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Cardiology Additive Manufacturing Implementation Challenges and Opportunities: A Qualitative Study

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Introduction

Additive manufacturing (AM), also known as 3D printing, creates objects from 3D model data by adding layers of material, in contrast to subtractive manufacturing technologies, which remove material. To put it another way, AM adds material layer by layer rather than removing matter. AM was initially developed for the rapid production of prototypes. AM is currently regarded as a crucial technology for humanity's future. Preoperative planning, instruction, and device development are the primary applications of AM in cardiology. Likewise, tissue designing is a promising region in AM, containing research on veins, complex vascular organizations, and the tissue vascularization, including procedures to create 3D-bioprinted vascular conductors that can fill in the patient's body [1].

Description

Even though AM has the potential to be a useful tool in medical education and clinical practice, there are obstacles to its implementation. Vukicevic and others recognized a few troubles related with utilizing 3D-printed inserts connected with the material's cardiovascular properties. Found that standardized care is less expensive than 3D-printed applications in cardiology. Luo and others also found that 3D printing could be used to improve preoperative planning; however, 3D printing technology and solutions are still experimental. Acknowledged the need for additional research into the materials, such as a 3D-printed heart. As a result, existing research has identified a set of obstacles to the implementation of AM in cardiology, most of which are related to technology and economics. As the factors (i.e., barriers and facilitators) that frequently influence implementation also encompass factors related to patients, healthcare professionals, and organizations, these two factors may not provide a complete picture [2].

A Swedish qualitative multiple case studies serve as the foundation for this investigation. There were three reasons Sweden was chosen. First, Sweden invested approximately 16 billion USD in research and development in 2017, or 3.4% of its GDP. Second, there are numerous medical technology (medtech) businesses in Sweden. Sweden had approximately 640 medtech companies in 2016, employing approximately 250,000 people. Thirdly, Sweden's healthcare system is publicly funded and of high quality. Sweden succeeds in a few markers for excellent consideration, including a future (82.5 years) more prominent than other OECD nations (80.7 years). These three factors suggest that Sweden has a cutting-edge healthcare system that provides high-quality care. This suggests that the healthcare system is likely to adopt new innovations like AM in cardiology. Sweden is a good location to investigate the application of AM in cardiology because the field is still in its infancy [3].

Based on our previous knowledge of their cardiac surgery departments and whether or not they had implemented AM in cardiology, two university hospitals in Sweden were chosen out of seven that were possible. This choice was made on the grounds that we needed to concentrate on both fruitful and not yet effective execution instances of new innovation. We chose university hospitals because they appear to be more likely than non-university hospitals to use 3D printing in healthcare [4].

Concerning the innovation, four barriers and zero facilitators were identified. AM major in cardiology According to respondents from both hospitals, clinical evidence is required for implementation, so its absence would be a barrier. Interestingly, they did not specifically consider whether cardiology had clinical evidence for AM. Respondents from the two clinics thought about that one significant hindrance to execution was the absence of reasonable material, for example, material like a vessel wall. Hospital A respondents perceived some shortcomings in the printing method and, in general, had difficulty identifying major applications for the technology [5].

Regarding healthcare professionals, four facilitators and three barriers were identified. The fact that respondents from Hospital A were not exposed to the technology made it difficult to implement. Due to the fact that their education and prior experience were in 2D printing, respondents from Hospital A were also concerned about the skills needed to work with the technology. The respondents from both hospitals thought that the technology could be used to better explain surgery to patients and help with preoperative planning. According to respondents from Hospital B, the fact that the technology and solution are based on the requirements of physicians is a significant obstacle to implementation [1].

We sought to answer two research questions by examining the implementation of AM in cardiology in two Swedish cardiac surgery departments: In cardiology, what are the advantages and disadvantages of implementing AM? In addition, what are the advantages and disadvantages of implementing AM in cardiology that distinguish implementers from non-implementers? Beneath, we will examine our discoveries considering existing exploration and answer the examination questions. Lack of suitable material, deficiencies in existing technolog, and a lack of clinical evidence for the technology are all identified in recent reviews on the adoption of AM in cardiology as significant barriers to adoption. Our findings are consistent with those of these reviews regarding the characteristics of innovation [2].

In addition to AM in cardiology, prior research on AM implementation in healthcare and other industries has focused a lot on technology-related issues. Limited availability of bioink, poor material properties of bioink required to enable functions such as vascularization, a lack of design tools and guidelines for AM, poor image visualization, and low technological maturity are among the technological and material barriers that have been identified. According to our findings, implementation may be hindered by a lack of appropriate materials and design tools—both of which may be indicators of low technological maturity. According to previous studies on the use of AM in cardiology, its implementation is also associated with increased costs. In routine cardiac care, for instance, AM applications are more expensive than CT or MRI, which typically provide sufficient imaging [3].

Our findings demonstrate that investing in new technology is perceived to entail an additional cost rather than focusing on the high cost of AM in cardiology as a barrier. Our findings, on the other hand, suggest that AM in cardiology could cut costs. Additionally, the improvement of presurgical planning, for instance, has been shown to improve AM's cost-effectiveness in complex cases like congenital heart diseases. High investment costs were found to be the most common barrier to organizational adoption of AM in a recent review. Several factors related to innovation, healthcare professionals, professional interactions, patients, incentives, resources, and capacity for organizational change were identified in recent systematic reviews on the adoption of digital technology in cardiology [4].

No specific factors related to "social, political, and legal factors" were identified. Shockingly, no tolerant related viewpoints were referenced by our respondents. This could, however, be due to the fact that AM in cardiology is

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a completely different kind of innovation than digital health technology. Digital health technology is used, for instance, to remotely monitor blood pressure, where difficult-to-use technology could be a significant barrier. A better way for a patient to visualize their surgical treatment and better preoperative planning could be made possible by AM in cardiology, on the other hand. However, the patient would not be involved in the use of AM in these instances [5].

Conclusion

AM implementation in cardiology may be affected by a number of facilitators and barriers. The most significant types of facilitators are healthcare professionals, while the most significant types of barriers are innovation factors. The low level of implementation in the other hospital may be due to unique differences in barriers between the two hospitals under investigation. When attempting to support the implementation of AM in hospitals where utilization is still low, it may be necessary to address these obstacles.

Our investigation has some limitations. First, we looked at two cases from the same nation. It is impossible to claim that this small number of cases from one nation represent all cardiology surgery departments in Sweden. Nevertheless, the included hospitals represent two university hospitals, so the findings provide a comprehensive overview of the challenges and opportunities facing university hospital care in a single nation. More quantitative studies focusing on Sweden are required to investigate and validate our qualitative findings. Furthermore, we assumed that university hospitals would be more interested in implementing AM in cardiology when conducting our research. This means that the findings must be investigated in non-university hospitals in order to verify their applicability in non-university hospitals.

Acknowledgement

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Conflicts of Interest

None.

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