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Introducing the v-RFA, a voice assistant-based geriatric assessment

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1. Introduction

A well-established tool for assessing fitness in older adults with cancer is geriatric assessment (GA) [1]. We developed a web-based electronic Rapid Fitness Assessment (eRFA) [1,2] to assess preoperative fitness. While 90% of our patients expressed a strong preference for completing the eRFA instead of the paper-based GA, approximately 50% of them used some degree of assistance to complete the eRFA. Not surprisingly, our preliminary data shows that frailer patients used more assistance. This finding is important as non-completion of GA tools such as the eRFA may result in undiagnosed or undertreated frailty, which would have a negative impact on outcomes.

A possible solution for frail patients' non-completion of the web-based GA without assistance is to develop and test novel methods of delivering the GA, for instance, using voice assistants (e.g., Amazon's Alexa, Google's Assistant, or Apple's Siri), which have become widely used over the past five years [3]. Voice assistants may be easier to use because they respond to natural human speech. Some argue that their ease-of-use makes them inherently more inclusive of digitally low-literate people [4,5]. They have also become ubiquitous, as they exist in many devices that connect to the Internet, including smart speakers and cell phones. It is estimated that, by 2024, more than eight billion voice assistant devices will be in use globally [6]. Abdi et al. [7] specifically cite voice assistants as one of eight emerging technologies that could potentially be used to meet older people's needs in various care and support domains.

In this manuscript, we describe our development of a new version of the eRFA, a voice-based Rapid Fitness Assessment (v-RFA). We also share initial feedback from healthcare providers who interacted with the v-RFA.

2. Materials and methods

2.1. Development of the vRFA

A timeline and description of our development process is included in the supplementary material.

2.2. Participants

We recruited ten care providers (seven women and three men) to try the v-RFA. Participants (who were colleagues of the last author) volunteered to participate in response to an email requesting feedback on our project. Two participants were registered nurses, two were nurse practitioners, and six were doctors. Five participants specialized in geriatric oncology, two in geriatric medicine, two in colorectal surgery, and one in hematology.

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2.3. System

The v-RFA can be installed in the Amazon Alexa devices of end users, much like apps are downloaded on smartphones. End users can then report health data after opening the v-RFA voice app by saying, “Alexa, open My Care Questionnaire.” The v-RFA begins by asking seven activities for daily living (ADLs) questions. After each short section, the v-RFA offers to continue the survey later. After responding to the ADL questions, if users ask to continue, the v-RFA will go on with questions about the instrumental ADLs (iADLs). Otherwise, their responses will be saved, and they can answer the iADLs later. This pattern continues until all question sets have been asked: Karnofsky Performance Scale (1 question), functional status (29 questions, including ADLs and iADLs), social support (4 questions), social activity interference (3 questions), emotional status (5 questions), nutritional status (1 question), polypharmacy (2 questions), and assistance with assessment (1 question).

2.4. Technical implementation

Using Amazon's protocol, we identified the v-RFA as a skill processing Protected Health Information (PHI) to make it HIPAA-eligible. It contains three main components: 1) interaction with users, 2) data persistence and exchange, and 3) data processing for PDF report generation. For interaction with users, we developed an Alexa Skill and deployed it to Alexa devices to deliver the v-RFA to patients. For data persistence and exchange, we utilized several Amazon Web Service (AWS) products: AWS DynamoDB as the database to store user responses, and AWS Lambda and AWS API Gateway to implement and deploy the data polling application programming interface. To generate the PDF reports, we used Python with the ReportLab toolkit to process user responses and format the responses to match the PDF reports currently in use at Memorial Sloan Kettering Cancer Center.

2.5. Procedure

We conducted seven, video-recorded Zoom interviews (mean duration: 34 min, standard deviation: 5.8 min). Six care providers were interviewed in pairs, and four were interviewed individually. An Amazon Echo Show (second generation) with a 10.1 in. high-definition smart display was placed in front of one of the researchers' cameras so that participants could interact with Alexa over the Zoom call (see Fig. 1). They were then given the invocation phrase and asked to imagine they were a patient completing the assessment. We suggested they stop after the iADLs, but half continued past those sets of questions. Once they had completed the interaction part, we sent a report with their responses to their emails and asked them to review it. Afterwards, we asked close-ended and open-ended questions to gather feedback on the quality of the different components of the v-RFA (e.g., seven-point Likert scales for the visual, spoken, and PDF report), the importance of each of the components, how and whether they would use this in their practice, and their overall reactions or feedback.

3. Results

3.1. Quantitative analysis

Table 1 shows how participants rated the visual and spoken components of the v-RFA, and the automatically generated Results PDF.

The spoken quality of the prototype (which included the synthetic voice and content) was given the highest ratings. The Results PDF received similarly high ratings, and the visual component was still high, but with slightly lower ratings. When compared to eRFA scores calculated from answers manually recorded by our team, the v-RFA ones were 98.92% accurate—one response was incorrectly transcribed and another one was missing.

3.2. Qualitative analysis

Participants indicated that they liked hearing the question and looking at the picture at the same time (P3, P7, P10), that the visuals were “very clean” (P9), and that the experience was “simple and concise” (P7, P10), or “seamless” (P4). Others gave feedback on how to improve the v-RFA, such as by programming Alexa to speak slower (P1, P4, P8) and more concisely (P8, P5). Some suggested that the text on the display should be larger (P2, P8). P8 brought up the benefits of having visuals and audio, in particular for patients with visual and hearing impairments, because the two modalities could be used to support each other. Finally, several participants gasped in awe when they received the Results PDF in their inbox during the study.

Others expressed the need to address conversation complexities (P2, P4, P5). P4 shared, *“I feel the need to explain. If I can't do it without help, I want you to know why I can't do it.”* Suggestions included allowing patients to explain why they responded a certain way, allowing patients to rephrase or correct mistakes, and giving Alexa the ability to clarify the questions it asks.

Table 1
Participant ratings.

What did you think of the quality of the following content:	Visual (*n*)	Spoken (*n*)	Results PDF (*n*)
Very high quality	4	7	6
High quality	2	1	2
Somewhat high quality	3	1	1
Neutral quality	1	1	1
Somewhat low quality	0	0	0
Low quality	0	0	0
Very low quality	0	0	0

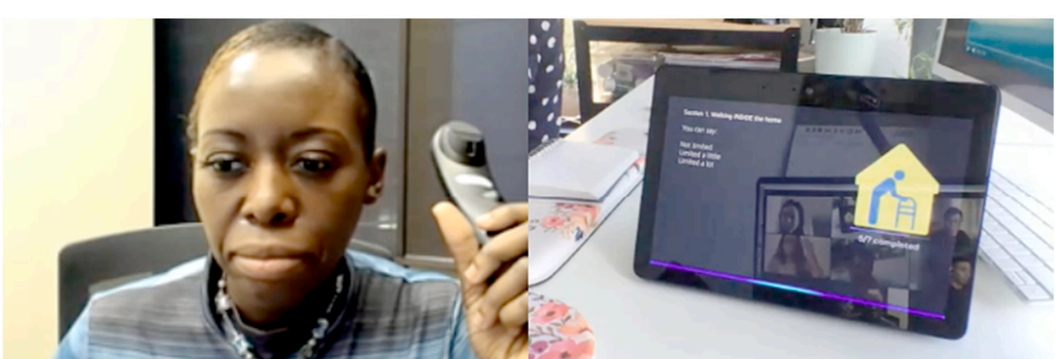

Fig. 1. Care provider (left) interacting with the v-RFA (right) over Zoom.

4. Discussion

Non-completion of GA tools such as the eRFA may result in undiagnosed or undertreated frailty. Our preliminary data has shown that patients with higher degree of frailty required more assistance in completing the eRFA, which could lead to non-completion and have a negative impact on outcomes on patients who may need treatment for frailty the most [8] (manuscript is under consideration for publication). To address this problem, we developed a novel way of delivering the GA, the v-RFA, to increase the number of patients who can complete the eRFA without assistance. We conducted usability and concept testing with care providers familiar with the eRFA in preparation for a pilot study with frail patients.

Overall, care providers gave highly positive feedback about the newly developed v-RFA. Participants were particularly impressed when they saw the Results PDF with their automatically transcribed responses that mimicked the reports they were already familiar with. However, some design challenges were brought up that need to be addressed. Relatively easy to address challenges, such as making the text on the display larger and programming the voice assistant to speak slower, should be addressed before the pilot study. More complex challenges, such as enabling voice assistants to accurately interpret the nuances and complexities inherent in human-human conversations, will become easier to address in the future as the technology improves. An interesting area for future work will be to develop new interaction patterns and standards to adapt medical questionnaires to voice format.

Despite these challenges, the v-RFA was able to capture and score responses from participants with 98.92% accuracy. This presents a promising opportunity to help frail patients overcome certain impairments (e.g., motor, visual, or cognitive), and to help bridge the digital divide by being more intuitive to use than graphical user interfaces. Our next step is to test the v-RFA with patients who require assistance completing the e-RFA to determine if this approach improves independence.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jgo.2022.05.001.

Ethics and consent

This research was reviewed and approved by the IRB at Cornell University. We obtained informed consent to record and analyze participants' interactions and interview responses. Participants were not compensated for their participation.

Consent for publication

This work is not under consideration for publication elsewhere, its publication has been approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the copyright holder.

Availability of data and materials

We agree to share our code, and any other useful materials for appropriate purposes if requested.

Authors' contributions

Study concepts: Andrea Cuadra, Deborah Estrin, Armin Shahrokni
Study design: Andrea Cuadra
Data acquisition: Andrea Cuadra, Yen-Hao Chen, Kae-Jer Cho, Armin Shahrokni
Quality control of data and algorithms: Andrea Cuadra, Yen-Hao Chen, Kae-Jer Cho
Data analysis and interpretation: Andrea Cuadra, Yen-Hao Chen, Kae-Jer Cho
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Manuscript editing: Andrea Cuadra, Armin Shahrokni
Manuscript review: Andrea Cuadra, Deborah Estrin, Armin Shahrokni

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Declaration of Competing Interest

No competing interests.

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