An Exploration of How the Development of Increasingly Advanced Medical Technology Has Contributed to the Segregation of Healthcare and Health Technology Solutions

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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

The advancement of medical technology has revolutionized treatment techniques, procedures, and healthcare overall, in turn drastically improving the lives of the patients it reaches. However, these innovations come severely short in reaching universal accessibility with underserved communities, low-income populations, and poorly resourced medical facilities left unable to experience any of these breakthroughs in medicine and care. The medical field is shaped by a complex group of relationships between medical device companies, pharmaceutical companies, insurance providers, healthcare facilities, and most importantly, the people. While the progression of medical technology is intended to contribute to enhanced healthcare and improved patient outcomes, it often deepens existing disparities and leaves an incredibly small proportion of the population to reap the benefits. The very populations that stand to benefit the most from such innovations are the same ones that are most often excluded due to financial, geographic, and systemic barriers.

In a study focused on reducing disparities in access across new and established technologies, Hoagland and Kipping highlight the industry wide issue of high costs associated with medical technology breakthroughs driving unequal distribution of access to healthcare. As seen throughout the medical technology landscape, cardiac technology is an example of how the cost of development and production leads to significant cost-based inequalities leaving those in lower-income communities and underserved populations unable to access these innovations (Hoagland & Kipping, 2024). Without being able to afford these new medical solutions, their availability depends on insurance providers and the coverage they dictate. The first layer of this disparity falls on the medical device and pharmaceutical companies whose fierce devotion to research and development creates incredibly high costs to develop new cutting-edge solutions as

it takes immense resources to change such an industry. The second layer comes in the form of insurance companies which have an inverse relationship between profits and coverage, often leading to strict restrictions being placed on their coverage plans. Additionally, from a more population wide perspective, underserved communities often lack well-funded and equipped medical facilities, stemming from inequitable resource allocation, inadequate taxation, and insufficient government support, hence the integration of this new expensive technology is severely limited (*Addressing the Shortage of Medical Supplies in Underserved Areas*). High costs, along with all its sub barriers, is just one factor that continuously leaves disadvantaged populations without key technological innovations that could drastically improve the lives of their people.

This paper will explore how the development of increasingly advanced medical technology has contributed to the segregation of healthcare and health technology solutions. The implementation of new technology often disproportionately favors will-resourced hospitals, privatized healthcare institutions, and for-profit organizations. Several barriers including high costs associated with cutting-edge technology, limited insurance coverage, and an uneven distribution of resources create significant challenges in establishing equal access across the globe. Addressing these disparities requires a restructured focus on these underlying influential systems throughout the development process of new technological innovation in order to reach equitable societal impact at the time of production and release to the world. Overall, despite the promise of improving patient reach and treatment, the very process of medical innovation not only fails to contribute to global progress in health but also deepens the disparities in this field.

Background & Significance

The investigation of how the development of increasingly advanced medical technology has contributed to the segregation of healthcare and health technology solutions is important because it highlights the responsibility of innovators to go beyond designing scientific breakthroughs and ensure universal access, regardless of economic and social status. While such medical technology holds the promise of greatly enhancing the quality of life for people facing nearly any medical condition, its development is embedded in a complex array of demands, barriers, and influence which results in an unequal distribution of access.

For medical technology to reshape the healthcare landscape and offer groundbreaking diagnostic and therapeutic solutions, both highly skilled personnel and high-tech infrastructure are a requirement which presents the first key issue of extreme costs associated with this technology. Limited to wealthier regions, this gap creates significant barriers for low-resource communities. Not only does this pertain to individuals physically being able to cover the cost of necessary treatment, but also the establishments and social systems of such low-resource communities. Distribution of medical technology is not universal, it is dependent on market potential, the regulations present in certain regions, the established medical infrastructure, private partnerships/relationships, and more. Other systemic barriers also exist limiting access to innovative medical technology. In a study conducted to investigate disparities in healthcare, it was found that minorities often face significantly greater personal challenges in accessing healthcare such as getting time off work to visit a doctor, leading to individuals forgoing medical evaluation, preventative care, and even treatment (SteelFisher, 2024).

Health insurance was originally established under the principle of helping individuals combat high-cost medical treatments to ensure that healthcare remained accessible regardless of

financial status. However, the industry is still structured in a way which prioritizes profitability which leads to strict and expensive coverage policies that disproportionately affect marginalized communities and under-resourced regions. A large portion of U.S. adults face difficulties affording health care costs with one in four stating that they have skipped or postponed getting the health care they needed due to the cost and four in ten adults report having debt due to medical or dental bills (Lopes, et al., 2024). On top of these existing issues within insurance providers, even the process of obtaining health insurance is flawed. While the affordable care act and policy changes during COVID-19 boosted overall insurance coverage in the U.S., the unwinding of the pandemic-era policies will lead to an increased uninsured population. In addition to this uninsured population, a large percentage of U.S. residents that maintain some form of health insurance still face high deductibles and other cost sharing that often lead to delayed treatment and negative health effects (Radley, et al., 2024). The profit-driven model of health insurance providers further drives healthcare disparities as those who are not able to obtain a comprehensive coverage plan are left unable to access necessary treatment and face serious health impacts as a result. Instead of acting as a bridge to equitable healthcare, insurance providers have become the barrier that reinforce geographic and financial restrictions to medical solutions.

While the underlying issue of disregarding global access throughout the development process exists within nearly all medical technology in the world today, one of the clearest examples of this significant oversight can be seen in the creation of telehealth. This platform advertises improved access and care, yet it too only deepens the disparities in healthcare. These health information technologies require adequate internet access, compatible devices, a strong sense of health and digital literacy, and access to private spaces for discussion with health care

professionals (Saeed & Masters, 2021). Without addressing these barriers, global health inequalities will continue to severely impact poorly represented and marginalized communities through the ongoing advancement of medical devices, systems, and treatments. The change to a more wholistic approach to development in this sector where implementation across a variety of populations is considered and built into the technology's design is necessary to achieve equal access and improved care for all.

Methodology

Similar to the energy justice framework outlined in *Revisiting the Energy Justice Framework: Doing Justice to Normative Uncertainties*, the segregation of global access to health technology solutions will be analyzed through a justice evaluative technique. Rather than focusing on the fair dissemination of the benefits and costs of energy services, this framework will assess the policies, systems, and innovations throughout the medical technology industry to determine whether they promote fairness and equity (Uffelen, et al., 2024). This will provide insights into the ethical implications of decision-making and how power dynamics influence such results. The justice evaluative technique will create the framework to analyze how the distribution of medical technology fails to align with the principles of fairness and equity. To evaluate the variables that contribute to the disparities within healthcare, several key areas will be explored including distributive, procedural, structural, and policy factors.

A distributive analysis will provide insight as to how access to medical technology is distributed among various social and geographic groups as well as if it is disproportionately benefiting wealthy individuals and well-resourced healthcare facilities. Shining a light on how certain groups such as low-income or marginalized populations are systemically excluded from obtaining care will highlight the underlying factors that are driving these disparities. It is only

with a clear understanding of these influential factors that plans for effective change can be developed and implemented. The devotion of healthcare resources will act as a strong guideline for this evaluation with trends such as how populations and investments are transitioning outward from central city locations, leaving central city residents, particularly those with lower incomes, with a problematic and highly unequal landscape of healthcare providers (Hawthorne & Kwan, 2013).

Procedural factors include how decision-making processes within the main actors including insurance, medical device, pharmaceutical, and healthcare provider companies influence global access. An evaluation of the transparency of the policies within these companies as well as the biases built into their systems that govern the allocation of resources and technology will define this portion of the justice evaluative technique. Many of these companies operate in a way where access to the technology and health solutions they control is dictated by financial incentives rather than patient need. For marginalized communities, this lack of inclusive thinking leads to significant disparities as they are frequently excluded from the processes that determine who benefits from medical advancements. The actual creation of insurance coverage plans, connections for medical facility outreach, and design of novel medical technology need to keep the concept of equity as a central focus point to close the current gaps in healthcare.

Structural factors outline the financial and geographic disparities that prevent equitable access to new medical technology. One significant structural barrier in healthcare is the high cost associated with health technology (Hoagland & Kipping, 2024). This often puts such treatment solutions out of reach for lower-income individuals, even those with insurance as coverage plans have become increasingly stricter. Additionally, underfunded medical facilities often lack the

infrastructure and resources required to integrate these technologies. Hence, patients who are reliant on such facilities only have access to outdated and inadequate treatment options. Technologies such as telehealth highlight how barriers like internet access and digital literacy can further marginalize disadvantaged populations with the development of new innovations (Saeed & Masters, 2021).

Addressing the inequalities that exist in medical technology will require a compilation of comprehensive policy reforms that push the field towards a more balanced relationship between innovation and accessibility. Cost-cutting strategies implemented by insurance companies that disproportionately harm low-income patients need to be combatted through policy reform so that life-saving medical treatment technology can reach all that are in need. There are various areas that can be targeted through a wave of policy change that can all drastically impact the disparities in healthcare. Government incentives can be implemented to encourage medical technology companies to develop more affordable solutions and prioritize underserved markets. Shifts in investment locations towards healthcare infrastructure in lower income areas could help close the gap in integration. Pricing regulations on essential treatments would allow them to be drastically more accessible across the globe.

The justice evaluative technique is the best way to evaluate how the development of increasingly advanced medical technology has contributed to the segregation of healthcare and health technology solutions because it directly examines the fairness, equity, and systemic barriers of the healthcare industry. The breakdown of distributive, procedural, structural, and policy factors creates an in-depth view of not only the existing disparities in the industry, but also why they exist.

Literature Review

While the rapid advancement of medical technology is constantly creating new opportunities to treat health conditions, disparities in access to such solutions remain. These disparities are driven by numerous factors including racial and ethnic inequalities, the integration of digital technology, socioeconomic barriers, and biases in the development process.

Racial and ethnic minorities face significant barriers in the medical industry which greatly limit their access to equal treatment opportunities. A report by the Kaiser Family Foundation highlighted how these groups often struggle to access new drug therapies and treatments due to a lack of diversity in clinical trials along with other limitations including financial restrictions (Ndugga, et al., 2024). This underrepresentation in clinical trials can lead to the development of treatments that are less effective or even harmful for these populations. Building on the issues existing in clinical trials, there are clear disparities within those who have Medicare regarding the use of advanced medical procedures. In a report by AdvaMed, significant disparities in access to advanced interventions for racial minorities, women, and individuals with dual eligibility for Medicaid are identified (these disparities exist even after accounting for patient clinical histories and provider factors) (Unuigbe, et al., 2024). These findings indicate the presence of serious racial and ethnic inequalities within the healthcare space.

The integration of digital technologies into healthcare has created a wide range of opportunities yet also introduced a new dimension to these disparities. The digital divide is an evolving barrier that is characterized by differences in access to internet services and digital literacy. This divide significantly impacts access to health information technology (HIT). Research has shown that poor digital literacy, limited internet access, and a lack of technical assistance all hinder the effective use of HIT, hence contributing to inequalities in healthcare

access and outcomes (Saeed & Masters, 2021). Studies have shown that disparities in the adoption and use of digital health tools are more pronounced among racial minorities. These groups lack awareness and complete access while also combatting linguistic barriers, all of which impact their health outcomes (Ailawadhi, et al., 2023).

Socioeconomic status has been shown to significantly impact access to medical technologies. Financial barriers are the main challenge with high costs associated with novel medical technologies, leaving patients and facilities in economically poor areas out of reach of such treatment options. When new medical innovations are introduced into the field, they completely shift the landscape of available treatments, which often creates disparities in who maintains access. Focus must be placed on the development, funding, and distribution of all future medical technologies to promote equitable access to avoid new technologies from segmenting the population (Hoagland & Kipping, 2024). The current development and commercialization process that medical technology companies go through includes several costly checkpoints including obtaining regulatory approval which further drive these innovations towards wealthier populations and institutions.

The technological development process is filled with biases built into its infrastructure, perpetuating health disparities with each innovation. Artificial intelligence is one prominent example of a healthcare system with existing biases that lead to severe consequences. These biases often arise from non-representative training data and can result in the reinforcement of existing healthcare disparities with unequal diagnoses and treatments (Chen, et al., 2021). The consequences of such built-in features within medical technology range far beyond just artificial intelligence data sets, leading to significant variations in healthcare outcomes. For example, pulse oximeters, a device used to monitor blood oxygen saturation in a noninvasive manner, have

been found to provide less accurate readings for patients with darker skin tones (Perrone, 2025). This could lead to inadequate treatment of hypoxia in such populations, leaving them without the critical care they need, even though it is readily available.

Discussion & Results

While technological advancements in the medical space have the potential to greatly enhance healthcare outcomes, they disproportionately benefit wealthier populations and well-resourced institutions. The application of the justice evaluative technique, focused on the development and distribution of medical technology, highlights the exclusion of underserved communities in this industry. This analysis shows that the existing barriers of high costs, profit-centered institutions, inadequate infrastructure, and restrictive insurance policies further drive inequalities in access to life-saving medical innovations. Through the justice evaluative technique, the distributive, procedural, structural, and policy factors shine a light on how medical technology is often developed and integrated into healthcare systems in ways that deepen existing socioeconomic divides rather than resolve them. To address these inequalities, significant changes need to be made within the processes that govern medical technology companies along with the structures that guide healthcare accessibility.

One key finding of this analysis is that access to medical technology is unevenly distributed across different socioeconomic and geographic groups. Wealthier hospitals and private healthcare institutions receive the most advanced medical devices and treatments, hence translating to the highest quality of care for its patients. Lower-income facilities often struggle with outdated equipment and a lack of established medical technology relationships, hence leaving them unable to obtain the most recent treatments available. Research has highlighted trends that contribute to these disparities such as how populations and investments are

transitioning outward from central city locations, leaving central city residents, particularly those with lower incomes, with a problematic and highly unequal landscape of healthcare providers (Hawthorne & Kwan, 2013). This distributive disparity in medical technology access reinforces these inequalities as patients in underfunded hospitals do not have access to the latest tools and innovations, hence greatly impacting health outcomes. Additionally, the high cost of medical technology including imaging machines, robotic surgical systems, and personalized medical treatments leaves them only accessible for well-funded hospitals and institutions. The distributive factors within the justice evaluative technique emphasize the need for more equitable resource allocation strategies that prioritize accessibility.

The second key point highlighted through the justice evaluative technique is the procedural component and how it reinforces these inequities. The processes that direct medical device manufacturers, pharmaceutical companies, and insurance providers all prioritize financial profitability rather than equitable access. Organizational focus and resource/fund allocation is based on market demand, yet the purchasing power that guides this market and the market research itself is skewed to primarily focus on wealthier populations. This profit-centered approach to medical innovation greatly decreases the investments and research into conditions that disproportionately affect marginalized communities while also limiting access to existing treatments for these same communities. Insurance providers are a particularly prominent example of procedural barriers that contribute to the disparities in healthcare. Many insurance companies impose strict reimbursement limitations, deny claims for costly procedures, and require high out-of-pocket expenses for advanced treatments. Additionally, a large percentage of U.S. residents that maintain some form of health insurance still face high deductibles and other cost sharing that often leads to delayed treatment and negative health effects (Radley, et al.,

2024). This procedural barrier can only be combatted with increased transparency and regulation to ensure that the decision-making processes that govern these organizations align with key ethical principles and overall patient health.

Structural barriers also play a critical role in reinforcing disparities in medical technology access. High costs are associated with the entire lifespan of new medical technology from its initial development, through manufacturing, and into distribution. Underfunded hospitals lack the financial resources to acquire novel medical devices, pharmaceuticals, and technology which leaves these marginalized communities unable to benefit from these innovations. Geographic disparities are a key pillar of the structural barriers that exist as many rural and low-income urban areas do not have well-equipped medical facilities. This issue has been made even more severe with the evolving technological landscape as new platforms such as telehealth that advertise improved access and care only deepen these disparities as they are misleading in their requirements. These health information technologies require adequate internet access, compatible devices, a strong sense of health and digital literacy, and access to private spaces for discussion with health care professionals (Saeed & Masters, 2021). Without targeted efforts to address that gap in infrastructure between wealthy and marginalized populations, medical technology will continue to benefit a subset of the total population.

The justice evaluative technique also highlights policy reform as an essential focus to address these disparities. While there is a wide range of actions that can be taken in this area, government intervention focused on regulating medical technology pricing to promote affordability is one potential solution. These policies would provide incentives for companies to develop cost-effective solutions that can reach underserved regions and bridge the gap in accessibility. Research shows that countries with stronger government intervention in healthcare

innovation tend to have more equitable distribution of medical technologies (Blumenthal, et al., 2020). Policy changes centered around insurance policy reform is another shift that offers immense opportunity. Stricter regulations on insurance companies to ensure that profits do not overshadow patient needs would open the door for low-income patients to gain access to life saving treatments. Redirecting resources towards hospitals and clinics that serve disadvantaged populations is one more strategy within policy reform to combat the disparities in medical technology access.

Conclusion

The development of increasingly advanced medical technology has contributed to the segregation of healthcare and health technology solutions by linking barriers which reinforce and extend existing disparities to multiple stages throughout the development process. This paper incorporates a justice evaluative technique to outline this conclusion with the primary focus points of distributive, procedural, structural, and policy factors. The distribution stage of the latest advancements in health technology is often guided by the incredibly high costs of these innovations. Access is limited to well-resourced hospitals, located in wealthier communities, while facilities in underserved communities are left with outdated technology and insufficient resources to provide its patients with adequate care. The procedural decision-making stages which guide these medical technology companies are all centered around a for-profit approach, resulting in research and development being focused on where the greatest market opportunity lies rather than global health improvement. The divide in the structural development stage is highlighted through innovations such as telehealth which keep under-resourced populations from experiencing the full extent of the advancing medical industry. The evaluation of the policy intervention stage showed a lack of government intervention over medical technology pricing

and insurance coverage, an area that has the potential to drive drastic change in the direction of equal access. These barriers are especially problematic because they support a system where the communities that would most benefit from medical innovation face the greatest challenges to gain access. This directly limits the impact of medical technology and its ability to improve global health. To address these disparities, the mindsets, investments, and policies surrounding medical technology companies need to undergo change. Every stage of the development process must be met with a consideration for global access to avoid integrating new factors that perpetuate these barriers. Investments into under-resourced communities targeting the necessary infrastructure required to support the evolving medical landscape would help to close the structural divide. Government agencies can implement stronger oversight into pricing and insurance coverage plans as well as offer incentives for medical technology companies to cater towards achieving equitable access.

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