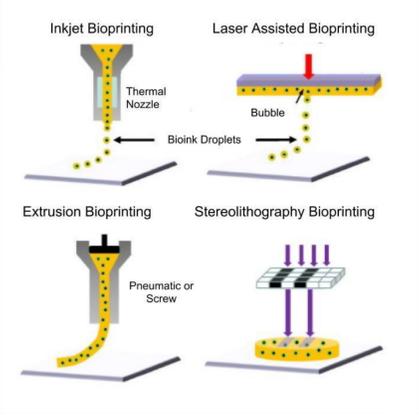
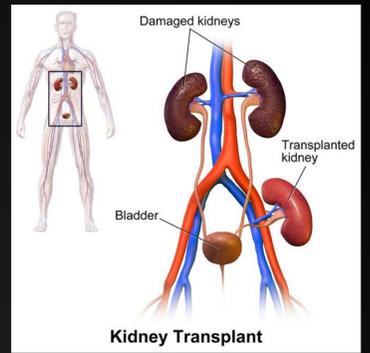


Investigating 3D Bioprinting as a Solution to the Kidney Shortage in the United States

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Abstract

Researching new technologies to address the kidney donor shortage in the United States is a critical social issue. With over one hundred thousand people living in the United States in need of an organ transplant, in 2018 only about one fifth of the people, about 20,000, received the organs they need according to the United Network for Organ Sharing (UNOS). The other 80,000 patients that remain on the donor waitlist will continue to need recurring dialysis treatment to remain alive, at a significant cost to them, the insurance industry, and society in general. In addition to the cost, the time involved for repeated dialysis treatments keeps them from being as productive as they could be in society. The ultimate goal of many bioprinting experts is to design a method to print organs in order to solve this organ crisis. Bioprinting organs would provide a safe and stable way to produce transplantable organs, and eventually eliminate the organ shortage and work towards creating a future where organs can be printed on demand, and are no longer in demand.

Annual Kidney Transplant Donation Data

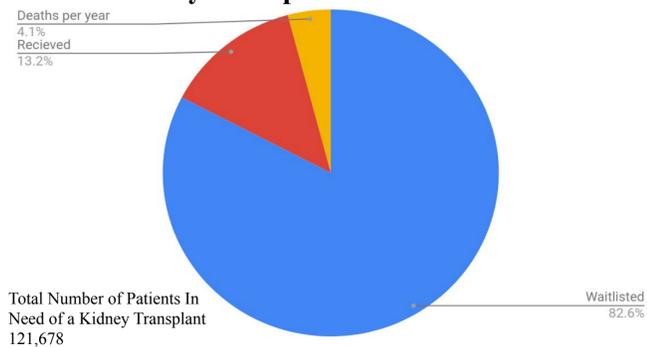


Figure 1. Annual kidney transplant donation data 2013

Bioprinting is a 3D creation technology that is already being used to construct functional human tissues, and even some living organs, with a matrix of live cells. While still in developmental stages, bioprinting has already shown its potential in regenerative medicine to create a plethora of human tissues, including skin, cartilage, and bone. In this study I analyzed the kidney shortage and how the 3D bioprinting of kidneys could be a potential solution to it.

References: UNOS. (n.d.). Retrieved from <https://unos.org> United States Renal Data System. 2012 Annual Data Report: Epidemiology of Kidney Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2012. Ozbolat, I. T., & Yu, Y. (2013). Bioprinting Toward Organ Fabrication: Challenges and Future Trends. *IEEE Transactions on Biomedical Engineering*, 60(3), 691-699. doi:10.1109/tbme.2013.2243912 National Kidney Registry. (n.d.). Living Donors. Retrieved from https://www.kidneyregistry.org/living_donors.php?cookie=1 Organ Procurement and Transplantation Network. (n.d.). Retrieved from <https://optn.transplant.hrsa.gov/data/view-data-reports/national-data/>.

(See Academic Paper)

Methodology

Data Search

- Systematic Literature Review
- Secondary Data Analysis

Article Collection

- UNOS
- PubMed
- National Kidney Registry
- Research Gate
- National Kidney Foundation
- Organ Procurement and Transplantation Network

Data Collection

- Kidney Transplant Donation Data
- Annual Types of Kidney Transplants
- Viability of Living versus Deceased Donor Kidneys
- Survival Rate of Kidneys Post Transplant

Purpose and Research Question

Purpose: The purpose of this study was to research the current kidney shortage in United States, analyze factors causing it, and investigate 3D bioprinting kidneys as a solution. The scope of this project was limited to assessing the kidney shortage in United States since the United States the highest rate of kidney disease throughout the world and more data was openly available.

Research Question: Are the current methods of providing kidneys effective and would 3D bioprinting provide a more efficient means of supplying organs to reduce the shortage in the United States?

Hypothesis

The current methods of providing kidneys to patients are not effective and 3D bioprinting will be the most effective way of providing donor kidneys to future recipients in the United States.

Results

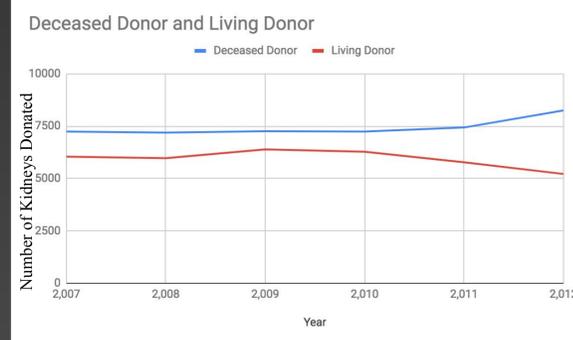


Table 1. Number of deceased kidney donors VS amount of living kidney donors from 2007-2012

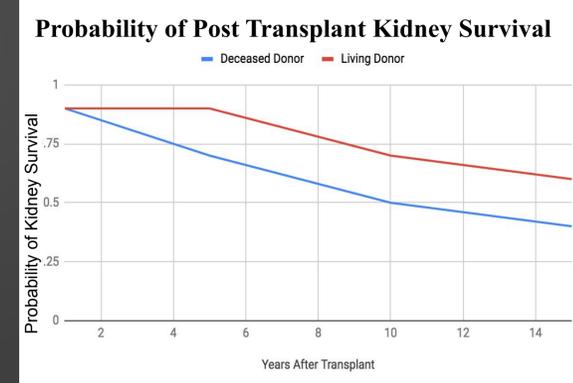


Table 2. Chance of living donor kidney surviving from one to fifteen years vs chance of deceased donor kidney surviving from one to fifteen years

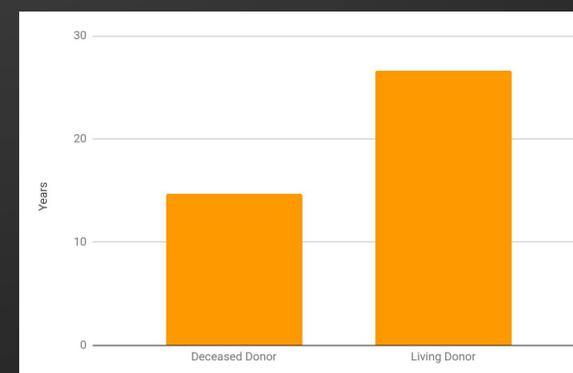


Fig. 4 Kidneys transplanted from living donors are superior because they last nearly twice as long as kidneys transplanted from deceased donors.

Conclusion

Through my research, it has become clear that the current methods of acquiring and providing kidneys to patients on waiting lists are ineffective and are not providing enough donor organs to resolve the organ crisis, in fact, waiting lists for kidneys grow each year despite more willing donors. In this study I was able to come to the conclusion that deceased donor kidneys and expanded criteria donor kidneys are not as safe or as longevitous as living as well as living bioprinted kidneys. Although 3D bioprinting technology is still a young and developing technology, in the near future it may be able to relieve the stress of the organ shortage in United States. The use of 3D bioprinting provides solutions to the two major factors causing the organ shortage, not enough living donors and grafting survivability by being alive when they are printed, and being created specifically for patients based on their specific medical needs. Overall, the current methods of providing kidneys to patients is ineffective, and in the near future 3D bioprinting may be able to take over as the primary method of providing kidneys to patients, and eventually eliminate the kidney shortage in United States.

Further Work

Further research into current uses of 3D bioprinting would provide a strong argument as to why bioprinting will be able to soon print entire organs, as well as examples for what it is currently being used for in commercial medicine. For the amount of time given, the research only allowed for the examination of the prospects of bioprinting organs and not bioprinting of other complex structures such as cartilage or artificial bone. Moreover, other possible solutions to the organ shortage such as xenotransplantation were not able to be included because of a lack of time to research that possible conclusion. Comparing the prospects of only 3D bioprinting to current methods causes there to be no other methods to compare viability in reducing waiting lists for kidneys across the United States.