2018 MSIWF GRANT: REPORT OF RESEARCH RESULTS

Title: Developing an automatic beverage thickening device for elderly with swallowing impairment

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Summary:

One of the most common ways for elderly with swallowing impairment to hydrate safely is to modify the thickness of their liquid beverages based on recommendations by the speech therapist. As pre-packaged, ready-to-drink thickened beverages are unavailable in many parts of the world, thickened beverages are prepared by measuring and mixing thickener with liquid by hand. This research aimed to identify the barriers faced by healthcare workers, caregivers and patients in this process. These would contribute to the development of an automated thickening system to address issues with thickening by hand.

Users were unsatisfied with the time needed to hand-thicken beverages, subjective and inaccurate judgment of liquid thickness, incorrect steps taken to thicken liquids and issues with the final product (e.g. lumps).

A simple prototype was created to address the issue of subjectivity in evaluating liquid thickness by testing the parameters associated with different liquid thickness categories. This would allow objective and automatic categorization of liquid thickness for the end-user, as well as verification that the final thickened mixture is of the correct thickness for safe consumption.

Aims of Research

1. Determine the difficulties faced by nurses, patients, caregivers and speech therapists in thickening liquids accurately.

2. Develop a prototype of an automated drinks thickening device to address the difficulties identified in Aim 1.

Method of Research & Progression

To address Aim 1, nurses, speech therapists, patients and caregivers were interviewed and surveyed in the following areas: Thickening frequency and practices; training received by nurses, patients and caregivers or conducted by speech therapists; problems encountered in thickened liquids by hand; and desired functions if a thickening device was available to replace thickening by hand. Ethics approval for data collection was obtained in May 2019 (CIRB 2019/2393, "Barriers and solutions to thickening liquids accurately for patients with dysphagia").

Data were collected from 29 participants (16 nurses, 6 speech therapists, 7 patients or caregivers) between May and October 2019. Descriptive statistics and content analysis were used to analyse survey and interview responses respectively. The survey development procedures and findings for the patient and caregiver group were analysed and submitted as an honours thesis in November 2019 by Ms Maria Chuah, a final year student in the Bachelor of Speech Pathology (Honours) programme at the University of Newcastle in Australia.

To address Aim 2, the research team received support from the SingHealth Medical Technology Office to conceptualise the components that would serve the following key functions for a simple prototype: 1. Measure and categorize liquid thickness according to the 5 categories specified by the International Dysphagia Diet Standardization Initiative (IDDSI) (thin, slightly thick, mildly thick, moderately thick, and extremely thick), and 2. Mix thickener with liquid to form a thickened product. After evaluating 3 companies to pitch this idea, a research collaboration agreement was signed between Singapore General Hospital and Akribis Systems Pte Ltd (Akribis) in January 2020. Akribis created an experimental set-up for proof of concept testing for the measurement of different liquid thickness. The components of this set-up form the basis of the current prototype.

Results of Research

<u>Challenges experienced by users:</u>

1. ***Preparing thickened liquids by hand is time-consuming***
    - Although only 31 % of nurses reported that thickening liquids involved many steps, 63 % found the whole process too time consuming.

- 100% of the speech therapists interviewed reported the same when considering that nurses and caregivers have other care duties besides preparing thickened drinks for the patient.
- Caregivers and nurses reported taking between 1 to 10 minutes to prepare a cup of thickened liquid.

2. ***Inaccuracies arising from hand-thickening: inaccurate thickening steps, inaccurate perception of thickness, lumps in the mixture***
    - 81 % of nurses surveyed found it hard to achieve the correct thickness unless they accurately measured liquid volume and thickener amount. The same proportion of nurses also reported difficulty in achieving accurate thickening when mixing thickener with warm liquids.
    - Interviews with patients and caregivers revealed inaccurate practices at home. 43 % of them did not consistently measure liquid volume although they would add the correct amount of powdered thickener. Patients and caregivers also assumed some beverages (e.g. soups, coffee with milk) were already thick enough without needing to further thicken. Some used unsafe methods of testing, for instance, whether the patient coughed after drinking as an indication of whether the thickened fluid was of the correct consistency. There was also the incorrect perception that adding protein or milk powder would achieve the same thickening effect as starch or gum-based thickeners meant for the management of swallowing impairment.
    - 75% of nurses and 43 % of patients or caregivers reported problems with lumps in the thickened liquids.
    - Similarly, 50 % of speech therapists often experienced issues raised by nurses and caregivers regarding lumps and inaccurate thickness.

3. ***Regression of skills in thickening liquids after training***
    - Speech therapists were confident of nurses' and caregivers' ability to thicken accurately immediately after training with modelling and return demonstration, but 83 % of them were not confident that caregivers could remember to do the same after the training session.

<u>Desired features of a thickening device:</u>

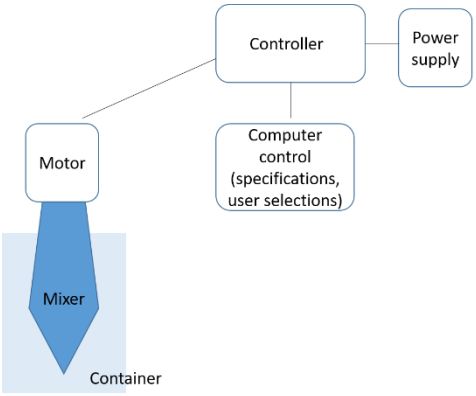
Nurses, caregivers and speech therapists would like the device to be able to:

- Dispense the correct amount of thickener and liquid for the required thickness.
- Measure thickness and confirm that the desired thickness has been achieved before serving the drink to the patient.
- Cater to a variety of beverages and liquid temperatures.

- Eliminate lumps in the final product.
- Nurses and caregivers have reported that a device will save them time while they carry out other duties as the liquid is thickening automatically.

Pilot proof of concept testing

Through the research collaboration with Akribis Systems Pte Ltd, the project team together with SingHealth Medical Technology Office has created a simple prototype consisting of the following components:



This prototype enabled the testing of parameters associated with different liquid thickness categories (thin, slightly thick, mildly thick, moderately thick, extremely thick) specified by the International Dysphagia Diet Standardization Initiative (IDDSI). This would allow objective and automatic categorization of liquid thickness for the end-user.

Future Areas to Take Note of, and Going Forward

The next level of funding to continue developing the thickening device has been awarded to the same project team (Principal Investigator: Wong Seng Mun), amounting to $100,000, by the SingHealth Duke-NUS Academic Medicine & NHIC Joint MedTech Grant. This will fund further experiments to focus on the design of the mixing stirrer to prevent lumps during mixing, and to create several iterations of the prototype that can be tested by users in clinical settings.

Means of Official Announcement of Research Results

Results of the proof-of-concept testing will be submitted for journal publication.