

Impact of Scientific Advancement and Politics on Healthcare Outcomes and Cost

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

In the United States, science and politics directly impact the quality of healthcare a patient receives when treated for an injury or illness. However, there is an unmet need in understanding how important these scientific advancements and political thoughts correlate with morbidity and mortality rates. There are many contributing factors and through this thesis I hope to identify how and in what ways these two completely different societal influences correlate to the healthcare world. For example, through new technological advancements the mortality rate in the U.S. has dropped from 9.516 per 1,000 people in 1970 to 8.782 per 1,000 people in 2019. This indicates that there have been advancements in this area, however, I strive to provide direct evidence as to what has aided in this decrease in mortality rate. Specifically, I hope to identify how science and innovation can directly impact the human dimension of a system through analyzing the advancements in technology in the air ambulance industry. Regarding politics role on healthcare outcomes, I hope to display the correlations between healthcare legislation and patient's healthcare experience. Throughout the healthcare experience, patients receive treatment based on certain legislations passed. Whether it be approval of an emergency vaccine designation or access to insurance through Medicaid or Medicare, the U.S. population is directly impacted by the policies and legislation passed by the government on a yearly basis. In this thesis, I will provide direct evidence on the strong correlation between scientific advancement and the improvement of healthcare outcomes and politics negative impact on the cost of treatment for patients.

The Role of Science and Politics in Healthcare through the Framework of Co-Production

To identify the role of science and politics in transforming healthcare outcomes and cost for patients, I will utilize the framework of co-production to draw conclusions from my research.

Co-production can be defined as the idea that society and science evolve together (Jasanoff, et. Al, 2004). Co-production occurs when consumers (society) are engaged in the development of a service or product, thereby helping to ensure quality and enhance value (Turakhia, et. Al, 2017). Within healthcare, co-production can be applied to improving patient outcomes and care based off of their experiences and implementing changes to technology based off of the patient's inputs.

To study a technology or system through the framework and pathway of co-production, there are four main instruments to developing the framework: making identities, making institutions, making discourses, and making representations. Making identities takes inputs from various stakeholders on how a technology or system is defined. Making institutions analyzes the institutions that come out of a new technology and how to regulate this new system. Making discourses identifies public needs on the tolerable and intolerable sections of the new technology. Lastly, making representations analyzes how political and cultural influences have shaped the use of the technology over time. Through the use of this framework, I hope to establish how science and politics have shaped the healthcare industry, with a specific dive into the air ambulance industry. I hope to illustrate that the current policies are creating costs that are too high for patients reliant upon systems such as Medicare and Medicaid. In addition, I hope to illustrate that innovation in the air ambulance services industry have created lower morbidity and mortality rates.

Health systems in the United States are designed to allow policymakers to increase the populations health benefits through incentivizing individuals to use more services through the use of increased insurance coverage, policies to improve quality of care, and accessibility of healthcare services. Policymakers have an incredible impact on the quality and access to care an

individual can receive in health systems in the United States. However, they also have a huge impact on the costs associated with these healthcare needs. Through the use of co-production, I hope to identify how policymakers have or have not established quality care within the air ambulance industry. I will do this by identifying and making representations that illustrate how cultural and political changes have allowed for scientific improvement over the past fifty years.

I will illustrate the impact of technological innovation in the air ambulance industry through the use of meta-learning. Meta-learning attempts to explain the progress of technology over time by relating innovation to learning via scaling, doing, planning, and sharing. This theory believes in the idea that innovation is a probabilistic process and that there is a mutual dependence for growth between product and process technology over time. Through this theory, I can uncover how the air ambulance industry has evolved over time through technical innovation and how it has allowed air ambulances to lower morbidity and mortality rates. In addition, I will be able to identify what scientific improvements they specifically made that have aided in their transportation capabilities.

Case context

As mentioned previously, the healthcare industry is too large and broad to discuss and analyze in this thesis, thus I have chosen to focus on the air ambulance industry. The air ambulance industry provides evacuation and transportation services to patients across the United States. Oftentimes air ambulances are used for emergency operations, but can also be used for procedural transportation of patients. There are both fixed wing and rotary wing transportation located throughout the country and are used dependent on the distance and time needed to travel. The air ambulance industry currently serves over 550,000 patients on a yearly basis with an

annual revenue of \$4.2 billion. The main drivers of this industry are patients over 65 years old, insured individuals both private and public, and total healthcare expenditure.

Within this industry, there are multiple technology and personnel suppliers that have aided to the improvement in morbidity and mortality rates. For example, manufacturing of rotary and fixed wing aircraft, machinery maintenance, medical suppliers, and gasoline/petroleum suppliers who each provide a key technology to the industry. In my thesis, I will detail how the technological improvements of these suppliers have led to a sharp decrease in the morbidity and mortality rates for patients who are transported by air. In addition, regarding policies surrounding the air ambulance industry, roughly 27% of the revenue in the air ambulance industry comes from patients on Medicare and Medicaid. As the U.S. population continues to age, more patients will utilize Medicare for air transport, thus resulting in a greater importance in the policies surrounding the industry.

Research Question and Methods

I will explore the question: How does science and politics shape healthcare outcomes and cost in the United States? This question allows me to analyze two key institutions, technology and politics, which have impacted the healthcare world. This will allow me to establish an argument how over time there have been significant increases in healthcare outcomes due to technology and cost due to policies passed. I will analyze this research question through the framework of co-production. Through the use of the co-production framework, I will conduct research on the healthcare industry by examining historical case studies and engaging in policy analysis. The historical case study analysis will be conducted to understand the relationship between scientific improvements within the air ambulance industry and healthcare outcomes of patients over a finite period of time. I will collect this data from various sources starting in 1970,

when civilian air ambulances were first used in the United States, to 2019. I will gather data on both the morbidity and mortality rates of the patients to understand how the air ambulance industry has evolved from its beginning in 1970. I hope to identify the key scientific improvements and technologies that have shaped this change. This data will then be analyzed through the four instruments of the co-production framework. Analyzing the scientific improvements that have improved morbidity and mortality rates within the air ambulance industry provides a snapshot of how medical innovation has impacted the United States over the past fifty years.

A policy analysis will help illustrate the various laws and regulations that have impacted air ambulance and healthcare costs in the United States since 1970, the inception of civilian air ambulances. I will base my policy analysis off of the framework where it utilizes a pathway analyzing policy and health outcomes over a finite period of time. Since there is an abundance of healthcare policy change since 1970, I have chosen to narrow my focus to only the air ambulance industry. The two policies I will focus on include the 1978 Airline Deregulation Act and the Ambulance Fee Schedule enacted as a part of Medicare. These two policies have had the most direct influence on the price of air ambulances and provide a strong correlation between the impact of legislation on cost of healthcare services. Through this, I will analyze the impact policymakers have on costs incurred by individuals, with a focus on the costs associated with air ambulance services for Medicaid and Medicare patients across the United States.

Results

Scientific advancement and politics have played and continue to play a critical role in shaping positive healthcare outcomes for patients and increasing the cost of treatment in the United States. Technology has led to quicker response times to patients and transportation back

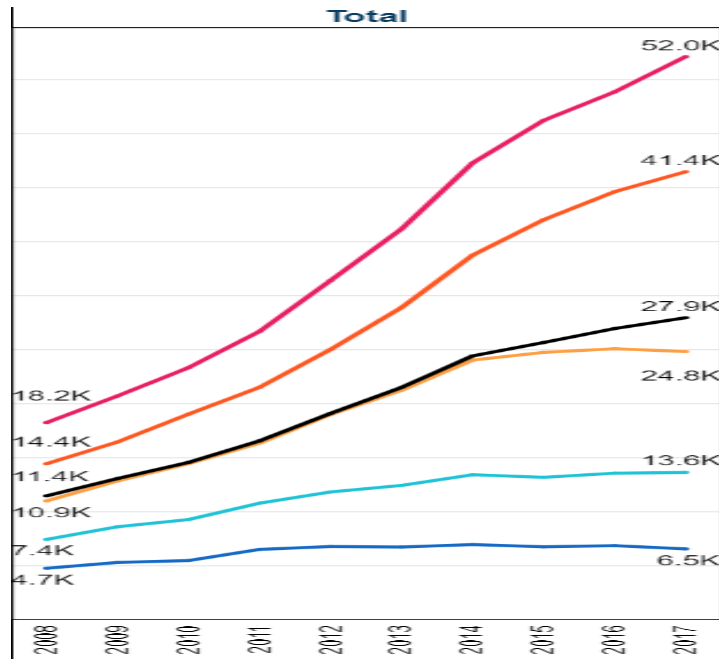
to the hospital. In addition, improvement in care of patients through automated technology have helped to decrease mortality rates when compared to ground ambulances. The policy analysis concluded that there has been a significant increase in the cost of healthcare, specifically within the air ambulance industry, due to policies passed by regulators. Two laws and regulations have significantly increased the cost of air ambulance transportation since its inception, the 1978 Airline Deregulation Act and the Ambulance Fee Schedule passed in 2002 (“Ambulance Fee Schedule”). The first, the 1978 Airline Deregulation Act was enacted by the Federal Government of the United States, removing federal control over fares, routes, and market entry of new airlines. This act introduced a free market within the airline industry and had a large impact on the cost of air ambulance transportation (“Airline Deregulation”). In addition, the Ambulance Fee Schedule, established a fee schedule for the payment of ambulance services under Medicare (“Medicare Program”). Overall, through this research I was able to identify the positive impact of scientific advancement on healthcare outcomes and the often-negative impact of politics on cost of treatment, which will be explored further below.

Transportation via helicopters have significant benefits over their ground ambulance transportation counterparts. In one study, conducted in 2010, they conducted a study involving the in-hospital mortality rates of 56,744 people based on their transportation to the hospital. Out of this number, 18%, or 10,049, were transported by helicopter emergency services. Then, they were able to determine that the odds of mortality were 39% lower for those transported by helicopters than ground ambulances (“Reduced Mortality in Injured Adults”). Another study conducted between 2005 and 2015 found that there was a strong positive linear correlation between helicopter emergency services on-scene time and mortality. The correlation coefficient was $R = 0.962$, with a p value of $p=0.038$ (Pham, 2017). These numbers help to indicate how

technological improvements have allowed transportation to be quicker and more effective. Due to technology improvements, emergency medical personnel arrive quicker and spend less time on the scene. Although this is a small sample size, there are key studies that identify that patients transported via air ambulances have a lower mortality rate. Although this often changes based on the severity of the injury or illness, air ambulances have been proven to be effective in more long-range situations. This is mostly due to the fact that helicopter air ambulances can travel up to a distance of 100 miles, with an average range of 73 miles. Helicopter air ambulances can travel up to 120 mph and better achieve care for a patient within the “Golden Hour” (“Urban Air”). Air ambulances are able to cover more ground through their technological advancements in aircraft and the improvements in casualty care on the scene due to technological advancement.

The 1978 Airline Deregulation Act and the Ambulance Fee Schedule have both had a significant impact on the cost incurred by the patient. The 1978 Airline Deregulation Act created a free and open airline market, where the industry was able to set the prices for transportation to a medical facility. Unlike the commercial airline industry, the air ambulance industry often sets the price of their services upon completion of the flight. This led to two billing methods commonly used which are balance billing and the ambulance fee schedule. Balance billing is the practice of billing the patient’s insurance company, who will pay part of the invoice, then the remaining balance will be billed to the patient (“Airline Deregulation act and Air Ambulances”). However, the most significant impact has come from the air ambulance fee schedule. Before 2002, the majority of air ambulances were operated by hospitals. With the enactment of the ambulance fee schedule, it increased the Medicare reimbursement rate for helicopter air ambulance transport, particularly for rural transportation. As a result, more than half of air ambulances are now for-profit and the number of helicopter ambulances have increased from 545 in 2003 to 1,045 in

2015. From these two legislative actions, it has led to a huge increase in risk for consumers to incur very large bills that are not covered by their insurance due to the aggressive business practices of for-profit air ambulance companies (“Up in the air”).



To illustrate these high costs, I have included direct examples and information on the price changes over time. In the Figure above, it illustrates the total cost change in helicopters from 2008 to 2017, with adjusting for inflation (“Air Ambulance – Ten years”). In 2017, the Medicare “base rate” covered for air ambulances is \$3,496.75 in urban areas and \$5,245.13 in rural areas (“Up in the air”). In 2015, the average base rate coverage of Medicare between both urban and rural areas was \$4,624, with an additional \$31.67 per mile traveled, with a total average around \$6,556 (Luthi, 2018). Based on an independent study carried out by the consulting firm Xcenda, this only covered 59% of the actual costs associated with air ambulance transportation (Luthi, 2018). This is a significant issue because many people over the age of 65 are in retirement and may not be able to pay this bill. In addition, an example company that

practices aggressive business practices is Air Methods, the largest for-profit air ambulance provider in the US, accounting for 25% of all air ambulance revenue. According to a recent study, Air Methods average charge for transportation was \$17,262 in 2009, skyrocketing to \$50,199 in 2016 (“Up in Air”). These costs were able to significantly increase due to the open market created by the 1978 Airline Deregulation Act and the implementation of the ambulance fee schedule in 2002, displaying the impact of politics on cost within the healthcare industry.

Discussion

The research presented in the Results section directly relates to the theory of Co-production through the way I utilized the four main instruments throughout. In my analysis and data, I would make identities through the various sources and information I found on how different stakeholders view the technologies and policies. In addition, I made use of making institutions, by identifying how these policies have impacted the institution of healthcare as a whole and how these regulations continually impact the system. Then, I made discourses by illustrating how there are public needs in identifying change in the way the cost of healthcare is distributed. As mentioned previously, there are many consequences from these legislations that have led to severe impacts on patient’s livelihoods. Lastly, I tied it together with making representations, illustrating how over time politics have shaped the air ambulance industry over time by showing the changes in cost. The more the technology has been used, the greater the increase in cost, which is a way of making representations.

Within this research, there are limitations to my efforts stemming from focusing solely on the air ambulance industry. There has been significant technological improvement and innovation in the air ambulance industry since 1970. However, it was very difficult to obtain actual numbers quantifying how scientific achievements have improved healthcare outcomes.

There is not a lot of data on the actual morbidity and mortality rates of patients in air ambulance travel and it was difficult to find a connection between what technology has directly led to an improvement if there was. In addition, I was unable to fully quantify the impact of politics on healthcare costs. Although I was able to provide some support, the air ambulance industry has not been heavily regulated by the Federal government. If I had chosen another area of focus within the healthcare industry that is more heavily regulated, a more thorough policy analysis would have been possible.

In future work, I would attempt to isolate the impact of technology and politics on a smaller scale. Attempting to quantify the impact of specific technologies and policies from 1970 in the air ambulance industry is a very difficult process. In addition, there are many other factors outside of technological advancement and politics that have improved healthcare outcomes from patients. Various things such as societal change (more active lifestyles, healthy habits) can also contribute to a decline in morbidity and mortality rates. Coupling with this research, additional factors should be included to expand on why morbidity and mortality rates have improved. This would give a wider view on how healthcare as a whole has changed and why patient outcomes have improved.

I will utilize the research that I have conducted in this thesis to help me both in my career and in any future work I will carry out. Through recognizing the importance of both scientific achievements and politics in healthcare, I would be able to design new technologies or policies revolving around the healthcare industry. Personally, I will be working in the life sciences consulting industry post-graduation. Through carrying out this research, it could impact the future work on my projects that I will be working on with biotech and pharmaceutical companies. This will also advance any future work that I carry out in the engineering field. My

main focus in engineering will always be healthcare and through this research I have been able to determine various factors that play a role in the morbidity and mortality rates for patients. Lastly, by understanding how cost can impact the patient is a key aspect of the creation of any technology. Creating and designing engineering technologies that are accessible for everyone will be key for the future and I will ensure that I focus on that.

Conclusion

In conclusion, identifying how technological advancements have improved healthcare outcomes and politics have negatively impacted price, illustrate how different aspects of a system can impact the human dimension of a system. There are many issues within the healthcare world and by trying to point out what is going well and what is not, can help both healthcare experts and politicians decide how to best help patients. Healthcare experts, specifically air ambulance companies, should do further research to discover which technologies have contributed the most to the decrease in mortality and morbidity rates within healthcare. Then, using these findings, they could offer definitive results that encourage hospitals to purchase more or develop more of these technologies that positively impact patient's health outcomes. Based on these findings, politicians should be held more accountable by the United States population to create legislation that improves access and cost to healthcare. There should be an internal and external review of the policies that have led to these significant cost increases so that people can have more affordable care. For the next step, broadening the scope of this thesis to find more areas that provide definitive mortality and morbidity rate changes based on technological improvement would be important. When engineers are creating a new technology, they could use this research to add or improve the technologies that have worked well in the past. Politicians could use this work to see how these policies have created a cost burden on patients

and lead to them passing new legislation that helps the consumer. Overall, this work can impact decisions engineers make in the healthcare world and show politicians where improvements can be made.

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