3D-printing Technology for Resource-limited Setting: Personalized Patient Care Accessories & Training Modules

Corner for Healthcare Innovations

Objectives

-The objectives of using 3D-printing technology for personalized patient care accessories and training modules in resource-limited settings are as follows:

- To create patient-specific medical instruments such as prostheses, orthotics, and dental appliances at low cost and lower lead times compared to traditional manufacturing methods.
- To create realistic models of medical anatomy for training healthcare providers on common medical procedures, helping them become more proficient despite the lack of adequate resources and specialized equipment.
- To provide access to medical equipment and educational resources normally not available in resource-limited settings or are expensive to purchase by academic institutions
- To reduce the risk of infection with 3D-printed products that can be sterilized and reused also potential solutions for implants
- To bridge the gap in the quality of care available in resource-limited settings regarding care and education

3D Printing in Medicine

3D printing technology is revolutionizing the medical device industry, allowing for low-cost customization and rapid prototyping. 3D-printed medical devices include braces and prosthetics, orthotic and fracture implants, tissue models, and surgical instruments. Even implantable medical devices such as stents and artificial organs are being 3D printed. The process is cost-efficient, allows for rapid iterations in design, and can be used to produce complex structures that would otherwise be impossible to manufacture. It also reduces the risk of infection, as no manual labor is required for assembly. 3D printing is helping to make medical care more accessible and affordable for everyone.

Fig 1. 3D printer (PRUSA i3 MK3 by Josef Prusa)

3D Printing in Healthcare Services for Resource-limited Settings

3D printing has the potential to revolutionize healthcare services in resource-limited settings. In these areas, access to medical supplies is limited and costly. 3D printing offers a cost-effective solution, by allowing for the creation of custom medical tools and devices that fit the exact need. Moreover, 3D printing can enable the on-demand manufacturing of medical devices, eliminating the need to store physical items. In addition, 3D-printed devices can be sterile and long-lasting. They can also help to reduce the time and cost associated with rapidly changing medical needs. 3D printing could be a major leap forward in advancing healthcare services for people in resource-limited settings around the world.

3D-printing technology can be used to create personalized patient care accessories and training modules in resource-limited settings. This technology can be used to quickly and cheaply generate patient-specific medical instruments, such as prostheses, orthotics, and dental appliances (sometimes implants). 3D printing can also be used to create realistic models of medical anatomy for training healthcare providers on common medical procedures. This technology could give resource-limited healthcare workers access to medical equipment and educational resources that may otherwise not be available to them. 3D-printing technology has the potential to revolutionize healthcare in resource-limited settings and help bridge the gap in the quality of care in environments like Ethiopia.

3D Printing Materials for Resource-limited Settings

There are a variety of 3D printing materials available for use in resource-limited settings. Examples include PLA, polyurethane, ABS, PETG, Nylon, and PCL.

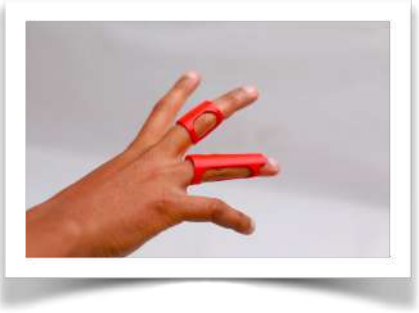
PLA is the most common material used in 3D printing, as it is economical and provides good strength and rigidity. Polyurethane is flexible and can be used to create shock-absorbing materials. ABS is used in combination with other materials to create durable products. PETG is an environmentally-friendly alternative to traditional plastics. Nylon is an excellent choice for strength and durability. Finally, PCL is a biodegradable and eco-friendly material used for medical applications. These materials are all suited for 3D printing in resource-limited settings, allowing for the customization of medical devices and training modules to meet the specific needs of these environments.
NB: Currently, there are attempts to also build 3D printing materials from plastic water bottles as a cause for recycling and sustainability.

Examples of 3D Printing Medical Devices for Resource-limited Settings

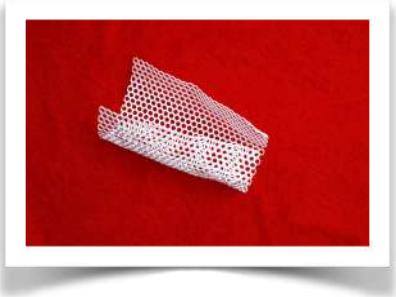
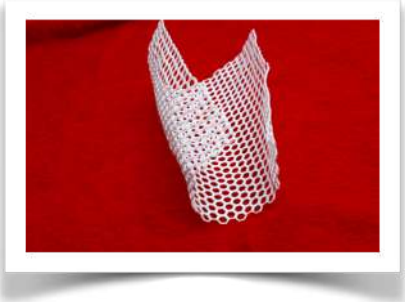
3D printing is enabling the production of affordable and customized medical devices in resource-limited settings, improving healthcare access and outcomes for those in need. Here is a list of 3D-printed medical devices that are suitable for use in resource-limited settings like Ethiopia:

- Prostheses and Orthotics





- Meshes and Lightweight stents

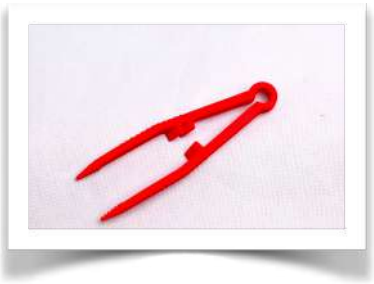




- Dental appliances and academic models for educational purposes (models to show medical students and patients how to brush their teeth): lower mandible, left hemisphere of the brain


- Medical equipment which is not adequately available in resource-limited setups




- Surgical instruments (OR light handles)



- Implants (for cranioplasty)
- Custom-fit patient-specific products (Mechanical Insulin Cooling system)

- Maternity medical equipment (for OBGYN): menstrual cup, fetoscope, umbilical cord clamp

- Nursing care assistant medical devices: pill popper, pill crusher, pill spliter

- Others: manufactured out of scarcity of resources or complication for easy purchase: Pill crusher, Oxygen tube splitter/divider (to share a single oxygen source like a cylinder for 2 patients)

In conclusion, 3D printing has the potential to be a game-changer for resource-limited healthcare systems in Ethiopia and beyond. However, for this potential to be realized, 3D printing must be adequately developed, generated, and made available in a cost-effective and efficient manner. Top-down strategies are necessary to ensure that materials, hardware, and software are in place. Bottom-up initiatives can foster the actual printing of medical devices and other healthcare resources by developing local fabrication hubs, pursuing partnerships, and implementing education and training programs for these purposes. Ultimately, a collaboration between policymakers and healthcare organizations can help ensure that 3D printing technology is used as effectively and efficiently as possible in the Ethiopian context. CHi envisions being part of the change with you.