Fostering Collaboration in Healthcare: The Renaissance of 3D Printing
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Abstract:

3D printing is an innovative tool employed across medical disciplines like Occupational Therapy, Physical Therapy, and Nursing. This study is an analysis of the literature to examine collaboration between healthcare professionals and to also look at the attitude of clinicians in a collaborative environment. The project involved a collaboration between middle school students and Occupational Therapy (OT) students; during this interdisciplinary collaborative project. A survey using a Likert scale was given to the OT students. Survey questions included if they believed 3D printing was the future of OT and medicine, 27% of those surveyed scored between 5 and 7, and 59.46% of all respondents surveyed scored between 8 and 10. The next question looked at interests in learning a new program associated with 3D printing, the average score of was 5.8 out of 10. This survey indicates a positive opinion of 3D printing and demonstrated students willingness to incorporate new technology in healthcare. Nurses and OTs could potentially work together on improving quality of patient care; for example, they can use 3D printing to improve end of life services by quickly producing products that meet a patient’s healthcare needs.

Introduction:

“Three-dimensional (3D) printing is a method of fusing or depositing materials - such as plastic, metal, ceramics, and powders - to produce a 3D object” (Ventola, 2014). 3D printing has numerous industrial and medical uses including, but not limited to creating product prototypes in the manufacturing industry like motor vehicles or business machines, printing tissues and organ fabrication, creating prosthetics and implants, and pharmaceutical research in medicine (Ventola, 2014). 3D printing has been used as an education tool for students of all ages and subjects across the board. It has proven to be especially beneficial in teaching architecture, engineering, history, and medical classes. With more research, 3D printing could be incorporated into the nursing and healthcare profession to reduce workload and improve efficiency. It can also be used to produce artificial limbs, produce models for study, and create
inexpensive simulations for nursing students to be able to apply their clinically-based theoretical knowledge and gain first-hand practice in a clinical setting to be able to refine and develop new skills needed in healthcare.

The quality of healthcare practices is enhanced when there is collaboration between medical professionals and their stakeholders to improve the quality of life of all patients, regardless of their background or prior medical history. Such a team would include not only healthcare professionals, but also the patient and their family as well, thereby emphasizing a client-centered approach. When a healthcare team works together in harmonious accord, it allows the patient to receive the best treatment possible. A collaboration of this nature focuses on achieving common goals and is often used for solving complex issues that arise in healthcare settings. Collaboration between healthcare experts is a regular occurrence in the field of medicine, covering patient advocacy and health care collaboratives, collaborative learning, business collaborations, interprofessional collaboration in practice and education, health care value collaborations, and collaborative efforts in research and funding (Green & Johnson, 2015).

When it comes to healthcare, it is generally believed that collaborative efforts lead to better health services and more optimal outcomes for the recipients of said services. Littlechild and Smith (2013) state that collaboration leads to improved efficiency and responsiveness, a greater array of skills to draw upon, more holistic services, increased levels of innovation and creativity, and a more user-centered practice (Littlechild & Smith, 2013). The World Health Organization (WHO) has associated interprofessional collaboration (IPC) to better outcomes in the areas of family health, humanitarian efforts, infectious diseases, responses to epidemics, and noncommunicable diseases. Further studies have illustrated greater levels of access to healthcare, more highly-coordinated healthcare services, more appropriate uses of specialty care, more positive outcomes for patients suffering from chronic diseases, and an increased degree of safety. Collaborative care environments are also capable of decreasing the number of
health complications and error rates, the length of a patient’s hospital stay, conflicts between caregivers, staff turnover, and mortality rates, all of which are important indicators of safety, patient care, and environment of care (WHO, 2010).

According to Dodziuk (2016), 3D printing is a revolutionary type of technology, one that has brought about grand changes in the field of medicine. 3D printing has many roles in healthcare; for example, it can optimize the way in which surgeries are carried out, customize implants and prosthetics, produce medical models, fabricate tissues, organs, and medical devices, manufacture specialty surgical instruments, and facilitate pharmaceutical drug research. Additional medical applications for 3D printing include tailoring medical products, drugs, and equipment to suit a patient’s needs, increasing the productivity of medical professionals in a cost-effective fashion, and streamlining the design and manufacturing of medical products (Dodziuk, 2016).

However, there are many challenges related to 3D printing and its further use in healthcare settings. According to McDonald et al. (2016), a lack of materials, time, and access to training can restrict health professionals from printing any 3D object. While 3D printing has assisted healthcare professionals in providing cost-effective and efficient healthcare services, its viability in a clinical setting has yet to be determined (McDonald et al., 2016). Nevertheless, 3D printing can be used to not only educate medical students and nursing students, but also assist patients in everyday healthcare settings. For example, it can be used to assist patients in rehabilitation clinics, pharmacies, and hospital settings. In addition, 3D-printed objects have immediate healthcare benefits, as 3D printing can be used to repair damaged tissues, replace damaged organs, and produce prosthetics to replace lost limbs.

Aims and Hypothesis:

Aims:

1. To Investigate the Current Benefits Of 3D Printing in Healthcare
2. To Analyze the Collaboration of Healthcare Professionals in Relation to Patient-Centered Care

Hypotheses:

1. Clinicians attitude towards fostering collaboration is an important step in improving healthcare and patient’s quality of life.
2. 3D printing benefits the quality of future healthcare and forms a platform of connection and collaboration with encouraging and promoting quality patient care.

Methods:

This study consisted of two parts - a literature review and an analysis of anonymous surveys between Occupational Therapy graduate students.

Literature Review:

This study looked at several published articles relating to collaboration in medicine as well as the benefits and limitations of 3D printing in the world of health care. For this review, a total number of 3 different search engines were used - namely, PubMed, the Association for Computing Machinery Digital Library, and the Journal of Medical Imaging and Radiation Sciences. A total number of 11 articles were reviewed and summarized in this paper. The studies were chosen based on the year published. The keywords used when searching for these studies were: collaboration, health care, nursing, benefits, limitations, interprofessional collaboration, and 3D printing.

Analysis of Survey:

For this specific pilot study, Occupational Therapy graduate students partnered with middle school STEAM students to work on a 3D printing project. This study allowed for STEAM students to work on client-centered solutions for a functional problem using the 3D printers provided by the STEAM program makerspace. These students made assistive technology, orthotics, prosthetics and adaptive equipment for functional limitations. The OT graduate
students then filled out a survey describing their experience with the project which has been summarized and analyzed using excel to calculate descriptive variables.

**Results:**

**Literature Review:**

The articles elaborated that 3D printing is the future of healthcare due to being cost-effective, patient-friendly and innovative. It has become a technology that adapts to various scenarios. However, there are limitations that prevent 3D printing from being widely used in hospitals and clinics. According to Morley (2017), providers of all specializations are called together to innovate and bring about positive change. Extraordinary healthcare is furthered with interdisciplinary collaboration through shared decision making, coordination, and more detailed and accurate treatments. By functioning cooperatively, health care services become more efficient and effective in improving patient care and safety (Morley, 2017). Fostering collaboration between health professionals is a resourceful way of improving patient-centered care and quality of life. With better communication and openness to treatments, patients benefit from interprofessional collaboration.

**Analysis of Survey:**

This pilot study showed that the students found the cooperative learning experience beneficial. The summary of experiences will help design the future experience with 3D printing with or without cooperative learning model and help enhance the use of 3D printing in graduate occupational therapy education which may improve the use of a 3D printer in clinical contexts. This study helps to understand the initiation and the need for the use of innovative technology like 3D printing in clinical practice and occupational therapy education.
Fostering Collaboration in Healthcare: The Renaissance of 3D Printing

**Discussion:**

Interprofessional collaboration is beneficial in healthcare systems and improves patients care and quality of life. According to Mulvale, Embrett, and Razavi (2016), IPC is able to flourish under key decision-makers that focus on a shared vision and goal for the hospital and patient. The structure of these teams is important, and their understanding and dedication towards the collaboration make everything run smoother. With open and honest communication, teams can minimize conflict and make sure each group member has valuable contributions. It is essential for these groups to reflect and find ways to improve their care, through regularly scheduled meetings and having quality audits, they can grow and learn from each other (Mulvale, Embrett, & Razavi, 2016). Collaboration is key for effective use of a 3D printer because a team is needed to work the printer and be able to design intricate prototypes. However, there are limitations related to 3D printing; Baskaran, Štrkalj, M. Štrkalj, and Di leva present those limitations in the 2016 study. There is a limited amount of materials to choose from for additive fabrication, which limits the color and product durability. The layering processes can jeopardize the surface finish and also create difficulties for the creation of a working machine, where specific parts work together to achieve a distinct function. The size of the objects developed is restricted by the size of the printer used, which can, in turn, hinder large structures from being produced (Rengier et al., 2010). Cost can be viewed as a limitation since rapid prototyping machines can cost
hundreds to thousands of dollars, and not even including the cost of resin and plastic-based materials (Berman, 2012). The final product requires a relatively long time to produce, with estimates in the hours or days depending on the type of 3D printer used and the intricacy of the actual product (Berman, 2012); which can be justified for one of a kind and demanding applications but would not be useful in common scenarios or emergency cases (Rengier et al., 2010). However, through further research, there is a considerable probability that new developments will comprise of a wider range of materials that will make more durable and realistic products. To achieve greater strength and durability in these products, improvements need to be made in the layering process including fusion of substrate materials (Berman, 2012). It is also possible that the cost and speed of these printers will improve, which will increase the usability of 3D printers in different fields (Berman, 2012). 3D printing has the potential to continue to revolutionize the anatomical and surgical sciences to further benefit educators, surgeons, and patients (Baskaran, Štrkalj, M. Štrkalj, & Di Ieva, 2016). Although there are notable and relevant limitations with 3D printing, the benefits it provides in a variety of healthcare settings outweigh it.

There were limitations to the study and survey performed on the OT and middle school students. For example, the survey itself was limited to the OT students, and the middle schoolers did not get a say in the experience, and since it was just OT students that participated, it is hard to transcribe it into other healthcare professional collaborations. The study was done only once and was restricted to a certain skill set of students. It can be seen that 3D printing is a groundbreaking technology that can be applied to various health disciplines and improve patient quality of care. Collaboration also benefits patient’s quality of care as well as strengthens medical professionals’ views and teaches them the importance of working together. This study enhances the benefits and limitations of 3D printing and collaboration, and with further research done, it can be seen that both of these are potential benefits for patients and hospitals alike.
References


