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# A Brief History of Medicine and Future Healthcare Improvement

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## Honors Thesis Paper

# A Brief History of Medicine and Future Healthcare Improvement

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## ABSTRACT

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Medicine is and always has been an essential part of human existence. Throughout history, our ancestors have been consistently striving to cure disease, ease pain and prolong life. Although medicine has drastically evolved through time, these goals still define the core of today's medicine, and thus history intimately connects us with our ancestors. This link allows humanity to learn from countless years of human experience, and gain valuable information that enables incredible improvements. By implementing knowledge from past successes and failures in medicine, changes can be focused, efficient and evidence based. Therefore, the undeniable synergy between the history of medicine and healthcare improvement, warrants a thorough review of medicine's past, present and future.

Healthcare has rapidly developed through history and its progression is still rapidly increasing. A once barbaric and chaotic trade has evolved into one of the most precise and calculated professions in the world. Although medicine has become highly advanced with cures for complex diseases and innovative treatments, that is not to say it is perfect by any measure. In fact, our US healthcare system is badly broken. There are numerous improvements to be made, primarily to improve the quality, access and cost of good healthcare. More specifically, the major problems in our healthcare system are: medical errors, physician time with patients, access to care and end of life care. Reassuringly, there are many feasible innovative solutions and great minds dedicated to fixing these issues.

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## Part 1: The History of Medicine

Medicine, the science and practice of diagnosis, treatment and prevention of disease, has always been integral to human existence in some form. However, since it is difficult to decipher unwritten history, it is not easy to pinpoint the exact start of medicine. Additionally, studying drawings, tools and bony remains of early humans provides valuable insight, but still excludes information about the mental attitudes towards disease and death. Despite these limitations, studies show that once early humans developed reasoning skills, they were able to discover various medicinal uses for plants through trial and error. Therefore the use of herbal remedies likely exists as the emergence of interventional medicine.

Thousands of human skulls with large holes bored in them from 5,000 to 10,000 years ago exist as the earliest evidence of surgery. This primitive surgical procedure, called trepanation, involves drilling or cutting away the skull to expose the dura matter of the brain. Trepanations were individually developed and performed in ancient Greece, Africa, North and South America, the Far East and

Polynesia. Although evidence is difficult to come by, studies show that people were trepanned as part of rituals to allow evil spirits to escape. Other studies showed that this procedure was also used for more scientific medical interventions like treating migraines, cerebral hemorrhage, seizures and mental disorders. Additional evidence shows that trepanation was used as a form of primitive emergency surgery to remove shattered bone pieces and blood from a damaged skull. Despite how barbaric this procedure seems by today's standards, trepanation marked dawn of interventional surgery.

Between 500 B.C. and 300 B.C. Hippocrates was a major catalyst that helped the field of medicine solidify and form its moral compass. Hippocrates, now considered the founder of modern medicine, accelerated the field of medicine beyond magic, superstition and the supernatural. Hippocrates collected experimental data to characterize disease processes and to show that disease symptoms were a result of the body's natural reaction to the ailment. As an integrated and holistic view of the health, Hippocrates viewed the human body as composed of four humors: yellow bile, phlegm, black bile, and blood. He believed that diseases are the result of an imbalance of the humors, and that

rebalancing will cure the problem. This idea led to treatments such as bloodletting, purging, leaching, cupping and other practices that were thought to rebalance the humors. Despite the fact that this theory has been disproven, The size of this leap in medical ideology cannot be overestimated. Additionally, Hippocrates wrote the Hippocratic Oath, which was used to have physicians to swear to the Greek gods that he or she would uphold the highest ethical standards. This was the earliest expression of medical ethics in the Western world, which included medical confidentiality and non-maleficence among other morals. Although the original oath is outdated today, the core message remains extremely relevant: do no harm. Louis Lasagna, Academic Dean at Tufts School of Medicine, updated the Hippocratic Oath in 1964 with the main line: "I will apply, for the benefit of the sick, all measures [that] are required, avoiding those twin traps of over treatment and therapeutic nihilism." Nearly all medical schools in the nation incorporate the Hippocratic Oath into their white coat and graduation ceremonies.

The growing medical field necessitated a way to formally train new physicians. In 1100 this need began to be met with the first medical schools in Paris, Bologna, Oxford, Salerno, and Montpellier. The curriculum at these institutions were based on the work of Hippocrates and other medical scholars, and they taught anatomy, surgery, medical astrology, and the use of medicinal herbs.

The next interesting milestone in medicine's history occurred in medieval Europe from people that weren't even doctors at all. These practitioners were called Barber Surgeons, and unlike many physicians of the time, they performed surgeries. In the middle ages, clergymen were the surgical and medical practitioners in many places. However, in 1215, Pope Innocent III prohibited priests from performing bloodlettings. Since barbers routinely use razors, it was surmised that they would be adept at performing treatments that involved cutting the skin. So surgery was taught to barbers and the Barber Surgeon was born. This concept quickly spread, and then in the 14th and 15th centuries the Plague decimated so many of the trained physicians that barber surgeons became universally relied upon for medical procedures. Following this, King Henry VIII unified the Company of Barbers with the Fellowship of Surgeons to create the Company of Barber Surgeons. This niche field was still only considered a trade, much like being blacksmith, and most barber surgeons were uneducated and illiterate. Nevertheless they were highly skilled tradesmen and essential practitioners of the time. In addition to the grooming services that we are familiar with today, barber surgeons would also provide minor surgeries, bloodletting,

tooth extractions and sometimes amputations. This period also marked a time of great advances in anatomical and surgical knowledge, with barber surgeons performing anatomical dissections regularly to master their craft. Despite these advances, surgery's inherent brutal and barbaric nature created great fear and skepticism in the public. One root cause of this anxiety was the extreme pain that people had to suffer through while fully awake—a problem that badly needed to be addressed.

The beginnings of a solution to this major problem occurred in the late 18th century, when English chemist Joseph Priestley started experimenting with nitrous oxide and its effects on the body. Although Priestley was awarded the Royal Society's prestigious Copley Medal in 1773 for his work with gasses, he failed to find any useful medical applications. Progress stagnated until the 19th century when Humphry Davy decided to study Priestley's gasses. He built and airtight chamber to breathe nitrous oxide, and discovered that the gas produced euphoria and analgesia. He described nitrous oxide as "capable of destroying physical pain," and that "it may probably be used with advantage during surgical operations." Despite the promising findings, his studies went largely unnoticed for almost 50 years. However on December 10th 1844, the world of anesthetics was changed forever. Medical school dropout, Gardner Colton, was demonstrating nitrous oxide's effects on the body when his volunteer badly hurt his leg. Much to the surprise of everyone observing, the volunteer felt absolutely no pain. A local dentist in attendance, Horace Wells, took particular interest in this observation. Wells was so excited and confident about nitrous oxide, that he had Colton administer the gas to him for an extraction of one his own teeth. Wells felt no pain at all and decided to test the gas with his own patients. However, when Wells was demonstrating the effects of nitrous oxide on one of his patients during a tooth extraction, his patient screamed out in pain and he was publicly humiliated. Luckily, Wells' former colleague, William Morton, decided to keep testing anesthetics. Morton began studying ethyl ether's anesthetic properties with promising results. Then on October 16th 1846, history was made when Morton became the first person in the world to successfully use ether anesthesia for surgery. As news of Morton's successful surgery spread, the use of ether in surgery exponentially increased. Although some doctors questioned the safety of ether and resisted adoption, they could not deny benefits of relieving patients from pain during surgery. Suddenly, surgery changed from an incredibly agonizing and savage practice, to a much more refined and practical field. Still, a major problem remained: huge numbers of patients fell incredibly ill and died after surgeries.

Although there were major debates about the causes of this, there was universal agreement that something needed to be done. Despite the support behind various theories, Louis Pasteur proved the “germ theory” of petrification to be true. This theory states that infectious disease is caused by microorganisms like bacteria and viruses. Pasteur eventually proved this by boiling broth in a swan necked flask to sterilize it, and then leaving it to cool. The design of the swan necked flask allowed the broth to be open to the air, but prevented dust and debris from landing in the broth. To the surprise of many, nothing grew in the flask, proving that putrefaction was not caused by bad air, but instead by microorganisms that land in the broth and grow. This revolutionary finding was studied by Joseph Lister, a British surgeon and medical scientist. Pasteur’s work inspired Lister to start implementing “antiseptic techniques” in surgeries that prevent the mysterious microorganisms from entering incisions. Lister eventually discovered that bandages soaked in carbolic acid could successfully work as an antiseptic barrier. He also invented a device that sprayed carbolic acid in the air during surgery, where it would cover the surgeons hands and the wound. After implementing these techniques in 1865, surgical mortality fell from 45 to 15 percent in just four years. Despite the initial skepticism and opposition, many successful antiseptic surgeries and decreasing mortality rates convinced the world that Lister’s methods revolutionized medicine and made it incredibly safer.

### ***Vaccines***

Vaccinations are considered one of the greatest contributors to human health of any invention in history. The man that is credited with the development of vaccinations as a health tool is Edward Jenner. Because of his work, this English physician and scientist went down in history as the father of Vaccinology. Jenner spearheaded the development of vaccines which his cowpox work in 1796. At the time, it was common knowledge that smallpox survivors became immune to the disease; however, injecting live smallpox viruses caused severe disease or death. Furthermore, the injected person could pass the disease to other people, thus exacerbating the spread of the infection. Jenner took notice to the intriguing fact that people who had suffered a relatively harmless attack from the cowpox virus were also immune to the vicious smallpox virus. After some contemplation, Jenner deduced that not only a cowpox resistance protected against smallpox but also this protection could be transferred from one person to another—and Jenner planned to do just that. On May 15, 1796 Jenner extracted fluid from a milkmaid’s cowpox lesions, and inoculated an eight-year-old boy with the fluid. The boy fell ill for nine

days, but by the tenth day he was well. Then on July 1st, Jenner injected the boy once more, but with the smallpox virus this time. To great astonishment, the boy not only remained healthy, but also gained complete immunity to smallpox. After numerous more successful cases, the practice of vaccinations quickly spread throughout the rest of Europe, to America and around the world. Shortly thereafter smallpox mortality rates plummeted, and Jenner received worldwide recognition.

Despite the success of vaccines, many difficulties still remained. Doctors occasionally botched the simple procedure, pure cowpox vaccine was in short supply, and it was difficult to preserve and transport. Most importantly, limited knowledge of how the human body acquires immunity to pathogens made it exceedingly difficult to improve the safety and effectiveness of vaccines. This gap in understanding remained for almost a century, until Emil von Behring and Shibasaburo Kitasato made a paramount discovery. In 1890, Behring and Kitasato noticed that infected animals produce a substance that has the ability to neutralize toxins. They named this substance antitoxin. Subsequently, they proved that antitoxins produced by one animal can confer temporary immunity in another animal. After confirming these observations it was later discovered that these antitoxins were antibodies. Antibodies bind pathogens in a highly specific manner and help the body recognize, destroy and eradicate the invader. This information paved the way for the elucidation of the immunization mechanism, thus enabling the creation of a wide variety of perfected vaccines.

Although there are many types of vaccines, at their core they are an injection of a dead or attenuated pathogens. Introducing the antigens from the pathogen stimulates the body’s immune system to produce antibodies and T-lymphocytes against the antigen. Once the body clears the antigens from the vaccination it builds a supply of “memory” B and T-lymphocytes. As their name implies, these lymphocytes have the ability to remember the antigen from the vaccine and recognize it when a real virus or bacterium invade. This recognition allows the immune system to mount an incredibly rapid and efficient immune response to kill the pathogen before it is able to proliferate and attack the body.

### ***DNA and Genetics***

With the advent of antiseptics and germ theory, the field of infectious diseases began to blossom within medicine. This newfound knowledge catalyzed the creation of preventive techniques and many cures for infectious diseases. Despite

this development, a tremendous gap in knowledge still existed. People suffered from incredibly debilitating and life threatening diseases—sometimes since birth—without the presence of any infection. Even more perplexingly, these diseases could sometimes be passed from parent to offspring. Something unknown was causing these disorders that was completely unrelated to germ theory. The first step was taken towards an answer with the incredible works of Charles Darwin and Alfred Wallace. Although ideas of evolution predated Darwin and Wallace, they were the first to solidify all the evidence and propose a convincing mechanism of evolution. Starting in 1835 Darwin spent several years studying various inhabitants, most famously, the finches. Darwin discovered that the finches had varying beak structures depending on the food sources available in the environment. For example, thick beaks for cracking open nuts, and long beaks for eating cacti. This massive discovery enabled Darwin to propose the mechanism of evolution: natural selection. The idea that beneficial traits are selected for by the environment by providing increased fitness and survival, while deleterious traits were selected against with death and the inability to pass traits to offspring. Although this was an incredible discovery, the controversial ideas made Darwin hesitant to publish his findings for fear of repercussion. Years later, Wallace went on an eight-year expedition to what was then the Dutch East Indies, modern day Indonesia. During this time Wallace collected more than 100,000 insect, bird and animal specimens, and by 1855 he independently came to the same finding as Darwin—that living things evolve. Wallace immediately wrote his theory in a paper, and unknowingly sent it to Darwin for peer review and editing. Seeing Wallace's results prompted Darwin to share his findings, and in 1858 the two published a joint paper arguing the theory of evolution and natural selection. Although controversial, this earth shattering discovery offered undeniable evidence that completely changed the way the world thought. This launched the field of genetics.

Although Darwin and Wallace knew evolution was occurring via natural selection, they did not know how traits were passed from parent to offspring. Fortunately, the work of Gregor Mendel, an Austrian monk, answered this question and more. From 1856 to 1863, Mendel cross-fertilized tens of thousands of pea plants to observe the phenotypes (physical characteristics) of the offspring. Mendel crossed plants that had visibly opposite characteristics—tall with short, wrinkled peas with smooth peas—in order to formulate his famous theories of heredity. Based on his results, Mendel posited that there are units of hereditary that determine phenotypes that are passed on to offspring. Today Mendel's theories are still the foundation of modern

genetics, and today we call his units of hereditary “alleles.” Unfortunately, Mendel's work went largely unnoticed for almost 50 years, in part because missing information about genetic material made Mendel's theories too abstract and difficult to apply.

Mendel's ideas were put in much greater context and the fields of medicine and genetics leaped forward with the discovery of DNA. However, with limited technology and knowledge, the discovery of DNA was long and arduous. DNA was first identified and isolated in 1869, by a Swiss student by the name of Johann Friedrich Miescher. While styling white blood cells from puss, Miescher noted that when acid was added to the cells, and substance separated from the solution. This substance also dissolved back into solution upon the addition of a base. Upon further examination he discovered that this substance contained phosphorus and nitrogen, but possessed different properties than proteins. Because Miescher believed this substance came from the cell nucleus he called it ‘nuclein.’ This discovery prompted German biochemist, Albrecht Kossel, to understand the complexities and composition of nuclein. In 1893, Kossel discovered that nuclein is composed of five different nucleotide units: Adenine, Guanine, Cytosine, Thymine and Uracil. This important discovery was a great step towards elucidating the complete DNA structure.

In the middle of the nineteenth century German anatomist and cytogeneticist, Walther Flemming, discovered a fibrous structure inside cell nuclei that he called chromatin. Walter Sutton and Theodor Boveri expanded on this new knowledge and developed the chromosome theory of inheritance, stating that genetic material that is passed down to offsprings is in chromosomes. Interestingly Sutton and Boveri worked independently, studying grasshopper chromosomes and roundworm embryos, respectively. Boveri's work with embryos proved that sperm and egg chromosomes are linked to the characteristics inherited by the offspring. Sutton expanded on this work by identifying the sex chromosome. The work of Boveri and Sutton perfectly complemented Mendel's work and helped explain his inheritance patterns. Finally, after over a century, Mendel's work could be fully appreciated and utilized. Now with the knowledge of chromosomal DNA and inheritance, genetic diseases could begin to be uncovered. This was a huge advancement in medicine because it now was revealed that chromosomal abnormalities can cause hereditary diseases. This was a great advancement; however, it was just piece of the puzzle. It was completely possible for someone to have normal chromosome structure, yet suffer from a genetic disorder. Evidently, there is a substructure to chromosomes that is highly regulated and critical to function. Much to be

uncovered about the structure of DNA, and its function in the cell and heredity.

After various experiments proved that DNA truly is the genetic material, it was a race to discover DNA's structure. This knowledge was the missing puzzle piece that led to the elucidation of the mechanisms of heredity, replication, mitosis, of course genetic diseases. This part of history has been told many times; however, James Watson and Francis Crick do not deserve all the credit for elucidating the DNA structure. In fact, it was Rosalind Franklin and Maurice Wilkins that provided the crucial evidence that enabled Watson and Crick's discovery. Franklin worked in Wilkins' lab where they both were experts in a technique called X-Ray Crystallography—a method that enables molecular structures to be identified. Franklin obtained two photos of two crystalized DNA fibers, one more hydrated than the other. From these two images, she was able to discover not only DNA's helical structure with the nitrogenous bases hidden on the inside but also its dimensions. In the meantime, Watson and Crick analyzed existing data about DNA's structure in order to create models and synthesize new information. Then without Franklin's permission, her unpublished report and photos were shown to Watson and Crick. Her data, most famously image 51, proved to be the missing information that Watson and Crick needed to solve the DNA structure. With the compilation of Franklin, Wilkins, and other's work, in 1953 Watson and Crick were able to determine that DNA was a double helical structure, with two strands base pairing together. Unfortunately, Watson and Crick did not acknowledge Franklin's massive contribution to their discovery; therefore, she was excluded from the Nobel Prize that Watson, Crick and Wilkins won in 1962. Despite the injustices that were done, this was one of the greatest discoveries in all of science and medicine.

After this breakthrough, discoveries about DNA exponentially accelerated. By 1966, Marshall Nirenberg, Har Khorana and Severo Ochoa and their colleagues cracked the universal genetic code. They elucidated that the four bases, A,G,C and T, are read in sets of threes, called codons, in order to code for the amino acid sequence. Additionally, Crick discovered the process of transcription and translation, thus formulating the central dogma of biology: DNA to mRNA to protein. These discoveries, DNA structure and the genetic code, launched humanity into unprecedented areas. With this, the field of medicine took a huge leap forward. Suddenly, countless genetic diseases could be explained: a mutation in the DNA sequence causes proteins to become dysfunctional or not made at all, leading to disease. This marked the beginning of molecular biology and molecular genetics. Research focus shifted to discovering root causes

of DNA mutations and their results, thus opening up possibilities of treating whole new patient populations. Patients being plagued by once unknown diseases, could now be identified and treated accordingly.

Now with the new knowledge of the DNA and the genetic code, the ability to read DNA sequences became essential. Being able to determine sequences of DNA opens unlimited potential in both medicine and research. In the lab this would allow researchers to study the effects of specific mutations by enabling them to identify mutations with the DNA sequence, and then look for its effects. In medicine, sequencing could be used as a tool to identify mutations in patients in order to diagnose and treat their disease. Thanks to the work of many brilliant scientists, this is the reality we live in today. The first sequencing method was established in 1970, and the technology has been rapidly improving ever since. Initially sequencing was extremely time consuming, laborious, expensive and inefficient. As time progressed, technology and knowledge improved to make sequencing easier and more affordable. As sequencing improved, it became more accessible to labs and as a result research involving sequencing expanded. Today a 1000 basepair sequence can be easily obtained by mailing the DNA and a few dollars to a company. As great as this is, sequencing technology has advanced into an even more exciting territory: whole genome sequencing. With recent technological advancements, we now have the ability to quickly sequence an entire organism's genome very precisely. Furthermore, this technique is becoming more affordable every year. Today, the entire three billion base pair human genome can be sequenced in under an hour for less than a thousand dollars. This incredible technology opens up countless exciting possibilities in medicine. Firstly, people can have their genome's sequenced prophylactically to screen for genetic disease predispositions. This would be extremely beneficial because early detection of diseases allows people to make necessary lifestyle changes and gives people the best chances for a cure. Additionally by catching diseases early, it would make treatments much more efficient by eliminating all the guess work of diagnosis. Quick diagnosis and more efficient care will save people and hospitals a lot of time and money.

The other great application for whole genome sequence is custom care tailored specifically to patient's genomes—pharmacogenomics. Pharmacogenomics is defined as the study of variability in drug responses due to heredity and genes, and it holds great potential for drug therapy. More specifically, this is the use of whole genome sequencing to determine the most effective drugs with the least side effects to give patients. Because genome variability slightly alters

the presence, efficiency and activity of enzymes and other proteins, everybody can react differently to various drugs. A drug that works flawlessly for one person, can just cause harmful side effects in another person. Pharmacogenomics eliminates the guesswork from drug prescription, making care more accurate, more efficient and less expensive. No matter the application of whole genome sequencing in medicine, the common theme is that it streamlines care, making it more accessible and more accurate. The numerous centuries of DNA research have created a bright future in medicine, that is not too far off.

### **Antibiotics**

Before the 1920s, there were no effective treatments or cures for bacterial diseases. Doctors were overloaded with patients suffering from pneumonia, syphilis, gonorrhea and many other infections, and the best they could do was wait it out. Even a small scratch could spell death if it became infected. There were various treatments involving arsenic, mercury, plants and some other various chemicals, but they were mostly ineffectual and caused vicious side effects. It was evident that a better solution was badly needed, and luckily the answer came. This serendipitous part of history has been told time and time again. As the story goes, in 1928, upon returning from a vacation, Alexander Fleming stumbled upon contaminated *Staphylococcus aureus* Petri dishes. After examining the plates under his microscope, he discovered that a mold called *Penicillium notatum* inhibited the growth of the *Staphylococcus aureus*. Upon further research, Fleming discovered that the mold was producing a factor that had the ability to kill not only *Staphylococcus aureus*, but also many other pathogenic microbes. This was a great discovery; however, the practicality of medical application was remained uncertain. Fleming's assistants, Stuart Craddock and Frederick Ridley, were tasked with isolating pure penicillin—a job that proved to be extremely arduous. Their attempts to purify penicillin repeatedly resulted in an unstable and crude product. Due to this, when Fleming published his paper on penicillin in 1929, he only briefly mentioned penicillin's potential medical application. At this point, it seemed to Fleming and his team that the main application for penicillin was merely to select for resistant bacteria in a lab setting.

Fortunately, Oxford researchers, Howard Florey and Ernst Chain, saw penicillin's true potential and decided to pursue better purification techniques. In 1939, the team began culturing massive amounts of *Penicillium notatum* in custom made vessels that enabled easy extraction and maintenance. Meanwhile, biochemist Norman Heatley utilized innovative techniques to extract penicillin from the massive volumes of

fungi filtrate. Another biochemist, Edward Abraham, then utilized a novel technique called alumina column chromatography to filter out any remaining impurities. In 1940, Florey conducted several experiments that proved penicillin's ability to protect mice from a normally lethal Streptococci infection. Then on February 12, 1941, Albert Alexander became the first patient to take penicillin after he contracted a life-threatening infection. Within days after the penicillin injection, his huge abscesses disappeared and he made an amazing recovery. Unfortunately the penicillin supply ran out and he died a few days later; nonetheless, this was a very promising result. Even more positive results with following patients, prompted plans to make penicillin a widely available drug.

Before penicillin could feasibly used as a mass market drug, the efficiency and yield of penicillin production needed to be greatly improved. Just a few weeks after attempting to solve these problems, Andrew Moyer found that substituting lactose for sucrose in the *Penicillium notatum* culture medium greatly increased yield. More importantly, he also discovered that the addition of corn-steep liquor to the fermentation medium increased yield ten-fold. After these discoveries, the practicality of penicillin started to become more clear; however, strains of *Penicillium notatum* being used only produced small amounts of penicillin. This sparked a global search for strains that make more penicillin. Eventually a strain was found that not only produced more penicillin, but also could be exposed to ultraviolet radiation to promote increased production. From this point penicillin manufacturing took off, and the era of antibiotics began.

Although Fleming's discovery and the subsequent advancements is one of the greatest advancements in medicine, penicillin alone was not enough to combat the wide variety of bacterial infections. Penicillin and other antibiotics like it, are called beta-lactam antibiotics. These drugs utilize a beta-lactam ring to prevent cross linking in the bacterial cell wall, leading to a deficient cell wall that causes death of the bacterium. This is great because human cells do not have cell walls, so penicillin can selectively attack bacteria while leaving good cells alone. Unfortunately, this benefit can also be a draw back. Not all bacterial cells have thick cell walls either, and thus penicillin is largely ineffective against many types of bacteria. This limitation necessitated research to discover more types of antibiotics, and this need was met. Now there are antibiotics that prevent bacteria growth by inhibiting protein synthesis, RNA synthesis, DNA synthesis and many other mechanisms. With this wide variety of mechanism, antibiotics are able to kill all different types and strains of bacteria in order to eliminate infections. However, the effectiveness and

ubiquity of antibiotics has led to overuse and subsequent consequences.

Bacteria have the ability to rapidly mutate and adapt in order to make themselves more fit to survive in the environment. This includes changing food preferences, neutralizing toxins, and most importantly gaining resistance to antibiotics. Bacteria are able to gain antibiotic resistance by random mutation or by picking up a plasmid with gene that confers resistance. Then when people take antibiotics, it kills all the susceptible bacteria while the resistant cells remain alive. This selects for the growth of the mutants by giving them a great advantage over non-resistant cells. This can exacerbate the original infection by strengthening the bacteria and making them even harder to kill. This has created a whole new problem for medicine: super bugs. Infections caused by antibiotic resistant bacteria are incredibly difficult to eliminate, resulting in increased healthcare costs, very poor health and even death. Also when trying to treat resistant bacteria with a different antibiotic, the bacteria can gain resistance to that antibiotic too, making it even more difficult to kill. This has become such a huge problem, that there are now resistant strains of bacteria for nearly every type of antibiotic. Although this is a multifaceted and complex issue, a clear remedy to this crisis is to eliminate the overuse and misuse of antibiotics. Doctors need to be frugal with prescribing antibiotics and both patients and doctors need to be in search of alternate solutions. Probiotics offer a great alternative in many situations, by promoting the growth of good bacteria to out grow the harmful bacteria. Additionally, pharmaceutical companies need to be funding the research for alternative drugs and solutions. Reassuringly, alternate interventions with promising results are being introduced, but this is not a problem that is going to go away quickly or easily. The moral of this part of history is that too much of a good thing can be very bad. Although antibiotics have revolutionized medicine and made infectious disease care highly effective, the overuse has created massive problems that need to be addressed immediately. Both patients and healthcare providers are in charge of making meaningful and beneficial changes to remedy this problem.

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## Part 2: Healthcare Improvement

Medicine has undoubtedly evolved drastically to meet human's insatiable need to treat diseases and improve health. The developments of human knowledge and skill have paved the way to the modern medicine that we know today. Despite medicine's dubious history, it is now known to be one of the most advanced and reliable fields. Although we have a bright future of exciting technology and

advancements, there are still many improvements that we need to make in our broken healthcare system.

In the United States we spend over *\$3.3 trillion dollars* annually on healthcare, almost 20% of our nation's GDP, yet our health outcomes are some of the worst in the country. Despite spending more of our GDP than any other country in the world, we are ranked 50th in life expectancy and number one in obesity rates. Due to complex inefficiencies and wastefulness, we are paying more for our healthcare and getting less. One of the greatest inefficiencies in our system is in the way we treat preventable diseases. Shockingly, 75% of our total healthcare costs go to treating diseases that are preventable. Instead of promoting healthy life decisions and preventative care, we as a nation wait for disease to set in before taking action. Another frivolous expense weighing on our healthcare system is drugs. We spend about *\$300 billion* annually on pharmaceutical drugs, which is almost as much as the rest of the world combined. Drugs do play a vital role in the health of some patients; however, physicians are overprescribing to patients who do not need them. Additionally, the United States is one of only two nations in the world where it is legal for pharmaceutical companies to advertise drugs. This is important because it not only increases healthcare spending, but also because studies have shown that physicians are markedly more likely to prescribe drugs that have been marketed, even if they are unnecessary. Furthermore, patients hear about drugs from advertisements and then demand that their doctor prescribes them. One of the greatest consequences of drug marketing is vastly inflated drug prices, that decrease their accessibility to patients. A quintessential example of this is the hepatitis C curing drug: Sovaldi. One pill is sold in America for *\$1000 dollars*, while the same pill is sold in India for *\$4*. In the US, the 12-week regimen of this drug costs a staggering *\$84,000* — a price that is out of reach for many patients that need this drug to survive. Astonishingly, because the company spends no money on advertising in India, they still make a profit selling the drug for *\$4*.

Another great contributor to our problems is our fee-for-service model of healthcare. Fee-for-service means that the government and insurance companies pay hospitals and physicians every time a procedure is performed. This incentivizes even good intentioned doctors to order more tests, do more procedures and overbook more patients into a day. This also prompts hospitals to book more operations, fill more beds and push doctors to see more patients. This emphasis of quantity over quality has dire financial and health related consequences. Not only are unnecessary expensive procedures being performed, but doctors are spending less time with patients. This means physicians have



less of a chance to fully get to know patients to hear their stories and learn their goals and beliefs. This increases healthcare costs, and more importantly can result in care that is not inline with what the patient wants—leading to unhappy patients and poor health outcomes. If we could change the system to pay doctors and hospitals for keeping patients healthy, preventing disease and keeping them out of hospitals then we would undoubtedly see health improvements.

To exacerbate all these problems, we have an entrenched system that resists positive changes. Insurance companies, hospitals, pharmaceutical companies and medical device manufactures are all making large amounts of money from our deteriorating health—and they want to keep it that way. In fact, these companies spent almost 1.1 billion dollars just between 2016 and 2017, to lobby on behalf of healthcare issues. This money is to ensure that nothing ever changes, Americans stay unhealthy and the healthcare system remains very profitable for them. Many of these problems necessitate system wide changes starting with new leadership and legislation, but there are also many problems that healthcare providers can help right now.

### ***Time Spent with Patients***

Why is spending adequate time with patients so critical? Foremost, time with patients is the single most important part of diagnosing and more importantly, treating. Being able to communicate effectively enables doctors to build trust and authentic bidirectional relationships with patients. This strong relationship is so important because it helps empower the patient to ask questions and advocate for themselves. Additionally, spending quality time with patients enables providers to validate and address fears, concerns and grievances related to the diagnosis or treatment plan. Addressing these also enables the doctor to provide culturally competent care: ensuring the treatment plan is in line with the patient's cultural values and personal priorities. All of this together enables shared decision making and patient centered care, where the doctor and patient are co-creating a plan as a team. Interestingly, in surveys asking patients what makes a high-quality doctor, the majority of people ranked attentiveness and listening *above* accurate diagnosis and competence. This speaks volumes about how important strong communication is to patients.

Due to numerous factors, healthcare providers are being forced to spend diminishing amounts of time with patients. A shortage of doctors and overwhelming numbers of patients and tasks greatly detracts from the quality time providers get to spend with their patients. In a typical office day, doctors

spend 49.2% of their day charting and doing other paperwork and only 27% with patients. This short amount of time with patients leads to rushed encounters and an insufficient amount of time to listen and diagnose.

In addition to just having less time to communicate, the time restrictions and numerous responsibilities put doctors under great pressure. When stressed or rushed like this humans naturally stop listening actively and visually. This is a great hinderance to patient interactions because only about 7% of communication is in the words and content. On the other hand, 55% of communication is visual, and 38% is auditory. This means that when doctors are overwhelmed with patients, crucial non-verbal communication such as tone, volume and body language is completely missed. Sometimes *how* patients say something conveys much more information that *what* they are saying, and if a doctor is not tuned into this they could miss critical information that is pertinent to the patient's health or diagnosis. The consequences of these time restrictions can be dire.

It is evident that these hurried encounters result in poor health outcomes for patients. Missing important information that would have altered a treatment plan or diagnosis greatly increases the chance of providing ineffective or undesired care. Studies show that communication failure is the root cause of over 70% of errors that cause serious adverse health outcomes. Furthermore, poor communication makes doctors blind to a patients lack of knowledge or understanding. In fact, studies have shown that two-thirds of patents are discharged without even knowing their diagnosis and 60% misunderstand doctor's directions after an appointment. Altogether, short patient interactions can lead in ineffective care that results in increased healthcare costs and even death.

Less evidently, these rushed patient encounters also have great effects on healthcare providers themselves. Many doctors enter the field because they love interacting with people, building relationships and making a positive difference in peoples lives. Therefore, hurried encounters and resulting poor quality of care diminishes the joy of serving patients and leads to burnout. Additionally, studies show that time with patients and number of malpractice lawsuits are inversely related. So when these doctors are forced to spend less time with patients, the increasing the chances of being sued. Malpractice lawsuits not only create financial burden on physicians, but also trigger self-doubt, anger, frustration and depression. It is clear that decreasing the amount of time that doctors get to spend with patients is a big problem that needs to be solved.

Reassuringly, some aspects of this problem can be remedied by healthcare providers themselves without having to wait for major system wide changes or new legislature. One of the root causes of poor communication between doctors and patients are the traditional patient-provider roles. This is the idea that providers should maintain a professional distance while deciding what is best for the patient. Meanwhile patients are told to be a “good patient,” that is blindly obedient, does not ask too many questions, and does not challenge authority. These outdated and out of touch roles eliminate opportunity for good communication and shared decision making. Further, this idea of a “professional distance,” diminishes doctor’s humanity, compassion and empathy. This especially hurts patients because they need more than just a hardened technician, they need someone they can confide in and share emotions with. Therefore, providers can help make the limited time they do have with their patients truly count by rejecting these traditional roles and advocating for their patient to do the same. Providers need to take the time to sit down, actively listen and truly get to know their patients on a deep level. Putting in the effort to make every patient interaction meaningful and effective will make massive strides towards a solution.

In addition to solutions on the microscopic patient level, there also needs to be system wide changes to fully fix this time shortage. Foremost, streamlining the paperwork for physicians and eliminating unnecessary paperwork would be a huge advancement. Perhaps a great way to start would be to invest the time and money into perfecting electronic health records. Having digital paperwork could make charting and filling out forms much more efficient and time effective. Because almost half of a doctor’s day is spent doing paperwork, this would free up a tremendous amount of time to spend with patients. Additionally, it has been proposed to hire on more people to share the responsibilities with physicians. Delegating lower expertise tasks to other teammates would be an excellent way to free up more time. An interesting and effective example of this are medical scribes. Scribes follow doctors around while they are seeing patients, take all the notes and do all the charting. Not only does this free up time for the doctor but it also eliminates distractions and enables the doctor to be fully focused on the patient. Innovative solutions like this are exactly what we need to solve this problem and many others in our healthcare system.

### **Medical Errors**

New studies from researchers at Johns Hopkins have uncovered the unnerving fact that medical errors cause over 251,000 deaths per year in the United States. This makes

medical errors the third leading cause of death, only behind heart disease and cancer. Even errors that do not result in death are extremely problematic because they decrease quality of life, increase length of hospital stays and greatly inflate medical bills. In order to fully make sense this finding, a firm understanding of human fallibility is requisite.

In medicine there is a distinction between complications and errors. Due to the fact that medicine is an imperfect science, there are sometimes unavoidable risks like surgical infections, drug side effects and other negative events. These issues that are inherent to the practice of medicine fall under the category of medical complications. On the other hand, medical errors are *preventable* adverse events. As dubious as all medical errors seem, not all medical errors are the result of maleficence or malpractice; some are caused by systemic errors. As the name implies, this type of error is caused by something that is inherent to the system. This includes limits of sterilization techniques, highly complex patients, missing fail-safe plans, improper tools, understaffing, and any other problem built into the system. And because humans comprise our medical system, even simple human errors that result from human limitations fall under the category of systemic errors. At some level, system wide changes and awareness can remedy these problems, but despite taking the proper steps these systemic errors can still occur. The other, more unsettling type of error, is negligence. The definition of negligence is: the failure to provide a standard level of care or, in other words, the delivery of substandard care. This could be anything from neglecting to check a chart, or failing to follow the correct treatment procedure. Despite all these error categories, all of these distinctions of error types are quite arbitrary. Most errors do not fall neatly into one category. Many complex factors and causes make most errors fall into several or all categories. For example, if a doctor gives a patient a drug that they have a life-threatening reaction to, this looks like negligence at the surface. However, numerous factors could have caused this error such as miscommunication, incomplete records, poor patient history or just chance. All of these root causes potentially make this error fall simultaneously into complication, systemic error and negligence.

No matter how complex an error; however, at the very root of all mistakes is human error. Humans are not perfect. We enviably make errors and we are naturally fallible. Fallibility, the tendency to make mistakes or be wrong, has three components: ignorance, ineptitude and necessary fallibility. Ignorance arises from lack of human knowledge, which arises from both human limitation and scientific limitations. Although science can only provide a limited

amount of information, ignorance can be mostly overcome by scientific discovery. Ineptitude, on the other hand, occurs when the knowledge is available but it is applied incorrectly. This has become increasingly problematic in medicine because there is extensive knowledge of how the body works, what can go wrong, and how to fix it; but it is impossible for humans to perfectly integrate and apply this information to every situation. A variety of solutions can help overcome ineptitude, but arguably the greatest is specialization. With physicians specializing in fields that focus on specific physiological systems or problems, the amount of required information and skill is focused and ineptitude is stifled. Each provider can become highly skilled and knowledgeable about a specific field, and when the patient is beyond their limits, they can refer them to another specialist. Today we are now seeing hyper-specialized fields where physicians focus on an extremely specific field or single procedure with hopes of limiting ineptitude and increasing quality of care. Even with specialization there is still a fair amount of ineptitude, due to the vast amount of knowledge just within specific fields. At this point physicians need to take it upon themselves to effortfully keep learning and training in order to maintain sharp skills and up to date information. The last and most vexing component of fallibility is called necessary fallibility. This is the fact that there is knowledge that science and technology will never deliver. Because medicine does not happen in a vacuum, certain things are inevitably unpredictable. Millions of factors contribute to health and disease; therefore, the human body's response to a procedure, treatment or drug can never be fully predictable. Two identical patients with the same disease and same history can have two completely different outcomes from the exact same treatment. It is clearly evident that medical errors are a unique, complex and massive problem that cannot be fixed with one simple change. Preventing and eliminating errors will take the collective efforts of doctors, nurses, patients, administrators and political leaders to effectively develop and implement positive changes.

Misdiagnosis, delayed diagnosis, improper or ineffective treatment, failure to prevent a disease, failure of communication and equipment failure are only a small fraction of medical errors. Due to the massive variety of errors and root causes, multiple changes will need to be implemented for each specific type of error. This creates one of the major barriers to error solutions: it is extremely difficult to figure out the logistics and gain compliance when making several system wide changes. The system is resistant to change, and it is difficult to maintain accountability for maintaining the changes. While there is no simple answer to this, it is something to consider while thinking about error

prevention in medicine. Reassuringly there are countless measures that everyone involved can take to help prevent errors and improve care.

The first and perhaps the most obvious improvement is increasing communication and awareness. Increasing open discussion of medical errors between doctors, nurses, patients, and administrators is a great step towards prevention. If people are more sensitive to the causes of certain errors, the risk of committing those errors falls greatly. Furthermore, if the team openly communicates these potential pitfalls, the risk falls even more. Therefore strengthening the line of communication about errors between providers would be a great improvement. This allows providers to teach each other and learn how to prevent the error in the future. If people remain silent and complacent after an error is made, that error is doomed to be repeated by others. Furthermore increasing communication about errors with patients, empowers the patient to advocate for their health and safety. This could mean asking questions, or providing information about their health that is vital to preventing error. Finally, communicating with administrators about an error opens up the possibility of finding the root cause and implementing system wide administrative changes that prevent the error from ever happening again. Nonetheless, this communication is easier said than done. Talking to a patient, a boss or colleagues about a committed error can be incredibly difficult for providers. Fear losing a patient's trust, the feeling of incompetence, embarrassment and fear of sanction, all make talking about errors burdensome. Due to the shameful nature of errors, improving communication about errors requires some changes in medical culture. Although committing errors is incredibly hard on physicians, it needs to be widely recognized that making errors is part of being human. People need to feel comfortable with talking openly about errors without fear of scrutiny or punishment. Once we change stigma behind errors, we open up numerous possibilities of improvement.

A massive barrier to communication and awareness of medical errors arises from the Center of Disease Control. As of now, the CDC does not recognize medical error as an official cause of death. This means that even if someone dies as the result of a medical error, it is not recorded on their death certificate. For example, if a patient comes in with kidney failure and the doctor neglects to follow the proper protocol of performing kidney dialysis and the patient dies, the cause of death would still recorded as kidney failure. This is a such a big deal because deaths caused by medical errors do not show up on CDC's national health statistics. These statistics strongly influence research priorities,

research funding and awareness campaigns; therefore, medical errors are widely under appreciated and unrecognized. Because cancer and heart disease are listed by the CDC as the top causes of death, most research effort and money is spent on cancer and heart disease. Meanwhile since medical errors are absent from the CDC's records they are overlooked. Clearly, recognizing medical errors as an official cause of death would be an incredible improvement. Not only would this increase public awareness and help create a community that openly discusses medical errors, but also this would foster a great appreciation of medical errors as a serious problem. This would shift research focus and help support people who are working hard to find solutions that prevent errors and improve our healthcare system. Considering all the benefits that can come from increased awareness, it is evident how crucial strong communication is about errors. In addition, learning from errors is a crucial component of improvement.

Since humans are not perfect, errors are going to happen. Therefore it is crucial to learn from errors after they happen. Learning what caused the error enables the physician to adapt and ensure that error never occurs again. Instead of just being a source of punishment and shame, errors need to become a learning opportunity that result in improved patient care. This is the idea behind morbidity and mortality conferences. These conferences are a forum for clinicians to discuss errors that have occurred with each other and administrators in order to learn from the mistakes and increase awareness of the problem. Although this is a great start, these traditional conferences offer little in the way of system wide improvement. Therefore, it would be greatly advantageous to utilize the causal information gained from the conference and utilize it to make improvements. For example, if several conferences reveal that miscommunication is at the root of errors, then administrators and physicians should work to implement changes that improve communication. As odd as it sounds, the medical field could learn a lot from the commercial aviation industry. Compared to the 251,000 people that die every year from medical errors, not a single person died in 2017 from a commercial plane crash, for the fourth year in a row. Despite this aviation safety, airplane reliability and crash prevention are constantly a top priority for the aviation industry. Whenever a plane crashes, a full formal investigation is launched: looking at every communication log, flight records, interviewing everyone involved and reviewing any other pertinent information to uncover the exact root cause of the crash. Then once a cause is found, preventive measures are put into place, and the results are published. Because of this the entire aviation community learns from this crash and improves from it. In medicine

hospital teams perform root cause analysis to find the causes of errors and implement changes; however, their findings are rarely shared to the wider community. A hospital down the street or hospitals all over the nation could be killing patients with the same error that a hospital found solutions to, all because there is no formal process of sharing knowledge from root cause analysis. Creating a standardized investigation process and sharing solutions among hospitals would massively reduce medical errors, improve our nations health, and greatly decrease medical costs.

Another great way for physicians to learn from errors are autopsies. Autopsies enable to physicians figure out exact causes of death, and learn from the pathology. Autopsies provide such an incredible learning opportunity that they used to be an integral component of health care: after a patient died the natural next step was an autopsy. In fact, physicians used to illegally dig up buried patients that refused being autopsied in order to perform an autopsy on them. In contrast to this, in the most recent statistics autopsies were being performed after less than 10% of deaths. But The US National Center for Health Statistics has stopped collecting autopsy statistics, so we don't even know how rare they have become. At the surface this does not seem that alarming, but considering what autopsies used to uncover, this decrease in autopsies should be a cause of concern. Three separate independent studies have shown that 40% of autopsies reveal a major misdiagnosis that led to death. Further, a third of these misdiagnosed patients would have been expected to live if the proper treatment would have been administered. Without autopsies today, providers may never even know if a mistake was made or a patient was misdiagnosed. Autopsies provide an important opportunity to see what incorrect assumptions they made, to learn from their mistakes and prevent future mistakes. Some may argue that patients were misdiagnosed more back when autopsies were performed, and that less patients are misdiagnosed now because of advanced knowledge and technology. However, this does not seem to be the case. A Harvard researcher performed a meta-analysis of medical records, and compared the number of missed diagnoses in 1960 and 1970 to the number missed diagnoses in 1980—before and after the advent of CT, ultrasound, MRI, and other breakthrough medical technologies. Surprisingly, he found no improvement in the rate of misdiagnosis. Physicians missed 25% of fatal infections, 33% of heart attacks and almost 66% of pulmonary emboli in their patients who died regardless of the decade. It is clear misdiagnoses was and still is a major problem in medicine, and now without performing autopsies we are compounding those errors by burying important information.

With great number of errors and potential causes, we not only need many solutions but we also need outside the box solutions. We need innovative solutions that are inexpensive yet highly effective and beneficial. This is exactly the type of solution Johns Hopkins physician, Peter Pronovost, set out for. When looking for a wide spread medical problem to solve, central line catheter infections were the perfect candidate for Peter. A central line catheter is a tube that is inserted directly into a patient's chest, arm or leg in order to administer nutrients, medications, fluids or blood. Central lines are very widely used with ICUs putting in about 5 million every year. Despite this being a simple procedure, about 4% of these central lines become infected. It is so common for central lines to become infected that it is just a planned course of treatment. With 4% of central lines becoming infected, that's 200,000 people a year that get an infected central line. Furthermore, 5-28% of central line infections are fatal, meaning that anywhere from 10,000-56,000 people die every year from infected central lines. The people who survived spent an average of a week longer in the ICU, costing them about \$4,000 extra. This massive healthcare problem badly needed to be fixed. Peter's solution? To make a checklist.

In aviation, checklists are a staple. These extensive lists containing five to over a hundred items are consistently utilized for routine tasks like preflight checks and maintenance and for less routine tasks like emergency landings. These checks prevent against forgetfulness, whether the pilot is under immense stress or bored with repetitive task. This simple idea is effective, but can it be adapted for medicine? With extensive knowledge of aviation checklists, central lines and the healthcare system Peter set out to answer this question. Peter constructed a simple and easy follow checklist for placing central lines:

- ☑ 1. Wash hands with soap
- ☑ 2. Clean the patients skin with chlorhexidine antiseptic
- ☑ 3. Put sterile drapes over the entire patient
- ☑ 4. Wear a mask, hat, sterile gown and gloves
- ☑ 5. Put a sterile dressing over the insertion site once the line is in.

Peter asked the nurses in his ICU at Johns Hopkins to observe doctors for a month and record each time a step was completed. In over a third of patients, the doctors missed at least one step. Next, Peter convinced the Johns Hopkins administrators to authorize nurses to stop doctors if any step was skipped. This was revolutionary because it formally neutralized the power difference between the doctors and nurses, and greatly increased the communication between them. With these new changes in place, Peter and his team recorded what happened over the next year. The results were

so astounding, they were hardly believable. The ten day infection rate went from 11 percent to zero. In just two years, the simple checklist prevented forty-three infections, eight deaths and saved two million dollars in costs.

With these inspiring results, Peter traveled the country to teach doctors, nurses, insurers and administrators about his checklist. Despite the good intentions and the need for change, Peter had a hard time getting anyone to buy into the idea of checklist. Nurses did not want yet another piece of paper to fill out and doctors did not believe they needed a list for such a simple procedure. Additionally, his limited testing made for skepticism about real world application. So far, Peter only tested his checklist in Johns Hopkins' well staffed, well funded, ICU; where he could walk the halls and monitor checklist use. Would his idea work in ICUs with a limited number providers that are overwhelmed with patients? Amongst the doubt, the Michigan Health and Hospital Association decided to implement the central line checklist into every ICU in the state—a state where central line infection rates were dramatically higher than the national average. This was a massively difficult project not only because of the sheer volume, but also because Michigan is home to some of the most impoverished areas in the country. Hospitals in Detroit, for example, care for a population with the lowest median income in the country and more than a quarter of a million uninsured patients. Due to resulting financial trouble, Detroit hospitals had to lay off a third of their staff and the state had to bailout the hospitals with \$50 million to prevent bankruptcy. The remaining staffs were stretched extremely thin, burnt out and many were considering leaving. Now, Peter was tell them fill out some checklist every time this simple procedure was performed? Against the odds, the hospitals were able to successfully integrate the checklists and the results are stunning. Within the first three months, the central line infection rates decreased by 66 percent, and many hospital cut their infection rate to zero. Michigan's infection rates fell so low that it outperformed 90 percent of ICUs nationwide. In the first 18 months, the hospitals saved more than 1,500 lives and an estimated \$175 million. All because of a simple checklist, Peter and the Michigan ICUs were able to make a massive improvement in the quality of health and health care. Not only does this prove the effectiveness of checklists but also it illustrates the importance of innovation. We need to create a medical community that values revolutionary new ideas and is open minded change—no matter how obscure the ideas seem.

*End of Life Care*

Not everybody suffers from diabetes, or gives birth or faces cancer. People experience different facets of healthcare based on their needs. On the other hand, every person inevitably faces aging and death. At some point in life everybody must come to terms with their mortality and accept death. Due to this universality in the human experience, end of life care occupies an extremely unique place in medicine. Because this is an area of medicine that everyone experiences in one way or another, it is critical that it is not overlooked. Unfortunately in medicine, death is largely viewed as a disease. As a result, many people spend the last moments of their life in a hospital bed, alone and in pain.

With these end stages of life comes difficult conversations, decisions and experiences that most people, especially doctors, are unequipped to handle properly. In our society we are taught to focus on how to save lives, not how to care for dying people. We are conditioned to fight aging, fight death and delay the inevitable. Unfortunately this mindset is doing a great disservice to people at the end stages of their life. We have a problem in our healthcare system, a problem with death, and it needs to be fixed.

Despite the incurable nature of death, humans naturally want to search for a shred of hope. Instead of facing reality, we would rather pursue treatment after treatment, until the inevitable happens. Physicians, patients and families are all guilty of this. From the very beginning of medical school physicians are trained into this mindset. Medical students are given a cadaver, but only for the sole purpose of studying anatomy. There traditionally has been little to nothing about aging and dying in medical school curriculums. Then when practicing it is human nature for physicians to want to have something positive to say. So in the midst of a poor diagnosis, physicians don't want to be the bearer of bad news. Doctors see death as their failure, so they want to do everything they can to help and they want to avoid telling patients about inevitable death. Offering experimental drugs or brand new treatments gives this escape from reality, offers a glimmer of hope and delays the conversations about death. Since patients and families want to cling on to any possibility of extending life, many want to try every treatment possible. People are not ready to say goodbye, even when death is imminent. This is especially problematic because these long shot treatments create debt, suffering, and can even shorten the patients life.

Families and doctors are purposely avoiding the difficult end of life conversations. Having these conversations are not just a suggestion, or just "a good idea;" they are absolutely critical. People care about more than just living another day.

Controlling their own destiny, making their own decisions and pursuing goals is essential to maintaining meaning in life. Without these end of life conversations, we have absolutely no idea about the goals and priorities of our patients and family members at the end stages of their lives. By avoiding these difficult conversations with treatment after treatment, you provide care that is not in line with the patients goals. Furthermore, some treatments just end up causing immense amounts of pain and decreasing health. So not only has their life been cut shorter, but they spent the last moments of their life suffering in a hospital bed. So, all because doctors and families avoid end of life conversations, they end up spending hundreds of thousands of dollars on last chance treatments, that not only erode the patients remaining dignity, but also causes an enormous amount of pain and suffering the family and the patient.

As saddening and disheartening this is, you cant blame doctors and families for avoiding end of life conversations. They are painful, awkward and sad; and there is no natural "good" time to have these conversations. But they are also extremely important. It is critical that we shift medical and public culture in a way that makes end of life conversations the default place to start. Just simply talking about the end of life with loved ones makes the whole process of dying go smoother. Being able to know exactly what a patient wants at the end stages not only reduces suffering, but also eliminates moral dilemmas and guilt. For example, if a family member made it clear that they did not want to live on a ventilator, and that situation arises, you would know exactly what to do without feeling guilty. You would be in a good position to make a decision that you knew the person would have wanted. And this is just one example, there are numerous decisions to make at the end of life where prior discussions would make a massive difference. It is evident that these conversations allow the person to die with dignity while greatly reducing the emotional pain and suffering of family members—now the proper changes need to be made. The promising thing is that this important change doesn't require some large administrative or legislative change—it starts with us. Whether it is a patient or a family member, we always need to make a conscious effort to reach out and start the difficult conversations.

Excitingly there has been a relatively recent emergence and emphasis on palliative care. Palliative care focuses on anticipating, preventing, and treating symptoms caused by life-threatening illnesses. This means taking proactive steps to ease pain and improve the quality of life for patients and their families at the end stages of life. When people think of pain, they often only consider physical pain. In fact, there is also emotional pain caused by loneliness, regret, stress and

many other death related feelings. The goal of palliative care is to alleviate both physical and emotional pain associated with death for both patients and families. Palliative care has now become a bonafide field, with teams of physicians, nurses and other specialists that are specifically trained to handle this type of care. In addition to understanding the patient's illness and creating effective treatment plans, these palliative care specialist's most important job is to help patients and families understand the nature and prognosis of their disease. This means not only communicating effectively with patients, but also facilitating end of life conversations in order to discover exactly what the patient's priorities are. Palliative care physicians know what questions to ask, what types of things to say and what not to say in order to effectively navigate these difficult conversations. Then the physician acts as an advocate for the patient and family in order to ensure every treatment plan and every decision is in line with their wishes. This is an incredible and much needed advancement in end of life care.



Throughout history medicine has fascinatingly evolution, with each advancement increasing its reliability and effectiveness. Today's doctors are known to be highly capable, knowledgeable and reliable; but before these findings, doctors were more harmful than helpful. From the bleak beginnings of crude trepanation and mercury regiments, medicine has blossomed into a field filled with vast physiological knowledge, advanced pharmaceuticals, intricate procedures and incredibly adept practitioners. Thanks to the keystone discoveries like antiseptics, antibiotics and DNA; medicine was launched into this highly effective and beneficial field. Without the brilliant minds of Darwin, Lister, Franklin, Jenner and many more, medicine today would undoubtedly be different.

However, repeatedly at each at each point, practitioners believed what they were doing was the absolute best and their knowledge was infallible. But sure enough, new knowledge or people came along and found flaws in the period's thinking. Retrospectively, this hubris in medicine throughout history is exceedingly humbling. Nonetheless, when you look at today's medicine some of these same beliefs of infallibility are held, and that begs the question: in hundreds of years when people look back at our time period, will they see the same hubris and subsequent enlightening? History tends to repeat itself, so it is crucial to put things in perspective and recognize our limitations.

After thorough analysis, it is very evident that our healthcare system is badly broken. We spend much more money on healthcare than any other country, yet our health outcomes

are among the worst in the world. We have both systemic problems and individualized problems that are greatly harming our nations health and the effectiveness of healthcare. Foremost, administrative and legislative changes need to be made to address limited healthcare access, increasing costs and quality of care. Fixing problems like our fee-for-service system that incentives quantity over quality and for-profit insurance companies will make enormous strides towards better health and healthcare. These changes necessitate collective activism to raise awareness and evoke a desire to change in our nation's leaders. Other problems like overprescription, errors, shortened time with patients, inadequate end of life care and many others can be partly remedied by legislative changes; however, great changes can most effectively be made by practitioners themselves. Learning about these issues, identifying their own mistakes and making effectual changes in everyday practice with patients is the best way to fix most of the problems. There is such great potential for countless positive changes, but having just a few providers make changes will accomplish little. We absolutely need widespread participation and teamwork to achieve the common goal of better patient care and improved population health. Although humanity has accomplished a staggering amount throughout history, that does not mean advancement stops now. We have much to improve and perfect, change and adjust. Together we get to decide where medicine goes from here, what goals we want to achieve and what problems we want to solve.

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