

The use of 3D Bioprinting for Artificial Organs

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Three-dimensional printing, believe it or not, has the ability to save lives. When people think of three-dimensional printing, they picture it to create 3D models of small objects. These objects are usually drawn up 2-dimensionally, which brings the three-dimensional printer into play. A three-dimensional printer allows people to see all angles of an object and get a better feel of how it would look in a person. What if we told you that 3D-printing could be used to produce a living and functioning human organ? The process of organ donation is difficult. In 2017, Organdonor.gov recorded over 114,000 people who were on the waiting list for an organ transplant. Out of the 114,000 people who were in need, there was only a total of 34,770 operations performed. Currently, 20 people die each day waiting for a transplant; however, these statistics could be improved with three-dimensional printing. The three-dimensional printing of organs could reduce the waiting time for recipients and give them a fighting chance at life. There a number of people who die from waiting for an organ donation. Three-dimensional printing can provide recipients with a temporary organ, or with an organ that lasts a lifetime. The use of three-dimensional printing for artificial organs has quite a few negatives to it because it is a new idea; however, we believe with further research that it could become successful and decrease the patients waiting list substantially.

From the research we have conducted, it is clear to see that the organ donation process is lengthy. In addition to the long process, patients cannot even be promised that they will receive an organ donation. Many of these patients cross their fingers hoping for a donation to come their way. One of the great benefits of 3D-printing artificial organs is that it can cut down the wait time. The average amount of time it takes for a 3D-printer to print an object is about 30 minutes. When it comes to producing artificial organs, it could take double the time; however, who is to say the process couldn't become more quick over time? As we gain more knowledge about 3D-printing organs, the wait could be drastically decreased. The benefits of 3D-printing include providing temporary or permanent help to recipients. Should a patient choose to, he or she could use an artificial organ until they receive a natural organ. In severe cases, this is great way to give patients temporary means to live. If we took 3D-printing a step further, the organs produced could provide a permanent means of life for patients. Now, some people might wonder what the recovery process

could look like. As of this moment, there is no answer for that question because we have not tested this concept on humans. That being said, the recovery process could vary. If the organ is constructed and implemented correctly, then it should take little-to-no time for a patient to recover. If it is not constructed or implemented successfully, then the process could be longer.

As we focus on the positives of using 3D-printed artificial organs, we must also consider the negative aspects. As we stated before, this is a new concept to science and the medical field. When constructing an organ, the people who are doing the constructing must understand how the particular organ operates. They must understand what it takes to keep the organ alive and how to construct it so that the organ can function correctly. A strong vascular system and the structure of the organ are two critical ideas that must be considered. If they are not considered, then the organ could die from lack of blood supply or the structure could collapse inside the body. Thus, for a 3D bioprinter to successfully print an organ, a lot of time must be taken to scan, print, and evaluate every single artificial organ. Another negative aspect we must be aware of is the cost. 3D-printing is an expensive process; a simple 3D bioprinting system for educational purposes can cost hundreds of thousands of dollars. Professional systems that would actually print the organs used in transplants cost even more. If we were to replicate a coffee mug, the price for that would range from \$50 to \$240. The fact that a coffee mug could cost up to \$240 is ridiculous. Keeping that in mind, imagine how much a replicated organ could cost. The organ would need to be much more detailed, constructed to operate well, and scaled properly with no blemishes. The prices for these organs could be well doubled, or even tripled. These prices could discourage patients from receiving an artificial organ because they are so expensive. Much of the focus will be shifted to insurance companies to see if they will help cover some of the expenses. Possible organ failure is a negative aspect, too. While all organs have the potential to fail, artificial organs could have an even higher chance. Patients must be aware of the risk that many man-made organs have. People make mistakes and could easily make an error while constructing an organ.

Bio-printing has proven to have multiple benefits including helping society fight against organ failure and serving as a substitute for treatments. Now, the last issue that comes to 3D bioprinting regards

where we, as a society, draw the line on the ethical boundaries of producing artificial organs. The current problem with 3D bioprinting is that it is an expensive procedure that many cannot afford to pay for. Thus, the system is left being available only for the wealthy and therefore making it, "a rich man's option." So, society must introduce a plan that affords people of all economic status to be able to have the option to receive the procedure if needed. The next issue that comes to mind regards drawing an age restriction on eligibility to be a recipient of an artificial organ. As individuals get older, their organs slowly begin to deteriorate which usually leads to death by organ failure; with the creation of 3D bioprinting, older individuals have the option to replace their deteriorated organs with brand new artificial organs; Thus, there is an ethical problem of humans altering their body in ways beyond what many would consider to be humane, not to mention that only the rich could afford multiple procedures. As a result, society must decide on an age restriction that allows these people to perform artificial organ transplants at older ages without intruding on their individual rights. Lastly, individuals may use artificial organ transplants to "better" their body. There is a Russian that has used a similar process to "better" his hearing capabilities, vision, and other abilities by artificially altering his body. Similarly to performance enhancement drugs, 3D bioprinting gives people the ability to change their bodies in ways that are not natural. As a society, we need to formulate a set of standards that prohibit people from carrying out transplants that are beyond the primary purposes of 3D bioprinting: giving individuals a suitable and temporary option to an operation in order to survive.

3D bioprinting has the potential to be very beneficial for the human race. Every day people are faced with fighting organ failure. Because transplants exceeds the number of donations received, individuals are faced with an organ shortage that often leads to death. The use of 3D bioprinting can go a long way, not only in civilian life, but also the military world. The military could mass produce common organs with 3D bioprinting as an alternative for saving critically wounded soldiers by creating temporary transplants to save their lives. Our technology in the health sector is advancing at a tremendous rate, and it is only a matter of time before 3D bioprinting becomes an essential tool in saving the lives of many.

REFERENCES

Admin. (2018, April 17). Low Cost 3D Bioprinters Are Opening Up the 3D Bioprinting Market Creating New Opportunities. Retrieved from <https://www.smarttechpublishing.com/blog/low-cost-3d-bioprinters/>

Harris, W. (2013, December 17). How 3-D Bioprinting Works. Retrieved from <https://health.howstuffworks.com/medicine/modern-technology/3-d-bioprinting1.htm>