

Project Title

3D-Printed Universal Adaptive Holder for Differently abled People

Project Lead and Members

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Project members: Chung Kai Siang and Wilson Chin Wei Sheng

Organisation(s) Involved

Tan Tock Seng Hospital

Project Period

Start date: 01 July 2021

Completed date: 30 June 2023

Aims

- 1) Create a new 3D-printed adaptive device that can help improve availability for clinical use, accommodate to many disabilities and weaknesses, while ensuring affordability and maximal usability for patients:
 - Can be used with utensils and other personal daily items
 - Can be semi-customized by adjusting the 3D print template file.
 - Can be easily cleaned and made of sustainable material (reduced rate of wear and tear).
- 2) Obtain positive usability feedback on the innovated 3D-printed device and produce in scale for use.

Background

Adaptive devices are commonly prescribed by therapists to facilitate activities of daily living (ADL) and to maintain independence in individuals with physical impairments. There is an extensive range of adaptive devices available to individuals with impairments, ranging from low-cost devices to customised high-tech devices such as ADL equipment, communication devices, transfer devices, mobility devices, orthoses,

and environmental control units (ECU). There is a wide range of ADL equipment available in the market, such as feeding devices, adapted utensils, adapted dressing kit, shower chairs, and toileting items.

There are various kinds of adaptive device for feeding and grooming available in the market. However, there are several limitations to existing products:

- Limited models available in local context/ from local vendors; these have to be ordered from overseas manufacturers at high cost.
- Lack of flexibility to modify to client's needs.
- Lack of accommodation to different kinds of disabilities and weaknesses.
- Not interchangeable/ limited fitting with different types of utensils/ personal items.

Methods

1. Prototype iteration using 3D printing technology and it can be semi-customizable by adjusting the 3D files (electronic files that represent objects in three-dimensional created by Computer Aided Design programmes) to meet individualized needs. Special features of the innovation:
 - a) Multi-purpose use, it has an attachment that can hold various utensils, personal grooming items, handwriting tools and other daily use items that can fit in the device.
 - b) Has a quick release ball joint that has lock and unlock system, to allow changes of angle for the circular and horizontal motions, to reach to desired part of the body (for example: direct utensil/ toothbrush-to-mouth, comb-to-hair).
 - c) Has an enlarged handle with ergonomic adjustable strap to match different hand sizes and promote independency in wearing the device.
2. DSRB approved usability test to evaluate the design concept of the iterated universal holder prototype, and to determine the usability and functionality of the prototype, in assisting individuals with impaired upper limb impairments in self-care activities, specifically feeding and grooming tasks in the study. Prototype improvement and refinement based on the outcome of usability test.
3. 3D-printing of prototypes with internal and external 3D printing services

Results

1) Usability Testing started after DRSB approval obtained in March 2022 and completed in March 2023.

- Aim of the usability testing:
 - Understand the usability and function of prototype in aiding users to perform feeding and grooming tasks.
 - Gather user's feedback on design of prototype.
 - Identify features of design which are useful to users for further refinement and improvement of device.
 - Understand the needs and challenges of individuals faced when conducting self-care tasks and their own existing solutions/devices.
- Collated outcomes:
 - 10 out of 12 (83.3%) participants considered standard kit as Excellent/ Good in terms of user friendliness. 9 out of 12 (75%) participants considered advance kit as Excellent/ Good in terms of user friendliness.
 - 9 out of 12 (75%) participants feel more independent after using it.
 - 11 out of 12 (91.6%) participants prefer using it with the strap.
 - 4 out of 12 (33.3%) participants prefer using both standard and advanced kit; 3 (25%) of the participants prefer using advanced kit only, and 5(41.7%) participants prefer using standard kit only.
 - 8 out of 12 (66.7%) participants stated they will use it in the public.
 - The top 3 aspects of an adaptive aid that the enrolled users considered to be the most important: weight, ease of use and effectiveness.

2) Modification and refinement in the design features done after the team weighed between the collated data and team's prioritization of the design:

- the weight of the prototype: modified the handle design and the 3D material filling of the handle while maintaining the durability and function.
- ease of use and effectiveness: refined the design of the twist cap (smoothen the edge to enhance independence in using the feature) and the adjustment method of the handle strap.

Lessons Learnt

1. Collaborative decision making among team members, for the design refinement
 - Before moving forward with the project's progress, it is important to constantly review the project's goals, objectives and milestones, in order to ensure agreement and acknowledgement among team members.
 - After review, proceeding to design changes would be a clearer and smoother process. Design refinements happen when the needs and principles of the project are listed out and if the previous designs do not meet those principles

and needs. Refinements were made with engineering, design and user experiences in mind.

- Collaborative decision needed to determine which features of prototype to be revised not only based on users' feedback, but also clinical and engineering expertise, weighing the pros and cons, without compromising the overall intended functionality of the device.
2. Engagement with 3D printing services/ vendors
- In order to retain a long-term working relationship between the project team and vendor, communications between both parties have to be clear, including relaying project's objectives and milestones.
 - Evaluate available 3D printing services and engagement of other 3D printing service/ in-house service that allows long term collaboration if the device to be prescribed in the clinical setting.

Conclusion

Our results gathered from the usability test suggested the potential of this innovative 3D-printed adaptive holder to assist individuals with upper limb impairments in daily living activities.

Final 40 sets (20 standard and 20 advanced kits) with the improved features are printed out by TTSH Medical 3D Printing Centre, which the team will be using the final prints in OT dept inpatient and outpatient, to collate further data on proof of value and ensure usability to targeted population.

Additional Information

This project is funded by the Centre for Allied Health & Pharmacy Excellence (CAPE).

Project Category

Technology, Prototyping Resources

Keywords

Innovation, Usability Test, 3D printing

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Pictures Documentation

Initial



Standard Kit



Advanced Kit

Iterated Prototypes used in DSRB approved Usability test



Standard Kit



Advanced Kit



Strap and handle (indicator for palm placement)



Advanced kit locking mechanism

Final Prototypes



Revised prototype with 2 different diameters of handle



Revised twist cap design



Revised strap and its adjustment