

The Impact of Telemedicine on Antimicrobial Resistance During the COVID-19 Pandemic

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Sarah Hall

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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

Advisor

Sean M. Ferguson, Department of Engineering and Society

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The COVID-19 pandemic emerged in early 2020, completely altering daily life for individuals across the globe. Social distancing guidelines were enforced to prevent the spread of the virus, resulting in businesses closing, children staying home from school, people losing their jobs, and decreased access to basic needs. These needs included going to the grocery store, getting physical exercise, and attending doctor appointments. The United States healthcare system was extremely overworked, as hundreds of thousands of COVID-19 patients lost their lives and resources were limited. Although telehealth existed prior to the pandemic, this technology has drastically grown in popularity due to minimization of in-person appointments. While there are many benefits to virtual conferences, including time efficiency, safety from disease spread, and the ability to meet regardless of geographical location, telehealth could be threatening the health of the human race. Physicians who solely utilize this technology to treat their patients are neglecting the need for additional tests and in-person examinations. Therefore, antibiotic prescriptions have increased in this virtual environment and could potentially contribute to antimicrobial resistance (AMR). While it is too early to determine exactly how AMR is impacted, this societal threat cannot be ignored.

Telemedicine, COVID-19, and AMR

Contribution of Telemedicine to Healthcare

Telehealth is defined as “the use of electronic information and telecommunications technologies to support long-distance clinical healthcare, patient and professional health-related education, public health, and health administration” (Enlund & Vesey, 2019). This technology is a useful tool and has a large societal impact on how individuals receive medical care. The four ways in which telehealth is utilized are real-time communication, store-and-forward, remote

patient monitoring, and mobile health. Real-time communication entails a video conference in which a patient can communicate with their physician. Additionally, an individual can fill out a series of questions about their symptoms in order to be provided a diagnosis and a prescription if needed (*Telehealth: Technology Meets Health Care - Mayo Clinic, 2020*). This type of telemedicine does not require a video conference, but should only be used for minor illnesses as more serious ailments should receive a more thorough examination. Store-and forward is the transferring of data between doctors' offices or hospitals for analysis or to get additional opinions. For example, a general physician could communicate with a specialist to discuss symptoms that their patient has demonstrated. Remote patient monitoring occurs when a patient is not physically at the healthcare site but their vitals and possibly other health information is being recorded and sent back to their physician to ensure that they are remaining healthy while at home. According to the American Telemedicine Association (ATA), remote patient monitoring "uses devices to remotely collect and send data to a home health agency or a remote diagnostic testing facility (RDTF) for interpretation. Such applications [...] include a specific vital sign, such as blood glucose or heart electrocardiogram (ECG)" (Hoffman, 2020). Mobile health utilizes a mobile device for educational purposes or other services (Enlund & Vesey, 2019). Telehealth has allowed patient records to be shared at high speed with the help of a personal health record (PHR) system. This system is shared with the patient to ensure that they understand their illness/condition and have access to important health information. In the case of an emergency, the PHR system is shared with the hospital to inform them on a patient's medical history (*Telehealth: Technology Meets Health Care - Mayo Clinic, 2020*). While the technological innovation and unique advantages of telehealth should be acknowledged, the problem that will be addressed in this thesis lies within the category of real-time communication.

COVID-19 Impact on Telemedicine Usage

During COVID-19, this technology has become an attractive alternative to in-person care. The reality of the COVID-19 became apparent in March of 2020, when the World Health Organization categorized the virus as a pandemic and Trump declared a National Emergency. Additionally, the Centers for Medicare and Medicaid Services (CMS) declared on March 17th that telehealth should be used more broadly to treat elderly people, as they are a portion of the population that is more vulnerable to the side effects of the illness (*A Timeline of COVID-19 Developments in 2020, 2021*). The Centers for Disease Control and Prevention (CDC) noted that the use of telemedicine increased by 50% in the first quarter of 2020 compared to the first quarter of 2019. Also, in the second week of March alone, usage increased by 154%. Emergency department visits decreased drastically during this time, as people feared possible exposure to the virus (Koonin, 2020). The pandemic has highlighted the potential benefits of this technology, as people can have access to healthcare without leaving their homes. Our country was on lockdown and people had difficulties doing basic things such as going to the grocery store. Telehealth allowed individuals to remain in contact with their physicians for check-ins, prescription refills, and treatment of minor illnesses. For extreme cases, hospitals were still utilized, but telehealth helped to ease the burden of too many patients in the emergency room.

The Crisis of AMR

AMR is an increasingly prevalent problem worldwide. Antimicrobials are defined as “medicines used to prevent and treat infections in humans, animals, and plants” (*Antimicrobial Resistance*, 2020). These include antibiotics, which are used to fight bacterial infections. Antibiotics are relied upon for many different aspects of healthcare, including chemotherapy for cancer treatment, organ transplantation, hip replacement surgery, and intensive care for preterm

newborns (Prestinaci et al., 2015). AMR occurs when a small population of bacteria, a virus, fungus, or parasite mutates to become immune to the drug being used to target the infection. This population continues to reproduce, creating a larger population of the infection that will not respond to the drug. Thus, the drug eventually becomes ineffective as a treatment option. At least 700,000 people die each year worldwide due to bacterial infections that cannot be treated due to AMR, and it is projected that 10 million people will die per year by 2050. In the United States, there are over 2.8 million cases of multidrug-resistant bacterial infections per year, resulting in \$20 billion in healthcare spending (Strathdee et al., 2020). For example, antibiotics used to treat urinary tract infections, sexually transmitted infections, and other bacterial infections are becoming less effective. For *E. coli* specifically, rates of resistance ranging from 8.4% to 92.9% were reported. Factors that contribute to AMR include using antibiotics for an illness that is not targeted by the drug, a patient not completing the full course of the antibiotic, lack of clean water, sanitation, and hygiene, lack of quality/affordable medications, lack of awareness both personally and legislatively, and poor disease/infection prevention in farms and healthcare facilities (*Antimicrobial Resistance*, 2020). Resistance is a problem that society cannot ignore, as it threatens human survival.

Actor-Network Theory Framework

The topic of telemedicine impacting AMR will be viewed through the lens of Actor-Network Theory (ANT). This theory analyzes the interaction between inanimate objects and society, examining the various stakeholders or “actors”. Actors are defined as the “source of an action regardless of its status as a human or non-human.” ANT focuses on the reliance of each actor on each other in order to function and have the societal implications that they each produce (Cresswell et al., 2010, p.). The actors for this thesis are telemedicine, the United States

healthcare system, patients (members of society), AMR, and COVID-19. All of these entities are intertwined and have changed as a result of the impact of the other actors present in the network. Telemedicine was created to improve our healthcare system and has grown in popularity as a response to the pandemic, yet patients are victims of antibiotic over-prescription leading to increased AMR present in society. Physicians are disregarding the global crisis of AMR, which is evolving more rapidly each day. Additionally, antibiotics have been used to treat patients who are ill with the coronavirus. Ultimately, the central claim of this thesis is that telemedicine results in less thorough examination of patients and their symptoms during the pandemic, leading to the prescription of broad-spectrum antibiotics that are not effective for every illness being treated and thus, physicians are contributing to the spread of AMR.

Effect of Telemedicine on AMR

While telemedicine has many benefits that will be discussed further in the following section, this technology is detrimental to the health of patients if used as a sole treatment method. Studies have shown that virtual doctor's appointments have led to an increase in prescriptions. Physicians at children's hospitals in Pittsburgh, Pennsylvania and Boston, Massachusetts examined the prescription of antibiotics for pediatric patients at direct-to-consumer (DTC) telemedicine visits. They looked at data for treatment of acute respiratory infections (ARIs) in three settings: DTC telemedicine, urgent care, and primary health care provider (PCP) offices. This data was gathered by a large national commercial health plan from 2015-2016 (prior to COVID-19). Their findings were that telemedicine appointments resulted in 52% of patients being prescribed antibiotics, while only 42% for urgent care and 31% for PCP visits. The increased amount of prescriptions resulting from telemedicine visits was statistically significant compared to the other two methods of patient care, with p-values less than 0.001. Furthermore,

they looked at guideline-concordant antibiotic management, which is defined as proper prescribing for illnesses that warrant antibiotics and nonuse of antibiotics for illnesses that cannot be effectively treated by the drug. For DTC telemedicine visits, children received guideline-concordant care for 59% of all visits examined, while for urgent care and PCP these figures were 67% and 78%, respectively. Antibiotics were properly prescribed for 54% of telemedicine visits, while 66% for urgent care and 80% of PCP visits. The decrease in accuracy for telemedicine visits was statistically significant for both cases (guideline-concordant and accurate prescription), with p-values less than 0.001 (Ray et al., 2019). Another study looking at data in 2018 from a telemedicine company called Doctor On Demand also found evidence suggesting that telemedicine resulted in over-prescription of antibiotics. This study looked at upper respiratory infections (URIs), bronchitis, sinusitis, and pharyngitis. With the addition of education and individualized feedback, clinicians were less likely to prescribe antibiotics compared to receiving education alone, with URIs and bronchitis treatment showing statistical significance decreases. Thus, programs that provide education and feedback could be put into place to effectively decrease the likelihood of antibiotic over-prescription (Du Yan et al., 2021).

Many physicians have voiced their perspective of telehealth and its impact on the United States healthcare system. While telehealth is definitely incorporated into the future of medicine, it cannot be the entire picture. J.D. Zipkin, MD, is the associate medical director of Northwell Health's GoHealth Urgent Care Program in New York, and he discusses the many potential shortcomings of telemedicine, especially with regards to poor quality of care. He states, "there are just too many things that truly require a stethoscope, a visualization of an ear drum, or a strep swab. Without that additional needed access to a complete medical examination, telemedicine providers are further pressured to cut corners and make incorrect assumptions to avoid sending

the patient to the appropriate setting and losing their business” (mHealthIntelligence, 2019). This quotation was said prior to the pandemic, but still holds value to the argument that telemedicine does not always provide quality care. Timothy Porter, MD, is a pediatrician in Chicago, Illinois. He wrote an opinion article and his perspective of telemedicine that briefly discusses pros and cons of the technology. While he speaks highly of the capabilities of telemedicine, including revenue growth for physicians as they can see more patients, flexibility for physicians as they can take calls from their homes, and increased patient involvement in their treatment which leads to improved outcomes. The challenges he discusses are insurance reimbursements, security to ensure that Health Insurance Portability and Accountability Act (HIPAA) requirements are being followed, and quality of care. While he believes that telemedicine can deliver quality care effectively, he states that “providers must be able to recognize when an in-office visit is in order” (Porter, 2016).

Dr. Mia Finkelston, Senior Medical Director at Amwell, was interviewed about her perspective of the emerging technology. She discussed how physicians were required to take telemedicine assessments and were interviewed about their opinions of the technology in order to get their medical licenses in various states. These requirements are beneficial to ensure that quality of patient care is maintained in a virtual setting. She believes that telehealth is useful for simple tasks such as prescription refills, especially during the pandemic. Prior to 2020, physicians often referred patients to urgent care facilities. COVID-19 has helped physicians open their eyes to the fact that they can, and should be, accessible to their patients outside of normal hours. She also discussed how telemedicine could never fully replace in-person care. Chronic illnesses need more attention, and patients want reassurance of their health so additional tests and appointments are necessary. She advised that in order for a practice to succeed, a hybrid model is

absolutely necessary. While this claim is true, she focused more on the business aspect of healthcare instead of patient wellness. This economic perspective is common among physicians, and a major problem contributing to AMR increasing due to telemedicine. Lastly, the interviewer mentioned that he was treated via telemedicine for a cough and the doctor prescribed him medication without bringing him into the office. He stated that in this moment, he realized how checking vitals at the doctor's office is "theatre" and that telemedicine is fully capable of complete care in some cases. Dr. Finkelston saw some truth in this statement, but also challenged it to say that some cases require more tests and a patient's medical history should be looked into prior to making a diagnosis and prescribing. This story perfectly captures the claims of this thesis, that corners are cut and more thorough examination is required before prescribing, as the prevalence of AMR is growing (Lynn, 2021).

A study conducted in Wuhan, China across two hospitals and 191 patients found that 21% of patients with COVID-19 were treated with antivirals, while 95% were treated with antibiotics ("Antimicrobial Resistance in the Age of COVID-19," 2020). This evidence demonstrates how the misuse of antibiotics is very common within the global healthcare system, and that COVID-19 could be putting additional stress on the issue of AMR. Experts from the European Centre for Disease Prevention and Control (ECDC) have investigated this problem further. While they admit that there has not been enough time to see the long-term effects of COVID-19, as it is still a prevalent issue globally, they still posited reasons as to why AMR could increase during this time period. Specifically, they look at various healthcare settings/conditions: antibiotic use in hospitals, infection prevention and control in hospitals, antibiotic use in the community, hygiene practices in the community, cross-border spread, and public health policy making. According to their research in the hospital setting, ~70% of

COVID-19 patients are treated with antibiotics and 16% develop a secondary infection that will require antibiotics. Furthermore, the pandemic shifts the focus from antimicrobial stewardship towards COVID-19 efforts, in combination with healthcare workers being overworked. They discuss how the ECDC, the European Medicines Agency (EMA), and the European Food Safety Authority are working on a report to publish this year on AMR data from 2016-2018, illustrating the long wait time that will be required to see the effects in 2020 (Monnet & Harbarth, 2020). Another issue that warrants concern is the new precedent that people who have flu-like symptoms will be treated with antibiotics, as this has been a common response among physicians this year to treat COVID-19 patients. In regards to telemedicine, evidence suggests that physicians are indeed prescribing more antibiotics “just in case” at virtual visits due to social distancing limitations. In addition, more antibiotics have been prescribed relating to dental care during the pandemic. Tests cannot be done on a patient without requiring them to come in person and schedule an additional appointment, which is undesirable for both physicians and patients who want a fast diagnosis (Knight et al., 2021).

Discussion

Ultimately, given the evidence that has been discussed, there is reason to believe that telemedicine will negatively affect AMR for years to come. These effects cannot yet be determined or quantified given that society is still navigating the current pandemic, but there are increased rates of antibiotic prescriptions through telemedicine appointments and increased use of antibiotics for treatment of COVID-19 patients. These combined facts exhibit how the pandemic is putting pressure on physicians to treat their patients, and how telemedicine allows for an easy diagnosis that could potentially be incorrect due to lack of further efforts. Physicians try to alleviate patients’ symptoms from the virus, or mistake them for other illnesses, without

considering the effect their prescriptions could have on the health of the general population. If antibiotics continue to be used in a haphazard way, humans will no longer be able to overcome infections. AMR does not elicit the same response from society that a pandemic does, but drug resistance cannot be disregarded as it threatens human survival.

Counterargument

While the negative societal implications of telemedicine have been discussed, it is worth acknowledging counterarguments. These include increased accessibility, increased patient monitorization, lower chances of disease transmission, and increased compliance with antibiotic prescriptions. Telehealth positively impacts many demographics, including people who live in rural areas who cannot travel easily to a doctor's office, people with full-time jobs who have trouble with availability, and people with disabilities who need the help of a family member to get them to a physical location (CDC, 2020). Additionally, telemedicine allows physicians to monitor their patients after hospitalization without the need for supplementary in-person visits (CDC, 2020; Hoffman, 2020). Another aspect of telehealth that is particularly advantageous during the pandemic is limited contact. With quarantining and social distancing guidelines, telehealth allows patients to be treated without the risk of being exposed or spreading illnesses to other individuals. This facet of telemedicine is a major benefit for the elderly and immunocompromised individuals, as they are more vulnerable to symptoms of COVID-19 and other illnesses (Monaghesh & Hajizadeh, 2020). Although less common, the likelihood of antimicrobial resistant organisms being transmitted between people is also reduced due to telehealth. Finally, a potential benefit that has not been utilized yet in society is to increase compliance. The general rule is to take an antibiotic for ten days to ensure that AMR is avoided. Given the ability for physicians to contact their patients virtually and more frequently,

reminders/alerts sent each day would be beneficial for reducing the chances of a person not finishing their prescription and becoming immune to the medication.

Conclusion

AMR, specifically the use of broad-spectrum antibiotics, is a problem that affects the entire globe. Broad-spectrum antibiotics target all bacteria in the body, killing ones that make individuals sick but also creating resistant bacteria. When this drug is presented to the body again, it becomes less effective in treating the illness. Telemedicine has shown to be a vehicle for physicians to prescribe broad-spectrum antibiotics without providing a thorough examination and running proper tests on patients. The COVID-19 pandemic has increased the amount of telemedicine appointments, leading to more prescriptions and potentially higher chances of AMR in the next few years. To combat this issue, physicians must become more aware and practice medicine with the intent on not simply solving a problem temporarily, but utilizing antibiotics in an effective and appropriate manner. Also, more narrow-spectrum antibiotics must be developed and used, as common antibiotics currently in use are becoming less effective for more of the world population. While telehealth benefits various groups of people and has many advantages, it cannot be the sole tool for patient care as it has been used for some practices during the pandemic.

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