Undergraduate Thesis Prospectus

# Towards the Development of a Dashboard to Improve Pediatric Heart Transplant Decision Making

# Artificial or Human Judgement: Implications of Automating High-Stakes Decision Making in Healthcare

by

Allison Miller

October 27, 2022

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 the Thesis-Related Assignments.

*Allison Miller*

*Technical advisor*: Sara Riggs, Department of Engineering Systems and Environment

*STS advisor*: Peter Norton, Department of Engineering and Society

**General Research Problem**

*Taking into account social, technical, and cost values, how may the cost-benefit ratio AI systems be reduced?*

By definition, artificial intelligence (AI) systems emulate human intelligence; they may support human performance or alleviate administrative burdens through automation (Kabalisa & Altmann, 2021). Countries and industries are promoting and adopting AI projects to maintain a competitive edge in a global market. AI systems can boost productivity, optimize resource allocation, reduce labor costs, and increase GDP (Kabalisa & Altmann, 2021). Regulatory policies, however, have not kept pace with the rapid proliferation of AI systems. Unregulated intelligent algorithms can worsen pervasive biases because they reflect the biases of their developers and of the datasets they are trained on (Rainie & Anderson, 2022). Jenny Korn of the University of Illinois at Chicago contends: "The discussion of algorithms should be tied to the programmers programming those algorithms. Algorithms reflect human creations of normative values around race, gender and other areas related to social justice" (Rainie & Anderson, 2022b). While AI systems relieve humans of tedious tasks, standards are needed to prevent undesirable social effects.

**Towards the Development of a Dashboard to Improve Pediatric Heart Transplant Decision Making**

*In the UVa Health System, how may cardiologists' expert decisions in response to pediatric heart transplantation opportunities best be supported?*

My capstone project is sponsored by the UVa Health System and directed under the Department of Engineering Systems and Environment with Professor Sara Riggs as the technical

advisor. The students involved on my capstone team are Joseph LaRuffa, Olivia Kaczmarskyj, Angela Wan, Lilleth Snavely, and Connor Hyldahl. The overarching goal of this project is to develop a workable interface that aids in the decision making process for pediatric heart transplantation. The existing user interface, which is a general spreadsheet with patient data, requires cardiologists to primarily rely on their intuition and expertise to make critical decisions. Once a donor-candidate match has been established and the cardiologists are notified, they have 30 minutes to reach a potentially life or death decision. With the current system, nearly half (44%) of all viable pediatric donor hearts are not utilized and discarded in the United States (Baez Hernandez et al., 2020). Factors attributed to this statistic include inconsistencies in acceptable donor characteristics across national programs, lack of regulatory oversight, and pressures on transplantation programs from third party organ procurement organizations (Butler et al., 2020). In addition to the underutilization of viable organs, pediatric patients waiting for heart transplants have the highest mortality rate of any patient listed for organ transplantation (D'Addese et al., 2019). Our objective for the functional dashboard is to streamline the decision making process for cardiologists in order to decrease time spent on the waiting list, reduce waitlist mortalities, and increase utilization of viable donor organs.

An unusual constraint discovered through our preliminary research is the politics of healthcare that play into high stakes decision making. From client interviews, a general consensus has been gathered that cardiologists experience immense pressure from external stakeholders, such as the United Network for Organ Sharing (UNOS). UNOS operates the national Organ Procurement and Transplantation Network (OPTN) in the US and conducts routine reviews of transplant program performance. If transplant centers are found to have poor outcomes of post-transplant survival then they will be penalized with financial and public

relations costs or, in worst cases, be suspended permanently (Butler et al., 2020). Not only do cardiologists have to consider donor match characteristics when deciding acceptance or rejection, but they also have to scrutinize the implications of high-risk outcomes on their respective programs. This impedes the decision process and is a factor we will have to consider as the user interface is developed.

Our methods of achieving a workable user interface are encompassed in the following timeline: research and consultation with cardiologists, wireframing, iteration, prototyping and end user testing. Interviewing our end users prior to development is essential towards understanding the decision process within the scope of their expertise so we can build an interface that effectively matches their mental mapping. The interface we build will incorporate data visualizations from a database collected by the School of Data Science from the UVa Health System. Our wireframing and prototyping will be performed using software such as Figma and PowerBI.

If this project succeeds, the interface will be implemented into the pediatric cardiology department at the UVa Health System and further tested to ensure that it meets our objectives of reducing waitlist time, waitlist mortality, and the non-utilization of viable organs for pediatric heart transplant candidates. Next steps following local deployment will involve the interface being used across programs nationally.

**Artificial or Human Judgment: Implications of Automating High-Stakes Decision Making in Healthcare**

*In the U.S. how are healthcare providers, medical professionals, advocacies, and patients competing to influence the applications of AI in medicine?*

AI systems are now common in healthcare, for example in medical diagnostics, patient monitoring, and learning healthcare systems (Lysaght, 2019). This burgeoning reliance is due to an institutional inclination towards mitigating human error and bias in healthcare. Like other humans, medical professionals are subject to cognitive biases. Verghese et al. (2018) found that optimism bias can lead clinicians to overestimate life expectancies by a factor of 5. Yet automated systems are not immune from bias; indeed algorithms can further embed racial and socioeconomic inequalities in healthcare (BMJ, 2020). For decision making and diagnostics, AI algorithms are trained with data derived from electronic medical records (EMRS) that contain anonymized patient information from previous diagnostics, procedures, and outcomes (Verghese et al., 2018). However, ethnic minorities have a history of being underrepresented or misrepresented in these datasets, resulting in mistreatment and worsened inequalities (Norori et al., 2021). Patient concerns with the applications of AI in healthcare include data privacy, cybersecurity, accuracy of automated diagnostics, responsibility of errors produced by algorithms, and the lack of regulatory oversight over the creation of AI systems (Musbahi et al., 2021).

In response to concerns about AI in medicine, the U.S. Food and Drug Administration (FDA) has proposed a regulatory framework establishing risk management principles for pre-production and post-market performance (FDA, 2021). Under the "Algorithmic Change Protocol," manufacturers and programmers are expected to commit to transparency during development and performance monitoring, and are required to provide intermittent status updates as needed. Through such oversight, the FDA seeks supervisory authority over the recursive improvement capabilities of AI systems (FDA, 2021).

Participants include digital advocacies such as the Algorithmic Justice League (AJL), which demand affirmative consent, procedural transparency, continuous oversight and accountability, and actionable assessments. AJL warns: “AI systems can perpetuate racism, sexism, ableism, and other harmful forms of discrimination, therefore, presenting significant threats to our society - from healthcare, to economic opportunity, to our criminal justice system” (AJL, n.d.). Healthcare technology companies, such as Optum Health, promote AI in healthcare. They state: “The responsible use of AI can help health systems strengthen and scale essential functions and reduce administrative burdens, all of which helps clinicians focus on their core mission of patient care” (UnitedHealth Group, 2022). Patients who oppose or welcome AI in healthcare are also key participants. An anonymous patient in support stated: “ I don’t think you will cure a lot of diseases without that advanced intellect. Obviously, we’ve come a long way with the human brain, but we could probably go a lot farther and speed the process with AI” (Richardson, 2021). Some patients are apprehensive about AI in healthcare. One explains: “I believe the doctor always has the responsibility to be checking for you, and you’re his responsibility, you know? The AI is not responsible; that’s just a tool” (Richardson, 2021). Opinions on algorithm implementation also vary amongst physicians. Dr. Ziad Obermeyer, associate professor of health policy and management at the University of California, Berkeley has said, “When I work in the emergency department, learning about a new patient feels like drowning in information. What electronic medical records have done is convert a large, inaccessible stack of paper charts into a never-ending stack of virtual notes and results. It’s not a good task for humans; we just don’t have the bandwidth to process it.” Dr. Danton Char, assistant professor of anesthesiology, perioperative, and pain medicine at Stanford, stated, “The first fear is that AI and machine learning may worsen the economic and racial disparities already inherent

in U.S. health care. Second, U.S. health care is in a constant tension between profit and delivery of health. Those two agendas rarely line up. Consequently, the values of AI designers or the purchasing administrators are not necessarily the values of the bedside clinician or patient. Those value collisions and tensions are going to be sites of significant ethical conflict" (Ward, 2019). Beyond the individual and organizational perspective, the FDA generally welcomes AI in healthcare. In a statement, it asserted that "AI has the potential to transform health care by deriving new and important insights from the vast amount of data generated during the delivery of health care every day" (FDA, 2021).

## References


Baez Hernandez, N., Kirk, R., Davies, R., Bano, M., Sutcliffe, D., Pirolli, T., Jaquiss, R., Daneman, S., & Butts, R. J. (2020). A comprehensive strategy in donor acceptance: Impact on pediatric waitlist and heart transplant outcomes. *Pediatric Transplantation*, *24(6)*. doi.org/10.1111/petr.13764

BMJ. (2020, Feb 13). Can we trust AI not to further embed racial health inequalities? www.bmj.com/company/newsroom/can-we-trust-ai-not-to-further-embed-racial-health-inequalities

Butler, A., Chapman, G., Johnson, J. N., Amodeo, A., Böhmer, J., Camino, M., Davies, R. R., Dipchand, A. I., Godown, J., Miera, O., Pérez‐Blanco, A., Rosenthal, D. N., Zangwill, S., & Kirk, R. (2020). Behavioral economics—A framework for donor organ decision‐making in pediatric heart transplantation. *Pediatric Transplantation*, *24(3)*. doi.org/10.1111/petr.13655

D'Addese, L., Joong, A., Burch, M., & Pahl, E. (2019). Pediatric heart transplantation in the current era. *Current Opinion in Pediatrics, 31(5), 583–591*. doi.org/10.1097/mop.0000000000000805

FDA (2021, Sep. 22). U.S. Food And Drug Administration. Artificial Intelligence and Machine Learning in Software as a Medical Device. www.fda.gov/medical-devices/software-medical-device-samd/artificial-intelligence-and-machine-learning-software-medical-device

Kabalisa, R., & Altmann, J. (2021). AI Technologies and Motives for AI Adoption by Countries and Firms: A Systematic Literature Review. Economics of Grids, Clouds, Systems, and Services, *39–51*. doi.org/10.1007/978-3-030-92916-9_4

Lysaght, T. (2019, Sep 12). AI-Assisted Decision-making in Healthcare. *SpringerLink*. link.springer.com/article/10.1007/s41649-019-00096-0?error=cookies_not_supported&code=9ae2e918-f69d-4ebf-a15f-e1ae89407817

AJL (n.d.) The Algorithmic Justice League. Mission, Team and Story. www.ajl.org/about

Musbahi, O., Syed, L., Le Feuvre, P., Cobb, J., & Jones, G. (2021). Public patient views of artificial intelligence in healthcare: A nominal group technique study. *Digital Health*, *7, 205520762110636.* doi.org/10.1177/20552076211063682

Norori, N., Hu, Q., Aellen, F. M., Faraci, F. D., & Tzovara, A. (2021). Addressing bias in big data and AI for health care: A call for open science. *Patterns, 2(10), 100347*. doi.org/10.1016/j.patter.2021.100347

Rainie, L., & Anderson, J. (2022a, Sep 15). Code-Dependent: Pros and Cons of the Algorithm Age. *Pew Research Center: Internet, Science & Tech*.

www.pewresearch.org/internet/2017/02/08/code-dependent-pros-and-cons-of-the-algorithm-age

Rainie, L., & Anderson, J. (2022b, Sep 15). Theme 4: Biases exist in algorithmically-organized systems. *Pew Research Center: Internet, Science & Tech*. www.pewresearch.org/internet/2017/02/08/theme-4-biases-exist-in-algorithmically-organized-systems

Richardson, J. P. (2021, Sep 21). Patient apprehensions about the use of artificial intelligence in healthcare. *Nature*. www.nature.com/articles/s41746-021-00509-1?error=cookies_not_supported&code=13759d9e-aec6-4ff3-80a5-1538f1b9917a

UnitedHealth Group. (2022, July 26). AI Survey: Health Care Organizations Continue to Adopt Artificial Intelligence to Help Achieve Better, More Equitable and Affordable Patient Outcomes. www.unitedhealthgroup.com/newsroom/2021/2021-12-15-optum-ai-survey-for-better-equitable-affordable-outcomes.html?cid=EM:SubscribetoNews:OA:000:standard:NAT:Newsroom

Verghese, A., Shah, N. H., & Harrington, R. A. (2018). What This Computer Needs Is a Physician. *Journal of the American Medical Association, 319(1), 19*. doi.org/10.1001/jama.2017.19198

Ward, L. (2019, October 15). The Ethical Dilemmas AI Poses for Health Care. *Wall Street Journal*. www.wsj.com/articles/the-ethical-dilemmas-ai-poses-for-health-care-11571018400