IT adoption than strong national-level leadership. Implementing health IT involves a complex set of relationships among individuals and organizations with competing goals and priorities. Moreover, as discussed above, health IT involves numerous societal (spillover) benefits that the market does not adequately capture, as well as benefits that may accrue to entities other than the entities that implement health IT systems.

The global leaders—Denmark, Finland, and Sweden—have all implemented national-level strategies to drive and coordinate health IT adoption. Other developed countries with high levels of health IT adoption, including the United Kingdom and the Netherlands, similarly have designed national policies in pursuit of this goal. Rather than simply letting the market drive adoption or waiting for the adoption of health IT to occur gradually, the nations that lead in health IT adoption have developed aggressive and coordinated strategies to organize the various actors and overcome barriers to health IT adoption. Many national health IT initiatives in developed countries have been driven by goals such as improved patient safety, better quality care, and overall cost savings.

Denmark and Finland stand out for having the foresight to establish a national vision for health IT adoption well before other countries reached the same conclusion. But their higher level of adoption of health IT is not necessarily just the result of their having a head start. In a 2002 survey of European EHR adoption, Denmark and Finland came in third and fifth respectively,

behind Sweden, the Netherlands, and the United Kingdom.[113] Denmark and Finland are certainly ahead of the curve in part because they started earlier, but much of their success in health IT can be credited to the clear goals they established, the formal institutions they created to pursue these goals, and the commitments they have made to regularly revisit and renew their national e-health strategies.

Denmark, for example, has shown early and continuous efforts in developing and revising its national health IT strategy. Although the health care delivery system is distributed throughout local regional authorities, Denmark's Ministry of Health acts as the central organization for coordinating activities between the counties and planning a national vision for health care. The first national e-health plan in Denmark began in 1994, when Denmark's Ministry of Research published objectives for developing an "information society" by 2000. Denmark's Ministry of Health followed up on this publication by developing an "Action Plan for Electronic Health Records" in 1996. The Ministry of Health created a parallel effort in 2000 by outlining a national strategy for health IT use in hospitals. Denmark's Ministry of Health again revised the national strategy in 2003 and focused the national efforts on using IT to directly improve health care service. Denmark's national health IT efforts have been led by MedCom, a cooperative venture between authorities, organizations, and private firms linked to the Danish health care sector that was first established in 1994 to manage certain health IT projects. In 1999, MedCom was made permanent to "contribute to the development, testing, dissemination and quality assurance of electronic communication and information in the health care sector with a view to supporting good patient progression."[114] In 2001 the Danish Regions brought together the public partners running the health care sector in Denmark and jointly established a non-profit organization, the Danish National e-Health Portal—Sundhed.dk. The e-health portal is run by a political board with members from the Danish Regions, the Ministry of Health, the Association of Danish Municipalities, and the Association of Pharmacies. Although these early efforts in Denmark resulted in substantial progress, in June 2006, Denmark's Ministry of Health, the Danish Regions, and the municipality association came together to form a new, cross-governmental organization—Connected Digital Health in Denmark (Digital Health)—to coordinate health IT initiatives between different government organizations and ensure that the nation follows a clear and consistent national health IT strategy.[115] In 2007, Digital Health created a new four-year national strategy to further apply IT to health care. The new strategy emphasizes participation by more health care actors and a stronger role of the national government.[116]

Much of the success of Denmark and Finland in health IT can be credited to the clear goals they established, the formal institutions they created to pursue these goals, and the commitments they have made to regularly revisit and renew their national e-health strategies.

Like Denmark, Finland was early in establishing a national strategy for health IT adoption. In 1996, Finland's Ministry of Social Affairs and Health established the first strategy focused on using IT to create a more integrated, patient-focused health care system. The government revised the strategy in 1998 to target specific goals for health IT, including an EHR for every patient, interoperability with legacy systems, and high levels of security and privacy.[117] Since 1998, Finland has launched a number of initiatives to further the adoption of health IT, one being to move toward the goal of nationwide EHR adoption by 2007. The Finnish e-health strategy was structured so that the initial priority was implementing tools for health care providers, such as sharing patients' information, and the secondary priority was developing e-health services for citizens.[118]

Sweden, too, has established an early lead in applying IT to health care through coordination at the national level, although a true national strategy for health IT in Sweden did not materialize until

2006.[119] In 2000, Sweden's Federation of County Councils, the Association of Local Authorities, the Private Health and Social Care Employers' Association, and the National Co-operation of Swedish Pharmacies (Apoteket AB) formed an organization called Carelink to coordinate the use of health IT projects throughout the country by working with different health care partners. Carelink focused on developing support services and a common infrastructure such as Sjunet, a secure private network for health care organizations, directory services, and information security applications.[120] In 2002, Sweden's Ministry of Health published "Vård ITiden" a report proposing strategies for making broader use of IT in health care.[121] In 2006, Sweden published its Strategy for eHealth laying out objectives in six action areas: laws and regulations, information structure, technical infrastructure, interoperable IT systems, access to information across organizational boundaries, and accessibility for citizens. Although the Strategy for eHealth originated with Sweden's national government, the plan was developed in cooperation with the local authorities responsible for implementing the program.[122] In addition, each county and municipal council must formally adopt the strategy and plays an active role in the decision-making process. As of late 2008, all of the county councils had formally adopted the national strategy. Although many municipalities still need to adopt it, collaboration on the e-health strategy's goals has continued through the Swedish Association of Local Authorities and Regions. Sweden has also established a "national ICT steering committee" to coordinate future development of the national e-health strategy with representation from various health care stakeholders.[123] This high degree of involvement by many stakeholders has allowed Sweden to develop a national strategy even with its decentralized health care system. As part of the Strategy for eHealth, Sweden's Ministry of Health and Social Affairs monitors and tracks progress on meeting the objectives of the strategy.

Perhaps one of the most striking differences in health IT policy between the United States and recognized leaders such as Denmark, Finland, and Sweden is an absence of a centralized strategy for deploying health IT. As one recent article describes it, "the U.S. approach, which the federal government has encouraged rather than led, has been to let regional organizations experiment with local initiatives."[124] The de facto strategy in the United States has focused on building the network from the bottom up by establishing regional health information organizations (RHIOs) or health information exchanges (HIEs). The U.S. approach, including until now its lack of national-level executive leadership, has failed to produce a nationwide system of interoperable EHR systems.[125] The majority of these regional initiatives are not yet operational, with only 57 HIEs operational out of 193 active HIEs nationwide.[126] Without strong national-level leadership, progress will likely continue to be incremental at best.

The U.S. approach, including until now its lack of national-level executive leadership, has failed to produce a nationwide system of interoperable EHR systems.

While progress in the United States has been slow, one notable milestone occurred in February 2009 when the national health information network came online and allowed data sharing for disability claims processing between MedVirginia, a RHIO, and the Social Security Administration. In addition, the recent U.S. stimulus legislation—the American Recovery and Reinvestment Act—included a number of provisions to spur health IT adoption. One of the principal features of the health IT portion of the legislation was to codify and make permanent the Office of the National Coordinator for Health Information Technology (ONC) in the Department of Health and Human Services. The ONC was previously created by executive authority, but the legislation made permanent the office and its role in directing the national strategy for health IT adoption. Importantly, Congress has directed the ONC to establish a national strategic plan for a national interoperable health information system and mandates that the plan be updated annually.[127] The

burden is now on the current administration to build and execute a national strategy for health IT in the United States.

Health Care System Organization and Financing

The organization of a country's health care system and health care financing can have a significant impact on health IT adoption. In Denmark, Finland, and Sweden, and other countries with single-payer health care systems, the costs and benefits of investing in health IT systems are better aligned than they are in countries such as the United States, where multiple governmental and nongovernmental entities pay for health care. Moreover, in these nations governments can afford to take a longer term view and make investments that might not pay off fully in the short term. More government involvement in health care also leads to more accountability. One of the reasons that Finland and Denmark have achieved significantly higher rates of EHR adoption in hospitals than other countries is that their hospital systems are government-run. Thus, political leaders have direct accountability for the quality of the care delivered at these institutions, and the government can prioritize needed upgrades and recoup public investment in hospital IT systems.

Sweden's health care system is decentralized but emphasizes universal access to quality health care and is primarily supported by public financing. The country is divided into 21 county councils and regions responsible for providing primary care, hospital care, and psychiatric care to citizens. The county councils have authority and responsibility for the provision of health care, and most health care facilities are owned and operated by the county councils. County councils operate primary health care centers with salaried physicians and staff, but Sweden's National Board of Health and Welfare has supervisory authority over all health care personnel and issues medical licenses.[128] In addition, 290 municipalities in Sweden provide home care for the disabled and elderly. Sweden's health care system is primarily funded by taxes. The county councils and municipalities have taxation authority to finance health care services, and local funding is supplemented by some national funding. Private medical practices remain common in some regions of Sweden, and physicians may be reimbursed by the county councils if they have an agreement in place. Although national level policies and organizations help coordinate activities between regional organizations, regional entities in Sweden have considerable autonomy in making decisions about the health care delivered to citizens in their jurisdiction.[129]

Finland provides universal health care to all people living in the country. Each of the 399 municipalities in Finland is responsible for managing care for its residents and has authority to collect taxes for this purpose. Each municipality manages or comanages a health care center or regional health care organization that operates facilities where citizens can receive primary care. In 2007, Finland had 229 primary health care centers.[130] Such centers provide inpatient care, much like a hospital, and provide other health care services such as dental care and maternity care. Finland is divided into 20 hospital districts, and each hospital district operates publicly owned hospitals within its jurisdiction. There are a few private hospitals in Finland, but they represent less than 5 percent of the total hospital beds in the country. Private practices are common in Finland, with about 11 percent of all physicians in a full-time private practice, and a quarter of all public health service doctors operating a private practice when they are off the clock.[131] In general, all permanent residents of Finland qualify for Finland's National Health Insurance, which partially covers visits to private practice providers.[132]

The health care system in Denmark is also publicly funded: 85 percent of health care costs are financed through taxes and the majority of health care services are provided directly by the public sector.[133] Hospitals in Denmark are run by the public sector, and primary care providers work under contract for the counties. Primary care physicians generally work in private practices, and about one-fourth of them work in solo practices.[134] Physicians' earnings come from a combination of

fee-for-service and per capita payments. In Denmark, however, primary care physicians have paid for EHR systems without additional financial support from the central government.[135] The Danish model emphasizes equal access to care regardless of the economic situation of the patient. Regional level authorities manage health care services for citizens within their region, and the national Ministry of Health provides guidance and support to ensure that the local authorities continuously work to improve health care delivery.

Governments in countries with single-payer health care systems may be more likely to invest in e-health systems than countries like the United States because the benefits will accrue to those systems. Finland's national government has been the primary source of funding for health IT initiatives in that country. Between 2004 and 2007, Finland's Ministry of Social Affairs and Health allocated €30 million per year for health IT projects, with a third of the money distributed through the county councils and the rest distributed directly through the ministry.[136] This represents annual spending of approximately 0.02 percent of Finland's gross domestic product (GDP). In addition, as discussed further below, Finland has recently launched a new €20 million project—referred to as KanTa—to further develop the national health IT infrastructure to enable the transfer and archiving of electronic patient records and electronic prescriptions.[137]

The United Kingdom is another example of a single-payer health care system, where the government has made a large investment in health IT. In the United Kingdom, most doctors and hospitals are paid directly by the government, and an estimated 90 percent of acute hospital beds are in public hospitals.[138] The country's National Health Service (NHS) is one of the world's largest employers with over 1.3 million individuals on its payroll.[139] As a result, government can more directly enact broad changes in the health care system while also receiving many of the cost savings benefits of health IT investments. Not surprisingly, the NHS National Programme for IT (NPfIT) is one of the most ambitious, and one of the most expensive, e-health programs in the world with a budget of £12.4 billion over 10 years.[140] On an annual basis, this program's budget represents spending of approximately 0.08 percent of GDP and 1.2 percent of the NHS budget.[141]

The United States, unlike Denmark, Finland, Sweden, and the United Kingdom, does not have a single-payer health care system. Thus, one of the principal barriers to health IT adoption by health care providers in the United States has been the asymmetrical relationship between the costs and the benefits of adopting EHR systems. Some health care providers choose not to implement EHR systems because the return on their investment does not always justify the cost.[142] Many studies have demonstrated that health IT can lower the total cost of health care, but the savings from the adoption and use of health IT do not always flow to the health care providers who implement health IT. Currently, many of the benefits of investing in health IT go not to the health care providers who implement such technology but to health insurers or patients.

One of the principal barriers to health IT adoption by health care providers in the United States has been the asymmetrical relationship between the costs and the benefits of adopting EHR systems.

Financial Incentives for Health IT

Researchers consistently identify the high initial cost of EHR systems as a barrier to more widespread health IT adoption.[143] Financial incentives for health IT adoption by health care providers therefore can be an effective policy tool to spur the use of health IT.

In Denmark, for example, early efforts to computerize medical practices relied on financial incentives. In the 1980s, Danish primary care physicians received small subsidies for submitting medical claims electronically by disk.[144] Financial incentives have also been used in the Netherlands. IT investments by health care providers in the

Netherlands are tax deductible, and since 1991, Dutch primary care providers who use an IT system have received incentive payments for every patient and health care encounter.[145] The United Kingdom has used financial incentives to increase the use of EHR systems among primary care physicians. In 2003, the country's National Health Service (NHS) established large financial incentives for physicians to meet certain quality standards, thereby spurring the use of EHR systems.[146] Australia has established the Practice Incentives Program (PIP) to reward primary care providers that implement certain improvements, including the use of health IT applications, that boost quality of care. Australia's PIP has been a success, and "more than 91 percent of GPs receiving PIP payments use computers for prescribing and sending and receiving data electronically."[147] Medical practices in Australia that meet PIP's requirements for health IT can receive up to AU$50,000 annually in additional reimbursements from Medicare Australia.[148]

The converse is also true—a lack of financial incentives can explain lower rates of health IT usage in some countries. In South Korea, the government offered financial incentives for CPOE and Picture Archiving and Communication Systems (PACS),[149] which led to their high use in hospitals, but did not offer any incentives for EHR systems in hospitals, partially explaining hospitals' low rate of adoption of such systems.[150]

Similarly, the publicly funded health care system in Japan provides few financial incentives for small health care providers to adopt EHR systems. Currently, providers receive a bonus payment on the order of 25 cents per patient (30 yen) for adopting health IT.[151] As noted earlier, EHR adoption rates among primary care providers in Japan is only around 10 percent. In cases where Japan has used incentives it has seen more success. In 2001, for example, Japan initiated the "Grand Design for the Development of Information Systems in the Health Care and Medical Fields" through the Ministry of Health, Labour, and Welfare. At that time, fewer than 2 percent of hospitals in Japan used EHR systems. One goal of the Grand Design was to increase the use of EHR systems in large hospitals to 60 percent by 2006. Although the overall rate of adoption of EHR systems by hospitals in Japan reached just 10 percent in 2008, the adoption rate among larger hospitals is significantly greater at 31.2 percent. Much of the progress in the adoption of EHR systems among larger hospitals in Japan can be credited to government subsidies to 249 hospitals, almost all of them large hospitals.[152] Smaller hospitals did not receive government support nor have efforts been made to subsidize these hospitals. Providing more government incentives to spur private investment in EHR systems for hospitals in Japan may not be a very good idea. As one scholar notes, the reason for a lack of interest in public financing to spur private hospital adoption of health IT is an excess of hospitals: Japan, with just half the population of the United States, has roughly twice the number of hospitals as the United States.[153]

Financial incentives for health IT have also been used in the United States, albeit only recently. In 2008, for example, the U.S. Congress passed the Medicare Improvements for Patients and Providers Act (MIPPA), which set up a system of financial incentives and penalties to encourage e-prescribing. Beginning in 2009, doctors who submit prescriptions electronically will receive an additional 2 percent of their allowable Medicare charges. In 2012, the incentives end and doctors who do not use e-prescribing will be subject to penalties. This system has already shown its effectiveness, as suggested by the fact that e-prescribing rose from 2 percent in 2007 to 7 percent in 2008.

The U.S. economic stimulus package enacted in 2009, the American Recovery and Reinvestment Act, also provided a system of incentives and penalties to encourage adoption of EHRs. In the stimulus package signed by President Obama, physicians can receive up to $41,000 over five years in incentive payments if they are using a qualified EHR system. The incentive payments begin in fiscal year 2011 and continue through 2015. The plan structures the incentives so that early adopters receive the maximum benefit and those adopting after 2011 receive a smaller

incentive. After 2015, physicians who have not implemented such systems will begin to receive reduced Medicare and Medicaid payments—a 1 percent reduction in 2016, a 2 percent reduction in 2016, and a 3 percent reduction in 2017.[154] The U.S. Congressional Budget Office predicts that the incentives for health IT in the stimulus package will eventually result in 90 percent of doctors and 70 percent of hospitals adopting EHR systems by 2019.[155] Yet other analysts have questioned the impact of the stimulus given the size of the incentives and penalties. One recent report argued that the stimulus bill provides most doctors an insufficient financial incentive to adopt EHRs because the costs of adoption including incentives are still greater than the penalties.[156] While the net societal benefit of EHR systems is positive, the cost savings to individual health care providers can be difficult to guarantee.

The American Recovery and Reinvestment Act of 2009 also provides substantial funding to hospitals in the United States that implement "meaningful use" of EHR systems. The Healthcare Information and Management Systems Society (HIMSS) estimates that a "75-bed hospital could receive up to $3.5 million in Medicare incentive payments while a 750-bed hospital could receive a maximum of $11.2 million."[157] Another industry report by PricewaterhouseCoopers Health Research Institute estimates that a 500-bed hospital could receive around $6.1 million in federal funding from the stimulus package. The report goes on to note that the same hospital could lose up to $3.2 million in Medicare funding by 2015 if it fails to implement an EHR system. As an author of the report notes, "[the incentives are] a small carrot compared to the amount of resources it will take to deploy this technology over the next five years. If an organization wants to have an enterprise-wide EHR up and running by 2011, they've got to start now. The incentives eventually go away, and the stick will only get bigger."[158]

Government Mandates to Spur Health IT

Apart from or in combination with financial incentives, government mandates also can help spur adoption of new technology. Governments can mandate either the use of specific functionality or the use of specific technology. Mandating specific functionality can be an effective means of tying the benefits of health IT to better health care outcomes. Requiring that health care providers be able to produce a list of all patients prescribed a certain medication, for example, is useful for drug safety.

Many countries use government mandates to achieve broad or universal health IT adoption. Denmark and Norway, for example, have achieved high rates of e-prescribing by making e-prescribing mandatory for primary care providers.[159] Denmark in particular has made effective use of mandates. Denmark requires primary care providers to issue all patient referrals to specialists electronically and maintain electronic clinical record using the MedCom standards. As of 2009, the providers must also offer online booking and e-mail consultations.[160] In Finland, the government has passed legislation requiring all health care providers, both public and private, to use the new national patient record system by April 2011. Pharmacies must also use the new e-prescribing service.[161] And in Sweden, some counties have mandated the use of structured data in EHR systems to improve data quality and support the reuse of clinical data.[162]

Government mandates have also driven nonclinical uses of health IT. In New Zealand, health IT adoption has been driven in part by a government mandate that doctors be able to submit claims and capture data electronically. Germany also spurred IT adoption among primary care providers by mandating electronic billing.[163] Sometimes health care mandates can have beneficial unintended consequences. As an example, legislation in Norway requires doctors to retain patient medical records, a requirement made much simpler and more cost-effective by using digital records. As a result, Norway is one of the few countries with "paper-light" offices where primary care providers keep few paper medical records.[164]

The United States has used mandates for health IT only in a few cases for limited technical changes rather than to implement broad reform. The

Health Insurance Portability and Accountability Act of 1996 (HIPAA) included a number of mandates for the privacy and security of electronic medical data and for electronic data interchange. Thus, for example, for electronic data interchange, HIPAA mandated the use of a single, unique identifier for all health care providers. As of May 2007, all providers were required to obtain a National Provider Identifier (NPI) to be used on transactions such as health care claims and prescriptions.[165]

Size of a Country's Population

Large countries with a diverse group of stakeholders appear to be at a disadvantage when deploying health IT. Arguments can be made for both a positive and a negative correlation between a country's population size and health IT adoption. On the one hand, economies of scale would suggest that deploying health IT in larger countries would be cheaper and thus larger countries would be more likely to have higher rates of health IT adoption. For example, building shared health IT infrastructure can help reduce overall costs, as the cost to provide a single IT solution to deliver a given service can be distributed over multiple health care providers. Although larger countries would seem more inclined to invest in common infrastructure, as the cost can be distributed over a greater number of health care providers, examples of common infrastructure can be found in countries with smaller populations, such as Denmark, Finland, Sweden, and the Netherlands, as well as in countries with larger populations, such as the United Kingdom.

Large countries with a diverse group of stakeholders appear to be at a disadvantage when deploying health IT.

Conversely, smaller countries may be more likely to lead in health IT adoption because their smaller size allows easier coordination between various stakeholders. Indeed, a significant challenge with health IT is the difficulty of coordinating and bringing together various stakeholders to work towards a shared vision and overcome obstacles such as interoperability. Coordination is often easier in smaller countries in part because the ability to collaborate is closely related to the number of competing stakeholders, such as the number of health IT vendors. Some mid-sized nations, like the United Kingdom, have also been able to achieve a level of success coordinating the deployment of health IT because they have a more centralized health care system.

Structural Issues in the Health Care Sector

Several structural issues in the health care sector can have a significant impact on technology adoption. These include the average size of medical practices, the number of vendors for health IT systems, and the number of competing pharmacies.

The average size of medical practices can influence health IT adoption. As noted earlier, the adoption of EHRs among primary care physicians in the United States is significantly higher in larger practices than in smaller practices. One reason for this is that the average cost per physician of adopting EHRs is higher for solo and small practices than for large practices. Larger practices can reduce the average cost of expenditures for hardware, software, and training by spreading them across multiple doctors. Over time, it is likely that smaller medical practices will consolidate into larger practices to take advantage of the cost savings. Indeed, countries like Germany and the Netherlands have a high percentage of primary care physicians that work in solo practices. In Germany, 75 percent of primary care providers work in solo practices; in the Netherlands, the level is even greater at 80 percent. As a result, doctors in these countries are forming physician collectives or cooperatives to gain the benefits of working in a larger group, including common IT services.[166] Health IT adoption in the United States is made more difficult by the fact that over two-thirds of physicians work in solo or small group practices.[167]

The number of vendors for health IT systems also affects the level of adoption of EHR systems—fewer vendors often leads to increased

interoperability and greater rates of adoption. Interoperability can become more difficult with a large number of vendors, especially in the absence of national standards, as the number of systems with which an application needs to exchange data increases. This means that it is easier to deploy applications requiring interoperability such as transmitting EHRs, laboratory results, or prescriptions. For example, Jha et al. report that the Netherlands and Germany have higher rates of EHR use in ambulatory care because of the relatively small number of vendors in the health IT market.[168] Denmark, too, has benefited from relatively few vendors. In 2003, 11 vendors provided 16 different IT systems to primary care providers, with three vendors making up 57 percent of the market.[169] In Sweden the number of EHR vendors has dropped from 26 in 1995 to fewer than 15 in 2006, with three vendors making up 95 percent of the market.[170] And in New Zealand, the entire EHR system market is comprised of four vendors, with one vendor holding an 80 percent market share.[171] In contrast, the United States faces considerable challenges to interoperability with more than 200 EHR system vendors and many uncoordinated regional initiatives.[172]

The number of competing pharmacies in a country similarly affects health IT adoption. This principle can be seen in a comparison of the pharmacy systems in Sweden and Finland. In Sweden, the government has had a historic monopoly on pharmacies. The National Co-operation of Swedish Pharmacies, Apoteket AB, has been the sole supplier of prescription and nonprescription drugs in Sweden since 1970. As of 2008, the company also owned all 878 pharmacies and 39 over-the-counter medicine shops.[173] Although Sweden is now opening up the pharmaceutical market to competition, the existing state monopoly on pharmaceuticals has made the process of implementing e-prescribing simpler than in a country with many competing retailers and IT systems. For example, Apoteket partnered with Medco Health Solutions to provide an automated electronic prescription-review system to improve patient safety by alerting pharmacists of potential problems, such as drug interactions from prescriptions the patient's doctor may be unaware of. In addition, Apoteket AB has been able to play a leading role in Carelink, the national association of health care organizations, to promote health IT use in Sweden.[174]

In contrast to Sweden with one dominant pharmacy, Finland has many small pharmacies. Pharmacies in Finland are highly regulated. Finland has approximately 600 pharmacies and 200 branch pharmacies. Most pharmacies are privately owned and no pharmacist may own more than one pharmacy and three branches, with the exception being the Helsinki University Pharmacy which has 15 subsidiaries.[175] A license is needed to operate a pharmacy and the number of licenses is tightly controlled by the government. Since the national government regulates drug prices this means that pharmacies do not compete on price but rather on service. This fact has led some to observe that Finland's pharmacists offer the best service in Europe, offering advice and consultations rather than just dispensing medicine as is common in many countries.[176] Nevertheless, the percentage of prescriptions transmitted electronically by pharmacists in Finland is low. Part of the reason is that there is virtually no consolidation of pharmacies in Finland. In contrast, Sweden has a high level of electronic transmission of prescriptions in part because it has been easier to implement a national e-prescribing system with only one company. Apoteket, the national Swedish pharmacy chain, introduced the plan to adopt e-prescribing nationally.[177]

Denmark has had much more success with e-prescribing than Finland even though its pharmacy system is similar. Denmark's pharmacy sector is highly regulated with oversight from the Ministry of Interior and Health and the Danish Medicines Agency.[178] The Danish government standardizes many practices throughout the country with the goal of ensuring that all citizens have easy and affordable access to medication. Thus, for example, the Danish government regulates drug prices and pharmacies receive a fixed profit on all pharmaceuticals and receive no additional profit for selling greater quantities or more expensive medicine.[179] In 2007, Denmark had 246 licensed

pharmacies operating in the country and 57 additional branch pharmacies. The national government determines the total number of pharmacies as well as their location. Much of Denmark's success with e-prescribing is a result of action taken by the national government. In 2007, the Danish Medicines Agency created an online service to transmit prescriptions electronically from doctors to pharmacies. Initially the program suffered from technical problems and delays; however, Denmark is now one of the leading countries in e-prescribing.[180] The Danish Pharmacy Association also created Apoteket.dk, a health portal for Danes that not only provides information on drugs and personal health, but also allows patients to order medicine online for delivery or pickup at their local pharmacy. To ensure the security of the system, customers must use a digital signature, provided by the national government, to purchase medicine electronically. Pharmacies can also offer online consultation for their customers through online chat, webcams or e-mail.[181]

The United States has seen significant consolidation in its retail pharmacies over the past decade. Retail pharmacies, including Walgreens, CVS Caremark, Rite Aid, and Wal-Mart, currently dominate the marketplace. The growth of chain pharmacies has resulted in a decline in the total pharmacies in the United States by 2,000 over the past 7 years to around 38,000 retail outlets.[182] The landscape has also changed with the growth of mail-order pharmacies, such as Medco, Express Scripts, and CVS Caremark. As a result of consolidation, U.S. pharmacies show readiness for e-prescribing: nationwide 72 percent of pharmacies have joined the Pharmacy Health Information Exchange, including 97 percent of chain pharmacies.[183]

Societal and Cultural Factors Related to Health IT

Societal and cultural factors can have a significant impact on health IT adoption, as evidenced in Nordic countries such as Denmark, Finland, and Sweden. Such factors include the level of technological sophistication of the population, peer influences, and cultural norms.

It is little surprise that many of the Nordic and other countries leading in health IT adoption also rank high on other national indicators of technology adoption such as broadband or computer ownership. Denmark, Finland, Sweden, and the Netherlands, for example, all consistently rank among the top countries in broadband adoption.[184] In Denmark, 95 percent of the population has access to the Internet at home.[185] Residents of Finland also routinely use IT. Approximately 75 percent of Finnish households have a personal computer. Of those individuals in the age group 16-74, 79 percent have access to the Internet in the home.[186] Many of these countries see health IT adoption not as a standalone application, but rather as part of a broader government strategy to create a strong information society.

In Denmark, for example, as early as 1998, patients would consider their doctor "second-rate" if he or she did not have a personal computer in the office.

A high level of technological sophistication both reduces resistance by doctors to change and helps stimulate demand from patients. Familiarity with technology leads to ease of use, and helps diminish internal resistance to adopting health IT systems. For example, in Finland, virtually all primary care physicians use computers to store administrative data and have a computer in the room during a patient consultation. In addition, technological sophistication contributes to high expectations from patients to have their doctors use IT in health care. In Denmark, for example, as early as 1998, patients would consider their doctor "second-rate" if he or she did not have a personal computer in the office.[187] Today, Denmark, Finland, and Sweden have near universal rates of computer and Internet usage among primary care providers, and this has been the norm for many years.[188]

Peer pressure from other doctors to adopt health IT has also contributed to the mostly voluntary adoption of health IT in countries like Denmark

and Sweden. Research has shown that peer influence was a leading factor influencing health IT adoption in Denmark, Sweden, Norway, and the Netherlands.[189] Early adopters of health IT systems used workshops, conferences and informal gatherings to promote the use of health IT systems among their peers and associate using IT systems with best practices. In addition, Denmark has benefited from its "comparative culture," and MedCom has spurred regional competition by regularly reporting on the progress of the counties and regions in successfully implementing health IT initiatives.[190]

Cultural norms have also influenced Sweden's experience with health IT systems. Reflecting its tradition of egalitarianism, Sweden has adopted a consensus-based approach to promoting health IT. Health care in Sweden is provided by county and municipal councils, and these local governments have worked closely with their regional health care organizations to implement health IT systems that lead to better health care outcomes. Sweden has a tradition of county councils and health care regions working collaboratively to improve health care quality and efficiency, so this collaboration in implementing health IT follows that tradition. As mentioned above, Finland has similarly used a consensus-based approach to setting standards for health IT.

Deploying EHR systems with robust technical controls, including encryption, electronic identification, and audit logs can improve the privacy and security of personal medical data.

Privacy Issues Related to Health IT Systems

In implementing health IT systems, nations must grapple with issues related to ensuring the privacy of patients' sensitive health and other personal information. Many countries have adopted data security legislation to protect patients' privacy with the goal of improving users' confidence by assuring patients that their personal medical data are safe. Deploying EHR systems with robust technical controls, including encryption, electronic identification, and audit logs can improve the privacy and security of personal medical data.

In Denmark, patients have access to health information through the official Danish Web portal Sundhed.dk and can control many privacy functions through this portal. Access to the portal by patients requires the use of a digital signature. Using the online health portal, patients can monitor who has accessed or modified their personal medical records. Danish patients also have the option of restricting access to their medical record to specific health care workers and limiting access to certain types of sensitive medical information.[191]

Similarly, Finland's eArchive system for EHRs will require health providers to securely authenticate to the system and receive electronic authorization before accessing a patient's personal health data. Patients will also be able to review access logs about who has accessed their personal medical files, a significant improvement over the paper-based filing system found in many doctor's offices around the world.[192]

Sweden, too, has overcome the objections of privacy advocates through good policy. The Swedish government maintains various national databases to track population health information, such as births, cause of death and cancer rates, and health care quality, such as the treatment and outcomes of various medical conditions. Although these databases contain sensitive personally identifiable information, including a patient's unique identification number, only approximately 4 percent to 5 percent of citizens opt out.[193] In July 2008, Sweden enacted the Patient Data Act, new legislation designed to maintain the privacy and security of patient data while also allowing data exchange between health care providers. The Patient Data Act replaced previous legislation such as the Health Record Act and the Care Registers Act, which did not adequately provide for the free flow of data between health care organizations. The new legislation is intended to allow patient data to follow an individual between different health care providers, organizations and regions.[194]

The legislation also includes requirements to empower the patient and ensure privacy. As an example, patients must give consent for who can access their health records. In addition, the act requires patients to be able to access an electronic copy of their medical records and review a log of personnel that have accessed their health data.

In the Netherlands, data are stored not in a central government database but by the health care providers. The National Switch Point (Landelijk SchakelPunt or LSP in Dutch), the information hub for patient data, provides a record of where a patient's medical data are stored. The LSP also provides a record of who has accessed patient medical data since third-party access to patient data must be authorized through an electronic transaction. Patients in the Netherlands can opt out of the electronic exchange of their data, either through their health care provider or electronically with their Dutch Identity Card. To date, however, only about 2 percent of patients have opted out of the system.[195]

In the United States, advocacy groups repeatedly cite privacy fears as one of the major impediments to progress with health IT. Moreover, some advocacy groups have resisted legislative efforts on health IT initiatives citing privacy concerns. To the extent that concerns about privacy are likely tied to trust in government, the importance of privacy concerns may vary by country. In comparison to the population in Denmark, which has a high level of trust in the government, the population in the United States views government with considerably less trust.[196] Unless legitimate privacy concerns are properly addressed in the United States, privacy fears can create resistance among consumers to adopting certain helpful health care technology. If privacy laws at the state or federal level are too restrictive, however, they can impede the adoption of health IT and its use in clinical care. At the federal level, for example, the HIPAA Privacy Rule (45 CFR Parts 160 and 164), which provides the federal floor of privacy protection for health information in the United States while allowing more stringent state laws to continue in force, states that health care providers must "protect against any reasonably anticipated threats." This condition created much initial confusion for providers, who struggled to determine if the use of technology such as e-mail to communicate with a patient violated these terms (it does not).[197] At the state level, a recent study of health IT adoption rates found that states with more restrictive privacy laws were less likely to have high rates of EHR usage.[198] Thus, a balance is needed in the United States that can both reassure patients that their privacy is being protected while not implementing restrictive measures that reduce data sharing and result in lower quality care. Recent efforts to increase data privacy include the American Recovery and Reinvestment Act of 2009, which extended HIPAA's privacy protection to all organizations that handle protected medical data and included notification requirements in the event of a security breach.

The issue of privacy and data protection is of particular concern for health IT applications involving data sharing such as teleradiology. These issues become even more complicated when data must flow internationally, such as when a radiologist is located in another country. For example, teleradiology can involve sharing personal medical data with health care workers not directly involved in a patient's care. Yet countries often have many reasons to adopt teleradiology, even countries like the United Kingdom, known for strong data protection laws. Teleradiology addresses a number of concerns in the British health care system including a shortage of radiologists, government goals to reduce waiting times for patients, and the relatively higher salary for radiologists in the United Kingdom.[199] To take advantage of applications like teleradiology while still protecting patient privacy, the United Kingdom has put in place rules and regulations to protect patient data while still allowing access to telehealth applications. Thus, for example, health care organizations in the United Kingdom must verify that patients have been informed and given consent to any data sharing. Health care providers must also have proper controls and contracts in place to ensure data confidentiality with foreign partners. To help lessen the administrative burden, the United Kingdom's Data Protection Act allows data sharing within the European Economic

Area.[200] For the United States, patients can hold the original source of the data, such as their health care provider, accountable for misuse of their data, so additional protections for foreign data processing are probably unnecessary.

Policies to Support Telehealth

Many nations have enacted policies designed to either encourage or impede the use of telemedicine including funding mechanisms, licensing and regulatory barriers. To support telemedicine, medical insurance reimbursement schedules need to include appropriate funding for telemedicine applications, interstate and international licensing standards should be promoted, and regulatory barriers should be minimized.

Nordic countries such as Finland, Denmark, and Norway have traditionally promoted telehealth applications as a pathway to ensuring equal access to health care, especially in rural areas during winter. In Finland, both public and private sector providers can receive reimbursement for remote consultations.[201] Denmark set national reimbursement rates for e-mail consultations at twice the value of telephone consultations, and in 2008 had over 20,000 e-mail exchanges per month between patients and doctors.[202] Norway, too, has been a leader in telemedicine. The northern region of Norway has a small population distributed over a relatively large geographic area and has looked to telehealth applications to accommodate the health care needs of the population. The University Clinic in Tromsø pioneered many teleradiology applications and hosts the Norwegian Centre for Integrated Care and Telemedicine, a recognized world leader in telemedicine.[203] Norway was also an early promoter of telehealth applications by implementing a telehealth fee schedule in August 1996 that made "all telehealth services reimbursable by the national health insurer."

Denmark set national reimbursement rates for e-mail consultations at twice the value of telephone consultations, and in 2008 had over 20,000 e-mail exchanges per month between patients and doctors.

The U.S. Congress passed legislation in 1997 that directed Medicare to reimburse health care providers for certain telemedicine applications, and Medicare began accepting telemedicine claims in January 1999. However, Medicare's reimbursement provisions contain certain restrictions that prevent more widespread use of telemedicine. The most notable case is for teleradiology where Medicare's rules and regulations require that the radiologist performing the service be physically located in the United States—an obvious barrier to using radiologists located abroad.[204] State laws can also restrict telemedicine. For example, a 2002 study found that "no state expressly allows telemedicine practitioners to treat or diagnosis patients across state borders without being licensed in the patient's state." In addition, the study found that 13 states had enacted or were considering legislation specifically limiting telemedicine.[205]

Licensing standards can also have an impact on the use of certain health IT applications. Maintaining high licensing standards can be an effective means for improving quality of care; however, it can also be misused to advantage certain health care workers. In the United States, licensing standards are set by medical associations and state licensing boards made up of the doctors that would be affected by less stringent licensing requirements. In effect, the doctors setting the standards are the same doctors that could be hurt by a more open market. As a result, hospitals that want to use international teleradiology face certain barriers. In contrast, in the United Kingdom foreign radiologists can either obtain certifications and training with the United Kingdom or apply to the Postgraduate Medical Education and Training Board (PMETB) to have existing credentials accepted. Foreign doctors from within the EU face little review as efforts have been made to standardize licensing requirements across member countries.[206]

Other laws and regulations can also provide a barrier to telehealth applications. For example, in Japan, Article 20 of the Medical Act outlawed doctors from diagnosing and treating a patient

without a direct meeting, a law that stunted the growth of telehealth applications in Japan. Japan's Ministry of Health, Labor, and Welfare clarified the law in 1997 to allow telemedicine which contributed to the rapid growth in telemedicine applications now seen in Japan today. A similar restriction prevented doctors in South Korea from practicing telemedicine. Previously, doctors could only offer medical advice, but they could not treat patients or order prescriptions remotely. As of July 2009, South Korea's Ministry for Health, Welfare, and Family Affairs revised its regulations to allow doctors to treat patients examined online.[207]

Common Health IT Infrastructure

An important component of the national health IT strategies in many of the countries leading in health IT adoption is developing shared IT infrastructure—that is, technology that can be used by multiple health care providers. Building IT infrastructure creates network externalities—positive benefits that flow to others outside the network. Because of these network externalities, the market alone may not invest in IT infrastructure at the optimal level and government involvement may be necessary.

Building common infrastructure helps lower costs and increase interoperability by creating a shared platform for health care organizations to use.

Building common infrastructure helps lower costs and increase interoperability by creating a shared platform for health care organizations to use. Examples of common health IT infrastructure include shared EHR systems, online authentication services, electronic billing systems, secure e-mail, online portals, and health data networks. Providers that invest in health IT systems often receive more value when common infrastructure is available than when they must use a standalone health IT system, a reason that helps explain why the adoption rates for EHR systems among primary care providers in countries like Denmark, Finland, and Sweden are higher than in other countries without this common infrastructure. For example, physicians in Denmark identified a number of functional improvements from implementing health IT systems that depend on common infrastructure, such as the ability to receive test results electronically and notify doctors when one of their patients is admitted to the emergency room.[208] The ability to file billing claims electronically has also spurred investment in EHR systems in countries such as Denmark, Norway, and the Netherlands, as EHR systems often include computerized billing systems that automate billing and reduce administrative costs.[209]

Denmark has long benefitted from common infrastructure, having developed the National Patient Registry, a longitudinal record of patient contact with hospitals, in 1977.[210] Denmark's common national health IT infrastructure today includes the national e-health portal Sundhed.dk, which allows Danish citizens and health care professionals to access general and individual health information and to communicate with each other. Another component of the national health infrastructure is the Danish Health Data Network managed by MedCom, which enables health care organizations to securely exchange health data. In 1997, Denmark established an after-hours service so patients could visit a doctor outside of normal office hours. To facilitate this service, the counties in Denmark jointly funded the implementation of a computer system to generate e-prescriptions and send reports to the patient's primary care physician. Doctors were required to use this computer system to receive payment for their services.[211]

Finland, too, has worked to develop a common national health IT infrastructure. Although much of the work to integrate IT into health organizations and build regional networks occurs at the local level, local systems use common infrastructure and services defined at the national level. The public key infrastructure used to authenticate health care providers to online services, directory services, and patient ID cards, for example, are all implemented at the national level.[212]

Finland's most ambitious plan is to implement a €20 million national electronic health IT infrastructure—referred to as KanTa—for its 5 million citizens.[213] While Finland currently has high EHR adoption rates, interoperability between these systems continues to be a problem. A major component of KanTa will be a centralized national electronic archive called eArchive, to which health care providers will provide official health records, allowing data to flow seamlessly between health providers.[214] Data stored in the eArchive will be the official repository of patient records, although health care providers may maintain a local copy. The repository will also give patients access to their personal health information. The planned completion date for e-Archive is 2011.[215] Another major project of KanTa, also to be operating by 2011, will improve e-prescribing in Finland. As noted earlier, Finland currently trails other countries in the electronic transmission of prescriptions. To remedy this shortcoming, KanTa will include an electronic prescribing center that will allow the secure transmission of prescriptions from health care providers to pharmacies. The system includes smart ID cards for health professionals, a secure messaging system, and a central data repository for all pharmacies. KELA, the Social Insurance Institution of Finland, also plans to build in decision-support features to improve drug safety.[216] Over the next 10 years, Finland predicts that the e-prescribing system will generate total savings of €10 million.[217]

Because Sweden's health care system is decentralized, with county councils and municipalities responsible for much of the care delivery, national entities work in partnership with local organizations to ensure coordinated efforts are leading towards national goals. Organizations working at the national level have also focused on developing health IT applications that provide important infrastructure needed across the country and support activities at the local level. Examples of common resources built at the national level are the Health Services Address Registry (a national directory of health care providers and their duties and roles), and the Secure IT in Health Services (SITHS) system (security infrastructure that makes it possible to authenticate health care workers to ensure only authorized individuals get access to patients' private information).

Two ongoing projects in Sweden designed to improve the exchange of health information between various health care organizations are the National Patient Summary project and the Standards for Electronic Interoperability in Health Care and Social Services (also known by its Swedish acronym RIV). The National Patient Summary project is intended to make patient information available to health care providers anywhere in the country. In Sweden's decentralized health care system, regional health care organizations have adopted different IT systems. This project was initiated by the Swedish National Board of Health and Welfare in 2004 to create a centralized system for collecting and distributing summary health care information for patients. The goal is to have the National Patient Summary operational in Sweden by 2010, with all county councils connected to provide all patients access to their medical data regardless of location.[218] The Standards for Electronic Interoperability in Health Care and Social Services project aims to facilitate electronic data interchange by setting standards for both technical interoperability and semantic interoperability.[219] The intent is to give health IT developers in Sweden a common framework on which to design their systems to promote interoperability.

Sjunet is another important Swedish health IT project deployed on a national level. Sjunet is an IP-based broadband network separate from the Internet connecting all hospitals, primary care centers, and many other health centers. Begun in 1997 as a regional initiative to connect local health care organizations over a virtual private network, Sjunet has evolved into a national secure broadband network for the exchange of health information.[220] Sjunet has defined standards, rules, and security features. Thus, for example, Sjunet includes access to services such as Domain Name System, directory services and a public-key infrastructure for secure communication between hospitals and personnel. Sjunet has led to the development of other important national and regional health IT applications in areas such as e-

prescribing, teleradiology, and video conferencing. Today almost all hospitals and primary care providers have access to Sjunet.[221] Sjunet is used for multiple clinical and administrative purposes in Sweden, including video-conferencing, teleradiology, secure e-mail, electronic data interchange, and e-learning in medical education. These projects have succeeded in part because of the availability of a common communications infrastructure to build upon. Notably, Sweden was the first country to build a national broadband health network infrastructure.

The national coordinating body for health IT in the Netherlands is the National IT Institute for Healthcare (NICTIZ), a nonprofit organization operating with funding from the Dutch Ministry of Health, Welfare, and Sport to develop national health IT initiatives and standards. The NICTIZ has worked to develop the national health IT infrastructure called AORTA. AORTA includes a national registration system for patients, health care workers, and insurers in the Netherlands. It also includes a system for authenticating individuals and authorizing access to medical records.[222] The Netherlands has chosen not to pursue a centralized national EHR system (like Finland and the United Kingdom), but rather to use a decentralized system that uses a record locator service to point to medical data stored in regional databases. A central component of this effort in the Netherlands is the National Switch Point (Landelijk SchakelPunt or LSP in Dutch), the basic infrastructure for national electronic data exchange of medical data between health care providers. Operational as of 2007, the LSP provides the foundation for the development of a nationwide "virtual" EHR for patients. In addition, the LSP is used for e-locum services (after-hours services) for patients to see doctors other than their primary care providers. The government of the Netherlands is funding the development of the LSP through its initial startup phase, and all health care providers in the country can use it at no cost. The NICTIZ has defined a number of requirements providers must satisfy to connect to the LSP, including using certain privacy and security features.[223]

In the United Kingdom, the NHS has invested in national IT projects that are efficient because of their large scale or that work more effectively because all users are using the same application or service. For example, the NHS has developed NHSmail, a secure e-mail, SMS, fax and directory service for NHS staff. The NHS was uniquely positioned to provide a secure platform for transmitting patient data because it could encourage all NHS employees to participate. The NHS wisely did not limit the service to its own staff but also opened the service, at no cost, to NHS partners, such as pharmacists and dentists. In simple economic terms, the value of the network increases as the number of users increases, and in this case, the NHS benefits from creating a more efficient health care system. As of early 2009, NHSmail has over 400,000 registered users.[224]

In comparison to these leading nations, the United States has done little to develop common infrastructure. The most notable common infrastructure project funded by the U.S. government is the Veteran's Health Information Systems and Technology Architecture, or VistA, an open-source EHR software package. Developed by the U.S. Department of Veterans Affairs over two decades at a cost of several billion dollars for use in VA hospitals, the software is now open-source and freely available for any medical group to implement or further develop. The idea of using the VistA software more widely in the United States has been promoted by Sen. Rockefeller (D-WV) who has introduced S. 890, the "Health Information Technology (IT) Public Utility Act of 2009," to provide grants to safety-net and rural hospitals to fund the implementation of government-supported health IT applications, including VistA and the Resource and Patient Management System (RPMS), of the Indian Health Service. The legislation would also create a federal board tasked with updating the open-source software and introducing new software modules as needed. Critics of this approach point out that even with no licensing fees for software much of the cost of an EHR system is in the implementation, support, and hardware.[225]

In addition, the U.S. federal government has funded the development of CONNECT. CONNECT is open-source software that federal government agencies have developed to connect their information systems to other health IT systems participating in the national health information network. It consists of three primary software modules that provide organizations access to core network services, basic enterprise functions, and a client framework for further development of end-user applications. More than 20 federal agencies jointly funded the development of CONNECT and purposely created the software under an open-source license so other agencies could reuse the software without incurring additional licensing costs. In addition, CONNECT was made publicly available in 2009 to help accelerate adoption of health IT systems.[226]

Robust Standards to Support Health IT

Robust standards are critical to the effective application of health IT and play an important role in spurring the use of new technology. The Digital Imaging and Communications in Medicine (DICOM) standard introduced in the early 1990s, for example, facilitated the development of Picture Archiving and Communication Systems (PACS)—computer systems dedicated to the storage, retrieval, distribution and presentation of medical images.

To facilitate the standard-setting process, many governments actively engage with all stakeholders, including those from the private sector, to coordinate the development of standards.

Standard terminology, nomenclature, data formats and certification requirements facilitate interoperability between unrelated health IT applications, help ensure patient safety, and help deliver better quality care.[227] While various international standards setting organizations, such as Health Level 7 (HL7), International Organization for Standardization (ISO) and the European Committee for Standardization (CEN), have made extensive progress in developing usable standards, standards must still be approved at the national level.

To facilitate the standard-setting process, many governments actively engage with all stakeholders, including those from the private sector, to coordinate the development of standards. In Denmark, for example, MedCom, the Danish health care organization responsible for setting standards for health IT systems, acts as a coordinating body to bring together health care providers, laboratories, vendors, and others to the table to develop standards. As Finland develops its new centralized EHR system, the Ministry of Social Affairs and Health has created a number of working groups to define various standards including core data elements, interfaces, data security and document metadata. Finland's Ministry of Social Affairs and Health has sought to achieve national consensus on standards through its working groups that include health care professionals, IT vendors, and experts from the hospital districts.[228]

Nationwide uniformity between standards and their various versions helps ensure interoperability between different implementations of health IT systems. Some countries must also develop localization projects to adapt standards to their needs. A key pillar of Sweden's e-health strategy, for example, is to create a common information structure. Sweden has initiated a number of projects to create a national information structure for developing future health IT applications. In addition, the country has made efforts to standardize clinical documentation, especially for EHRs. Sweden expects to complete a national interdisciplinary terminology for health care concepts and terms using the Systematized Nomenclature of Medicine (SNOMED). The goal is to create an unambiguous set of terms translated into Swedish by 2011.

In Finland, regional authorities have significant independence in delivering health care, and many regions have adopted different EHR systems. As a

result, interoperability has been a challenge. In the absence of an interoperable national EHR system, Finland has had success in developing a widely used "reference directory" that contains patient record location information.[229] In addition, in 2003, Finland's Ministry of Social Affairs and Health, the government organization responsible for setting the nationwide e-health strategy "defined the common semantic and technical structure that should be utilized in every [EHR] system in all organizations."[230] Included in the strategy were national guidelines to ensure security, privacy, and interoperability, such as the use of a public-key infrastructure, informed consent, and open standards.

Early efforts in Denmark to exchange data used EDIFACT as the primary standard for electronic communication. Since then Denmark has initiated the use of XML standards for data exchange. MedCom simplified data exchange by replacing the hundreds of different paper-based letters used for various processes, such as discharge letters and referral letters, and replaced these with a single, electronic letter. By standardizing these forms for health IT vendors, MedCom has facilitated interoperability between various local hospital systems that can now exchange data.[231] The Danish government has also focused on translating and distributing the SNOMED CT nomenclature. The government spent €2.7 million to translate SNOMED CT and will in the future make it available to health IT vendors to implement in systems.[232]

In the United States, the 2009 stimulus bill—the American Recovery and Reinvestment Act— gives authority to the Office for the National Coordinator of Health Information Technology (ONC) within the Office of the Secretary of Health and Human Services to coordinate the development and adoption of health IT standards. Specifically, the ONC is responsible for establishing a health IT standards committee and evaluating and developing "standards, implementation specifications, and certification criteria" to achieve nationwide adoption of health IT technology and gives the federal government more control over the standard-setting process.[233] While formalized in the American Recovery and Reinvestment Act, the national coordinator for health IT has been responsible for developing data and communication standards and certification requirements since 2004. However, progress on standards harmonization has been slow, in part because of a resistance by the former administration to have strong federal involvement in standards development.[234] Under the American Recovery and Reinvestment Act of 2009, the ONC is also responsible for working with the National Institute of Standards and Technology (NIST) to recognize one or more organizations in the United States that will create voluntary certification programs to evaluate if a health IT systems qualifies for stimulus funds. As of August 2009, the Certification Commission for Health IT (CCHIT) was the only authorized health IT certification organization in the United States.

Health care claims and billing systems rely on a system of codes for electronic transactions that correspond to various conditions and procedures. The United States currently relies on a coding system developed about 30 years ago known as ICD-9. Most other developed countries (including Denmark, Finland, Sweden, Australia, and the United Kingdom) have already moved to a newer system called ICD-10. ICD-10 has 155,000 codes to define various ailments and procedures—10 times as many codes as ICD-9 has. Moving to ICD-10 in the United States would also allow more accurate billing for specific procedures and introduce new administrative efficiencies. Even more importantly, however, the improved and expanded codes for medical services and diagnoses in ICD-10 are needed to develop good EHR systems. The additional codes in ICD-10 provide additional and more detailed information that can be entered into patients' EHRs and could also be useful in clinical research and disease monitoring. The Centers for Medicare and Medicaid Services in the United States has estimated that the cost of moving to ICD-10 in the United States will total $1.64 billion over 15 years and entail more billing errors in the short term. The U.S. Department of Health and Human Services (HHS) issued a rule that would have required health care providers in the United States to adopt ICD-10 by October

2011 for all electronic transactions; after numerous objections were raised, HHS extended the deadline to October 2013.[235]

Use of Unique Patient Identifiers

A core function of any national health information system in which patients' medical data are spread across multiple health record databases is to identify and link patients' medical records. A record locator service must be used to ensure patient records are correctly matched from each database. Two principal methods exist for identifying and linking patient records from different databases. The first is unique patient identifiers. The second is statistical or probabilistic matching. Unique patient identifiers help facilitate data sharing between different health care organizations, and many health information systems around the world rely on the use of unique patient identifiers to locate records. Much like a passport number or a driver's license number helps distinguish between two individuals with similar names, a unique patient identifier is a unique key used to index every patient's record. This unique identifier can be used to quickly and easily pull data for a patient from multiple databases to create a complete patient record from a distributed set of data. In Denmark, for example, a unique national identification number is issued to each citizen. This number is routinely used for multiple purposes, including health care, banking, taxes, and pensions, and Danish citizens embraced its use because of the convenience.[236] In Finland, too, a single national identifier is used across various sectors.[237]

Statistical or probabilistic matching—the alternative to using unique patient identifiers to link patients' medical records maintained in multiple databases—uses various algorithms to find matches between patients' records in different databases using data such as name, date of birth, and mailing address. Such matching is not perfect. If there are two John Q. Smiths living in the same region, for example, a computer system may have a difficult time matching records; similarly it may have trouble verifying that the records for John Smith and John Q. Smith belong to the same person. The problem can also be even more complicated when two individuals live at the same address, for example, a father and son that share a name. As one study found, the problem with statistical matching is that the personal attributes it uses "are usually not unique to the individual, change over time, and are often entered into different systems in different formats."[238] The problems with statistical matching are magnified as the size of a health information network increases.

Benefits from unique patient identifiers include reduced risk of medical error, improved efficiency, and better privacy protections for patients. Many of the benefits occur because of the increased accuracy of matching records using a unique patient identifier. As a result, using patient identifiers can help decrease the likelihood of false positives and false negatives. More accurate and complete medical records help enable better medical research, increase patient safety, and improve quality of care. Using unique patient identifiers also ensures more timely medical data and imposes less of an administrative burden on health care providers—with probabilistic matching, a health care provider must sometimes review a record when a possible, but ambiguous, match is found. Such uncertainty can also introduce delays in receiving complete patient information. In addition, using a unique patient identifier actually helps increase patient privacy as no private information needs to be disclosed to match records. Moreover, statistical matching may inaccurately attribute a record to the wrong person, thus compromising an individual's private medical records. Using a unique patient identifier increases the accuracy of patient record matching and thus helps prevent privacy breaches. Improved matching through the use of unique patient identifiers also facilitates medical research and epidemiological studies as longitudinal data can be more easily compiled.

As shown in Table 8, the use of unique patient identifiers is common in many of the global leaders in health IT, including Denmark, Finland and Sweden.[239] Unique patient identifiers are also used in much of the European Union, Australia, and New Zealand.[240] The implementation of unique patient identifiers in different countries

varies. Decisions have to be made about whether to make such identifiers permanent and lifelong, whether the identifier is considered private or public information, and whether the identifier will, by itself, reveal any demographic information. In addition, techniques can be used to use identifiers with check digits, such as what are used in bank routing numbers, which help prevent data-entry errors. The Netherlands, for example, uses the Citizen Service Number (BSN), a unique identifier much like the social security number in the United States, to identify patients. The Dutch government mandated the use of the BSN in 2006 as a necessary step towards achieving nationwide interoperability of health information. The Ministry of Health also runs the Unique Healthcare Practitioner Identification (UZI) system to provide identification and authentication of health care providers. Providers use an UZI smart card to sign electronic transactions such as prescriptions or letters of referrals. These electronically signed transactions have the same legal status as documents with paper signatures. The Netherlands has a separate registry for health care insurers. Insurers receive a Unique Health Insurer Identification and a digital certificate to use to securely exchange data online. In the United Kingdom, Dr. Peter Drury, head of information policy in the department of health stated: "We came to a conclusion in 2002. I don't think you can do it [create an EHR] without a national identifier."[241] The NHS in the United Kingdom is working to fully implement a national identifier solution as many hospital information systems still rely on a local numbering system. As a result of this slow progress, over 1,300 incidents involving patients' identifying numbers were reported to the National Patient Safety Agency between June 2006 and August 2008.[242]

In Canada, Health Infoway does not have a national unique identifier for each patient; instead, each province manages patient identifiers for its own region. In effect, though, this has created a federated system of unique patient identifiers for Canada.

Table 8: Use of Unique Patient Identifiers in Seven Developed Countries

Country	Uses a National Patient ID?
Australia	Yes
Canada	Partial (Provincial) *
Denmark	Yes
Finland	Yes
Netherlands	Yes
New Zealand	Yes**
Sweden	Yes
United Kingdom	Yes
United States	No

* Provinces in Canada assign patient IDs.
** Every health system user in New Zealand, including tourists, receives an ID.[243]

The United States has not adopted a system of unique patient identifiers. The decision not to adopt a system of unique patient identifiers has been supported strongly by many groups, including the Markle Foundation's Connecting for Health program, a public-private partnership engaged with developing policy and technical recommendations to promote the development of health IT in the United States. Groups such as Connecting for Health have called for a decentralized and distributed health IT architecture in the United States with no unique patient identifiers in an effort to preserve patient privacy and promote data security.[244] However, a decentralized health IT architecture does nothing to further these goals because privacy and security can be integrated in many different types of system designs. Originally, the Health Insurance Portability and Accountability Act of 1996 (HIPAA) included plans to develop a system of unique patient identifiers; however, privacy and security fears derailed the process, and federal efforts to link regional health information organizations using a national unique patient identifier have been halted.[245] Instead, the effort to develop a national health information network in the United States is relying on the use of a system of interconnected patient indexes that rely on statistical matching. Researchers have noted that the lack of a unique patient identifier in the United States is a hindrance to using data from EHRs for research.[246]

Part III: Conclusion

Our analysis in this report indicates that several developed countries—including Denmark, Finland, and Sweden—are clearly ahead of the United States in moving forward with their health IT systems. Some of the factors that influence health IT, including the type of health care system, are entrenched in the nation and not likely to change. Yet other factors, including organizational challenges, technical hurdles, and societal issues, are more amenable to change by national policy. Our analysis also demonstrates that national government policies can play an important role in shaping and facilitating a country's health IT adoption and use. Although there is no one-size-fits-all set of rules for achieving widespread health IT adoption, government policymakers can learn many lessons from global health IT leaders about how to spur progress in modernizing their health care systems.

Achieving widespread health IT adoption requires bringing together multiple actors in the health care sector with competing interests to work towards a common goal. As discussed in this report, strong national leadership is needed to coordinate the actions of these various health care stakeholders. A key theme across every nation leading in health IT adoption is national-level leadership, either from a government agency or a public-private partnership, responsible for setting goals, measuring progress and overcoming barriers to adoption. Another common policy tool found in many of the countries leading in health IT adoption is the use of incentives and mandates. Many health care organizations are resistant to change, for various reasons including market failures, and so policymakers must use both carrots and sticks to spur technology adoption. Incentives should ideally be tied to performance requirements that reward health care providers for using an IT system that generate proven health care benefits or savings. Mandates should be used to achieve ubiquitous adoption and ensure health IT system upgrades stay on schedule.

Policymakers need to address various technical challenges posed by health IT. For example, interoperability continues to be a significant impediment to more widespread health IT adoption in many countries. Developing common infrastructure can help overcome some of these interoperability challenges as health care organizations would be using the same systems. In addition, developing common infrastructure, such as electronic billing or e-prescribing systems, gives health care providers more of an incentive to invest in their own IT systems. While health IT systems confer some benefits on health care providers irrespective of the level of adoption among other health care organization, because of positive network externalities, the benefits are greater with more widespread adoption. Policymakers can also help overcome interoperability challenges by bringing together various stakeholders to set standards for electronic data exchange, such as data standards and the use of a unique identifier.

Policymakers may not be able to change all of the societal and cultural issues affecting adoption rates of health IT, but they can respond to them. For example, with regards to privacy, policymakers should establish clear functional requirements to protect patient data and the appropriate legal safeguards to prevent the misuse of private patient information in the event of disclosure but allows for appropriate data sharing. Policymakers should also be cognizant of the need to ensure policy stays current with technology and that regulatory barriers preventing the use of health IT applications, such as telemedicine in Japan and South Korea, are remedied promptly. In addition, policymakers must ensure that national standards setting organizations work cooperatively with all stakeholders to promote health IT adoption and best practices. Finally, policymakers should remember that a nation's e-health strategy should be part of a larger agenda to create a fully connected information society since many aspects of health IT require, or are enhanced, by conditions such as fast and affordable broadband Internet, a digitally literate population and other technical achievements such as robust electronic identification and authentication systems.

Part IV: Recommendations for U.S. Policymakers

Health care is increasingly an information-rich field. Every health care encounter creates hundreds of new data points, from blood pressure readings to lab results to drug prescriptions. Every day, millions of new bits of health data are created in hospitals, laboratories, and clinics around the world. To succeed in this environment every person involved in health care, from patients to doctors to insurers, must be equipped with the tools and information needed to make effective decisions. While IT systems have been used in medical settings since their inception, the latest advancements in IT such as low-cost mobile personal computers, wireless connectivity, and broadband Internet access have created an entirely new platform for providing health care applications. IT offers many opportunities for managing this wealth of information to improve quality of care, reduce health care costs, increase access to health information, and increase convenience. In addition, all of this raw data offers medical researchers many opportunities to develop new knowledge through technologies like rapid learning health networks.[247]

Learning from past successes and failures is a critical component of evidence-based medicine—the practice of using the best available evidence on the risks and benefits of possible treatments to make decisions about health care. Medical researchers constantly look back at past performance to determine the efficacy of current treatment strategies and find potential new treatments on the horizon. Policymakers must similarly turn to rigorous analysis when shaping the health care policies and priorities within their jurisdiction. Given the importance of health care to quality of life and the billions of dollars invested in health care each year, it is not enough to simply find a strategy that works—policymakers must constantly strive to build the best health care system possible. Mistakes will be made, and policies must be reviewed and revised as lessons are learned and new best practices emerge. However, to make these improvements, national health care leaders must learn from the past performance of not only their own health care system but also that of their neighbors.

The United States has many opportunities to improve its use of health IT by learning from the global leaders in the field. Some of these lessons mentioned in this report have already been implemented in the health IT provisions of the American Recovery and Reinvestment Act of 2009. The next important step is for the U.S. Department of Health and Human Services (HHS) to define "meaningful use" for qualified health IT systems. HHS must ensure that meaningful use not only includes important performance requirements but also interoperability and reasonable privacy standards. Further actions for policymakers to spur use and maximize benefits of health IT include the following:

- **Provide strong national-level leadership on health IT.** Every nation leading in health IT has a comprehensive national strategy for e-health, with clear metrics and goal posts to measure progress. Strong national leadership is needed for the United States to break through existing barriers on health IT adoption and make progress towards a future of interconnected health data systems.

  Much of this leadership should come from the Office of the National Coordinator for Health Information Technology (ONC) within the Office of the Secretary of Health and Human Services, which was directed by the American Recovery and Reinvestment Act of 2009 to revise the Federal Health IT Strategic Plan published in 2008 and to continue to track its progress.[248] In addition, the current administration must ensure that the ONC receives the support and resources needed to carry out its mission.

- **Provide sufficient funding for health IT adoption.** The American Recovery and Reinvestment Act of 2009 has provided a needed boost in funding for deploying EHR systems in the United States. As some have

noted, the funds available for EHR systems may be insufficient to spur the needed change by some providers. In addition, the total cost of implementing health IT exceeds the level funding in the stimulus package: RAND predicts that implementation of EHRs by all medical practices would cost approximately $8 billion per year over 15 years.[249]

If necessary, Congress should consider providing additional financial incentives, including entitlement spending and direct grants, or the use of mandates and penalties, to spur adoption of qualified EHR systems. Congress should also continue to fund pilot programs and demonstration projects for innovative, new applications of health IT, including telemedicine, health record data banks and "smart" hospitals. For example, Congress could fund the deployment and evaluation of next-generation hospital IT applications, including robotics, wireless mobile technology, and RFID, in select hospitals within the Veterans Health Administration.

- **Build and share tools for health IT.** Although the United States has pursued a decentralized approach to building a nationwide system of interoperable EHRs, as other nations have demonstrated, policymakers should support efforts to build common infrastructure to spur more widespread adoption of health IT systems. In particular, the United States would likely benefit from the development of common infrastructure for routine tasks, such as electronic authentication for patients, which should be performed by every health care information system.

  Although additional development of the national health information network may occur through continued development of CONNECT by federal agencies, shared tools that help spur health IT adoption do not have to be developed by the public sector. The SureScripts e-prescribing network, for example, has a large enough market share that it effectively acts as a common infrastructure for electronic prescribing services in the United States. Similarly, in New Zealand, the privately-owned company HealthLink provides electronic messaging services to most of the health care sector, and the government uses its services to communicate with health care providers.[250] In cases where de facto national tools have been developed by the private sector, the federal government can support these tools by actively using them.

- **Encourage the creation of health record data banks.** Many countries appear to be moving towards a centralized repository for health information. Given the resistance to a government-run solution in the United States, health record data banks run by the private sector may offer a compelling alternative. Health record data banks would help create the necessary market incentives to spur adoption of EHR systems and provide patients with a single portal through which they could get access to and manage their medical records. They would also allow patients to maintain control over their medical records.

  Health record data banks would help create the necessary market incentives to spur adoption of EHR systems and provide patients with a single portal through which they could get access to and manage their medical records.

  Congress should pass legislation supporting the creation of health record data banks.[251] In the 110th Congress, Rep. Moore (D-KS) and Rep. Ryan (R-WI) introduced H.R. 2991, the Independent Health Record Trust Act, which would establish federally regulated health record data banks. This legislation establishes a fiduciary duty for each health record data bank to act for the benefit of its participants and prescribes penalties for a breach of these responsibilities. In addition, the legislation prohibits data bank operators from charging fees to health care providers for accessing or updating an EHR to which they have been

given access. This proposal has been included in other recent health care reform legislation including H.R. 2520, sponsored by Rep. Ryan Paul (R-WI), S. 1099, sponsored by Sen. Tom Coburn (R-OK), and S. 1240, sponsored by Sen. Jim DeMint (R-SC).

- **Encourage personal health records with data sharing.** A personal health record is a health record that is initiated and maintained by an individual. Individuals need access to their EHRs, maintained by health care providers, to use personal health record systems such as Microsoft HealthVault and Google Health, which help empower patients to make better health care decisions.

  The Health Insurance Portability and Accountability Act (HIPAA) established the right for individuals in the United States to obtain a paper copy of their health care records from their doctors, but under the current law, health care providers can charge fees associated with the cost of copying and mailing paper health care records. The American Recovery and Reinvestment Act of 2009 established the right of patients to obtain an electronic copy of their medical records from health care providers that maintain an EHR, but again, health care providers can charge a fee to receive this information.

  To encourage the use of personal health records, Congress should update this legislation to require doctors to provide patients with a no-cost electronic copy of their health information upon request.[252] In addition, the ONC should include the ability to export data to personal health record managers as part of the definition of "meaningful use" used to determine which EHR systems qualify for stimulus funding.

- **Address legitimate privacy concerns.** Privacy advocates have raised many objections to health IT initiatives that have slowed progress with this technology in the United States. U.S. policymakers need to recognize that some privacy objections have more to do with general issues concerning medical privacy than with specific technology. Preventing discrimination by employers or insurers who learn of an individual's preexisting medical condition, for example, is a policy issue that must be addressed regardless of whether the source of information about the individual's condition was in paper or digital form.

  Taking a lesson from some of the global leaders in health IT, U.S. policymakers should encourage the use of technical controls to ensure privacy such as the use of electronic identification, authentication and audit trails in health IT systems. In addition, a national discussion is needed so that policymakers and the public fully understand the costs that certain privacy measures impose on society and the benefits that come from a more liberal data-sharing environment, such as better use of decision support systems and improved medical research.

- **Eliminate barriers to health IT adoption.** Policymakers in the United States must work to identify and overcome existing barriers to the adoption and use of health IT—including legislative, regulatory, and societal obstacles. Thus, for example, policy leaders must continue to work with the Drug Enforcement Administration to pass regulations to allow physicians to prescribe controlled substances electronically.[253] In addition, the Centers for Medicare and Medicaid Services should be directed to ensure that it develops fair reimbursement regulations for telemedicine. Finally, national leaders should ensure that an adequate workforce exists to implement health IT investments and provide workforce training if needed.

- **Leverage federal resources to support health IT initiatives.** The federal government is the single largest health care payer in the United States, spending more than $600 billion annually on 80 million Americans through programs such as Medicare, Medicaid, and the Children's Health Insurance Program (CHIP).[254] Congress should use the federal

government's substantial buying power to support health IT initiatives.

To help spur the adoption and use of health IT, Congress should cover the monthly access fees to participate in a health record data bank for all Medicare, Medicaid, and CHIP enrollees. In addition, Congress should require that health plan insurers for federal employees include access to health record data banks as part of their covered services. Because supporting broader use of health IT will lead to cost savings for health care payers, in this case the federal government, this strategy will help ensure a positive return on investment for federal health care dollars.

- **Encourage "in silico" health research.** Ultimately health IT has the potential to dramatically improve the quality of medical research as more and more medical data is digitized. To benefit from the full potential of health informatics, the United States should develop the capability to share medical data for authorized research in a timely and efficient manner.[255] This includes developing a comprehensive legal framework to address challenges to sharing research data, such as the appropriate use of de-identified medical data. Policymakers should also consider functional requirements for EHR systems to allow the secondary use of medical data for research. As an example, HHS should consider the importance of secondary use of medical data as it develops interoperability requirements and other standards in its evolving definition of "meaningful use" that will determine how funds are spent from the 2009 stimulus package.

  To gain access to important patient data, many current or proposed projects subject health care providers to an additional layer of reporting requirements rather than building a comprehensive solution for medical data research. Instead, the goal should be to develop a national data-sharing infrastructure to support health informatics research, including the development of rapid-learning health networks, rather than to just create isolated, project-specific research databases.[256]

- **Collaborate and partner with all stakeholders.** Stronger federal leadership in health IT in the United States should not come at the expense of a collaborative relationship with other health care stakeholders. The federal government should work to bring together health care providers, insurers, and the health IT industry to spur meaningful use of e-health applications. The U.S. government must partner with the private sector to continue to develop standards and certification criteria for health IT systems. Health care providers must be involved throughout the planning and implementation stages to ensure widespread acceptance from physicians and health care workers. As other countries have seen, positive peer pressure has been identified as an important factor that influences the adoption of health IT systems.[257] In addition, the United States should seek out more international partnerships to engage in the development of global standards for health IT and to continue to learn from the insights and experiences of the global leaders in health IT.

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