

Medical Advancements Due to Technology

By Shannen Lambdin, Lillian Bornstein, Kaitlyn Reichwaldt, Jaquelin Garcia, and Holly Lombard,

The Spontaneous Combustions

Mentors: Beth Neilsen and Erica Lam

Over the past couple of decades, humans have taken great pains to improve their technological understandings. One of the presiding incentives for this ambitious pursuit is the possibility of increasing the well-being of a community through medicine. By combining technology and medicine, scientists and doctors alike have been able to overcome enormous barriers through the development of more intricate and accurate technology. Anywhere from the creation of the prosthetic limb to aid the wounded soldiers in Iraq to the nanotechnology used to detect cancer within a small child, technology has played a prominent role in the medical field. Technology, however, has not always played the same role in medicine, rather it has been gradually process, but what many fail to realize is that despite the alluring promises technology has to offer, these gifts come with a price.

The advanced medical technology that we have today could not have been possible to develop if it weren't for the early discoveries. Without the invention of the microscope by Robert Hooke, today's medical engineering advances could never have been made. Knowledge of germs, cures for diseases, and other discoveries could not have been around without the microscope. Without the use of the microscope, Alexander Fleming couldn't have discovered penicillin, and neither could Luis Pasteur and Robert Koch have established the germ theory. The discovery of antibiotics dramatically altered not only the face of bedside practice but the entire course of medical research.

Then the discovery of genetics came about. Hence Mendel, or most commonly known as "the father of genetics", developed many laws regarding genetics like the law of segregation that today's genetic engineers take into account. According to an article called "Science: Transplanting a Gene" from the Time Magazine, genetic engineers bravely state that they will someday be able to cure genetic diseases. Can you imagine that cancer that has been passed from generation to generation can someday be eliminated? Genetic engineering can be seen as a controversial issue but it is definitely promising a lot for future generations.

The development of instruments has made it easier for people to survive. The pacemaker, for example, can "automatically detect life-threatening abnormal rhythm and then shock the heart" (Lawrence). This advance could not have been made without first inventing the electrocardiograph. This device was invented in 1903 by a German scientist named Willem Einthoven. Apparatuses like the pacemaker can develop into greater advances like robotic surgery.

Although many of these discoveries were made by accident, they sure have improved our quality of life. "The remarkable advances of medicine in the past few decades give great promise that even more marvelous advances, perhaps unimaginable even now, are yet to come," a Time Magazine's article "An Epidemic of Advances" clearly states, reinforcing the idea that the medical advances in the future are very promising. Even though we won't live to see all of the future medical technologies, we can help advance towards better medical care and medical technology instruments for future generations.

Medical technology instruments include contact lenses, wheelchairs, stethoscopes, prosthetic limbs and any other item used to diagnose or treat an ailment. Technology is evolving, and so is modern health care. Today's advanced medical technology lets doctors diagnose, assess and treat health conditions in safer, more efficient, and more effective ways and ultimately improve and lengthen the lives of patients. (Susan Sedgwick, 2011)

Examples of current advanced medical tools include CAT Scanners (medical imaging tools), MRIs (other noninvasive radiological imaging techniques), defibrillators (electronic devices that are used to rescue patients who go into cardiac arrest or who are experiencing irregular heart beats), laser cutters (very precise and accurate surgical tools), and medical robots. Each of these instruments and a plethora of others have greatly changed the medical world, but this section will mainly focus on the significance of medical robots, and what they mean for the medicine of the future.

There are many benefits of using medical robots during surgery. First of all, medical robots require smaller incisions to operate, which typically mean shorter hospital stays, less pain, and quicker recoveries. Also, many robots eliminate the problem of hand tremors - "machines can be calibrated to translate relatively large motions at the controller's console into tiny, ultrafine actions by the instruments". Doctors do not even always have to be in the same room as a patient to operate using a robot. Furthermore, robots limit blood loss: in an open procedure it is not unusual for the patient to lose a liter of blood, but robots lessen this amount drastically. Additionally, robots are more precise, with arms that can rotate 360 degrees. Finally, the robotic cameras offer a clear, magnified view of surgical fields that surgeons often did not see by themselves - they had to feel around for the correct parts, because fingers often obstructed their line of sight. (David von Drehle, 2010)

Medical robots have a great many uses including use in difficult surgical procedures, assisting patients in recovery and in the accomplishment of routine tasks for patient care, training surgeons, and providing comprehensive knowledge to students. One of the most popular brands of medical robots is da Vinci. According to an article by David von Drehle in the December 13, 2010 issue of Time Magazine, 1,000 hospitals and clinics in the U.S. use the da Vinci robot and 400 facilities elsewhere around the world have da Vincis. Although these numbers are not incredibly large today because of the sheer expense of da Vinci robots, robots in the medical field demonstrate a lot of potential.

Though using medical robots has many advantages, it also has some downfalls. One limitation is the expense: a da Vinci system costs over \$1 million, and roughly \$1,500 worth of parts must be replaced after every procedure. Surgeons also have to undergo significant, costly, additional training to be eligible to operate the robots. (David von Drehle, 2010) There is hope that eventually the price of the robots will decrease, but for now, most companies are unable to afford them. On top of having to undergo additional training, surgeons also have to get used to having no sense of touch when operating with robots. However, most surgeons feel that the loss of this sense is minor compared to all of the benefits that robots provide. (Jane Elliott, 2009)

Especially if the disadvantages of robots are mitigated, medical robots promise a lot for the future. For example, some doctors and scientists are predicting that within ten years, all surgery could be scarless because small robots can be inserted into the patient through the body's natural orifices (Jane Elliott, 2009). Also, robots may become popular for use in the army, as they could be operated by doctors miles away from the battlefield. Although it may be some time before these possibilities are made a reality, we are becoming closer to such advancements every day because of the modern technology on which we have become so dependent. As time continues to turn, current medical instruments like surgical robots will be developed, and new tools will be discovered.

Not only has technology altered the types of tools and instruments used in medicine, but it has also changed the types of communication used in the medical world.

The first physicians to document the process of healing to improve patient care were Hippocrates and Galen. The way diseases were viewed changed dramatically because of them. Diseases were no longer mysterious, unexplainable forces, which spurred on the desire to learn and advance medically. In ancient times, medical practices were about getting and processing information, but in the 19th century, the use of "modern" technology in medicine began.

The medical world is clinging to some of the technology used in the 1980's. Many doctors still rely on pagers and telephones to communicate. However, Microsoft is sending a message that is

important to physicians about the impact of communication, computerization of medical practices, and the internet in the future. Microsoft's "view of its future is that computing and software are shifting from personal computers with installed software to constellations of computers, devices and services that work together through the Internet to deliver broader functionality." According to the Voluntary Hospital Association, a reported 3% of patients use e-mail to communicate with their physicians. A large majority of them said that it is a valuable and convenient way to communicate.

In this era, it is extremely difficult to get ahold of your doctor by telephone. E-mail is becoming an efficient way to getting in contact with your medical care provider. Patients are more likely to get a rapid response to their questions and requests by using the internet. Within medical centers, e-mail systems are secure and often used, but if they communicate with another health care professional outside the medical center, it would violate HIPAA regulations. Many offices still fax their progress notes.

No form of integrated communication occurs between academic medical centers, hospitals, private practices, or ancillary facilities. Health information technology seems to be progressing towards the elimination of pagers and replacing communication tools with secure smartphone communication systems, and using tablets at bedsides and some sort of "Facebook/Twitter-like communication" within care teams. The speed towards this is slow. An increased pace is needed to make sure that health information technology keeps up with technological innovations outside the world of medicine.

Technology has created a relationship that is less face-to-face between doctors and patients. Technology also introduces other concerns and risks to the medical world such as:

- confidentiality
- unauthorized access to computers
- informed consent
- pre-existing relationships between the doctor and patient
- licensing jurisdiction
- sensitive subjects
- patient education and care management
- emergency subjects
- medical records
- practice web site considerations.

Because of higher technology, a barrier may be created between the doctor and patient. Technology may divert the doctor's attention away from his or her patient and restrict creative thinking. The relationship between the doctor and his or her patient may weaken. However, some people believe that technology may also strengthen the doctor-patient relationship. If the doctor has more ways to communicate with his patients, they can exchange information more quickly, and there may also be more time to talk with the patient if efficient technology is used. Doctors and patients are becoming used to communicating with more advanced technology, and may even be becoming dependent on it.

The declining mortality rates in industrialized countries, such as the United States, Japan, and China, show a clear relationship between the growing use of technology in medicine and increased life spans. According to William Safire in his book *The New York Times Guide to Essential Knowledge*, new vaccinations, along with improvements in sanitation, led to a dramatic decline in death rates in the years following the Second World War. It was also during this time, however, that new technology was introduced to aid and refine surgeries. By adapting and innovating technology to accommodate the needs and wants of the patients, it soon became apparent that technology would be the crucial

component of providing care and comfort for the future. The increasing reliance upon technology to solve medical problems is truly a double-edged sword, as the resulting dependency can be both beneficial and detrimental. In addition to intensifying our narcissistic values, as we disregard our well-being in an endless pursuit of perfectionism, the rapid expansion of technological advances in medicine has created a false sense of security, blinding us to the possibility of failure. With these unforeseen side effects, impending questions of the ethics behind the use of technology in medicine have begun to arise.

With the invention of the stethoscope, X-ray devices, MRI scanners, and countless other medical devices, doctors have been able to diagnosis patients with pin point accuracy. According to Stanley Reiser in his book *Medicine and the Reign of Technology*, doctors are relying more on evidence provided by laboratory experiments and these advancing medical devices and are straying further and further away from the “subjective” science that was employed centuries earlier as the only medium of diagnosing patients ailments. By relying mainly on objective evidence, rather than the patients and the doctors own observations of the illness, doctors have shown their willingness to place their unwavering faith in these seemingly invincible devices. The immediate acceptance of the accuracy of technology is unnerving as machines are not resilient to malfunction. A recent law suit against Wright Medical Technology was filed on the basis that their technology had a high failure rate of 11.8%. Even the recent developing medical imaging technology which allows us to examine internal organs and tissues has a “fewer than 100% accuracy.” Though slim, the possibility of failure is still present. An article published by the Peters Symonds College stated that despite the possibility of failure, patients believe that they’re entitled to “up-to-date technology” and have “little reservations when it comes to acquiring technological medicine.” For treatments that do not require surgery, patients are adamant on receiving the most modernized medical care, despite the risks. According to an article written by Gary Null, *Death by Medicine*, 7.5 million unnecessary surgeries are performed annually. Of these surgeries, there is an estimated nine hundred ninety nine thousand deaths annually. Despite these statistics, patients are carelessly insisting on entering these precarious surgeries, gambling their life for petty reasons such as beauty.

Though a fair share of people are willing to risk their lives narcissistic reasons, for others, the choice to become dependent on technology is negligible as their very life depends on the technological advancements in medicine. According to a recent research conducted by a group of trained pediatricians and renowned institutions, such as the Children's Hospital and Regional Medical Center, forty one percent of children of age seven are dependent upon technology, with another twenty percent of children dependent on devices such as gastrostomies and central venous catheters. Partially due to the increasing accuracy and complexity of technology, the number of child deaths in Japan average two out of one thousand births. Not only are more and more mothers capable of surviving early child births and C-sections, but the infant as well. From 1915 to 1997, the developing technology was able to decrease the infant mortality rate in the United States by ninety percent and the maternal rate by ninety-nine percent, as posted on faq.org in the article *Infant Mortality*. There are thousands of premature births every year, while technology cannot prevent them from occurring, the infants’ chances of survival increased exponentially, through the use of high-tech breathing machines and intensive care within the first weeks of birth and in many cases, for the rest of their lives. One in eight babies will be entirely dependent on medical technology for survival. However, our developing dependency on technology has stimulated debate, questioning the ethics of technology dictating a person’s life and when we should draw the line between giving or withdrawing life support.

Throughout the history of medicine, technology has been at the forefront of both perceived miracles and Frankenstein-esque affronts to nature. The development of new methods, treatments, and instruments have gone a long way to both save lives and make us question our collective views not only on morality, but on the very essence of human nature and the question of the soul. Although all kinds of

technology have been controversial, from crossbows to pesticides, progress in medicine has probably caused the largest uproar throughout history.

Probably the first medical controversy that comes to mind is abortion. Today, the issue of reproductive rights is one that divides our country, and helps to define our different political parties. We tend to think of abortion as a current issue. When we think of abortion, we think of modern technology; metallic instruments, recently developed pills, invasive surgeries. But abortion has been around since ancient times. Originally women would attempt to induce miscarriage with everything from intense physical exercise to blood-letting to the ingestion of herbs. Some of these methods, such as strenuous exercise and physical trauma, are still around today. Many of the methods were dangerous. Consumption of certain substances, like mercury, could kill the woman along with the fetus.

For the most part, induced miscarriage has been reviled throughout history, even earning a mention in the Hippocratic oath as being forbidden for a physician to assist in it. But this hasn't stopped women from finding ways to terminate their pregnancies. You can still find online guides to inducing miscarriage by utilizing all kinds of herbs, from rosemary to marijuana. Other methods, like using a coat hanger to remove a fetus, are firmly entrenched in popular culture as jokes. The methods used to abort a fetus have been as bizarre as they were often deadly. In the sixties, some women even took to douching with coca cola in an attempt to induce miscarriage.

Less dangerous methods, like the one's used in today's clinics, weren't developed until the middle of the 20th century and took many years to gain prevalence. Vacuum aspiration (which uses suction instead of a metal tool to remove the contents of the uterus) was developed in China in the 1950s. The other most prominent method, dilation and curettage, began to be used specifically for abortion in the late 19th century, but only gained popularity in the last quarter of the 20th century. As with most controversies over medicine, the primary conflict over abortion is based in religion. It tends to be a debate over the choice of the woman to terminate her pregnancy versus the life of the fetus, with the oft-quoted commandment of 'thou shalt not kill' being a common refrain among the right-to-lifers.

Another similarly controversial topic is euthanasia, which again brings up the question of when or if it is appropriate to terminate a life. For just as long as induced miscarriage has been a hot topic, the question of mercy killing has been intensely contested. As technology has improved, it has led to longer life spans, but not a consistent quality of that life. More and more there are invalids suffering intense pain with no end in sight. Painkillers can only go so far. Some argue that the kindest thing to do is to release the near-to-death from their suffering, while others say that this is too reminiscent of the mercy killings of the holocaust (where the mentally and physically infirm were perceived as genetic weak links and put to death) and can easily devolve from euthanasia of the miserable to euthanasia of the undesirable. It can be difficult to find a middle ground.

Like abortion, euthanasia was banned under the Hippocratic Oath, saying that the physician 'shall give no deadly medicine to anyone if asked, nor suggest any such counsel'. Still, it is believed that few physicians followed this oath to the letter, and assisted suicides occurred well until the dawn of Christianity, when the taking of any life was seen as unconscionable. Eventually, as medicine and theology developed, the question of euthanasia arose once more, only to be stopped in its tracks by the atrocities of the Nazi regime, namely the murder of the deformed and the mentally handicapped.

Probably one of the most well-known figures in the euthanasia debate is Jack Kevorkian, known for saying that 'dying is not a crime' and for serving eight years in prison on a sentence of second-degree murder. He invented two devices for the purpose of assisted suicide; the Thanatron ('death machine') and the Mercitron ('mercy machine'). The first released lethal drugs through an IV at the press of a button, while the second administered carbon monoxide through a gas mask. Philip Nitschke, another advocate for assisted suicide, invented the 'Deliverance Machine', which requires a patient to correctly

answer a series of questions before the device releases its fatal load. Nitschke's organization, Exit International, has been at the forefront of the right-to-die movement since 1997.

A slightly different issue, but one also involving the conflict over the right to life and the quality of it, is the subject of animal testing. Testing on animals has provided untold numbers of medical advancements and treatments for humans, but the debate over it has been as visceral as the experiments themselves. Some animal rights groups have been known for criminal acts, like bombing cars and stealing the animals being tested upon. One such group, the Animal Liberation Front (ALF), has been listed as a domestic terrorist organization by the US Department of Homeland Security for their actions against animal testing.

Vivisection, one branch of animal testing, involves the dissection or experimental surgery of a living animal. It has been around since the Greeks, and been controversial for just as long. Charles Darwin was disgusted by it. Others, like Claude Bernard (a French physiologist known as the 'prince of vivisectors'), were fans; he once wrote that 'the science of life is a superb and dazzlingly lighted hall which may be reached only by passing through a long and ghastly kitchen'.

A less disturbing aspect of animal testing is the Draize Eye Test, which tests for the irritation of products by applying them to an animal's eye or skin. Albino rabbits are typically used for this test, being restrained for several days to observe the side effects, and are often discarded and killed after a few runs. Similar is the Acute Toxicity test, which exposes animals to a substance in gradually increasing amounts to test the point at which exposure becomes deadly. Again, the test subjects are typically discarded afterwards.

One of the reasons that animal testing is such a volatile topic are the pictures, widespread across the internet, and the videos that animal rights organizations spread in order to garner support. Many of these videos show abuses unrelated to animal testing, where the workers subject the animals to unnecessary physical abuse. Whether these abuses are widespread throughout the testing industry or if these are just a few horrifying exceptions is a subject of debate.

Also up for discussion is whether animal testing is always helpful, or even practical. The differences between human and animal bodies are considered substantial enough by some to make the tests dubious in their applicability and unnecessary in their cruelty. Another argument against animal testing is that the physical and psychological stresses the animals experience are enough to skew the results. Looking at how stress and unideal conditions so dramatically impact human health, it's easy to see the connection.

As with all controversial issues, there are no easy answers. Although there is no denying that animal testing can be horrifying, it is also responsible for many medical advancements that improve and lengthen human life. It remains to be seen if there are more humane alternatives, or if human society is willing to sacrifice its own health and happiness for the sake of animals.

Advancements in medical technology will probably continue to be hotly debated throughout time. The conflict of medicine, theology, and the human conscience is everlasting. There is no black and white, and it is up to future generations to make the decisions that divide us in our own time.

Constantly improving technology has greatly altered our perception of medicine. This never ending debate, however, between the harmful and beneficial effects the increasing presence of technology has had in medicine, is futile. The benefits technology has offered not only in the medical field, but universally, are numerous, and as are the impeding controversial questions that have arisen. As technology and medicine continue to evolve, it has become evident that the fate of these two fields have been irrevocably intertwined. Only time can tell exactly how much technology will change the world in which we live.

Works Cited

- Arbor, Ann. "Born too soon: To prevent premature birth and its lifelong effects, U-M expert says future mothers should act now ." *University of Michigan Health System*. N.p., n.d. Web. 6 Feb. 2011.
- "Facts and Figures." *Teddy & Me*. N.p., n.d. Web. 6 Feb. 2011.
- "Giving life--giving death. Ethical problems of high-technology medicine." *PubMed.gov*. National Center of Biotechnology, n.d. Web. 6 Feb. 2011.
- "Imaging Technology Improves Accuracy and Diagnostics." *PlacidBlog*. PlacidWay, n.d. Web. 6 Feb. 2011.
- "Infant Mortality." *Internet FAQ Archives*. N.p., n.d. Web. 6 Feb. 2011.
- "Medicine as new technology." *Making the Modern World*. The Science Museum, n.d. Web. 6 Feb. 2011.
- Null, Gary, et al. "Death by Medicine." *Whale*. N.p., n.d. Web. 6 Feb. 2011.
- Organ, Claude. "The Impact of Technology on Surgery." *Archives of Surgery*. N.p., n.d. Web. 6 Feb. 2011.
- Reiser, Stanley Joel. *Medicine and the Reign of Technology*. New York: Cambridge University Press, 1999. Print.
- Safire, William. *The New York Times guide to essential knowledge: a desk reference for the curious mind*. New York: The New York Times Company, 2007. Print.
- "Wright Profemur Hip Replacement Lawsuits." *About Lawsuits*. Saiontz & Kirk, P.A., n.d. Web. 6 Feb. 2011.