Comparing EMR Adoption in Europe and the United States

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Introduction

A 2011 Commonwealth Fund report based on 2009 data stated that the U.S. “lags behind many other countries in the adoption of electronic health records” (Gray, 2011). A more recent report from the Commonwealth Fund compares EMR adoption in the three years following the initial report and found that the US has made significant progress with EMR adoption, due to incentive programs like Meaningful Use, but still lags behind Europe (Schoen & Osburn, 2012). This report explores the adoption of electronic medical records in Europe to determine what if any lessons may be learned that apply to EMR initiatives in the United States.

The nations of Europe are hardly homogenous with a variety of healthcare systems and EMR adoption rates. HIMSS Analytics Europe published a report in 2011 rating EMR adoption in eight European countries (Buddrus, 2011). The report used the HIMSS Analytics EMR Adoption Model to illuminate the significant variation in adoption rates between countries within Europe. The HIMSS Analytics EMR Adoption Model or EMRAM is an eight stage model, developed by HIMSS Analytics, to rate and track the progress of organizations on their maturity and use of EMR systems (Buddrus, 2011). Stage zero represents an organization that does not have the basic elements of an EMR system installed. At full maturity, stage 7 organizations have all EMR features installed and functioning including interoperability with external systems and are fully leveraging the data collected for analytic purposes (Figures 1a and 1b).

To study the range of variations in Europe, four countries, the UK, Germany, Sweden and Denmark were selected for case studies. To determine if population size played a role in EMR adoption, two larger and two smaller countries were selected. Countries were also selected for an assortment of different healthcare payment and administrative models, from centralized to decentralized, to see what effect healthcare system organization had on EMR adoption. Finally,
two of the selected countries had successful EMR adoptions while the other two countries’ were not as successful.

A wide range of factors influenced EMR adoption rates in different parts of Europe. Europe has both centralized and decentralized healthcare systems, although many are going through significant changes in structure and levels of local control (Saltman, Vrangbaek, Lehto & Winblad, 2011). By comparison, the US healthcare system has been described as neither, instead as being a “conglomeration of private, public and charitable organizations and institutions, which provide healthcare through what has been called ‘a confusing maze’ of hospitals, clinics and individual physicians” (Armstrong et al, 2011 p383).

The percent of US primary care physicians using an EMR in 2012 was 69%. In the UK EMR adoption was reported at 97% while in Sweden it was 88% and in Germany it was 82% (Thomson, Osborn, Squires & Jun, 2012). Denmark reported that virtually all physicians use EMR systems (Gray, 2011). These numbers are a bit misleading as they simply report physicians ‘use’ of an EMR. The 2012 Commonwealth Fund report makes the distinction between ‘use’ and ‘multifunctional use’, where at least two electronic functions like order entry management and generating medication lists and patient panels are accessed by the physician. With that distinction, the percentages drop significantly in many countries, particularly in some European countries (Schoen, 2012).

The US population far exceeds the population of the countries researched for this project. In 2010 the US population was 309,051,000, Denmark’s was 5,548,000, Germany’s was 81,777,000, Sweden’s was 9,378,000 and the UK’s population was 62,231,000 (Thomson et al, 2012). In 2010, the number of physicians per 1,000 in the U.S. was 2.4, the UK was close at 2.7 while in Sweden it was 3.8, Germany it was 3.7 and Denmark it was 3.5 per 1,000 (Thomson et
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US spending on healthcare as a percent of GDP was 17.6% in 2010. The closest of the European countries was Germany at 11.6%. In 2010, Denmark spent 11.1% of GDP on healthcare, while Sweden and the UK each spent 9.6% of GDP on healthcare (Thomson et al., 2012).

In addition to population size and healthcare organization in each country, other aspects of the EMR initiatives such as governance and leadership structure of the project, the use of incentives to motivate stakeholders, the approach used to deploy features and functionality, piloting strategies and many other unique characteristics were examined to determine what caused EMR adoptions to fail or succeed.

**United Kingdom (UK)**

**Healthcare System Structure:** The United Kingdom’s National Health Service (NHS), was founded by Aneurin Bevan on July 5th, 1948. The NHS is available universally and cares for people based on need and not ability to pay. The NHS is funded through taxes and national insurance contributions (Grosios, 2008). Each country in the UK adopted its own distinct healthcare structure and organization. In 2008, the NHS in England employed over 130,000 doctors and 400,000 nurses. Healthcare expenditures range between £1,676 and £1,919 across UK. Providers of "primary care" are the first point of contact for patients. These include over 36,000 general practitioners (GPs) in England, working in over 8,300 practices (NHS, 2013).

The National Institute for Health and Clinical Excellence (NICE) was established in 1999 and is responsible for developing national guidelines and standards related to health promotion and prevention and assessment of new and existing technology (NHS, 2013).

**Healthcare Funding:** Organizations known as "commissioners" manage planning and purchasing for the NHS. Commissioners can buy services from any provider that meets NHS standards of
care and prices (NHS, 2013). In the UK, healthcare is a publicly-funded and the NHS accounts for 86% of total healthcare expenditure. The NHS is mainly funded through general taxation (76%), national insurance contributions (19%) and user charges (5%) (NHS, 2013). Most GPs are paid directly by primary care trusts (PCTs) through a combination of methods including salary, capitation and fee-for-service (NHS, 2013).

**EMR Project Overview:** In 1997, the Labour government began to pursue a central technical infrastructure known as the “Spine” and shared, national electronic records. The National Program for Information Technology (NPfIT) in England was established in 2005. It aimed to provide secure, nationally integrated electronic records as part of a wider political vision. Implementation of the summary care records (SCR) began in 2007. The SCR were to be drawn from the electronic records held by practitioners (Greenhalgh, 2010a).

In Scotland, a basic CPOE prescribing program was developed by Dr. David Feguson in 1984. By 1994, the General Practice Administration System for Scotland (GPASS) was used by 800 practices (Protti, 2006). By 2011, a basic version of the Scotland’s Emergency Care Summary (ECS) was connected in 100% of general practices across Scotland (Greenhalgh, 2013b).

**Reasons Behind Implementation:** In 2009, NICE assumed responsibility for the development of pay-for-performance measures to ensure cost-effective care (Blumenthal, 2012). Personal electronic health records, managed by patients and interfacing with clinician held records, were seen as having a key role in the new care model, by facilitating storage and exchange of information, supporting continuity of care and promoting engagement and self-management (Greenhalgh, 2010b). In the UK, as in the US, there is increasing interest in the potential of information technology (IT) to enhance the safety, quality and efficiency of healthcare. Among
the many anticipated benefits of the EMRs were improved communication between different healthcare providers, better availability of information, reduced medical errors, improved organizational functioning and more streamlined work practices (Cresswell, 2012).

**EMR Funding:** Funding for the project came from the NPfIT initiative, financed by the NHS and the government. Accurate and reliable SCRs depended on the data quality of the local records from which they were created. From 2007 to 2009, a national incentive scheme funded work in general practices to achieve data quality targets, but funding for this was not renewed in 2009. By then, the program had accumulated a staggering cost of £7.3 billion (Greenhalgh, 2010a).

**Legal Framework:** The NPfIT faced multiple legal regulations and there was a lack of consensus in regards to patients’ privacy. A shift in patients consent strategy created confusion and delayed the rollout of the SCR. The program required the highest technical security standards, which users found bureaucratic, intrusive, and unworkable. Fear of surveillance stopped some medical staff from attempting to use the SCRs altogether (Shiekh, 2011).

**Physician Adoption:** England is well ahead of the US in the adoption of electronic health records in the primary-care sector, but has struggled to create a hospital system and to link inpatient and outpatient care electronically (Blumenthal, 2012). A number of general practice record systems were not compliant with the SCRs, and practices using these systems were unable to participate in the program without replacing in-house systems (Greenhalgh, 2010a). In general, the use of SCR by clinicians was low for a variety of reasons including inadequate data quality, inadequate technical infrastructure, opposition to the program, and competing priorities (Shiekh, 2011).

**Interoperability:** Similar to US, there are a vast number of disparate systems used by various GPs. The strategy used by England’s NHS was to introduce a set of national standards ensuring interoperability and relied on local health-care providers to develop and link local data
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(Blumenthal, 2012). However, there is still a lack of EMR interoperability between GPs and hospitals in England (Blumenthal, 2012).

**Key Results:** The adoption of EMRs across England was met with limited success. The latest report from the National Audit Office reports that 98% of the estimated benefits of the SCR, have yet to be realized (Waterson, 2013). However, in Scotland, the adoption was very successful. In Scotland, a small number of enthusiastic clinicians led the program from the outset with minimal input from government. In England, on the other hand, the technology and associated vision was announced by a top politician (Greenhalgh, 2013b). The solution in Scotland was focused on a limited set of core features. Conversely in England, the team was trying to solve many problems at once (Greenhalgh, 2013b). While, in Scotland, there was focused alignment of priorities on cooperation and improvements to patient care, in England because of a strong focus on technology, clinical engagement and fit to NHS requirements and workflow was from the start considered by many to be poor (Greenhalgh, 2013b). The expectation in England for the system to do everything at once after its initial implementation was highly unrealistic. When benefits anticipated by policymakers were not immediately evident, enthusiasm waned significantly (Greenhalgh, 2013b). In Scotland, on the other hand, there was no official independent evaluation. Without the political pressure, Scotland’s system was allowed to ensure that the base functionality of its EMR system worked.

In summary, the failure of the EMR adoption in England was due to flawed concept, flawed product design, flawed implementation and embedding, and flawed timing. Many NHS Trusts found that a common EMR was not ‘fit for purpose’ within their organizations (Waterson, 2013)
Challenges: The overall adoption of EMR in England was met with a variety of challenges. England had to implement a nationwide EMR system to manage a huge population of over 50 million people. This increased the complexity of the project substantially. Other technological and social challenges included a lack of synchronization between the system and clinical workflows, doctors who were poorly prepared to make appropriate decisions about what EMR system to purchase (Shiekh, 2011), high initial financial costs with uncertain financial benefits, high initial physician time requirements, difficulties with the technology, inadequate support for difficult complementary changes, lack of adequate electronic data exchange between the EMRs and other clinical data systems, lack of incentives and physician attitudes against the process (Kaye, 2010). The combination of the above mentioned challenges made it almost impossible for England to rollout a nationwide EMR solution.

Current Status: The implementation of EMRs in England was a "huge disaster [that] became impossible to deliver" (Cross, 2011). There is little or no communication between the various systems to form a truly integrated EMR. As the world enters into a period of austerity, England has to find ways to reduce costs and improve the quality of its healthcare system. Both the US and England are introducing similar modifications to health care payments including value-based purchasing and pay-for-performance programs, and not paying for cost incurred for ‘never events’ (Blumenthal, 2012). In order to meet these objectives, it is vital for England to move forward, learn from its initial failure and adopt a socio-technical, clinically driven, universal EMR system. Specifically, the next 10 year strategy recognizes that developments have to be local in order to meet local needs and that establishing standards for interoperability must be one of the top priorities for implementation (Greenhalgh, 2013a).
Discussion: The UK health system serves as an interesting model for the international community to learn what does and does not work in EMR adoption. In particular, it can be seen that adoption of EMRs worked really well in Scotland, but not as well in England. While it is true that most of the GPs in England have adopted some form of EMR in their private offices, the various EMRs do not communicate with each other. The lack of standards and underlying infrastructure was one of the reasons for this shortcoming. In addition, hospitals in general, have not adopted EMRs. This is similar to the situation in the US, in which hospitals’ HIT systems consist of many disparate legacy systems that were added as the need arose and hospitals do not see the need to disrupt workflow in order to integrate the systems. This has led to the lack of information exchange between hospital systems and physicians’ private systems. The adoption and use of a patient’s summary care record (SCR), similar to the continuity of care records (CCR) used in the US, was low in for a variety of reasons including non-availability of records, technical glitches, low levels of training and motivation, information governance issues and fear of surveillance (Greenhalgh, 2013b).

Yet, the key reason for the failure of EMR adoption in England was that the initiative was introduced by the government in a top-down approach. The program in England was led by politicians and IT personnel, instead of being led by clinicians and local communities. In addition, instead of keeping the requirements simple, England’s approach was filled with a multitude of requirements from different stakeholders (Kaye, 2010).

Critical Success Factors: A manageable population size of less than 5 million people as demonstrated in Scotland may be key to success. In addition, the Scottish program was locally led by a small group of clinicians with minimal input from the government.
Furthermore, a successful program would utilize a restricted number of vendors. Privacy concerns are of particular importance, therefore, issues such as security and privacy must be discussed at length. However, the solutions implemented must be pragmatic and simple. Other critical success factors include, a pace of progress commensurate with levels of engagement and tension for change, early and frequent dialogue between key stakeholders to develop a culture of collaboration, systematic attention to potentially contentious issues, strong peer influence, careful alignment of incentives for both individuals and organizations, transparency in monitoring and evaluation and balancing central and local leadership (Greenhalgh, 2010a)

**Similarity with USA:** The healthcare system in England is similar to the US in some aspects. The various GP private practices worked independently of one another, with little or no EMR exchange amongst practices or with hospitals. Both countries are changing the way physicians are paid and are exploring the use of ‘meaningful use’ to control the astronomical increases in healthcare costs (Gray, 2011). Other similar initiatives include bundle payments to encourage the coordination of care amongst different providers. Infrastructure wise, both countries are investing heavily in the use of data exchange and message transfer standards to increase interoperability amongst the systems.

The US and UK are facing similar healthcare challenges. For example, unhealthy environments and lifestyles have led to increased obesity and associated conditions such as diabetes and cardiovascular disease. Healthcare services are being transformed from the traditional episodic "disease" treatment, to increased focus on better management of chronic disease, with appropriate disease prevention and personalized medicine (Boyle, 2008).
Germany

Healthcare System Overview: Germany is a federal state with three levels of government: the Federal (Bund), 16 Laender (states) and several hundred local governments (Stroetmann, 2010). The population of Germany is approximately 82 million. While Germany has a history of universal health coverage, the 2009 reform law made participation in health insurance mandatory for all legal residents (Bidgood, 2013). The German Statutory (or public) Health Insurance (SHI) system is part of the evolution of a national social insurance system that was first established in 1883 by Otto von Bismarck.

The founding principles of the healthcare system are ‘solidarity’, ‘subsidiarity’ and ‘corporatism’ (Bidgood, 2013). Solidarity is the concept that everyone contributes to the system to ensure that even those of little means have appropriate access to health services. Subsidiarity means that policy is implemented at the lowest possible level in the structure. Germany has a decentralized system of hospitals, private practices and sickness funds (Bidgood, 2013). In Germany, the Federal government, under the Federal Ministry of Health, and the 16 Laender governments set the legislative framework and mechanisms for the negotiation process that occurs between the ‘decision-making bodies’ regarding the regulation of healthcare delivery. The decision making bodies are the governing boards that represent the interests of groups such as physicians, dentists, pharmacists, drug manufacturers and insurers (or ‘sickness funds’).

Corporatism is reflected in the election of employees and employers to the governing boards of the ‘sickness funds’ to participate in the negotiation process (Bidgood, 2013). In 2004 the Federal Joint Committee, made up of these governing boards, was established to provide a forum for the negotiation process. This Committee is supported by the Institute of Quality and Efficiency along with the Institute for Applied Quality Improvement and Research in Healthcare.
Together they provide recommendations to the Federal Joint Committee on the cost and effectiveness of drugs and procedures (Blumel, 2012).

In 2007 the per capita cost of healthcare in Germany was $3588 or 10.4% of the GDP. The percent of healthcare costs funded by public sources was approximately 76.9%, private insurance covered 9.3% and out of pocket expenses contributed 13.1%. By comparison, in 2007, the US per capita cost of healthcare was $7290, representing 16% of the GDP and the approximate percent of US healthcare costs funded by the public was 45.4%, private health insurance represented 36.2% and out of pocket expenses covered 12.2% (Armstrong et al, 2011). Germany, similar to the U.S. is trying to address rising healthcare costs along with an aging population (Armstrong et al, 2011).

Payment System: The German Statutory Health Insurance system insures approximately 85% of German citizens, 10% are covered under private health insurance and approximately 5% of citizens are covered under special programs for civil servants such as the police and military (Armstrong, 2011 & Bidgood, 2013). SHI is funded through a payroll tax currently set at 15.5% and supplemented by general tax funds. Employees pay 8.2% while employers pay 7.3% (Bidgood, 2012). Employees are free to select from among 154 competing ‘sickness funds’ or health plans (payers). Self-employed individuals and employees whose earnings exceed a threshold can choose to stay in the SHI program or purchase Private Health Insurance (PHI) (Blumel, 2012). The unemployed participate by contributing a portion of their unemployment benefits to SHI. The government pays SHI for the long term unemployed. Patients are not required to register with a specific GP and most sickness funds do not have a ‘gatekeeper’ function. Patients may go directly to specialists. Hospital physicians are almost all salaried employees of the hospitals. Private practice physicians are paid on a fee-for-service basis similar
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to physicians in the US (Knox, 2008). All SHI funds are collected into a central health fund and distributed amongst the varied public insurance companies according to an agreed upon formula based upon the morbidity of each fund’s insured population (Stroetmann, 2010).

**EMR Project Overview:** In 2003, under Chancellor Gerhard Schroder’s “Agenda 2010” the government passed the Modernization of Statutory Health Insurance Law, primarily meant to address the financial difficulties of that time. This law called for the introduction of electronic health cards for patients and providers. The law also provided for the establishment of a ‘Telematics Infrastructure’ to support these cards and the secure the exchange of patient information (Stroetmann, 2010). The goals of this e-health card project were to “support patient centered care, improve quality and services, reduce costs and provide better data for health system management” (Stroetmann, 2007). The intent was for the patient to have access to their records and control over who could access their health information. The strategy for establishing the electronic health record was to build a system based upon the use of secure electronic health cards that each patient would obtain. Providers would also be given electronic provider cards uniquely identifying them. The project included the development of applications that would leverage the electronic health cards on behalf of patients, payers and providers. With the patient’s consent and the use of their respective cards the patient could provide the physician access to their electronic health record. The project included the establishment of a secure national infrastructure to use to access and exchange patient information along with the creation of the institutions required to develop and support these services.

**Reasons Behind Implementation:** As mentioned, Germany is facing many of the same issues as the US including rising healthcare costs. Healthcare costs were reported at 11.6% of GDP in 2012, one of the highest in Europe (Thomson et al, 2012). Germany also has an aging
population and wanted to improve the quality of care. Funding is a growing problem since the system is funded primarily by payroll taxes and the population is aging. The ratio of people over age 64 compared to those between the ages 15 and 64, referred to as the ‘Old Age Dependency Ration’ is expected to double from .23 in 2000 to .47 in 2050 (Stroetmann, 2007). Germany has also set a goal to improve the quality of care for chronically ill patients and has identified the establishment of electronic medical records as necessary to achieve this goal (Stroetmann, 2007).

**Key Features of the project:** A key feature of the EMR system involved the establishment of a unique patient identifier across Germany. With patient information dispersed across various payers, providers and pharmacies there was no simple way to associate patient information. The system was designed to be deployed with several ‘mandatory applications’ and an initial list of ‘voluntary’ applications. The platform would allow the application list to grow as the technology evolved. The initial cost of the infrastructure would be justified by the benefit of the initial applications and future applications would benefit from the initial investment. The list of mandatory applications consisted of ‘provision of administrative data’, ‘online insurance verification’, ‘transmission of drug prescriptions’ and ‘provision of data required by European regulations’. Additional ‘voluntary’ applications for ‘drug interactions and contraindication checks’ would also be available in the initial roll out. The initial electronic health card roll out also needed to support a series of voluntary patient data exchange applications such as an emergency data set, physician notes and medication documentation (Stroetmann, 2007). While the e-health card is a Germany project, the European Union has its own eHealth initiative and the German e-health card was later designed to contain the data elements required for EU compliance (Stroetmann, 2010).
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**EMR Funding:** Initial funding for the project was provided by the Ministry for Health. Development, deployment and ongoing operation of the system were to be funded by the SHI along with the private insurers (Stroetmann, 2007).

**Legal Framework:** The project was initiated as a result of the 2003 Law for the Modernization of Statutory Health Insurance. The Ministry for Health initiated the project and has worked through the Joint Federal Committee to develop, deploy and fund the effort.

**Physician Adoption:** According to the HIMSS report on EMR adoption in Europe (Buddrus, 2011), Germany lags behind most other European countries in EMR adoption. While most hospitals have electronic medical record systems, approximately 88% of hospital systems are at stage three or below on the HIMSS adoption model. While almost all physician offices are equipped with computers, they are not equipped for interoperability. According to the eHealth Strategies report, a barrier to fully realizing the benefits of the eHealth Card initiative was the fact that most physician practices and hospitals would need to upgrade their technology infrastructures and systems (Stroettmann, 2010).

Physician adoption became a problem during the initial pilots and led to the suspension of the project in 2009. Within the physician governing board there wasn’t universal acceptance of the information security technology nor the funding arrangements for the acquisition of equipment and services upgrades required to support the project at the physician locations. The payers then said they could not support the effort without the involvement of the physicians. These issues were subsequently addressed when the project restarted in 2010. Full deployment of the new project with reduced scope is expected by the end of 2013 (Flach, 2013).

**Interoperability:** The initial deployment of the e-Health Card system would bring limited interoperability. Basic patient demographic information along with insurance information would
be available for insurance eligibility verification. Standards still needed to be developed and security technologies needed to evolve to enable full interoperability (Stroetmann, 2010). In addition, while almost all physician offices have computers, “in 2007 only 59% of German GP practices were connected to the Internet” and only 40% with broadband connections limiting possible interoperability (Stroettmann, 2010). “Only 3% of German GPs exchange administrative data with other care providers” and “not even 1% of GP practices reported making use of ePrescribing” (Stroettmann, 2010).

Key Results: The Ministry for Health enlisted major consulting firms like IBM and SAP to create a framework and initial technical specifications. A new technology organization was created called Gematik. This organization was funded by the stakeholder governing bodies representing the ‘sickness funds’ (payers), providers, pharmacists, etc. Gematik was charged with defining ‘the technical framework and security concept, the content and structure of data records” and “the testing and certification procedures” (Stroetmann, 2007). Gematik was also responsible for the roll out and ongoing support of a secure infrastructure along with establishing the financial regulations associated with the project deployment (Stroetmann, 2007). The project was initially expected to be deployed in 2006 at a total cost of 2 billion Euros. Delays were announced over the following years and in 2009 the project was officially halted due to concerns regarding patient information security, costs associated with needed equipment and infrastructure in the physician practices and the need to advance the development of interoperability standards (Stroetmann, 2007). In 2010, the project was reassessed and reinitiated on a smaller scale. The scope of the project was reduced to allow time to address the security concerns. The governance of the project was also restructured to create greater collaboration among the various
stakeholders. Specific stakeholder associations were assigned responsibility for deployment activities while Gematik established the foundation for the eHealth network (Stroetmann, 2010).

**Challenges:** The initial effort has been successfully restarted and is currently on track for rollout completion in 2013. However the scope has been significantly reduced in functionality from the initial deployment (Stroetmann, 2010). While there was a conscious effort to empower the stakeholders in the initial project, it may not have been early or effective enough. Germany is a relatively large country with a population of approximately 82 million people with a highly decentralized healthcare system. Gematik had difficulty gaining support and buy-in from all constituents. Ensuring an appropriate governance structure was necessary to restart the effort and rebuild support for the project (Stroetmann, 2010).

Security around patient information was another big concern. Gematik did not have standards for security and overall interoperability fully developed prior to the large scale pilots. The security issues had to be addressed in the revised project (Stroetmann, 2010).

**Lessons Learned:** In the re-launched EMR project the German government reconsidered assisting physicians to get the needed equipment and began offering an incentive that helped providers get the card readers, increasing their use (Stroetmann, 2010). Pilot testing was also seen to be very effective and the project was able to discover issues prior to deployment (Stroetmann, 2010). Reducing the scope and functionality has also helped to keep to the new projections (Stroetmann, 2010).

**Comparison to U.S:** Both the US and Germany are dealing with rising healthcare costs, aging populations and increasing expectations of the healthcare system (Armstrong et al, 2011). Many of the drivers for electronic medical records are similar. Both countries have large populations with decentralized healthcare systems and a complex mix of stakeholders who need to have
incentives to adopt EMRs. However, Germany is a social market economy based on the fundamental principal of solidarity, the belief that society should provide for the needs and assumes risks of all citizens, whereas the U.S. is a ‘free-market’ economy with a strong reliance on individual initiative and emphasis on personal freedom. (Armstrong et al, 2011).

**Sweden**

**Healthcare System Structure:** Sweden is a socially responsible country that provides generous programs for all its citizens including healthcare. For these programs, Swedish citizens pay one of the highest tax rates in the world, from 56-60% GDP, compared to 34-36% GDP in the US (Anell, 2012). For this high tax rate citizens expect and trust the government to provide high quality services. In 2005, Sweden spent $27 billion on healthcare services covering 9.2 million people. Sweden is the third largest country in the EU covering 174,000 square miles with 85% of its population living in urban areas. It has the world's eighth highest per capita income and the third lowest infant mortality rate. Life expectancy is 81.6 years and healthcare expenditure is 9.4% of GDP (Anell, 2012; Doupi, 2010; Gartner, 2009; Armstrong, 2011, Wikipedia, 2013).

The goal of Sweden’s public health system is to create conditions that ensure good health and equal access for all as defined in the 1982 Health and Medical Services Act. Sweden's health care system is organized into 3 levels: national, regional and local. The Ministry of Health and Social Affairs establishes principles and guidelines for care at a national level. The responsibility for providing and making decisions associated with hospital and primary care is highly de-centralized and spread across 21 county councils in regions that cover the nation (InterSystems, 2010). Two hundred ninety (290) municipalities provide local care outside hospitals, clinics, and physician’s offices including elder, at-home, and post-hospital care. In 2004, Sweden had 3.4 physicians per 1000 patients compared to 2.3 per 1000 in the US and 10.6
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nurses to 1000 patients compared to ~8 per 1000 patients in the US. Sweden has 8 regional hospitals, 70 county hospitals, 1000 health centers, and 25,862 in-patient beds (Anell, 2012; Armstrong, 2011; Gartner, 2009).

The General Practitioner (GP) is the main point of contact to the healthcare system for patients and one quarter of all physicians are GPs. Most GPs are salaried employees of the county councils and practice outside of the hospitals. Other physicians practice inside hospitals. Nurses are authorized to treat and prescribe medicine to children and adults. Patients are free to go to specialists without a referral and visit providers across states and county councils. Integrated care has been growing in Sweden where GPs, hospital, and other providers work together in a patient’s care. When a patient is in the hospital, physicians there keep GPs informed so care is seamless. In 2013, EMR/EHR systems were used by nearly 100% of hospitals, GPs, nurses, specialists, ambulances, laboratories and ADT. All cases are prioritized with emergency cases being serviced immediately and urgent cases seen within three (3) days (Anell, 2012; Doupi, 2010).

Healthcare Funding: The cost of Sweden’s health care has been hovering at 9-9.4% of GDP since the early 1980s. In 2007, per capita healthcare costs in Sweden were $3323, compared to $7290 in US. The cost of Swedish health care is covered by taxes collected by the county councils (71%), a State contribution from taxes (16%), patient fees (3%), and other sources like sales and contributions (10%). The Ministry of Health and Social Affairs supervises the lower levels (regions/local), through the allocation of grants, state insurance payments, and periodically validating that the services offered meet the country’s goals. County councils are responsible for financing and providing health care in their regions as well as regulating prices for private providers. Private providers must have a contract with a county council to be paid. To obtain
government coverage, patients must go to the contracted providers. Otherwise they must pay themselves (Anell, 2012; Armstrong, 2011; The Local, 2010).

With the cost of most healthcare (97%) covered by government taxes, there is little need for private insurance in Sweden. Not all health care costs are covered by insurance so patients are expected to pay $19 per GP, hospital or specialist visit, with fees capped at $115 a year. There is also a drug co-payment which is capped at $246 a year. Dentistry care is private and only partially covered by the government. Dental care is free for patients up to 19 years old (Gold, 2011).

The system includes coverage of lost wages while sick. When a GP or other physician determines that a patient is ill they are issued a certificate of illness. This allows the patient to be paid a percentage of their wages by their employer for 14 days. After the first 14 days the state takes over this payment until the patient is declared fit by the GP or physician (Doupi, 2010).

EMR Project Overview: Over the last 20-30 years the regional county councils developed various e-health systems with differing levels of success ranging from outright failure to partial success. However, because of the local focus, and differences in purpose, technology, and specifications, these systems did not work together or completely cover all needs. In 1990s, 27 different electronic health systems were brought by the 21 county councils. Again, none were connected and there was no clear winner. By 1999 it was clear at all levels of government that a more coordinated approach was needed. From 1999-2004, the Ministry of Health and Social Affairs, 21 County Councils and Municipalities began planning for and selecting a new integrated system (InterSystems, 2009; Health IT News Direct, 2009).

From 2004-2006, there was an initial pilot of the system covering 500 users including physicians, occupational therapists, nurses, and other staff that was expanded to four of the 21
regions. In parallel with the system pilot, the Swedish government revised the legal framework and started a national healthcare IT strategy. In 2006, Sweden defined a National eHealth Strategy that would improve safety, access, data sharing, quality of care, and patient care mobility to meet demands exposed by pilots along with past and expected future healthcare needs. From this experience, the government contracted Tieto, a Finnish IT consulting firm to help move the effort forward and pick a vendor and product to meet their needs (InterSystems, 2009; Health IT News Direct, 2009). In 2008-2009 contracts were issued to build the National Patient Summary (NPO) system based around the InterSystems HealthShare® health information exchange platform, a product from a Cambridge, MA vendor, with help from Tieto. In 2009, the first County Council, Orebro, went live on NPO, followed by 6 more in 2010, an additional 10 in 2011, and the remaining 3 in 2012. (InterSystems, 2010, 2009; Health IT News Direct, 2009; Means, 2009).

**Reasons Behind Implementation:** The National Patient Overview (NPO) EMR project was a vital component of the National IT Strategy for the healthcare and welfare sector in Sweden. Objectives included improving the consistency and quality of patient care in Sweden by having one place for all providers to access complete, on-line, always available, accurate, secure, consistent and trusted, current and historical patient data shared across all those involved in providing medical care and allowing patients to be cared for at any location in Sweden (InterSystems, 2010; Means, 2009).

Goals for the implementation included reduction in preventable medical errors, reduction in adverse drug events, improved quality of care and consistency of care, improved outcomes, reduced costs, and improved security and reporting. Another goal was the elimination of unconnected islands of data and systems that had grown out of the regions (InterSystems, 2009;
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Doupi, 2010; EMR Records and Information, No date; Gartner, 2009; Health IT News Direct, 2009).

Who Made the Decisions? The EMR project (NPO) was initiated by the passage of the Health and Medical Services Act of 1982. The act stated the County Councils were responsible for the planning and development of healthcare for their regions. The Ministry of Health and Social Affairs collaborated extensively with the regions on programs affecting the whole country and on investments in technology like EMRs. In 2008, Tieto was selected by the Swedish Healthcare Advisory Organization to develop, implement, manage applications, host and deliver the NPO. The Ministry, County Councils, and Tieto selected InterSystems HealthShare to function as the base of the NPO. Pilots were planned to allow for a phased roll out (InterSystems, 2009, 2010; Doupi, 2010; Health IT News Direct, 2009).

EMR Funding: In Sweden, responsibility for funding the EMR project followed that of healthcare in general in that the national and regional government covered the original and ongoing operational costs through taxes collected. Twenty four percent (24%) of project costs were for hardware, 18% for software, 27% for IT employees, 26% for services and consulting and 5% for communications. In 2010, Sweden spent about $990 million on e-health solutions. $19 million of this was to buy the initial software used for the NPO (Jerlvall, No date; The Local, 2010).

Legal Framework: NPO is jointly owned by Sweden’s County Councils and is a resource any provider can turn to for trustworthy data throughout the country. NPO is closely connected with Sweden’s ‘1177’ telephone medical information service and both access the same medical information database. As part of the definition, preparation, and roll out of NPO, the Swedish government implemented changes in the legal system and introduced several bills to address data
sharing, security, and access (Gelmato, No date). Implementation for the first wave of County Councils was suspended in 2009-10 to allow more time to work out security issues and ensure limited access to some data (Doupi, 2010).

In 2008, the Patient Data Act was passed allowing providers, with patients’ consent, electronic access to information held by other health care providers. Patients have the right to access their own information, but aren’t allowed to change it. Care givers access NPO data after logging in with a physical security card called SITHS. Healthcare data is owned by the County Councils and the primary version of the data is held at the source while a copy of some data is held centrally. Patient data is assembled on demand when needed to ensure the latest information is viewed. In addition, data security tools were adopted to control access and protect data including authentication, encryption, logging, authorization checks, consent management, and security protocols. (Doupi, 2010).

**Physician Adoption:** Physician, hospital, and clinic adoption is at nearly the 100% mark. Adoption was accelerated because of hospitals’, physicians’ and specialists’ ties to the County Councils who were committed to NPO. The City Councils run the hospitals, GPs, are employed by the County Councils and specialists work in Council run hospitals. To get reimbursed for care, a physician needs to have a contract with a County Council. Previously, the government ran pharmacies (they are now private) and 80%+ of all prescriptions are placed electronically through NPO. Technologies like telemedicine have further increased access for providers and patients alike (Doupi, 2010).

Besides the above groups, all psychiatry units, laboratories, X-ray, administrators, ADT, occupational therapists, ambulance units, nurses, and staff use the system. Dental and drug providers are also quickly adopting the system and most orders and payments come through
NPO. While in transport, patient information is transferred from EHRs in ambulances to hospitals ahead of arrival. All providers serving a patient see the same data, notes and tests on demand (Doupi, 2010).

**Interoperability:** The main goal of the NPO project was to provide integrated healthcare records across all providers, hospitals, and patients in all County Council regions. Message structures and interface standards were either defined or followed to facilitate data exchange between all data sources and destinations including using the CEN standard 13606 for transferring of information (HISA), private VPN access, the RIV interface (Regelverk for Interoperability Interface) and a national solution for authentication and IT-security. Interoperability was eased by having all systems use the same base technologies. In addition, common databases are shared where possible, including the web NPO interface and the ‘1177’ telephone medical information service. Finally, there is a project in progress to integrate other IT systems with NPO to increase overall security and reuse of healthcare data (Gelmato, No date; InterSystems, 2010; Doupi, 2010).

**Key Results – Successes:** Once all involved realized that coordination, having similar goals, and fewer systems were key to success, the time from pilot to full adoption by physicians and hospitals was a respectable 10-12 years. In addition, the team realized the need for expertise not contained within the County Councils or national government, so they contracted with Tieto to help drive the project, pick the technology, and design or acquire the needed components.

Some of the successes of the project included establishing laws and regulations needed to support the system, testing early with pilots to find issues and examine ideas, building out in phases, building a common IT structure and strategy, creating a common technical infrastructure (networks, messaging, directories, access, data stores, interfaces, logging), allowing for
distributed and central data storage but always displaying the latest data from all sources, providing patients with access to their data, providing standards other systems could use to interface with NPO thus increasing its value, allowing patients to go to any region in Sweden to receive care, expanding the system to include other users (laboratories, pharmacy, dentists, ADT, etc) (InterSystems, 2009, InterSystems 2010; EMR Records and Information, No date; Gartner, 2009).

**Key Results - Failures:** The 90s was spent implementing 27 different EHR systems across the 21 County Councils that weren’t connected, whose failures weren’t studied, and which were eventually abandoned. The decades before were spent building standalone systems of all types with no concern for interoperability. This proved that while having the County Councils (that are close to patients and communities) manage healthcare services in an area works on many levels, it doesn’t work for software systems due to limited expertise, funding, and vision (InterSystems, 2009, InterSystems 2010; EMR Records and Information, No date; Gartner, 2009).

**Current Status:** The Swedish NPO EMR is now widely (~100%) used by physicians, hospitals and providers. More than 90% of patients have internet access at home and 100% of those employed have access at work. NPO is integrated with other applications to provide a wide range of functionality including; medical records, prescriptions, order entry, test and procedure results (X-ray, Pathology, Micro biology), physician notes and alerts, allergy tracking, Rx reaction warnings and tracking, patient scheduling, patient administration (admission, discharges, transfers), billing, order entry, physician decision support, ambulance, picture archiving (X-ray, dental), telemedicine, data exchange, patient access, national healthcare reporting, and local and remote secure provider access. Future extensions include eServices,
medical advice, patient access through ‘MyPage’, and a smartphone app. (InterSystems, 2010; Gartner, 2009; The Local, 2010).

Lessons Learned: Sweden learned that more EMRs are not necessarily better. Sweden’s regional councils wasted 10+ years building regional health applications that are all likely gone now. Basing the system off a product instead of home grown solutions and hiring the expertise needed to make the project work helped lead Sweden to a more comprehensive and usable system. If Sweden’s 21 decentralized regional counties can agree on an EMR, it bodes well for the possibility of 50 US states doing the same. Sweden has 9 million people (versus 300 million for US), so it is likely that a US EMR program would take longer but it is not impossible, after all, the US got a man on the moon in less than a decade (InterSystems, 2009, InterSystems 2010; EMR Records and Information, No date; Gartner, 2009).

Data issues must be addressed early through clear specifications, standards selection and adoption, and most importantly needed changes to data and privacy laws. Giving patients the power to determine who sees their data while only providers may write to the system struck a successful balance in the Swedish system for data access. While defining interoperability goals, technologies and tools early made it easier for systems not part of the EMR to talk to each other and for multiple EMR vendors to communicate and share data. It was also important to determine how data would be shared so that data islands were not created and important data could be gathered in real time so up to date information is available to providers anywhere it is needed (InterSystems, 2009, InterSystems 2010; EMR Records and Information, No date; Gartner, 2009; The Local, 2010).

Using pilots and phased roll outs helped to detect issues early, build consensus and roll out in pieces. Once the initial functionality was in place new connections to dental, medications,
ambulances, laboratories and telemedicine were added based on evaluations of the care-chain (InterSystems, 2010; Gartner, 2009; The Local, 2010). The population in Sweden generally trusts their government to do the right thing. In the US pilots and slow, phased roll outs could help build the trust and consensus needed to make EMR adoption work (InterSystems, 2010; Gelmato, No date; Doupi, 2010; Gartner, 2009; The Local, 2010; Wikipedia, 2013; Gray, 2011).

**Denmark**

**Healthcare Structure:** Denmark’s nationalized, universal health care system (Denmark and eHealth, 2010) is governed jointly by the state, five healthcare regions and 98 municipalities (Protti, Bowden & Johansen 2008a; Denmark and eHealth, 2010). With few exceptions, hospital care is provided by 60 public hospitals and patients may go to a hospital in any region (Protti, Bowden & Johansen 2008a). The country’s approximately 3,500 general practitioners (GP) and 1,000 specialists (Denmark and eHealth, 2010) work in small private practices by contract with a region (Protti, Bowden & Johansen 2008a). People register with a GP (Protti & Johansen, 2010) who are the gatekeepers to other services (Denmark and eHealth, 2010). General practitioners are paid through a mix of fee for service and capitated payments (Protti, Bowden & Johansen 2008a). Danish GPs are compensated for time spent answering emails and spend from 8am-9am answers patients’ phone calls (Protti & Johansen, 2010). Life expectancy is 79 years (Danish Ministry of Health, 2012).

**Healthcare Funding:** The state imposes a 7% tax to cover the cost of healthcare expenditures (Danish Ministry of Health, 2012) which were $4,464 per capita or 11.1% of GDP (Thomson et al, 2012). The tax revenue is distributed to the regions to cover the cost of care in each area (Protti, Bowden & Johansen 2008a; Denmark and eHealth, 2010). Physician, hospital and specialist care is free, but there are copayments for medications, physiotherapy and dentistry
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(Protti, Bowden & Johansen 2008a). Each Danish citizen has an identification number that is used for medical care and taxation (Protti, Bowden & Johansen 2008a).

**EMR Project Overview:** The foundation for EMR use in Denmark was laid in 1977 when the health service developed the National Patient Registry and required physicians to file reports to a central repository for reimbursement (Harrell, 2009). In the 1980s GPs were given an incentive to submit billing information by floppy disk (Protti, Bowden & Johansen 2008b), starting a trend of GPs having a computer for administrative tasks (Protti, Bowden & Johansen 2008b).

**Reasons Behind Implementation:** Initially, EMR systems were regional projects. Denmark embarked on a national digitalization program to coordinate the IT approach in the various regions (Edwards, 2006), cut administrative costs (Edwards, 2006; Protti, Bowden, & Johansen, 2008b), save time (Edwards, 2006), enhance communication between different sectors of the health system and improve service (Edwards, 2006; National Strategy, 2007).

**Interoperability:** A major factor in electronic medical record adoption in Denmark was that it evolved from a regional electronic messaging platform, which built communications between providers from the beginning. In the late 1980s Funen country embarked on a program to have physicians send and receive electronic messages and by 1990 they had two primary care physicians, a hospital and a laboratory connected and exchanging electronic messages (Protti, Bowden & Johansen 2008b). This modest, independent project grew into Medcom (Protti, Bowden & Johansen 2008b).

**Medcom:** Medcom is a government established nonprofit organization started in 1994 that oversees the coordination of Danish electronic medical communication and information systems (Protti, Bowden & Johansen 2008b; Danish Ministry of Health, 2012). The organization helps to set standards, test and certify systems (Medcom, 2013) and ensure interoperability between
systems and implementations (Stroetmann, Jones, Dobrev & Stroetmann, 2006; Protti, Bowden & Johansen, 2008b). Medcom manages a virtual private network (VPN) for secure and private communications between providers (Protti, Bowden & Johansen, 2008d). Medcom also helps with implementation and training on EMR systems (Protti, Bowden & Johansen, 2008b). Medcom’s funding comes from the Danish government, the Association of Danish Regions, the Danish Association of municipalities and the Danish Pharmacy Association (Protti, Bowden & Johansen 2008b, Edwards, 2006).

Legal Framework: The Danish Act on Processing of Personal Data that governs how people’s health information is used went into effect in July 2000 (Protti, Bowden & Johansen, 2008c; Protti & Johansen, 2010). The act allows physicians to see their patients’ information. Patients’ control access to their data and others must request access (Protti, Bowden & Johansen, 2008c). Patients, however, are encouraged to and often allow open access amongst healthcare providers (Edwards, 2006). The act implements EU directive 95/46/EC regarding transmitting and processing personal data. The act forbids interconnection with sectors outside of healthcare (Protti, Bowden & Johansen, 2008c; Protti & Johansen, 2010)

Physician Adoption: Reporting through Medcom was voluntary until 2004 when it was mandated in physicians’ contracts. It was included in specialists’ contracts in 2006 (Protti, Bowden & Johansen, 2008c). While mandated to report, physicians and specialists are independent practitioners or work in small practices and are responsible for their own IT systems (Protti, Bowden & Johansen, 2008d; Edwards, 2006). Doctors were offered a small, financial incentive of 1,500 Euros per year to procure the hardware and software needed to meet the requirements (Protti, Bowden & Johansen, 2008d; Protti & Johansen, 2010; Edwards, 2006).
Use of electronic medical records is nearly universal by Denmark’s physicians who use the systems to manage patient care, order prescriptions, take notes and send reminders (Mahon & Fox, 2011; Protti & Johansen, 2010). Almost all providers involved in healthcare, across 4000 organizations participate in the system (Protti, Bowden & Johansen 2008a) to communicate lab results, make lab requests, send discharge summaries and make referrals (Protti, Bowden & Johansen 2008c).

**Hospital Adoption:** Physicians and hospitals use two separate systems with physicians able to see their patients’ hospital records (Gray, Bowden, Johansen & Koch, 2011). Hospital systems have lagged behind somewhat (Gray, Bowden, Johansen & Koch, 2011) however much functionality, especially that needed to send messages between physicians and hospitals, developed in tandem and hospital systems are becoming more robust (Gray, Bowden, Johansen & Koch, 2011; Protti, Bowden & Johansen 2008b; Medcom, 2012; Danish Ministry of Health, 2012).

**Patient Access:** Patients have access their health data, from both the physician and hospital systems, through a web portal, Sundhed.dk. They can use the site to contact providers, renew prescriptions and make appointments (Protti, Bowden & Johansen, 2008c, Danish Ministry of Health 2012; Denmark and eHeath, 2010; Edwards, 2006). Over 1,300,000 people have received a digital signature to use Sundhed.dk to obtain and track their health information (Protti & Johansen, 2010).

**Key Results:** EMR adoption has been credited for simplifying repeat prescription ordering, reducing calls to hospitals by 66% and allowing faster access to patient data and laboratory results (Protti, Bowden & Johansen 2008d). Physicians save 50 minutes a day using the system and feel they can get more accomplished during a patient visit (Protti, Bowden & Johansen 2008d). There were 60 million messages sent in 2011, up from a mere 4000 messages sent...
during the first year of the program (Ministry of Health, 2012). One hitch in the EMR development plan was a coding system that would have required providers to enter notes in alpha-numeric form that was abandoned in favor of integrating established systems (Harrell, 2009).

**Current Status:** Electronic medical record systems continue to be widely utilized in Denmark (Figures 6 & 7) and systems are improved incrementally and new features and functionality are added regularly (Medcom, 2012; Danish Ministry of Health, 2012). New project plans are published by Medcom frequently. Medcom’s current projects include: expanding admission and discharge reporting, improving the communication of rehabilitation plans electronically, chronic care management and expanding the use of telemedicine into the areas of ulcer assessment and telepsychiatry (Medcom, 2012). Plans are also in place to upgrade the VPN and healthcare IT hardware (Medcom, 2012; Danish Ministry of Health, 2012).

There has been a push to consolidate health information from the various EMRs and data stores. Work is underway to have a ‘Shared Medication Record’ that would distribute a patient’s medication information across providers to allow for safe and timely medication use across the healthcare system (Medcom, 2012; Danish Ministry of Health, 2012). Development of a ‘National Patient Index’ and ‘National Health Record’ are underway to have the ‘National Health Record’ display the health information stored in the Index in an intelligent manner at hospital workstations and online for patient use (Medcom, 2012; Danish Ministry of Health, 2012).

**Success factors:** Denmark and the Danish medical system are very different from the United States and its healthcare system. With a much smaller population that has a high level of trust in the government and a culture that would consider a doctor that did not use a computer ‘second-
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rate’, Demark has many advantages that aided EMR adoption (Protti & Johansen, 2010; Harrell, 2009). Despite the differences there are some lessons the United States could take from Denmark’s experience.

Because of contract arrangements Denmark could mandate the use of EMRs, however they took some steps to aid the transition for providers by offering modest financial incentives to physicians to install the needed hardware and software (Protti, Bowden & Johansen, 2008d; Protti & Johansen, 2010; Edwards, 2006) as well as non-financial incentives like training (Protti, Bowden & Johansen, 2008c) and faster claims processing (Edwards, 2006, Protti & Johansen, 2010). Medcom also provides system support and training for physicians and staff allowing them take advantage of the systems more fully and giving them a place to turn for support (Protti, Bowden & Johansen, 2008b).

Clinicians were involved in setting the messaging standards (Edward, 2006, Protti, Bowden & Johansen, 2008c) and were paid to help find ways to improve communications between hospitals and physicians (Protti, Bowden & Johansen, 2008c). Having Medcom coordinate discussions between the government, vendors, physicians and pharmacists to build new functionality and maintain systems increased buy in and the chances of success (Edwards, 2006; Danish Ministry of Health, 2012).

Denmark took a slow, incremental approach to developing its health IT systems. The EMR system started in one county and was expanded nationally (Protti, Bowden & Johansen 2008b). They began with the most essential features and gradually built greater functionality (Edwards, 2006). Medcom plans projects in 2-4 year increments that build on previous implementations (Medcom, 2012, Medcom, 2013) and it is understood that development and adoption will take time (Edwards, 2006). Medcom’s mandate to develop standards on which the
system would operate allowed for the growth of coordinated and interoperable systems although different regions and companies built them independently (Edwards, 2006; Protti, Bowden & Johansen, 2008d; Protti, Bowden & Johansen, 2009).

This focus on standards and independent action encouraged competition, a factor that is closely tied to the American ethos and should be readily embraced in the US, between regions, physicians, hospitals and vendors. Medcom publishes tallies of regional progress encouraging them to keep up with one another (Protti & Johansen, 2010; Medcom 2012). Promising regional ideas are promoted more widely (Protti & Johansen, 2010; Medcom 2012). Physician usage is also posted generating peer pressure to adopt (Protti & Johansen, 2010). Initially, listings of participating physicians encouraged them to make referrals electronically to others using the system. (Protti, Bowden, & Johansen, 2008b; Edwards, 2006) Since no one vendor was prescribed, vendors compete for customers and must keep up with the Medcom standards (Edwards, 2006).

**Cross Country Comparisons**

The case studies show a mix of approaches to EMR adoption in Europe that have yielded varying levels of success. As seen in the European HIMSS adoption model comparison of European countries (Figure 2) the progress of EMR adoption in Europe has not been universal (Buddrus, 2011). While Sweden and Denmark have stable, highly utilized, multifunctional, national EMR projects with the majority using stage three and above level systems, in Germany and the UK the initial projects were fraught with issues and had to be redesigned leaving them farther behind in the adoption scale. Despite the issues, the UK and Germany have more physicians using EMRs than the US (Figure 5) however their systems’ functionality may not be as robust as some of the US systems (Schoen & Osborn, 2012; Protti & Johansen, 2010; Buddrus, 2011).
Key Factors in Success: One of the many keys to success was collaboration. Building consensus between the government, providers, vendors and payers was noted in the successes of Sweden’s and Denmark’s programs (Jerlvall & Pehrsson; Edwards, 2006; Armstrong, 2011). While in Germany and the UK it has been one of the focuses in redesigning their systems (Stroetmann, 2010; Greenhalgh, 2010a). Clinicians especially have to be involved to buy into the program, make sure the system is adopted, and can be used effectively (Edwards, 2006; Protti, Bowden & Johansen, 2008d).

From this collaboration, there must be clear standards for project implementation. Having clear guidelines built both confidence in the system and interoperability in Sweden and Denmark (Edwards, 2006; Protti, Bowden & Johansen, 2008d; Jerlvall 2012) and developing standards for interoperability has been one of the top goals for the updated UK project (Greenhalgh, 2013a).

Related to having clear standards, nations must consider and make arrangements for the security of patient data from the onset. In Germany this was a major issue and was blamed for the downfall of the initial implementations (Greenhalgh, 2010a; Stroetmann, 2010). In England fears of surveillance prevented medical staff from making use of the initial system (Shiekh, 2011). Meanwhile provider confidence in Denmark in the secure messaging provided through Medcom increased EMR adoption (Protti, Bowden & Johansen, 2008d).

The project scope has to be carefully managed. The implementation of EMRs in England especially buckled under the strain of trying to take on too much (Greenhalgh, 2013b; Kaye, 2010) while working in small, manageable stages was seen as critical to the success in Sweden, Denmark and eventually in Germany as well (Edwards, 2006; Stroetmann, 2010; Jerlvall 2012).
Also of note, the size of the population being covered plays a role in the complexity and hence the success of EMR adoption. Germany and England with larger populations had a harder time building the needed consensus and implementing systems (Greenhalgh, 2010a; Stroetmann, 2010). Even in Sweden and Denmark, IT decisions were delegated to regional bodies with responsibility for smaller subsets of the population (Protti & Johansen, 2010; Armstrong, 2011).

Pilot programs can help to build engagement and commitment to the process while working out issues in program design. Sweden especially, used pilot projects to build support, show steady progress, test theories and resolve issues (InterSystems, 2009, 2010; Doupi, 2010; Health IT News Direct, 2009). The updated German implementation also used pilots to discover issues before full roll outs were completed (Stroetmann, 2010).

Appropriate incentives are necessary to help providers and vendors reach adoption goals. In Germany, providers did not see the benefit of purchasing the mandated card readers. With no clear utility to the provider and lacking incentives from the government they refused to purchase them, stopping a key element of the EMR plan. Later the German government reconsidered and began offering an incentive that helped providers get the card readers, increasing their use (Stroetmann, 2010). The incentive does not need to be financial (Edwards, 2006; Greenhalgh, 2010a). Faster processing and other benefits may encourage providers to adopt the systems (Protti, Bowden & Johansen, 2008d). In Denmark, financial incentives offered were relatively modest, but the incentive coupled with faster access to patient data and training spurred adoption (Protti, Bowden & Johansen, 2008c; Protti, Bowden & Johansen, 2008d).

Pitfalls to avoid: While there were a number of shared factors for success, there were also a number of pitfalls to be avoided. Both England and Germany showed the problems of trying to take on too many complex issues at a time (Greenhalgh, 2013b; Kaye, 2010; Stroetmann, 2010).
Underestimating the time and money needed to adopt EMRs also led to dissatisfaction with implementations. Again in the less successful German and UK programs, increasing costs and delays coupled with resistance to the top down approach taken made the programs politically untenable (Stroetmann, 2010; Greenhalgh, 2013b), issues that the US especially should take heed of given the very political nature of health care reform (Kaye, 2010; Greenhalgh, 2013b).

England’s initial EMR program failed because it was a large scale endeavor driven by the government to meet a political timeframe. It appears that USA is going down a similar path with the reforms being spearheaded by a government administration with tremendous political pressure to make it work and to prove success. Decisions should not be based on unrealistic assumptions of achieving cost savings or even short term returns on investment, but rather on introducing clinical and associated decision support functionality early so that these systems are used and deliver demonstrable clinical benefits (Shiekh, 2011).

The US should also beware of having multiple unrelated systems like those in the UK (Blumenthal, 2012) and the original regional products developed in Sweden (Anell, Glenngård, Merkur, 2012). Having a multitude of systems slows interoperability and keeps the EMRs from reaching its full potential.

Promising Developments in the US: The advent of the Centers for Medicare and Medicaid Services (CMS) Meaningful Use (MU) program has rapidly increased the number of US providers using EMRs (The Commonwealth Fund, 2012; Schoen, Osborn, Squires, Doty, Rasmussen, Pierson, & Applebaum, 2012). The HIMSS US adoption model, very similar to the European model, shows increase usage of more complex systems in the US (Figure 1b) (HIMSS Analytics, 2013a). Even with these increases the United States is behind in EMR usage, with
only 69% of physicians using EMRs, compared to Germany, the next lowest in usage at 82% (Figure 5) (Schoen, et. al., 2012).

There are many promising developments surrounding EMR adoption in the US and in some cases the key success factors discussed here are being taken into account. For instance, the MU program is separated into different phases that build upon each other instead of trying to take on all possible options at once (CMS.gov, 2013). Instead of depending on a centralized EMR, the US is allowing each provider to make its own EMR decisions and will only give incentives to those that use a certified system and use the data collected to perform functions like reporting to their local health departments (CDC.gov. 2012). This allows for regional control of projects, limits the size of the projects and the size of the populations they must serve.

Challenges for the US: It remains to be seen, however, if the specifications surrounding the communications are developed fully enough for useful data exchanges (Federal Register, 2012). The decentralized approach also runs the risk of becoming fragmented as was seen in Sweden’s initial systems (Anell, Glenngård, Merkur, 2012). This fragmentation is also seen in the laws and regulations surrounding healthcare in the US. While privacy and setting the correct legal framework is important, the US has a myriad of different privacy laws that make interoperability difficult, especially across regions and states causing them to remain fragmented (Bhanoo, 2010).

Conclusion

While EMR adoption in the US faces numerous challenges, many lessons can be learned from the European implementations. Taking heed of some of the pitfalls experienced by others and incorporating successful initiatives could pave the way for more rapid introduction of multifunctional EMR systems in the US. The variations between methods in the different
European countries show that there is no one path to successful EMR adoption, but that many factors conspire to build a successful system.
## Appendix

### EMR Adoption Model

<table>
<thead>
<tr>
<th>Stage</th>
<th>Cumulative Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 7</td>
<td>Medical record fully electronic; HCO able to contribute CCD as byproduct of EMR; Data warehousing in use</td>
</tr>
<tr>
<td>Stage 6</td>
<td>Physician documentation (structured templates), full CDSS (variance &amp; compliance), full R-PACS</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Closed loop medication administration</td>
</tr>
<tr>
<td>Stage 4</td>
<td>CPOE, CDSS (clinical protocols)</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Clinical Data Repository, Controlled Medical Vocabulary, Clinical Data Support System, may have Document Imaging</td>
</tr>
<tr>
<td>Stage 1</td>
<td>Ancillaries – Lab, Rad, Pharmacy - All Installed</td>
</tr>
<tr>
<td>Stage 0</td>
<td>All Three Ancillaries Not Installed</td>
</tr>
</tbody>
</table>

Figure 1a: The US EMR Adoption Model used to compare EMR adoption levels (HIMSS Analytics, 2008)
The main difference between the US and European models are at levels 5 and 6. The Europeans strive for full PACS capabilities earlier.
Figure 2: Comparison of adoption in European countries (Buddrus, 2011)
Figure 3: US EMR usage at each stage in 2013 (HIMSS Analytics, 2013b)
### EMR Adoption Model<sup>SM</sup> 2011 Q2 – Q3

<table>
<thead>
<tr>
<th>Stage 7</th>
<th>Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP</th>
<th>2011</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 6</td>
<td>Physician documentation (structured templates), full CDSS (variance &amp; compliance), full R-PACS</td>
<td>4.0%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Closed loop medication administration</td>
<td>6.1%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Stage 4</td>
<td>CPOE, Clinical Decision Support (clinical protocols)</td>
<td>12.3%</td>
<td>13.2%</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology</td>
<td>46.3%</td>
<td>46.1%</td>
</tr>
<tr>
<td>Stage 2</td>
<td>CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable</td>
<td>13.7%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Stage 1</td>
<td>Ancillaries – Lab, Rad, Pharmacy – All Installed</td>
<td>6.6%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Stage 0</td>
<td>All Three Ancillaries Not Installed</td>
<td>10.0%</td>
<td>9.6%</td>
</tr>
</tbody>
</table>

Data from HIMSS Analytics™ Database

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N = 5310/5299

Figure 4: US EMR usage at each stage in 2011 (Hoyt, 2011)
Figure 5: Multifunctional EMRs are those with the ability handle least two of the following functions: order entry management, generate patient information (medication lists, etc.), generate patient panel/registry information (lists of patients overdue for care) and/or clinical information support (drug interactions)

* Source 2012 Commonwealth Fund International Health Policy Survey of Primary Care Physicians (Schoen & Osborn, 2012) except the values for Demark which are from Widespread Adoption of Information Technology in Primary Care Physician Offices in Denmark: A Case Study published in 2010 (Schoen & Osborn, 2012; Protti & Johansen, 2010)
Comparing EMR Adoption in Europe and The United States

<table>
<thead>
<tr>
<th>Type of message</th>
<th>% digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge letters from hospitals to GPs</td>
<td>99</td>
</tr>
<tr>
<td>Referrals from GPs to hospitals</td>
<td>81</td>
</tr>
<tr>
<td>Lab results from laboratories to GPs</td>
<td>99</td>
</tr>
<tr>
<td>Lab test orders from GPs to laboratories</td>
<td>99</td>
</tr>
<tr>
<td>e-Prescriptions from GPs to pharmacies</td>
<td>85</td>
</tr>
<tr>
<td>Reimbursement from GPs to public health insurance</td>
<td>90</td>
</tr>
<tr>
<td>Notifications of admission / Notifications of discharge from hospitals to municipalities</td>
<td>98</td>
</tr>
<tr>
<td>Rehabilitation plans from hospitals to municipalities</td>
<td>80</td>
</tr>
</tbody>
</table>

Source: MedCom

Figure 6: Types of messages and percent of messages of each type sent digitally using Denmark’s EMR system (Danish Ministry of Health, 2012)

Figure 7: Total number of documents sent in Denmark by MedCom. Total as of 11/29/2013 at 10:20pm EST (Medcom, 2013).
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