

Usability testing of the iPhone app to improve pain assessment for older adults with cognitive impairment (pre-hospital setting): A qualitative study

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Running title

iPhone pain assessment for people with dementia

CONFLICTS OF INTEREST

None declared

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ABSTRACT

Objectives

Pain assessment in older adults with cognitive impairment is often challenging and paramedics are not given sufficient tools/training to assess pain. The development of a mobile app may improve pain assessment and management, in this vulnerable population. We conducted usability testing of a newly developed iPhone pain assessment application with potential users, in this case as a tool for clinical paramedic practice to improve pain assessment of older adults with cognitive impairment.

Methods

We conducted usability testing with paramedic students and a Delphi panel of qualified paramedics. Participants studied the app and paper-based algorithm from which the app was developed. The potential use for the app was discussed. Usability testing focus groups were recorded, transcribed verbatim, and analysed using a thematic approach. Proposed recommendations were disseminated to the Delphi panel who reviewed and confirmed them.

Results

Twenty-four paramedic students from two UK ambulance services participated in the focus groups. Usability of the app and its potential were viewed positively. Recommended changes to the app were grouped into the following areas: Overall opinion of the app for use in paramedic services; incorporating technological into the health care setting; improving knowledge and governance; and alternative uses. Sub-themes were identified and are presented..

Discussion

Our results indicate that the pain assessment app constitutes a potentially useful tool in the pre-hospital setting. By providing access to a tool specifically developed to help identify/assess pain in a user-friendly format, paramedics are likely to have increased knowledge and confidence in assessing pain in patients with dementia.

Key words

Pain assessment; Paramedic science; Dementia; iPhone app

INTRODUCTION

The past century has seen an increase in life expectancy (1) and for the first time people aged >60 years outnumber those <16 years (2). By 2035, we anticipate that 5% of the total UK population will be the “oldest old” (2) and this demographic shift is consistent across the world (3).

With increasing age we have an increasing number of diseases of old age, e.g., dementia. Globally, dementia affects approximately 35.6 million people (3) and an estimated 7.3 million adults affected reside in Europe (4). Further, it is estimated that the prevalence of dementia will double every 20 years (5), two thirds of people with dementia live in the community and one third in care homes. There is also evidence that the prevalence of pain increases with age, particularly disabling pain or pain sufficient to interfere with day to day living (6, 7, 8). We can therefore assume that pain is present in many older adults, and those with dementia are unlikely to be the exception.

Although pain becomes increasingly common with increasing age there is limited research to inform its assessment and management of pain in those >65 years, particularly those with dementia. Evidence suggests that this group may not receive adequate assessment of pain (9) and pain that is assessed is frequently under-treated or poorly managed (9, 10, 11). However, this is compounded by the fact that they are less likely to communicate their pain in a language which we can understand (12).

With an ageing population who are likely to remain within their own homes it can be assumed that older adults will be seen more regularly in the paramedic setting. Pain management in the paramedic setting is increasingly important in the UK where 80% of patients present with pain-related complaints (13). Paramedics report barriers to providing adequate pain relief, including: concerns about patient accuracy in pain report; and the effect of analgesia interfering with clinical assessments. Furthermore, paramedics report that patients with cognitive impairments can have difficulties communicating their pain, and that pain may be ignored, overlooked or mistaken for challenging behaviour in this population of patients (14).

Currently national clinical guidelines for paramedics recommend the Verbal Numeric Rating Score (VNRS) and Wong-Baker FACES Scale to assess pain. However, these scales do not account for patients who have difficulty communicating. This increasing demand for support for pain management and assessment can only be met with appropriate and effective techniques for pain management. Those in the health and care services should consider the use of technology-enabled products, services and systems as one way of improving successful and efficient management of pain in older persons.

Pain assessment in adults with cognitive impairment is hampered by communication difficulties, on the part of the adult, and limited access to assessment tools by paramedic staff. It is well documented that poor pain assessment leads to poor pain management and consequently serious adverse effects (15). With an increasing use of smartphones, it is becoming increasingly popular to download phone applications (apps). A recent review of pain apps (16) found 111 available apps across the major mobile platforms. The investigators included apps if they focused on pain education, pain management or pain relief, and were not specifically aimed at health care professionals. There was limited health care professional or key stakeholder involvement in the development of the apps (86% reported no involvement). All pain apps

offered the promise of pain relief however few contained evidence-based pain management features or had been evaluated in practice settings.

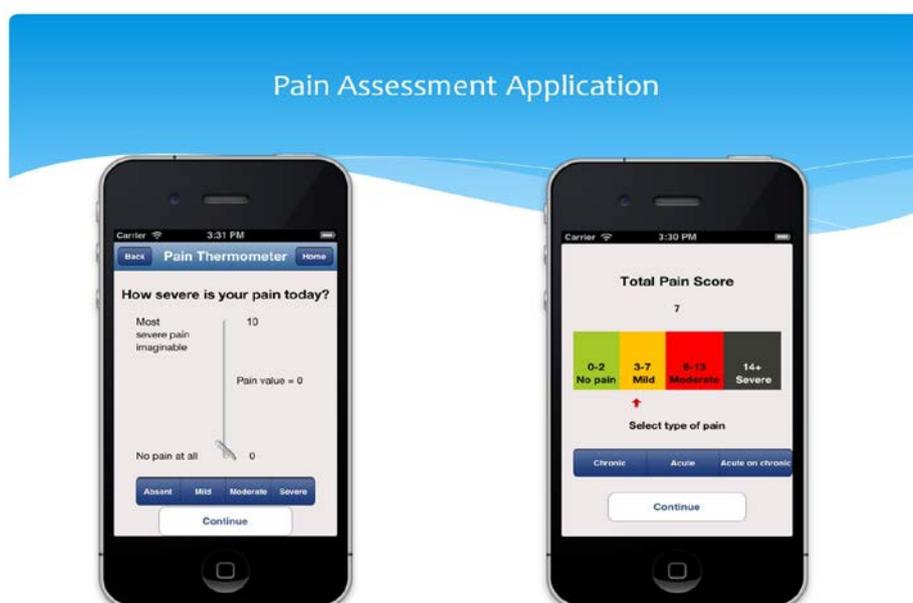
Palermo et al (17) published a special series providing a contemporary overview of technology-assisted self-management interventions for chronic pain in adults. In this review, the investigators rated the functionality of 279 apps, most of the apps provided self-monitoring or pain education. and were designed without any input from health care professionals. Despite an increasing numbers of smartphone applications for the management of pain, few apps include standardised pain measurement tools (18). Standardised tools are developed based on evidence-based best practice, and therefore should be included in any application for the management or assessment of pain.

While there is a growing evidence base regarding pain specific apps, existing apps predominantly focus on pain management as opposed to assessment; are not designed with input from key stakeholders or users; are not evaluated in practice; and do not specifically target paramedics. Therefore, the aim of this study was to complete usability testing of a newly developed iPhone pain assessment application, for use in the pre-hospital (i.e. paramedic) environment. Specific study objectives include:

- Conducting usability testing of the app to assess pain in adults with dementia treated by paramedics
- Evaluating the appropriateness of the algorithm incorporated in the app as a flow chart for pain assessment to be used in adults with dementia
- Identifying any areas for development within the pain app and improve user interaction
- Responding to recommendations made by the clinical teams and work with computing science experts to carry out any required modifications

METHODS

The iPhone pain assessment app was initially developed in collaboration with the Computing and Mathematical Sciences (CMS) department at the University of Greenwich. [See Figure 1 for screenshot].



The pain assessment app was designed based on the Abbey Pain Scale (19), a one-minute pain assessment tool for people with end-stage dementia. The app therefore brings the user through the Abbey pain scale, see Figure 2 for the original.

Abbey Pain Scale

For measurement of pain in people with dementia who cannot verbalise.

How to use scale: While observing the resident, score questions 1 to 6

Name of resident:

Name and designation of person completing the scale:

Date: **Time:**

Latest pain relief given was.....**at****hrs.**

Q1.	Vocalisation eg: whimpering, groaning, crying Absent 0 Mild 1 Moderate 2 Severe 3	Q1	<input style="width: 40px; height: 25px;" type="text"/>
Q2.	Facial expression eg: looking tense, frowning grimacing, looking frightened Absent 0 Mild 1 Moderate 2 Severe 3	Q2	<input style="width: 40px; height: 25px;" type="text"/>
Q3.	Change in body language eg: fidgeting, rocking, guarding part of body, withdrawn Absent 0 Mild 1 Moderate 2 Severe 3	Q3	<input style="width: 40px; height: 25px;" type="text"/>
Q4.	Behavioural Change eg: increased confusion, refusing to eat, alteration in usual patterns Absent 0 Mild 1 Moderate 2 Severe 3	Q4	<input style="width: 40px; height: 25px;" type="text"/>
Q5.	Physiological change eg: temperature, pulse or blood pressure outside normal limits, perspiring, flushing or pallor Absent 0 Mild 1 Moderate 2 Severe 3	Q5	<input style="width: 40px; height: 25px;" type="text"/>
Q6.	Physical changes eg: skin tears, pressure areas, arthritis, contractures, previous injuries. Absent 0 Mild 1 Moderate 2 Severe 3	Q6	<input style="width: 40px; height: 25px;" type="text"/>

Add scores for 1 – 6 and record here **Total Pain Score**

Now tick the box that matches the Total Pain Score

0 – 2 No pain	3 – 7 Mild	8 – 13 Moderate	14+ Severe
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Finally, tick the box which matches the type of pain

Chronic	Acute	Acute on Chronic
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Dementia Care Australia Pty Ltd
 Website: www.dementiacareaustralia.com
 Abbey, J; De Bellis, A; Piller, N; Esterman, A; Giles, L; Parker, D and Lowcay, B.
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For a demonstration of the pain app please see: <https://youtu.be/Vr14TPw6i6Y>.

The current project was conducted in two Phases as follows:

Phase I: Usability testing

We set out to explore the usability of the pain assessment app as a tool for the assessment of pain in adults with dementia within the paramedic setting, employing a qualitative usability testing approach.

Setting and sample: Usability was tested in focus groups across South London Ambulance Service NHS Trust (LAS) and South East Coast Ambulance Service NHS Foundation Trust (SECAmb), with trainee paramedics, to obtain their views and recommendations regarding the app. Participants were recruited through previously formed links with paramedics services, paramedic trainees were selected as the authors had worked with the paramedic team at the University of Greenwich and they therefore constitute a convenience sample. We aimed to recruit four focus groups in total, two groups from each of the paramedic services of interest.

Design: In-depth focus groups were conducted to obtain rich data regarding participants' opinions on the usability of the app and their ideas for changes, how best to implement the app, and the practicalities of using it in the paramedic setting.

Procedure and data collection: Participants were first shown the pain assessment app on iPads along with a brief presentation and printouts of the algorithm (see appendix 1).. Participants were then asked to work their way through the app, trialling out different routes and to think out loud about their likes, dislikes and difficulties with the app. Focus group facilitators followed an interview schedule to help guide the discussion, starting with general questions on current assessment of pain in older adults. The facilitators included the project manager and two senior lecturers in paramedic science. Subsequent questions were aimed at drawing out the participants' opinions on the app and its suitability for use in practice, followed by more direct questions related to changes and recommendations. See Table 1 for the topic guide.

Table 1. Focus group topic guide

Questions	Probing questions
How do you currently assess pain in older adults?	What pain assessment tools do you use, if any?
Do you find it difficult to assess pain in older adults?	If yes, Why? If no, Why not?
What are your general thoughts on using the Pain assessment App?	
Would you find the use of a Pain assessment App appropriate in practice?	If yes, Why? If no, Why not?
Would you be likely to use this App in your everyday practice?	If yes, Why? PROMPT: In what way do you think this App would benefit your practice / patients?
Are there specific changes you would make to the App?	If yes, what? PROMPT: Appearance; Ease of use; Wording; Structure
Would you recommend the App to other paramedics?	If yes, Why? If no, Why not?
Is there anything else you would like to say about the App?	

Analysis: Analyses were carried out according to the tenets of theoretical thematic analysis (20). The method has been widely used across the social, behavioural and more applied (clinical, health, education) sciences. In line with Braun and Clark (21) a six-phase approach was adopted which involved two independent researchers and the following stages:

Researchers familiarised themselves with the data

Audiotaped usability interviews were transcribed verbatim. While both independent researchers were involved in the data collection the first stage was to read the data again, the transcripts were read and

searched for meaning or patterns, transcripts were read twice by each of the researchers to immerse and familiarise themselves with their content.

Generating initial codes

Once familiarised, researchers worked systematically through the usability data, and identified important features and recurring aspects of data items. This was done manually by adding notes to the text to highlight potential patterns. Extracts of the data were copied into a separate word document and grouped together accordingly, with the broader context around each extract kept to ensure data was interpreted correctly.

Searching for themes

This phase involved examining codes and collated data to identify significant broader patterns of meaning (potential themes). Individual themes were identified but also overlapping and related themes. This was on a separate document where the extracts could be moved around to understand the “story” behind the data. At this stage researchers identified the main themes and sub-themes.

Reviewing themes

This phase involved checking the candidate themes against the dataset, to confirm that they told a convincing story of the data, and one that answered the research aims. In this phase, themes are typically refined, which sometimes involves them being split, combined, or discarded. At this stage if data did not fit well within a theme the researchers had an opportunity to rethink the themes and go back to the initial coding. Once researchers were satisfied that the themes accurately captured the data they moved on to the next stage, where they compared each of their independent themes to ensure both were similar.

Defining and naming themes

This phase involved developing a detailed analysis of each theme, working out the scope and focus of each theme, determining the ‘story’ of each. It also involved deciding on an informative name for each theme.

Writing up

This final phase involved weaving together the analytic narrative and data extracts.

Phase II: Delphi panel of paramedic experts

Following initial usability testing, Phase II aimed to take the proposed recommendations and further assess these using an expert panel of trained paramedics, with a goal of developing the app for implementation and evaluation within a larger scale study at a later date.

Setting and sample: The Delphi Panel members were recruited through links provided by co-investigator Matthew Lane, a senior lecturer in Paramedic Sciences within the University of Greenwich. The panel was composed of fully trained paramedics working as training officers, lecturers, or senior lecturer practitioners within LAS and SECAMB, and represented a convenience sample.

Design: The key recommendations collected from Phase I were separated into themes and sent to the Delphi panel over email. Emails were sent individually to each panel member to ensure results remained anonymous.

Procedure and data collection: This process involved two rounds, firstly panel members were sent the full list of recommended changes from Phase I and were asked to select, for each of the recommendations made, whether these were of low, medium or high priority. These were then returned via email or in person to the lead researcher. Following receipt of these, the answers were then summarised and sent back, anonymously, to the panel to ask for any further responses based on the feedback received from the whole panel.

Analysis: The final key recommendations for incorporating into the updated app were chosen based on those where more than 50% of the Delphi panel had selected them as medium or high priority for change.

Informed consent

Written informed consent was obtained from all participants and participants were offered £15 worth of high street vouchers as an incentive to participate.

ETHICAL APPROVAL

Ethical approval was received through the internal University of Greenwich Research Ethics Committee (UREC).

RESULTS

Phase I: Focus groups with paramedics in training

Demographic characteristics of the study sample

Across two paramedic services (SECamb and LAS) a total of 24 paramedic students attended focus groups. Four focus groups were conducted with an average of 6 participants in each group. Participating students included 11 (46%) females and 13 (54%) males who were all in their final year of paramedic training.

The key topics raised were classified into discrete themes and included: Overall opinion of the app for use in paramedic services; incorporating technology into the clinical setting; improving knowledge and governance; and alternative uses. A number of sub-themes were also identified and are discussed below.

In the quotes provided below (italicized text) the first number represents the focus group and the second number represents the participants, for example, P3.7 is the third focus group and participant number 7.

Overall opinion of the app for use in paramedic services

Need for improved pain assessment in paramedic services

The overall opinion of the iPhone pain assessment app and its potential to improve both assessment, and subsequent management of pain in older adults with cognitive impairment, was very positive. The participants identified the need, within paramedic services, for something that would help them in assessing pain in older adults with cognitive impairment.

P3.7 I actually think it is a really useful tool, I think it fills a gap where there is currently no way of assessing objectively people who have difficulty with communication or can't communicate at all

P4.5 I think we take a lot of people to hospital, particularly dementia patients, because we can't assess them properly...I think we often just cart dementia patients off to hospital because we don't feel comfortable enough assessing them properly.....I think yes it (the app) could help

Participants were also keen to recommend the use of the app to others in practice.

P3.7 I think it makes us more mindful of the different ways that people with communicative difficulties express their pain, so for that reason I think it's really good and would recommend it

Older adults are often stoic

The app was identified as particularly beneficial as participants reported they find older adults are often stoic and do not like to create a fuss regarding their pain, therefore often do not speak up when in pain and decline pain relief.

P3.4 when you've got an older person who you say "do you want any pain relief?" they decline it, but because they're not kicking up a fuss it is almost quite easy to forget about the fact that they might be in pain...for someone older, it's almost quite easy to overlook in some instances

Incorporating technology into the paramedic setting

Use of technology in a paramedic setting

There were repeated concerns around the usability of an iPad or similar device within the paramedic setting and whether it is professional to use an iPad in practice, particularly when they are not widely used.

P4.7 I think it might be quite hard for an ambulance paramedic to actually get out a tablet or get out a phone.....and also people in the ambulance service aren't used to technology

P1.7 I think it very much depends on the patient, because for some people if you were to bring out a phone or something like that I think they would find it inappropriate

Support and training required to facilitate incorporation of technology in health setting

In addition to use of technology in the paramedic setting identified as challenging, participants felt that paramedic services do not provide adequate support to their staff to allow them the opportunity to use such an app in current practice.

P4.7 At the moment no because the infrastructure around it (using technology)..... isn't there

P4.5 I think there's a feeling among a lot of people that we are using our own phones and things that they are wanting us to do, and they do nothing to support that

Integrating into current technology

A solution to these challenges presented above was the suggestion to integrate the app within Paramedics current electronic patient report form (PRF), which are being rolled out across some trusts.

P4.4 I think it would be good if we had electronic PRF's...when you're doing that you would do a pain score, you would click the pain bit and it would come up with this assessment

P3.2 I still don't think having it on an iPad is appropriate, but I think if you were using a digital PRF or, if that was encompassed in some sort of digital PRF system, that would be really good

Specific app based changes

These were changes that were indicated as essential to improving usability of the app.

Rewording of app questions

These were predominantly minor changes with understanding the questions from the pain scale once transferred to the app. For example, amending some of the questions where wording did not correspond with pain scales within the app.

Alternative pain scales

There were a number of suggestions made regarding the inclusion of alternative pain scales, including temperature colours on the thermometer to indicate increasing pain, and the Wong Baker Faces scale due to participants' familiarity with them.

P1.5 possibly the Wong Baker, we're all familiar with that, I've used that with dementia patients and it's not in a patronising manner, and I actually think it works effectively, so I don't know if that can be incorporated somewhat into it

Practical changes

There were also practical changes put forward to make the app more intuitive, in particular the location of the "next" and "back" buttons and the correction of some links.

An interesting idea that was raised was to investigate the use of a GPS system within the app that would allow identification of local care pathways and what is available in the geographical area the paramedic is working in.

Improving knowledge and governance

Increasing awareness

While some participants were not sure how regularly they would personally use the app, many felt that it would encourage paramedics to think more carefully about the issue of pain assessment in older adults with cognitive impairment, and therefore increase their awareness of the topic.

P4.5 get more maybe out of just having an awareness, from doing something like this (focus group), of knowing that pain assessment might be an issue with an elderly person who can't communicate

P3.3 some of the questions made us think a bit about, do we assess these things?

Training needs

While the app was generally welcomed by all participants, a key point raised was the need for additional training within current paramedic practice regarding how to assess pain in the older adult with cognitive impairment.

P1.3 Definite guidance is going to be needed, a lot of this is going to be about guidance...I think general pain management guidance is needed out on the road

P1.5 I think there needs to be some training package...and get everyone to look at this (algorithm), get everyone to understand all of the outcomes, all of the possible pathways

Method of clinical governance

A key issue raised was that use of a pain assessment app can provide staff with rationale for actions they take with regards to pain management, it therefore can act as a method of clinical governance.

P2.1 if there's a box to say that we used this pain app to help assess the pain, so they know we used our clinical judgement as well as something else...sometimes you have to try and justify why you gave a treatment to somebody or why you didn't, and if this was approved and this helps you get to whatever treatment you did or didn't provide, then it will be good

Alternative uses of the app

Finally, there were suggestions made with regards to how else the app might be used, some participants felt it would benefit from being trust specific and from the inclusion of a summary at the end that could then allow for a re-calculation of the pain score following pain management intervention.

While others were keen to utilize the paper based algorithm itself rather than the app, which they felt was more appropriate for use in clinical practice.

P3.3 personally the app for me no, however I do like the algorithm...so I'd probably look at that and take that and use it in my practice now...I think, the actual algorithm is a handy tool, but to actually have an app to use in practice, to me personally, doesn't look very professional

Phase II: Delphi panel of paramedic experts

The Delphi expert panel included 7 trained paramedics, 6 males (86%) and 1 female (14%).

Areas of the app identified for development, following recommendations from the focus groups, were then sent to the Delphi panel to identify those of highest priority. There were 43 recommendations in total received across the focus groups (see Appendix 1), of these 20 were identified as either of medium or high priority by the Delphi panel. The majority of these recommendations did not relate to changes to the app itself, but rather changes or considerations when using an app like this in practice and issues around training. Therefore, there were 4 changes made to the app from the high priority recommendations, however other points raised would need to be considered when using the app in practice. Changes that were feasible to make are detailed below:

Key changes:

1. Disclaimer was added at the start of the app (before pain assessment starts) to inform people it is based on best evidence and the University is not accountable, this included a disclaimer to explain to the user that they are about to start the Abbey pain scale
2. There is a thermometer pain scale within the app where users move up the scale to indicate higher levels of pain, colours were added to this scale changing from yellow – orange – red with increasing pain rating (yellow/orange (0-3) / orange/red (4-7) / red (7+))
3. At the final page of the app pain assessment there was no option to go back if a mistake has been made within the assessment, therefore a back button was added
4. Throughout the app the next and back buttons, following completion of each stage of the pain assessment, were not intuitive in terms of what side they were on (next button was on the lower left corner and back was on the lower right), these have been moved so next button is always on the right hand side

Following the confirmed recommended changes the team met with the CMS staff where all recommended changes of medium/high priority were discussed and those that were feasible to change were amended.

DISCUSSION

Our study suggests that the iPhone pain assessment tool for older adults with cognitive impairment could prove to be a useful tool in the pre-hospital setting and potentially other populations with communication difficulties. It is well documented that poor pain assessment leads to poor pain management and consequently serious adverse effects and evidence suggests that one of the most common reasons for dialling 999 (in the UK) is because an individual is experiencing acute pain (21). By providing access to a tool, in the paramedic setting, that has been specifically developed to help identify/assess pain in a user friendly format, we could see improvements in pain management and subsequently improved quality of life for the adult with dementia with communication deficits.

Paramedic student and staff participants admitted that current pain assessment, in their clinical practice for the older adult with cognitive impairment, is not substantial and at times is ignored "*I think we often just cart dementia patients off to hospital because we don't feel comfortable enough assessing them properly*". Participants responded, on the whole, very positively to the concept behind the app and were enthusiastic about its use in practice providing changes were made, both in the app itself and in the way that technology is introduced into the clinical environment.

The most common concern raised was the use of technology in the paramedic setting and how appropriate this is, and the lack of adequate support for paramedic staff to allow them the opportunity to use app based assessment methods in practice. The majority of participants did not feel that use of an iPad, or similar electronic device, was currently possible in the clinical setting. While this was not something that could be changed at this stage, suggestions for the future included using electronic PRF systems regularly where the app could be incorporated and changing the way paramedics work and record data to a more electronic based method.

There were a number of practical suggestions provided to make the app more intuitive from a user's perspective, the majority of these were picked up by the Delphi expert panel as being of high priority to change, including: rewording of certain questions; linking aspects of the app together so they corresponded with each other; and inclusion of the temperature colours on the thermometer pain scale. The use of the Wong Baker faces scale was repeatedly brought up in the focus groups, due to its common use in paramedic practice, however due to recent evidence it was decided that this would not be incorporated. Sampson and colleagues (22) found that, although it is widely used in UK hospitals, approximately half of older adult participants with dementia were unable to use this scale, and this proportion increased with more severe dementia. Research by Stinson et al (23) used a similar method in determining the usability of their iPhone pain assessment app for adolescents with cancer. Authors found that through testing usability of the app, at an early stage, they were able to refine it and improve it.

There was a clear lack of adequate training and awareness around pain assessment in older adults with cognitive impairment. Many participants felt that by attending the focus groups they were already beginning to think about the complex nature of pain assessment in this population. This is beneficial in terms of the app as, even if it is not regularly used, it has already started to make paramedics think more carefully and become more observant of older adults and what their pain needs might be. Regarding training, it is evident that this is an issue that requires further work to ensure our paramedic staff are being trained on key issues that they face on a daily basis in practice.

There were a number of recommended changes that were interesting but not feasible to implement at this point in time. Participants were keen to include a summary or record at the end of the app to allow a re-calculation of pain

score following administration of pain relief. While this would be beneficial for paramedics it was not possible to incorporate into the app at present as this would require recording of patient data.

There are a range of limitations with the study that need to be acknowledged. While authors utilised two paramedic services in their recruitment of participants, chosen due to pre-formed links, it is possible that the perspective of the participants may not apply to other paramedic services. Additionally, the paramedics recruited were all trainees, this was due to convenience sampling through our links within Greenwich and local ambulance trusts. It is possible that, as trainees, the paramedic students may not have had sufficient understanding of the clinical issues to provide informed feedback. However, the use of a Delphi panel to select the highest priority changes ensured authors had consensus across all levels of experience. In future work we aim to recruit fully trained paramedics.

Previous reviews of pain apps have found that the majority of apps available are for pain education, pain management or pain relief, as opposed to pain assessment. Of the apps that are available the majority do not use evidence-based features (16). The current iPhone app utilises the Abbey Pain Scale as its method of pain assessment, this scale is one of the most commonly used pain assessment tool for people with dementia. Any app that is to be used in clinical practice needs to have content that is valid, relevant and evidence based to ensure it is useful the user group. Involving users in app design can lead to products with better content and interface, improved functionality and usability (24). The purpose of this current project was to understand the usability of the pain app in paramedic practice and to refine the app accordingly. In doing so we carefully considered the opinions of those who would be actively using it in practice and made changes in response to their concerns.

In completing research like this it is essential that it can feed back into future developments of similar apps, particularly those in the health field. Following completion of this evaluation we have a few key recommendations to offer to others who are developing and testing apps to improve pain care:

- Developers should consider the fact that the use of technology in clinical settings is a potential barrier to people up-taking new apps in this setting, while it should not stop people from developing new apps as the digital age is going to continue, consideration needs to be given to what barriers this might create
- It is essential to get key stakeholder (to include end user) feedback when developing any app, those who are using an app directly in practice need to be the ones to help drive the development of it – aside from the fact that they are the ones who are going to be using it and pain apps are generally designed to make practice easier for those using it, users can also pick up on practical aspects that can be missed by designers

This study has provided new insight into an innovative method for pain assessment in the paramedic setting.. An important finding was the distinct lack of training in this area, therefore future work should focus on developing training packages for paramedics and investigating how electronic devices can be integrated and accepted in the clinical setting. The benefits of implementing such tools are potentially wide reaching, and could have a particular impact on improving paramedics' knowledge and confidence in pain assessment for older adults with cognitive impairment. Finally, we have applied for further funding, with an aim to test usability in the clinical environment across several NHS trusts throughout the UK.

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AUTHOR CONTRIBUTIONS

RD conducted the analysis and produced the first draft of the manuscript. P.A was the Principal Investigator overseeing work carried out by RD and MA, and commented on the draft of the manuscript - including comments on analysis, results and interpretation. MA was a co-investigator with RD, commented on the first draft of the manuscript and led recruitment through SECamb and LAS.

REFERENCES

1. Tse MMY, Pun SPY, Benzie IFF. Pain relief strategies used by older people with chronic pain: an exploratory survey for planning patient-centred intervention. *Journal of Clinical Nursing* 2005; 14(3): 315-320
2. Office of National Statistics (published on 24 June 2010). <http://www.statistics.gov.uk/default.asp> (8th July 2015, date last accessed).
3. World Health Organisation (2012) Dementia: a public health priority. http://www.who.int/mental_health/publications/dementia_report_2012/en/ (8th July 2015, date last accessed)
4. Europe As. <http://www.alzheimer-europe.org> 2012 [Accessed 24th May 2012
5. Ferri CP, Prince M, Brayne C, Brodaty H, Fratiglioni L, Ganguli M, et al. Global prevalence of dementia: a Delphi consensus study. *Lancet*. 2005 Dec 17;366(9503):2112-7. PubMed PMID: 16360788. Pubmed Central PMCID: 2850264.
6. Dionne CE, Dunn KM, Croft PR. Does back pain prevalence really decrease with increasing age? A systematic review. *Age & Ageing* 2005; 35(3): 229-234
7. Thomas E, Mottram S, Peat G, Wilkie R, Croft P. The effect of age on the onset of pain interference in a general population of older adults: Prospective findings from the North Staffordshire Osteoarthritis Project (NorStOP). *Pain* 2007; 129: 21–27
8. Docking RE, Fleming J, Brayne C, Zhao J, Macfarlane GJ, Jones GT, Cambridge City over-75s Cohort Study Collaboration. Epidemiology of back pain in older adults: Prevalence and risk factors for back pain onset. *Rheumatology (Oxford)* 2011; 50(9): 1645–1653
9. Closs SJ, Barr B, Briggs M, Cash K, Seers K. A comparison of five pain assessment scales for nursing home residents with varying degrees of cognitive impairment. *Journal of pain and symptom management* 2004; 27(3): 196-205
10. Helme RD, Gibson SJ. Pain in Older People. In *Epidemiology of pain*, I.K. Crombie, P.R. Croft, S.J. Linton, L. LeResche, M. Von Korff, eds. Seattle: IASP Press, 1999
11. Scherder E, Oosterman J, Swaab D, Herr K, Ooms M, Ribbe M, Sergeant J, Pickering G, Benedettie F. Recent developments in pain in dementia. *British Medical Journal* 2005; 330(7489): 461-464

12. Collett B, O'Mahoney S, Schofield P, Closs SJ, Potter J. The assessment of pain in older people. *Clinical medicine* 2007; 7(5): 496-500
13. Williams E, Sutton S. (2012) Elderly fallers referrals: update. London Ambulance Service: Clinical update (Issue 28) retrieved from:
http://www.londonambulance.nhs.uk/health_professionals/gp_information/idoc.ashx?docid=c5ec9929-66a8-41a1-8e9a-28d08fe25278&version=-1.
14. Harvey C. Is there scope for an observational pain scoring tool in paramedic practice? *Journal of Paramedic Practice* 2014; 6(2): 84-88
15. Bonica JJ, Loeser JJ, Chapman CR, Fordyce WE. *The management of pain*. Philadelphia: Lea and Febiger, 1990
16. Rosser, B. A., & Eccleston, C. Smartphone applications for pain management. *Journal of telemedicine and telecare* 2011; 17(6); 308-312
17. Palermo TM & Jamison RN. Innovative Delivery of Pain Management Interventions: Current Trends and Future Progress. *The Clinical journal of pain* 2015; 31(6): 467-469
18. Portelli P, Eldred C. A quality review of smartphone applications for the management of pain. *British Journal of Pain*. 2016 Apr 19:2049463716638700 [Epub ahead of print]
19. Abbey J, Piller N, De Bellis A, Esterman A, Parker D, Giles L, Lowcay B. The Abbey pain scale: a 1-minute numerical indicator for people with end-stage dementia. *International journal of palliative nursing*. 2004 Jan 1;10(1):6-13.
20. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative research in psychology*. 2006 Jan 1;3(2):77-101.
21. McLean SA, Maio RF, Domeier RM. The epidemiology of pain in the prehospital setting. *Prehospital Emergency Care* 2002; 6(4): 402-5
22. Sampson EL, White N, Lord K, Leurent B, Vickerstaff V, Scott S, Jones L. Pain, agitation, and behavioural problems in people with dementia admitted to general hospital wards: a longitudinal cohort study. *Pain* 2015; 156(4): 675-683
23. Stinson JN, Jibb LA, Nguyen C, Nathan PC, Maloney AM, Dupuis LL, Gerstle JT, Alman B, Hopyan S, Strahlendorf C, Portwine C, Johnston DL, Orr M. Development and testing of a multidimensional iPhone pain assessment application for adolescents with cancer. *Journal of Medical Internet Reserch* 2013; 8(15): 51

24. Shah SG, Robinson I. Benefits of and barriers to involving users in medical device technology development and evaluation. *International journal of technology assessment in health care*. 2007;23(01):131-7