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Abstract: 3D printing has been one of the recent buzzwords, along with Machine learning and AI. The combination of these three provides a great deal of improvisation in health education and healthcare management techniques. This paper studies various implementations of 3D printing solutions. Shortly, AI combined with 3D printing would revolutionize the healthcare industry in most areas, not just limited to human implants, pharmaceuticals, tissue engineering/regenerative medicine, education, and other evidence-based decision support systems. 3D printing is a manufacturing method in which objects are made by fusion or depositing materials such as plastic, metals, ceramics, powder, liquids, or even living cells in layers to produce a desired 3D-Object.

Keywords: 3D printing, AI, 3D imaging, Surgery planning, Healthcare Education, Pharmaceuticals, 3D rendering

1. Background & Introduction

Three-dimensional (3D) printing has elevated healthcare delivery due to its ability to customize medical products [1]. By the year 2030, the healthcare market size for 3D printing is expected to reach $5,846.74 million [2]. 3D printing uses the additive manufacturing technique of composing layers to create an object using 3D model data that relies on “computer-aided design” CAD [3]. For medical student and Newley-recruited resident, 3D printing play a major role in the learning process by accurately predicting the anatomy before the surgery [4].

This review aims to present brief insights into the applications and challenges of 3D printing in the medical field.

Data is only a provision within the data science domain, and data science actually is about the way of thinking about your data. Hypothesis based thinking in data science is the key methodology that needs to be followed in order to guarantee success.
2. Materials and Methods

Medical databases (MEDLINE, Google Scholar, and PubMed) were searched to select published articles using the following terms: 3D printing in healthcare and 3d printing machine learning, artificial intelligence, tissue regeneration, tissue engineering, 3d printing in pharmaceuticals, and computer-aided 3D drawing systems. The resulting studies were reviewed for 3D printing trends and applications, and once the review was complete, the authors set an implication and recommendation for 3D printing and its application in healthcare practice.

3. Applications of 3D Printing in Healthcare:

In a healthcare setup, a data scientist typically needs to address or carry out the functions such as data management, general statistics, biostatistics, feature selection, hypothesis design, data visualization, problem-solving, machine learning, and AI. Further, we would define the required skill set for each function.

3.1 Surgical Planning

3D printing technology is becoming increasingly popular in the surgical setting, as it offers a number of potential advantages. For instance, 3D printing could be used to create/prototype model organs and structures, which can lead to shorter surgery times, lower costs, and improved patient outcomes [5].

3.2 Implants and Prosthetics

One of the most exciting potential applications of 3D printing technology is the ability to create custom implants and prosthetics. As patients would no longer have to undergo lengthy and expensive procedures while achieving a better outcome. It has been used to create a variety of different implants and prosthetics, including hip replacements, knee replacements, dental implants, and cardiovascular implants [6].

3.3 Pharmaceuticals

3D printing can be used to create medicines that are specific to a patient's therapeutic requirements. The concept has been beneficial for all parties (patients, pharmacists, and the pharmaceutical industry) by allowing the potential for personalized dosages, shapes, sizes, drug release and multi-drug combinations [7].

3.4 Patient Education

3D printing in medicine was used by surgeons to help create 3D models of their patients for a better understanding of their anatomy, particularly in the case of patients with certain malformations or structures who required challenging surgery [8].
3.5 Regenerative Medicine and Tissue Engineering

Organ transplant is another area of interest when it comes to 3D printing, due to the acute shortage of available human organs opens a new window for therapies based on regenerative medicine and tissue engineering, where 3D printing can potentially help in regenerating cellular tissues / Organs.

4. Challenges

3D printing has many challenges despite the enormous advantages it offers the pharmaceutical industry. They mainly concern technology, dosage production, safety, quality control, resolution, and their application in clinical pharmacy.

4.1 Technology

Drug-excipient compatibility is a significant issue that needs to be resolved. Additionally, the finished product could have structural and surface flaws that need to be corrected by adjusting certain manufacturing parameters [9].

4.2 Materials

The main issue with 3D printing in medicine is the lack of readily available biodegradable, biocompatible, and physically and chemically stable materials. The availability of suitable materials for the production of desired dosage forms that should be compatible with 3D printing technology may also be a problem [10].

4.3 Resolution of 3D printers

While rapid prototyping and solid Fused Filament Fabrication (FFF) can generate excellent detail with 3D technology, printing medicines using it still has a limited resolution. High-resolution equipment should be created for precision dosage form development and smooth finishing [9].

4.4 Safety

Safety issues must also be taken into account. Some materials can cause skin or respiratory irritation when heated, extruded, or fused, there is a chance that harmful airborne matter will be released. As a result, sufficient safety precautions must be taken, and standard operating procedures must be followed to reduce the risk of exposure [11].

4.5 Regulatory Aspects

Another significant barrier to using 3D printing to manufacture pharmaceutical products is the lack of a regulatory framework. Furthermore, it is unclear whether the regulatory approval will apply only to the finished product or to a set of requirements which will apply to all components and stages of a product's design and manufacturing [9].
5. Conclusions

The main goal of 3D printing is to enhance healthcare using various innovative approaches and improve the learning processes for medical practitioners. Overall, the applications of 3D printing in healthcare can be broadly categorized as surgical/implants, pharmaceutical, Regenerative Medicine / Tissue Engineering, evidence-based decision-making, and medical education. Applying this type of technology has its own challenges in terms of available materials and it raises some concerns regarding safety and its governance.

References