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INTRODUCTION TO WIRELESS COMPUTING IN MEDICINE

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1.1 INTRODUCTION

Constant population growth has increased the need for more advanced scientific solutions for ever-growing healthcare demands. It requires a new paradigm and technology for more effective solutions. There has been a booming growth in technology, which has resulted in devices becoming progressively smaller and more powerful. One result of computer technology advancing at exponential speeds is wireless computing, which combines current network technologies with wireless computing, voice recognition, Internet capability, and artificial intelligence, to create an environment where the connectivity of devices is unobtrusive and always available. But as this connectivity improves, so does the collection and retrieval of data. In the field of medicine, because hospitals collect large amounts of unnecessary data on patients, it is difficult for doctors to distinguish a real emergency. We need to improve the standard of medical care provided to patients by helping doctors make more informed decisions. Doctors also require a greater degree of accuracy while treating chronic diseases, or for example, treating cancerous cells without affecting the regular ones. This chapter aims at promoting the discussion on how the use of wireless computing in nanomedicine helps integrate health monitoring and healthcare more seamlessly in

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the healthcare sector, ways it can help us to tackle the critical challenges faced by
doctors and patients regardless of space and time, and also present cutting-edge
perspectives and visions to highlight future developments.

Nanomedicine has been considered a possibility ever since the concept of
nanotechnology was first articulated in 1959 by Richard Feynman, in his famous
Caltech talk, “There’s Plenty of Room at the Bottom.” Feynman mentions that a
friend of his says “You put the mechanical surgeon inside the blood vessel and it goes
into the heart and ‘looks’ around.” The application of nanomedicine has a strong
potential for shifting myriad paradigms in the field of medicine. This is because
nanomedicine operates at the molecular, organellar, and cellular levels; precisely
where disease processes find their genesis. Once matured, these capacities will have
immense benefits in terms of positive patient outcomes and the alleviation of human
suffering across the board. There is a rapidly growing global trend toward the
development of more compact, minimally invasive, intelligent, more accurate, and
efficacious medical technologies. But the general consensus is that despite encour-
aging signals and growth, the field of nanomedicine has yet to fully mature.

Wireless computing is one of the techniques to help nanomedicine grow at the
rate seen by the visionaries. It’s a sure sign that wireless computing has entered a
new era—in some ways even more telling than the PC’s dominance or wireless
communication’s emergence. Wireless health system encompasses new types of
sensing and communication of health information as well as new types of interac-
tions among health providers and people, among patients and researchers, and among
patients and corporations.

The convergence of two domains of current research—nanotechnology and
distributed computing—presents a lot of applications in the field of medicine. In
this chapter, we briefly summarize and present the technologies underlying the state-
of-the-art research in the interdisciplinary field of medical wireless computing. In
the first section, distributed computing, we discuss its usage in treating cognitive
disabilities like Alzheimer’s, autism, etc., and how it can increase the portability for
monitoring the patient and reduce the redundancy of data. We also talk about the role
of wireless power and Markov decision process (MDP) in distributed computing. In
the second section, nanomedicine, we discuss about the technologies of nanocom-
puting and the ways they can be utilized in medicine. We also explain how we can
model brain disorders and detect biomarkers using nanotechnology. In the third
section, we discuss about ethics, privacy, and legal issues in the domain of nano-
medicine, and how we can implement these in a safe, ethical way to gain benefits.

This chapter intends to provide readers with a sense of the breadth and depth of the
field of wireless computing, and its potential effects on medicine. We define the tech-nologies of wireless computing, from the software that run cloud computing data centers,
to the technologies that allow new sensors to work. We also provide readers with case
studies of how these technologies are being implemented in the medical field through
both integrating into current systems and creating new forms of medical applications.

We hope that this chapter will be useful to anyone who wishes to learn about the
interdisciplinary field of wireless computing. We have tried our best to make this
material understandable at a beginner level. Students with backgrounds in the fields
of medicine, computing, health informatics, and even public policy should be able to understand the material presented within and gain useful insights.

1.2 DEFINITION OF TERMS

Nanomedicine: It is the application of nanotechnology (the engineering of tiny machines) to the prevention and treatment of disease in the human body. This evolving discipline has the potential to dramatically change medical science. Nanomedicine is also defined as the monitoring, repair, construction, and control of human biological systems at the molecular level, using engineered nanodevices and nanostructures.

Healthcare workers: In this case, we use the term “healthcare workers” to describe the ecosystem of doctors, nurses, hospital administrators, and people in the government who are involved in healthcare policy.

Distributed computing: The technology that enables computing in devices and allows their communication wirelessly. This includes the infrastructure of distributed computing, including but not limited to the physical infrastructure of the Internet, the algorithms for directing traffic on the Internet, cell phones, and other “smart” devices.

Pervasive computing: From a technology standpoint, pervasive computing is mostly the same thing as distributed computing, but it also refers to the way that computing has become part of the fabric of our social existence. Pervasive computing refers to the idea that computing is invisible and everywhere, that it is a part of our daily lives that we take for granted.

1.3 BRIEF HISTORY OF WIRELESS HEALTHCARE

Healthcare is a remarkably interdisciplinary field. Biology, chemistry, immunology, and psychology are just a few of the skills that are necessary for healthcare officials to understand in order to produce a working healthcare system.

An important part of any science is the gathering of information; this is no less true in healthcare. John Snow, the father of modern epidemiology, discovered the source of the nineteenth-century cholera outbreak in London by creating a map of all known cholera cases (www.udel.edu/johnmack/frec682/cholera/), finding patterns in the congregated data to help treat cholera not as the disease affecting a particular patient, but rather treating cholera as a pervasive condition that affected the City of London.

John Snow and other doctor-scientists ushered in a completely new form of medicine—the modern medicine that we have today. Epidemiology, a completely new field of medicine, led to discoveries such as the link between tobacco smoking and cancer, and along with the “germ theory” of medicine helped promote the use of disinfectants, which greatly improved our quality of life and increased the expected lifespan (www.sciencemuseum.org.uk/broughttolife/techniques/germtheory.aspx).

By looking at the total picture, congregating the data from many patients across London, John Snow was able to discover something about the nature of cholera that was completely invisible to anyone who only looked at each patient individually.
The information existed before, but defining epidemiology as a part of healthcare, as a new way to look at healthcare, gave doctors a revolutionary way to treat a disease.

Today, information has never been easier to gather or transmit. The Internet allows data to be sent almost instantaneously across the globe, and an enormous array of sensors are able to take our temperature, track our activity levels and sleep patterns, and gather other statistics about our lives. There are many new methods to gather information about patients and diseases that could drive the next revolution in medicine. These new methods are sometimes referred to as “pervasive computing.”

The intention of this chapter is to introduce readers to the application of wireless computing in medicine by giving an overview of wireless computing itself, providing a few examples of wireless computing in action through contemporary research projects, which are pushing the edge of medicine, and defining wireless computing as a hardware as well as a software phenomenon by providing examples of new nanoscale technologies. We also want to provide our readers with an idea of how wireless computing is changing medicine through these improvements in information transmission and generation. How will our medical institutions, our doctor–patient relationships, our society as a whole, change because of wireless computing in medicine? Although wireless computing may bring great improvements to our medical system, it also poses certain threats, such as information security and the fear of a surveillance state. These questions and more are discussed.

1.4 WHAT IS WIRELESS COMPUTING?

Wireless computing has gone by many names including ubiquitous computing, distributed computing, heterogeneous computing, physical computing, and the Internet of Things. What separated wireless computing from traditional computing was the idea that any object in the world—not just a desktop computer or set of servers—could do computing.

In this chapter, we will view wireless computing in two parts. One is the distributed computing architecture that allows applications to connect across the Internet. This includes all parts of the system that run in the “back end,” from servers to software. The other area that we will consider is the ever-growing list of “smart” things that collect data or user input and upload to the overlaying structure. These devices are not only increasing the amount of data that we can collect but are also changing the ways that we collect such data. Breakthroughs in nanotechnology may allow sensors to become truly invisible and computing to become truly wireless, around us at all times. We consider the ways in which new forms of both connectivity and data generation are changing the way wireless computing works, extending its reach.

Today, wireless computing has been integrated into many facets of our lives so successfully that we barely stop to wonder at the fact that our phones will tell us when it’s time to pay the electric bill; we take for granted that our homes will notify the police when there has been a break-in, and we fully expect that our friends will be instantly aware of our new high score on the latest game. However, when we
consider applying wireless computing to medicine, there are a number of questions that remain unanswered.

Medical applications entail a unique set of constraints and needs, from an increased desire for information security to the need for very accurate data. However, we believe that the application of wireless computing to medicine could provide many benefits to our healthcare system (in this chapter we primarily discuss the healthcare system of the United States, but we also look at research that is being done in Europe and across the globe). We discuss wireless computing in detail in Chapter 2, this volume [1]. We discuss both applications in distributed computing and in end-user devices. Some of the technologies are currently implemented, and we use these as case studies for implementing these solutions in a broader context; others have yet to be implemented but have strong potential for revolutionizing the way that we treat disease.

1.5 DISTRIBUTED COMPUTING

There are many applications for distributed computing in medicine. Analyzing the “big data” of medicine could allow doctors to prescribe truly personalized medicine, while the application of various sensors allows for a greater degree of accuracy in treating chronic disease. Mobile and wireless technology can improve the standard of medical care being provided to patients and will also help them make more informed decisions regarding their health.

In the area of distributed systems, much of the technology is already established. The architecture of the Internet, although nebulous, is fairly well defined. The architecture for dealing with large sets of data exists and is being used in other nonmedical applications; instead, it is the particular implementation of these technologies to medical uses that is interesting. Medical applications have various restrictions that are different from other purposes—the privacy of information is especially important and is one of the more talked-about issues, but there also are issues of patient safety—all devices used by medical professionals should be held to a higher standard than devices used by the average consumer. These issues pose technical challenges for both hardware devices and software algorithms.

Take for example an alert system for patients in a hospital or a nursing home that would tell nurses when a patient needs assistance, or emergency care. Theoretically, this system could help nurses be more efficient and respond to emergencies with a shorter delay. From a technical perspective, the challenges include but are not restricted to the following:

1. Create a set of sensors that can detect an anomaly in the patient that requires nurse assistance.
2. Network these sensors to a database.
3. Provide a user interface to the nurses or other health professionals who will be using the device.
4. Assure that all alerts will be delivered with some maximum time delay.
5. Make sure that the patient’s data is secure.

None of these challenges are trivial and most require knowledge of both the technology and the medical application. For example, the Internet Protocol (TCP/IP) does not guarantee a minimum delay for the delivery of information packets. If an application cannot tolerate small delays, TCP/IP might not be the best method with which to implement the system. Instead, an Intranet, or self-contained Internet that does not interface with the larger Internet, may be a better option, and in that system you may be able to ensure that information is delivered within a certain amount of time. On the other hand, user interfaces may seem to be a fairly simple thing, which many individuals and companies create on a daily basis, but when it comes to medical applications, it is important to create an interface that is not only easy to use but also prioritizes alerts that are important and at the same time does not swamp health professionals with a stream of data that is bothersome and takes away from their other activities. An overview of the distributed computing from a technical perspective is included in Chapter 2, this volume [1].

Each application of distributed computing faces its own unique set of challenges. Applying distributed computing to hospitals is very different from the quantified self-movement where individuals track their own blood pressure or activity at home, and the quantified self-movement is different from applications where medical professionals are trying to use home-collected data in a professional way.

One effect of distributed systems in medicine is to extend the reach of medicine from the doctor’s office or hospital into the home, and to extend the definition of medicine from reactive cures to preventative actions. Distributed computing not only allows the doctors to reach their patients in the home, but is also fundamentally changing the way that doctors and patients interact. Technology has continuously been changing how people interact with everything; in medicine, you see this in simple things that we take for granted such as looking up a disease on WebMD, being able to schedule a doctor’s appointment over the phone, or call 911 for an emergency. Even complicated technical procedures such as remote surgeries are possible today (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1422462/). Wireless computing continues to develop new ways for doctors and patients to interact, through ever-more-constant feedback and interaction, even if that interaction is through a curtain of technology.

In Chapter 4, Dr. Xian discusses how distributed computing and constant monitoring can improve patient care, and in Chapter 3, Dr. Wang-Roveda gives a broad overview of how hospitals are integrating distributed computing into their daily operations [3, 2].

Another use of distributed computing is not to use it as an augmentation of a doctor or healthcare worker, but to use distributed computing as a medicine in of itself. One application is for Alzheimer’s patients. Distributed computing can be used as essentially a vaccine against memory loss, helping people with dementia to remember basic tasks. Distributed computing also has uses for other types of mental disorders, for example, helping children with autism learn how to interact with the world.
Distributed computing can also be used as a diagnosis tool. By making consistent measurements, distributed computing can help to diagnose aspects that were impossible to quantify before, such as frailty in the elderly or the amount of eye contact made by children with autism. These uses of distributed computing are explained in greater depth in Chapters 3 and 6, this volume [2, 5].

In Chapter 4, this volume, we discuss a pervasive sensing platform that includes wireless “body sensor network” (BSN) and the “mobile base unit” (MBU) [3]. BSN acts as a sensor node and measures the physiological data using a group of sensors. Then, it is communicated using the MBU wirelessly for data transmission. It allows more portability. The patients could wear the sensors as watches, rings, clothes, etc.

Using mobile phones, we can study lifestyle and behavior that relate to the occurrence of a disease like smoking or overeating. They provide early evidence of an impending illness. We collect and analyze the data using mobile sensing. We present a mobile sensing toolkit called InCense and how it is used.

However, although sensors may generate a lot of new data, this data must first be processed into a useful form in order for this data to be useful. If distributed computing systems are going to be implemented in large scales in medicine, these systems must provide quality information that will make their use more efficient than face-to-face interactions. One of the main problems with things such as electronic health records at the moment is that they are not easy to use, are not standardized, do not give the doctors a good way of seeing a patient’s medical history, and take up too much time to fill out. In order for distributed computing systems to be useful and for doctors to pay attention to them, they need to be robust and not overwhelm doctors with data. Readability is what makes data worthwhile. If a sick patient wearing a distributed system is allowed to go home, that distributed system should send the hospital an alert if the patient has a genuine emergency. However, if the patient does not have an emergency, the system should not send a false alert, which would take away resources from legitimate problems. This is discussed more clearly in Chapter 5, this volume [4].

Two of the biggest technical challenges in implementing distributed computing in medical applications are providing consistent power to the devices being used and determining the priority among events sensed by a network of devices or body sensors. These two factors help conserve the two main resources for any system—the energy of the machines in the system and the energy and time of the people in the system.

Wireless power transfer has recently become a very important topic. We mostly want longer battery life. There are three approaches that are discussed in this chapter: electromagnetic wave approach, inductive coupling, and magnetic resonance coupling. Wireless power transfer is also used in implantable medical devices. It is explained in more detail in Chapter 7, this volume [6].

The other method used is wireless body area networks (WBANs), which is a class of sensors that support a variety of health applications. It comprises a set of sensors and an energy-constrained fusion center. The objective of this chapter is to maximize the lifetime of this unique sensor network while ensuring proper physical activity. It is discussed in more detail in Chapter 8, this volume [7].
One of the methods used to determine whether an event has occurred or not is through Markov chains, or a MDP. MDPs, or partially observable MDPs, are used frequently in robotics systems for things such as path planning and map building. These algorithms are robust because they merely require that the robot be able to hold a belief in a particular state and can operate with limited knowledge of the outside world. In this case, the techniques enable distributed sensor nodes to adapt their energy output by changing their sampling frequency, and can take more samples when they believe something interesting is happening, and take fewer samples when the environment seems more routine. This algorithm and its implementation are described in detail in Chapter 9, this volume [8].

So far, we have talked about mostly implementing current technologies in medicine. Although some of the techniques are problems that have not yet been solved, the technology used is somewhat mature—the Internet already exists, and mobile phones already use accelerometers and other built-in sensors and can connect to other devices. In Section 1.6 we introduce new discoveries in materials and devices that will extend the reach of wireless computing.

1.6 NANOTECHNOLOGY IN MEDICINE

Distributed systems can already take advantage of current medical implants and other data sources; however, with these new medical sensors, we could do much more.

Why is nanotechnology revolutionary to medicine? Maybe this is too obvious. A better question may be the following: How will nanotechnology change medicine? It could potentially provide scientists with a new way to look at and affect the world. Ideas are important. The germ theory of medicine did not in of itself cure any diseases, but the idea of the germ theory of medicine allowed doctors and scientists to develop and use cures and prevention techniques because now they understood why certain illnesses were contracted and spread. It was a technique for how to understand the world. The discovery of DNA had a similar effect, because now you could understand why some people were more or less susceptible to certain disorders, etc. Nanotechnology is a broad field, but at its core, the idea of nanotechnology is to understand our world at a level that we don’t understand it at right now. Nanotechnology will allow us to observe and change things that before were considered beyond our ability. It is transforming what was previously magic into science.

Applications of nanotechnology in medicine include but are not exclusive to the following:

1. Macro-sized materials with new properties because of the nanostructures that make up the material.
2. Nanoparticles as detection mechanisms.
3. Nanoparticles as drug delivery mechanisms.
4. Nanotechnology as implantable/injectable sensors for health monitoring.
Many uses of nanotechnology are special in large part because nanotechnology functions on such a small scale. Nanorobotics, for example, is a field that desires mostly to replicate the functions of macro-sized robots in a tiny form. The desired functionalities of nanorobots—actuation, sensing, and communication—exist in macro form, but have yet to be translated into the nanoscale. Medical nanorobots (while also being scary horror film gray sludge material), which have the capabilities of their macro counterparts, could perform functions such as drug delivery, diagnosis, or continuous sensing of various health parameters.

Medical nanorobots have a lot of potential. They could possibly decrease toxicity of cancer treatments by offering a more targeted precision on the cellular level. However, there are a number of challenges to be faced before medical nanorobots are viable. Some of those challenges are technical in nature. We do not know how to build or produce nanorobots in any quantity. Some so-called organic nanorobots have been produced, using modified bacteria, for example, salmonella, but these lack the control and communication that are necessary to truly describe them as nanorobots in a true sense. Other challenges are ethical or social in nature. Invisible, tiny robots that can track a person’s health are rightfully scary, and appropriate bounds on this technology should be put in place. It is discussed in more detail in Chapter 10, this volume [9].

Nanoparticles are useful both because they have properties different from their macrosized counterparts and because they are very small. For example, gold nanoparticles behave differently in carbon nanotubes. Nanoparticles that can be controlled by magnetic field are called magnetic nanoparticles (MNs). Using this property, we can send drugs attached to the MNs and direct these to the required location using external magnetic field. To combat heat issues, magnetoelectro nanoparticles were used instead. There are three processes that are transmission and targeting, drug release, and drug intake. It is explained in detail in Chapter 11, this volume [10].

One special case of nanotechnology is DNA. The size of a single tRNA is 7 nm, although the length of a DNA strand is much longer—a few centimeters of DNA per cell, when uncoiled. DNA studies are not only a part of nanotechnology but also go far beyond nanotechnology. One particular application for DNA is DNA computing.

DNA computation is made possible by encoding the basic components of computer logic—input, output, and logic gates—in DNA strand interactions guided by Watson–Crick base pairing. This property of DNA also enables the design and construction of self-assembling nanoscale structures with defined features at molecular resolution. Recently, DNA computing and DNA nanotechnology were integrated to create a new generation of molecular machines capable of sensing their environment, processing the data, and actuating in order to write into the environment a desired output. Since DNA is a biological molecule naturally interfacing with the biology, biochemistry, and genetics of living organisms, it now provides novel strategies for treating diseases. These features are discussed in Chapter 12, this volume [11].

DNA nanotechnology is a special instance of nanotechnology that uses biology-created nanostructures. Other fields of nanotechnology rely on human-created nanostructures that would not form in nature without human intervention.
Many applications of nanomedicine are based upon the properties of nanoparticles. One category of nanoparticles is nanoparticles made out of graphene. Graphene, a 2D material, is an allotrope of carbon. (An allotrope is a specific configuration of atoms, in this case carbon atoms; other allotropes include diamond and graphite.) Graphene can be wrapped into fullerenes (spherical carbon forms), carbon nanotubes, and other shapes. It is strong, light, and flexible. Graphene also has incredibly high electron mobility at room temperature, making it an excellent conductor of electricity.

Graphene exhibits characteristics unlike any other material, and these characteristics can be used to create novel sensors. Graphene’s high surface-to-volume ratio, high electrical conductivity, mechanical strength, and chemical stability provide sensing advantages. One application is to detect biomarkers, specific molecules that the body produces when it is diseased. The applications of graphene are discussed in Chapter 13, this volume [12].

Nanotechnology includes things such as computer chips made out of nanostructures. In these cases, it is not so important that the created items are small, but rather the properties of the new material are different from their macro-sized counterparts, and these characteristics can be used to develop new things. For example, obsessive-compulsive disorder (OCD), schizophrenia, and Parkinson’s are assumed to be incurable because the macrosized medicines used were not responding the way we require, but recently nanotechnology has changed the scenario. Neuromorphic circuits that model the disorders like OCD, schizophrenia, multiple sclerosis, and Parkinson’s are used to demonstrate behavioral differences with respect to healthy neural networks. Most of the circuits employ nanotechnology. It is explained in detail in Chapter 14, this volume [13].

Nanomedicine can be exploited to synthesize nanocomponents, which can be linked to microscale transporters and agents. The delivery of therapeutic agents to the site of treatment by navigating through the shortest vascular route so as to avoid circulation of highly toxic agents is an example of how nanorobotics can enhance medical interventions. We further explain the exploitation of the phenomena at all scales. It is discussed in detail in Chapter 15, this volume [14].

Nanomedicine’s transversality means that the absence of radical transformations in the nanomedicine field does not mean that it is a failure. It means that it is a road-map as to what is yet to come. There are three important areas in the contemporary biomedicine: predictive, personalized, and regenerative medicine. It intensifies and builds on the already existing tendencies within biomedicine. It is explained in detail in Chapter 16, this volume [15].

1.7 ETHICS OF MEDICAL WIRELESS COMPUTING

Although these technologies are promising, the fact remains that we should implement them in a safe, ethical way in order to reap the benefits. Misuse of technology is an old story, and there are specific fears that must be allayed before any of these innovations become realities, much less transform the way that the healthcare system
works. To that aim, we discuss the ethics of wireless computing in medicine from the extent to which a person’s medical data should be available for research to the power of nanotechnology. In discussing these problems, we desire to mitigate the unintended consequences of wireless computing in medicine and guide a conversation about how to implement these technologies in a way that maximizes the benefits while respecting reasonable ethical boundaries.

Application of the new information and communication technologies to medical diagnosis, record keeping, and treatment can revolutionize healthcare. However, this presents many questions about appropriate ethical behavior in regards to these systems. The vulnerability of computerized databases presents challenges often categorized in terms of patient privacy, but the range of issues is much broader. It is discussed in detail in Chapter 17, this volume [16].

Equally important is the accountability of healthcare professionals, whose behavior the databases also record, in the context of medical care. It raises the question of how doctors should be judged in light of this new data. If a patient refuses help, or if a surgery goes wrong, should the doctor be held accountable? If a doctor knows that every action is recorded, will his or her behavior change? The ethics of the medical profession traditionally focused exclusively on the doctor–patient relationship, but in the context of publicly funded healthcare and the necessity for an extensive epidemiological research to determine the differential effectiveness of treatments, the entire society becomes involved.

The basis for establishing ethical principles for the new technologies then expands to include issues of social inequality, political doctrine, investment in the welfare of children versus the elderly, and innumerable disputes concerning the extent to which government should monitor and control the behavior of citizens. Such issues become acute when the problems in question involve mental health, addictions, and what sociologists call the undue medicalization of deviant behavior. In Chapter 19, William Sims Bainbridge catalogs many of the ways that the technologies of wireless computing are transformative and draws upon classical perspectives on morality from philosophy and social science to understand their ethical implications [18]. It is discussed in the previous chapter [17].

In Chapter 18, Clark Miller et al. explore some of the specific dilemmas, which are mentioned in the previous chapter. They look at three prominent visions that ubiquitous healthcare promotes: the knowledge-empowered individual, routine health surveillance, and digital medicine, and explore some of the paradigms and effects that each of these three visions of ubiquitous healthcare may produce.

1.8 PRIVACY IN WIRELESS COMPUTING

Privacy is one of the issues that have to be solved in order for wireless computing to be widely adopted. Conversely, the sharing of data could help improve healthcare immensely, by allowing doctors to have an easy access to a patient’s complete medical history and also by sharing results of various studies and allowing researchers to mine this data for new results.
One of the issues receiving a lot of attention is Electronic Health Records (EHRs). In 2009, the United States enacted the Health Information Technology for Economic and Clinical Health Act (HITECH), which aimed at increasing the use of EHRs (http://www.gpo.gov/fdsys/pkg/PLAW-111publ5/html/PLAW-111publ5.htm). However, at this time, the adoption of EHRs remains at less than 50% and only 20% of doctors report that the health records are fully functional. (Are More Doctors Adopting EHRs? Retrieved 31 March 2011.) The standardization of Electronic Health Records needs to happen in order for EHRs to be useful, and EHRs should be shared across hospitals in order to be useful. However, the sharing of patient’s data should be done carefully. Confidentiality, accessibility, and security are major issues in the creation of e-healthcare systems. E-healthcare by virtue of existing takes data once only shared between a doctor and a patient, and shares it with the company that is operating the e-healthcare system. That data is also stored in servers that can be hacked. Additionally, there are legal gray zones, such as insurance companies who could require the patient’s EHRs before granting insurance. These issues and more are discussed in Chapter 19, this volume [18].

Due to the fundamentally different ways of treating patients, we have completely new ethical and privacy issues. The US intellectual property protection system has difficulty dealing with nanomedicine claims due to its interdisciplinary nature. The current laws and regulations are ambiguous when it comes to nanomedicine, and they need to be updated. It is discussed in detail in Chapter 20, this volume [19].

1.9 CONCLUSION

Wireless computing is a broad, interdisciplinary field that draws both from traditional distributed computing and nanotechnology. Applications of wireless computing have a potentially transformative effect on medicine, creating both opportunities for benefiting society and ethical pitfalls. Opportunities in distributed computing include creating integrated systems for hospitals, extending the reach of the doctor’s office into the home, and using computing itself as a treatment for Alzheimer’s and other cognitive diseases. Simultaneously, progress in nanotechnology has created new ways of sensing the world around us, opening up new ways of diagnosing, treating, and monitoring disease. As these technologies are integrated into medicine, we should also be aware of their effect on our society, how they change the definition of disease and medicine itself, and how these methods open up new vulnerabilities in data security and privacy. With a complete view of the technology and societal facets of wireless medicine, we can hope to gain the greatest benefits that the technology promises while respecting the rights of the people who use it.

REFERENCES

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