

Organ Transplantation During COVID-19: How the Pandemic Altered the Transplant System's Operation

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Sarah Grasmeder

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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

Bryn E. Seabrook, Department of Engineering and Society

STS Research Paper

Connections Between the Organ Transplant System and the Pandemic

Organ transplantations, procedures seen as a last resort option to keep patients alive and improve their quality of life, cannot afford to shut down their operations due to the spread of Coronavirus SARS-CoV-2 (COVID-19) infection. Instead, these transplant systems must strike a balance between performing life-saving operations and preventing the spread of COVID-19 to those within their system (Michaels et al., 2020). With new information on the severity and health-risks of COVID-19 constantly emerging, transplant centers continually consider how their operations need to be adjusted to prevent the spread of infection both within and outside the operating room. Thus, the pandemic spurred numerous changes in the organ transplant system in order to promote the safety of patients, their caretakers, and medical personnel (Pullen, 2020). These changes span a broad range of applications and vary based on the transplant center. The STS frameworks of risk analysis and social construction of technology (SCOT) are used to highlight how the assessment of perceived risks and the societal view of the pandemic have prompted the alterations in the organ transplant system since the emergence of COVID-19. These frameworks work together to justify the changes to organ transplantations, as well as analyze the effectiveness of the system's adaption to the pandemic. To understand the impact of the adjustments in the operations of organ transplant systems during the pandemic, the following research question must be analyzed: how effective are the sociotechnical systems that impact how the COVID-19 pandemic influences organ transplantation?

Approach to Researching Organ Transplantation During COVID-19

The research question "How effective are the sociotechnical systems that impact how the COVID-19 pandemic emergence influenced organ transplantation?" is addressed through

discourse analysis. Information is collected through published articles on the American Journal of Transplantation's "COVID-19 & Transplantation" resource page, which contains peer-reviewed articles submitted to the journal that deal with COVID-19. Additionally, articles published in online databases under the search "organ transplants during COVID-19" with keywords in their titles such as: "perceptions," "implications," "approach," "transplant programs," and "pandemic navigation" are used. The articles for analysis are published within the first few months of the COVID-19 pandemic, February to May, 2020, or are surveys performed during these first few months that were published later. These resources provide information about the changes to the operations of the organ transplant system, statistics on transplantations and organ donations, the general society's perception of the safety of transplants or current concerns, and patients' opinions on undergoing a transplant during the emergence of the COVID-19 pandemic. This information is used to identify what sociotechnical systems are the primary impactors on COVID-19's influence on organ transplantation and the effectiveness of these sociotechnical systems.

History of the Organ Transplant System and COVID-19's Impact on the System

Solid organ transplantation refers to the removal of an organ from one human to be placed in another human and configured so that the new organ can function properly in the new body. Transplants are used to extend the lives of patients who are experiencing total failure of an organ, as transplants are the only long-term, effective treatment. While the first successful organ transplant, a kidney transplant, occurred in the 1950s, the field has greatly progressed and expanded since then (Cameron & Cornejo, 2015). Advancements in immunosuppression to prevent the rejection of the new organ by the body's immune system, improved preservation of the organs, and expanding from kidney transplants to also offering lung, liver, pancreas,

intestines, and heart transplants, are some of these progressions that contribute to the modern organ transplant field.

Today's organ transplant system in the US consists of many components. While the organ transplant system is managed by the Department of Health and Human services, the primary healthcare services directly involved in organ transplantations are hospitals, transplant centers, and the organ procurement network: United Network for Organ Sharing (UNOS) (Harvey, 2019; *How We Match Organs*, n.d.). The hospitals and transplant centers work to assess patients, determining whether they need transplants and monitoring their health and other medical qualifications needed for transplantation. These healthcare centers also perform the transplants, with both centers performing scheduled transplants, while emergency transplants are only performed at hospitals. UNOS works directly with these hospitals to best match the donor organs to the recipient. UNOS determine which recipient receives an organ based on blood type, height, weight, organ size, other medical factors, and geographical locations of donor organ and recipients (*How We Match Organs*, n.d.). The organs UNOS procure for transplantations come from both living donors, who may or may not know the recipient, and deceased donors, who have given permission for their organs to be donated after their death.

While the organ transplant system operates successfully, there are shortcomings which lead to difficulties in performing transplants. Possible shortcomings include supply of organs not meeting their demand, ethical issues associated with procuring an organ, potential harm or long-term effects on donors, and controversy over incentives for organ donation (Beyar, 2011; Das & Lerner, 2007). These shortcomings may be exploited when increased stress is placed on the organ transplant system, such as during a pandemic.

The start of the COVID-19 pandemic drastically overwhelmed the US healthcare system. Hospitals were constantly at full capacity due to COVID-19 and other emergency patients, medical staff did not have proper personal protective equipment, supply chain issues led to lack of proper supplies and medical equipment in hospitals, and healthcare workers contracting the virus decreased available workers, putting greater stress on medical centers (Iyengar et al., 2020; Rinswer, 2020). These impacts were present in the organ transplant system and initially led to a shortened supply of donor organs, decreased rate in transplantations, and frequent delays to scheduled transplants (Michaels et al., 2020; *Recommendations and Guidance for Organ Donor Testing*, 2021). However, due to the lifesaving impact of transplants, operating in this less efficient manner was not sustainable for the transplant field. Better adaptation to the stresses of the pandemic led to the system focusing on making operational decisions that best balance health of all transplantation stakeholders and the importance of these surgeries.

Risk Analysis, Social Construction of Technology, and the Organ Transplant System

To understand the decision making behind alterations to the transplant system's operations, empathy and societal viewpoints must be acknowledged and incorporated into the decisions of the system. This societal understanding is especially important when majority of the current health-related impacts of the pandemic are not well understood, and the consequences and future directions are unknown. Using the risk analysis framework highlights society's perceived risks on organ transplants that arose due to the pandemic. Risk analysis is the determination of acceptable levels of risk in a system, as well as the compensation when harm is caused by the risk (Mythen, 2004). Ulrich Beck and Gabe Mythen are two prominent contributors to risk analysis. Beck's work emphasizes that society's perception of a risk is not just a calculation, but an entity with interests and values that must be acknowledged, not ignored

in hopes that it will fade away (Burgess et al., 2018). Mythen's work greatly draws inspiration from Ulrich Beck. Mythen uses Beck's term "risk society," a systematic way to deal with hazards in a system that are due to modernization of the system, to explain how finding a balance between all the underlying principle and policy components of the system, can stabilize and decrease the risk potential in the system (Mythen, 2004). Risk analysis has clarified that threats to a system are not fully external. Threats commonly arise from within as unintended consequences as modernization occurs, making risk analysis a continual process (Burgess et al., 2018). The risk analysis framework has contextualized the organ transplant system as a risk society and led to the understanding of how the risk of COVID-19 infection, a modernization to the system, altered the operations of the organ transplant system.

The societal views of the pandemic impacting the organ transplant system's adaptations are explained through the social construction of technology (SCOT) framework. SCOT is the analysis of how society shapes technology. Trevor Pinch and Wiebe Bijker developed the framework with five guiding components: interpretive flexibility, relevant social groups, closure and stabilization, wider context, and the technological frame. The guiding components allow their framework to be used to develop a structured system with multiple potential designs which satisfy all stakeholders (Klein & Kleinmann, 2002). Pinch and Bijker's work on SCOT and the guiding components were direct influences on the work of SCOT contributors Hans K. Klein and Daniel Lee Kleinmann. Klein and Kleinmann do critique the initial guiding components of SCOT, claiming they do not address analysis of power dynamics and the structure of systems. Therefore, they added another guiding component to SCOT framework, technological frame, to better address the structure of the system, which can help identify power dynamics as well (Klein & Kleinmann, 2002). The updated guiding components of SCOT explain how society's

perception of the pandemic have led to both naturally occurring and forced changes in the organ transplant system. While the societal perception of organ donation as a form of altruism and the societal views of the transplant system's history have been studied, there is a need for understanding how societal views sway the system's operation in a time of healthcare crisis (Batten, 1992; Fox & Swazey, 1974). Risk analysis and SCOT work together to determine the relationship between the organ transplant system as risk society generated from the pandemic and society's influence on organ transplant operations, which both result in the adaptations to organ transplant system that have occurred as the pandemic has progressed.

Motivations for the Changes in Organ Transplants Made During the COVID-19 Pandemic

The emergence of the COVID-19 pandemic presented a steep learning curve for the organ transplant system to overcome in order to continue to operate effectively and meet patients' needs. Due to the novelty of the virus, little scientific information about COVID-19 was available and organ transplant centers were reliant on anecdotal evidence as other transplant centers or other nations transplant systems experienced COVID-19's effect on organ transplantation and its stakeholders in order to better understand how to proceed. Key operations of the organ transplantation's sociotechnical systems, organ donation and transplant surgery, were adjusted at transplant centers based on both societal views of the pandemic and the risk analysis of potential system operation adjustments. The key operation adjustments of the systems: deceased donor organ donation, living donor organ donation, resource allocation and candidate prioritization, were effective in diminishing the COVID-19 pandemic's detrimental influences on organ transplantations, as they allowed the opportunity for organ transplant systems to promote the current viewpoints of society's perceptions of risks in organ transplant operations. These adjustments allowed for the sociotechnical systems to decrease the risk of

unnecessary exposure to COVID-19 infection of all stakeholders, promote the overall well-being of the healthcare system by supporting COVID-19 mitigation efforts and promoting the execution of transplantations that have the best chance for overall health success during the pandemic.

1: Organ Donation

The organ donation subsystem of the transplant system connects society's desire to contribute to the medical field, in order to extend the lives of others, with the physical ability to replace one's failing organ with an effective alternative. The transplantation field relies on organ donation in order to operate, as synthetic organs are not currently an efficient alternative. However, the start COVID-19 pandemic spurred a decrease in organ donation. This decrease, in general, reflected society's uncertainties about the impact of COVID-19 on both organ donors and recipient (Boyarsky et al., 2020). These uncertainties pertain to both living and deceased donors, though the causes for concern are different for each population, and both saw decreased rates of donation.

1.1: Deceased Donor Organ Donation

Organs from deceased donors saw significant drops in procurement rates worldwide. In Italy, one of the first few countries to experience a nation-wide outbreak of COVID-19 infection, experienced a 25% decrease in deceased donor organ procurement within the first four weeks of their COVID-19 outbreak (Angelico et al., 2020). While decreases in procurement like Italy's may be attributed to the large number of COVID-19 hospitalizations and deaths overwhelming hospital systems – leading to the inability to harvest organs from potential donors – societal factors also contributed to the decrease in deceased donor organ transplantations at the start of the pandemic. The use of organs from donors who died of COVID-19 infection was a major

concern for patients and healthcare workers alike due to the uncertainties of how COVID-19 infection spreads and how long the infection remained within one's body.

Transplant teams were concerned about the potential risk of the donor organ infecting its new recipient. The need for long-term immunosuppression in order to prevent organ rejection made transplant recipients particularly vulnerable to COVID-19 infection. Due to use of immunosuppressants, recipients T-cell immune response is suppressed, making it difficult to fight the virus (Zhu et al., 2020). If infected, medical teams have the difficult task of adjusting the recipients' immunosuppressive agents, such that the patients' immune system can fight the COVID-19 infections, while still preventing organ rejection. Similarly, transplant candidates were unsure about receiving organs from COVID-19 positive deceased donors. In a survey of transplant waitlist patients in Singapore conducted in May 2020, 71.8% of respondents did not feel that it was safe to receive an organ from a COVID-19 positive donor, due to potential donor-derived infection (Tan et al., 2020). These attitudes of patients and concerns of healthcare teams in regards to donor derived infection led to the need for transplant centers to weigh the potential risk of a patient suffering from COVID-19 infection while in a compromised immune state due receiving a transplant from an infected donor versus the risk of patients not receiving these organs and having to wait longer for their life-saving transplantation. In this case, the risk of donor-derived infection and the societal concern around it led to transplant systems advising against the use of organs from donors who died of COVID-19 (Michaels et al., 2020). While the exclusion of these organs reduced deceased organ donation rates, further limiting the supply for transplantations, this exclusion was beneficial for organ transplant system as it prevented a potential increase in infection of transplant recipients, which could have led to the further

overwhelming of hospitals and higher death tolls due to these patients compromised immune states.

1.2: Living Donor Organ Donation

While the risk of organ transplantations from a living donor currently infected with COVID-19 was clear and these transplantations were delayed until after the donor's recovery from infection, societal concerns about any living donor organ donations were present at the start of the pandemic. These concerns focused around the risk of the donation resulting in the donor contracting COVID-19. The virality of COVID-19 and the large presence of infected patients in hospitals at the start of the pandemic spurred the advisement of avoiding hospitals for non-emergency reasons. The harvesting of an organ from a living donor increased the risk of exposure to COVID-19 for a healthy person who could otherwise avoid this potential exposure (Fishman & Grossi, 2020). Additionally, the living donor recoveries from harvesting surgeries could further exacerbate the issues of hospitals being overwhelmed and decrease the number of beds available for COVID-19 or other emergency cases. These concerns led to many transplant centers suspending living donor transplantations (Boyarsky et al., 2020). These suspensions came about through the understanding that the perceived risk of unnecessarily exposing a healthy person to high-infection-risk environment for an elective surgery outweighed the risks of delaying the transplantation for the transplant candidate. While suspension of living donor transplantations also decreased the availability of organs for transplantation, its effectiveness in promoting the safety of transplant system stakeholders during the emergence of the COVID-19 pandemic was important in decreasing potential risk of exposure to the virus and preventing further spread of infection within healthcare environments.

2: Transplant Surgery

Transplantations, as a subsystem of the transplant system, is the connection point for the physical replacement of one's failing organ and the ability for the recipient to live a longer and better-quality life. With the COVID-19 pandemic causing disruptions in the general operations of healthcare systems, the societal perceptions of risks surrounding key aspects of transplantations alter the sociotechnical system's operations in order to balance addressing the COVID-19 pandemic and addressing non-COVID-19 populations who would survive if the healthcare system was functioning normally. For successful transplantation during the COVID-19 pandemic, the transplant system adaptations need to have considered financial, psychosocial, and medical factors as they adjusted their resource allocations and candidate prioritization.

2.1: Resource Allocation

Demand of hospital resources is a limiting factor for transplantations. These surgeries need blood products, clinical resources such as ICU beds and ventilators, and manpower (Halazun & Rosenblatt, 2020). However, the COVID-19 pandemic also took a toll on these same resources, especially in the first few months of the outbreak. Therefore, allocation of these resources regulated transplant rates, as the amount of organs a transplant center can accept is dependent on the amount of these resources that are available for transplant use (Ritschl et al., 2020). Determining the allocation of these resources to each hospital's COVID-19 ward and transplant center was based on the evaluation of the perceived risks of undersupplying each system. The conflicting demand for ICU resources, beds and ventilators, led to stakeholders of the transplant system to consider questions such as: "Can we as the transplant system community recommend that a donor takes priority over a live individual in need of ICU care and mechanical ventilation?" and "How can the healthcare workers care for our transplant patients while also

supporting the needs our institutions?” in order to better understand the ethical obligations the transplant system has to support hospitals in the management of COVID-19 infection (Wall et al., 2020). Additionally, since a decrease in blood donations was expected due to the pandemic, transplant systems had to consider the strain their operations could put on blood banks. However, these ethical considerations are contrasted with the consideration of how prioritizing COVID-19 hospitalizations over all others could impact the healthcare system post-pandemic. The risk of an “all-cause mortality” epidemic due to prioritization of COVID-19 cases after the pandemic faded needed to be considered during resource allocation (Halazun & Rosenblatt, 2020). However, the risk of an “all-cause mortality” was considered to be less than the risks associated with the lack of hospital resources for current COVID-19 patients. Therefore, the societal factors that promoted the choice to utilize hospital resources to prioritize saving the live individuals suffering from COVID-19 influenced the decision to reduce the number of hospital resources for transplantations.

The risk analysis of these resources led to the decision to decrease rates of transplantations so that resources could be allocated elsewhere in hospitals. The detrimental effects of taking supplies away from emergency health situations, such as COVID-19 ICU patients and emergency room patients would have vastly increased the death tolls, as compared to the effects of delaying the transplant surgeries. While decreasing transplantations did negatively impact the transplant waitlist, the promotion of resources for COVID-19 hospitalization benefitted the entirety of the healthcare system as addressing COVID-19 infection would help to slow the spread of the virus and promote the safety of all of society. However, the decrease in transplantation rate contributed to the need for reconsidering which

patients among the transplant waitlists should have priority for receiving transplants during the pandemic.

2.2 Candidate Prioritization

While the transplant waitlists have established prioritization criteria, the COVID-19 pandemic brought about additional considerations for transplant priority based on varying societal risks. One resulting advisement for transplant centers was delaying elective transplants (Michaels et al., 2020). These surgeries were deemed low priority due to both their non-emergency nature and that the majority of these surgeries utilized living donors. Societal views about emergency medical situations being of utmost priority and exposure of living donors to COVID-19 led to decision that the risks associated with delaying these surgeries were minimal.

The consideration of patients' post-operative living situations was also suggested as an advisement for transplant centers when determining the urgency of a patient's case. The requirement of immunosuppressants post-transplantation generated the societal view that recipients need a COVID-19-safe living environment for after their transplant. Delaying transplants for patients whose home-living environment cannot accommodate physical distancing or has a high risk of COVID-19 exposure should thus be considered (Wall et al., 2020). High density living situations increased the risk of the recipient contracting COVID-19, resulting in the perceived risk of severe infection and death making transplantation during the pandemic for these patients more dangerous than other patients whose living situations provided lower chances of exposure.

A final waitlist prioritization consideration that transplant centers may have implemented was the preference of candidates who had recently recovered from COVID-19 infection. Since recovered patients exhibited short-term immunity from COVID-19 after contracting the virus, a

society perceived that candidates who had recovered from infection could be ideal options as recipients of transplants during the start of pandemic, due to their immunity (Moeckli et al., 2020). Recipients would have a greater potential for fighting the virus if the transplantation exposed them to COVID-19 infection, even in their immune-suppressed state.

Societal considerations such as these helps inform transplant center decisions on how to continue transplantations in the most risk adverse manner. These considerations and how they affect the proceedings of the organ transplant, however, were advised to be openly shared with patients and caretakers, especially with those who may be considered lower priority for transplantation due these considerations. Decision-making information was viewed as important to share in order to prevent panic and misleading situations for these stakeholders, which would help promote trust in the healthcare system during the unprecedented time and would promote a patient-centric decision care model (Gori et al., 2020). The effectiveness of transplant operations is shown through how adapting patient prioritization allows for the continuation of transplants while also preventing patients from being unnecessarily placed in high-risk situations.

Limitations and Future Work

Due to there being no established national or global transplant system operation protocol, the adaptations to operations mentioned above were not applied at every transplant center, but were instead effective trends reported by individual transplant centers or guidelines published to advise centers on how to functionally adapt at the start of the COVID-19 pandemic.

Additionally, the research focuses on adaptations to the transplant system made within the first few months of the COVID-19 pandemic. During this time period, scientific information on the virus and its impacts were minimal, thus why the focus of this research was on how society's perceptions of risks related to the pandemic affected the transplant systems operations. Since

then, decision making on operations among transplant centers may have evolved as more concrete evidence of the virus and its effects became available. The increase in scientific information may have swayed decisions on operations to be based on data and statistics rather than societal views of risks that came with the emergence of the pandemic

Expanding “transplant operations during the pandemic” research to study more of the timeline of the pandemic is a future direction for this research. This expansion could reveal how transplant system decision-making evolved and how variants and vaccines potentially caused paradigm shifts within the healthcare system throughout the pandemic. This expansion could also study how the early pandemic’s adaptations and decision-making built resilience into the transplant system and prepared the system for long-term timeline of the COVID-19 pandemic.

Conclusion: The Importance of Understanding these Sociotechnical Systems

The sociotechnical systems which cause the COVID-19 pandemic to impact the organ transplant system’s operations are effective at promoting the safety of the transplant system’s stakeholders, while also helping to address the healthcare crisis caused by COVID-19. The research shows how societal perceptions of the risks associated with transplant during the pandemic led to operational changes and the impact of these changes leading to the transplant system effectively adapting to the pandemic. The explanations of how transplant centers adjusted as they did clarify how the pandemic weakened the system and in what ways these changes to the system restrengthen it in order to operate efficiently once again. These adaptations are also important to understand as they likely helped inform transplant centers on the predicted impacts of future operational changes as the pandemic evolved. Additionally, they may promote resiliency within the organ transplant system, which would better prepare the system for future healthcare crises.

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