Original Paper

An investigation into software requirements for systems supporting task-shifted interventions in mental health

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Abstract

Background:

Mental health problems are common and pose an ever-increasing burden on societies. In most low-middle income countries there is a considerable shortfall in the treatment of mental health problems. One reason for this is the lack of specialized resources to deliver services. This has led to the implementation of task-shifted interventions, in which specific tasks are moved away from highly qualified health workers to health workers with less training. The World Health Organisation has published recommendations for such interventions, but guidelines for software and systems supporting such interventions are not included.

Objective:

The objective of this paper is to formulate a number of requirements for computer systems supporting task-shifted interventions and to illustrate their use in a mobile system created for a task-shifted depression intervention to be provided to older adults in deprived areas of São Paulo, Brazil.

Methods:

Using a set of recommendations based on the World Health Organisation's guidance documentation for task-shifted interventions, we identified nine software requirements that aim to support health workers in management and supervision, training, good relationship with other health workers, and community embeddedness of the intervention. These nine software requirements were used to implement a system for the provision of a psychosocial depression intervention with mobile Android interfaces to structure interventions and collect data, and web interfaces for supervision and support of the healthcare workers delivering the intervention. The system was tested in a two-arm pilot study with 33 patients and 11 health workers. Eight of these 11 health workers participated in a 'usability' study subsequent to the pilot.

Results:
Qualitative and quantitative feedback obtained with the System Usability Scale suggest the system was deemed to have a usability of between 'OK' and 'Good'. Nevertheless, some participants’ responses indicate they felt they needed technical assistance to use the system. This was reinforced by answers obtained with an 'ease of use' questionnaire, which indicated some users felt they had issues around correct use of the system and perceived ability to becoming skilful at using the system.

**Conclusions:**

Overall, these high-level requirements adequately captured the functionality required to enable the health workers to provide the intervention successfully. Nevertheless, the analysis of results indicated some improvements are required for the system to be useable in a task-shifted intervention. The most important of these are better access to a training environment, access for supervisors to meta-data such as duration of sessions or exercises to identify issues, and a more robust and human-error proof approach to availability of patient data on the mobile devices used during the intervention.
Introduction

Depression is common among older adults [1-4] and is associated with poor quality of life [5, 6], adverse social and health consequences [7-9], and increased health care utilization and costs [10, 11]. Depression in later life often goes unrecognized and untreated [12-15]. There are effective treatments for depression in later life [16-18] but these are complex interventions, which often require specialized resources. One of the most salient barriers to deliver these programmes is the lack of specialized staff [12-15, 19].

To address the lack of specialized resources, the most common strategy followed has been that of task-shifting. This strategy involves moving specific tasks, where appropriate, from highly qualified health workers to health workers with shorter period of training and fewer qualifications, so as to make more efficient use of the available human resources [20]. Most of these task-shifted programmes have been delivered by Community Health Workers (CHWs) who are generally people of all ages, often community members, with no professional education but who receive a few months of training. Task-shifting has a long history in many guises with structured implementations in, for example, China and Thailand from the 1950's and 1970's onwards respectively [21, 22]. In Africa, task-shifting has been used for various diseases and notably in response to the HIV/AIDS pandemic [23]. Task-shifting is not limited to low to middle income countries (LMIC) [24], but is especially appealing where the existing traditional health care resources are scarce. A review of task-shifting studies in LMIC found that task-shifting was a promising approach to efficiency improvements and the increased provision of services at a given quality and cost [25].

Notwithstanding the merits of this strategy, there have been problems with its implementation [25, 26]. Between 1980 and 1990 many established task-shifted programmes were discontinued due to poor implementation, resourcing issues or the absence of lasting health outcome improvements [27]. In recognition of these and other challenges, the World Health Organisation (WHO) collated a set of recommendations for successful implementation of task-shifting interventions [20]. Campbell and Scott [27] divided these recommendations into five categories and added a sixth:

1. Strong management and supportive supervision
2. Appropriate selection of CHWs
3. Suitable training
4. Adequate retention and incentive structures for CHWs
5. Good relationship with other healthcare workers
6. Community embeddedness of personnel and intervention
Information and Communications Technology (ICT), though acknowledged as a useful tool in some task-shifting interventions [28], is somewhat overlooked in these recommendations as an opportunity to overcome some of the fundamental issues in supporting task-shifting. ICT can play an important role in the training, support and supervision of CHWs delivering task-shifted interventions. The need for such functionality is illustrated by several studies of task-shifted interventions in mental health, which reported challenges around training and supervision of the intervention providers [29, 30], treatment quality [31] and fidelity [32].

As part of a project to improve the treatment of depression for elderly people in São Paulo Brazil, we used Campbell and Scott’s framework to develop an ICT solution to support CHWs delivering the intervention [27]. This intervention aimed to allow CHWs, who normally provide basic services to elderly citizens within Brazil’s family unit-based health system [33], to deliver a complex psychosocial intervention to older adults resident in poor neighbourhoods of São Paulo, Brazil. As far as we are aware, specific software requirements for ICT systems that play supporting roles in task-shifting interventions are not currently available. This paper seeks to address this gap by formulating a set of software requirements and illustrating the use of these requirements in a software platform for the support of task shifted interventions. Although the application described focusses on mental health interventions, the applicability of the chosen approach is not limited to the domain of mental health.

Methods

Definition of task-shifting software system requirements

Four of the recommendation categories proposed by Campbell and Scott are relevant to the functionality that can be provided by ICT systems: management and supervision, training, good relationship with other healthcare workers, and community embeddedness. During the initial stages of the project, a needs analysis and ‘use case’ scenarios were employed to define software requirements for these four categories.
Software requirements for strong management and supportive supervision

The mobile nature of modern ICT systems allows users to manage their tasks effectively and obtain appropriate supervision input as and when required. Such interactions can be user initiated, prompted by the system or may result from supervisor intervention. The developed system contributes to such management and supervision by implementing the following requirements.

Requirement 1 Guidance:

The ICT system should provide the carer with a means of structuring the intervention, automatically presenting the key aspects of the intervention at the appropriate time.

Requirement 2 Decision Support:

The system should either aid in decision making, or automatically make certain decisions for the care provider.

Requirement 3 Supervision:

The system should enable supervisors of the carers to remotely monitor the intervention, assess progress and potential issues and initiate corrective action when required.

Requirement 4 Accountability:

The system should provide all users with the trust and confidence that: 1) they receive automated prompts in regard to their duties; 2) the recording of the execution of such duties is performed automatically insofar as practically and ethically possible; 3) any deviation from these duties is flagged accordingly and reported to line managers; and 4) any storage and communication of patient data is performed in a secure manner.

Requirement 5 Record Keeping:
The system should automatically maintain records of information resulting from the intervention. These records should then be available for later sessions to support Guidance and Decision Support and for Supervision and Accountability purposes.

**Software requirements for suitable training**

Characteristics of learning identified as important for task-shifting [34], such as learner-centred, experiential, problem-orientated and context-appropriate can be appropriately provided by ICT, especially as a refresher after initial, more formal training.

**Requirement 6 Training Environment:**

The system should allow carers to quickly review the content of a specific session and practice delivery of the intervention and all its exercises.

**Software requirements for good relationship with other healthcare workers**

The relationship between carers within a team and between carers and their supervisors is crucial to a successful task-shifted intervention [35]. ICT can contribute to a good relationship by providing effective and transparent communication between carers amongst themselves, and between carers and their supervisors or general practitioners.

**Requirement 7 Automated Communication:**

The system should automatically communicate important information and events to relevant stakeholders. It should be clear to all stakeholders what information is relayed to whom. Where required, stakeholders should be able to respond.

**Requirement 8: User-initiated Communication:**

The system should allow immediate communication with relevant stakeholders involved in the care of that particular patient.
Campbell and Scott [27] defined community embeddedness as: “... when community members ‘own’ the project by having substantial control over the selection, monitoring, activities and priority-setting of CHWs”. Whereas this definition goes far beyond the physical location of the intervention, an important aspect of community embeddedness is that interventions can be provided where this is deemed most suitable by the community, and often this may be the patient’s own home. Especially for the older adults targeted in this work, mobility may be a limiting factor in the delivery of care through health centres.

Requirement 9: Delivery in the community:

It should be possible to deliver the full intervention in the community, certainly in a location acceptable to the patient and if necessary in their own home. Hence, all intervention resources and patient data should be accessible on a mobile device without direct connection to the internet, for instance through an app.

Development of the pilot system

The system requirements gathered in the early stages of this development process indicated the necessity for an architecture with interfaces for carers on mobile devices, a central storage of gathered data, and web interfaces for supervisory actors. The resulting system, which was named PROACTIVE, contains a mobile Android app developed for tablets with a minimum screen size of 8” and various interfaces accessible through an online portal for remote supervision and management purposes.

Mobile Android Interfaces

The CHW performs all interactions and sessions with the patient using the Android app. Sessions start with a review of homework from the previous session after which information on the patient’s
current mental and physical health status is updated using a set of questionnaires. After these questionnaires the session continues with the presentation of multi-media resources (videos and animations), which provide the patient with a better understanding of their mental health issues and potentially beneficial behaviours. This information is then used to perform exercises and decide on homework for the next session. Sessions conclude with the scheduling of a new appointment. As internet connectivity is not always available at the patients' homes, the app contains all information for the patients under the care of the CHW who uses the device. Upon logging in with a username password combination, the Android app’s starting screen gives the user an overview of the patients in their care (see Figure 1).

When selecting a user and choosing ‘Start Session’, the correct session content will be compiled for the chosen user and an intervention session started. The various screens in each session can be navigated using swipe actions to move to neighbouring screens similar to browsing through a book page-by-page. Additionally, ‘chapters’ in the session can be selected using a horizontal menu bar at the top of the screen and pages within these chapters can be selected using a vertical menu at the left-hand side of the screen. Wherever the interface presents or requests dynamic (patient/user specific) data, a custom-built Application Programming Interface (API) was used to provide a quick and easy means of defining user interfaces with automated storage and retrieval of information. The information thus obtained is stored in database tables.
The first screen of every intervention session (apart from the first session) displays the homework assignments agreed upon in the previous session (Figure 2) and allows the patient and CHW to start the new session discussing and recording progress and exploring potential barriers and solutions for homework assignments.

After reviewing their homework, patients will respond to a number of questionnaires. On every visit, depression is assessed with the 9-item Patient Health Questionnaire (PHQ-9; [36]) and mood is rated on a Likert rating scale (Figure 3). Other information, such as medication use (Figure 4), can be updated if required using a questionnaire. Based on the answers provided in the PHQ-9, the system will, if any of the answers indicate the presence of a depressive symptom, automatically add an extra question to assess how PHQ-9 symptoms have affected the patient’s life. The response to the ninth question of the PHQ-9 on suicidal ideation automatically determines whether a suicidal risk assessment is added directly after the PHQ-9. In this assessment, the patient will be asked about recent suicide attempts; if there have been any, this will result in the CHW automatically being given the instruction to stay with the patient until a friend or family member has arrived.

Having gathered and updated the patient’s mental and physical health status, the intervention continues with multi-media resources that explain aspects of the patient’s symptoms, behaviours and ways to improve these symptoms. One of the main goals of the intervention is to strengthen the autonomy of the patients and highlight the role they have in their own improvement. For this, it is
important that they engage in pleasant activities. Hence, in most sessions patients choose a symptom or potential solution to focus on, and design strategies to incorporate healthy changes in their lives. The focus of care is thus on increasing patient involvement in pleasant activities, on reducing avoidant behaviours associated with symptoms of depression, and on continuing to develop the autonomy of the patient to identify and deal with symptoms of depression at present and in the future.

As mentioned previously, an important goal of the system is to empower CHWs with limited training in mental health service provision to provide a psychosocial intervention. To this end, the system provides automated support to the CHWs. This support consists of session content recommendations, as well as support in scheduling intervention visits and further recommendations personalized to that patient, such as warnings regarding adherence to the intervention, suicidal ideation and progress in the intervention. The CHW has access to these recommendations and warnings in a dedicated screen in the app. Where necessary, the system forwards recommendations and warnings to supervisors by email.

To further support the supervision of CHWs, he/she can, in consultation with the patient, choose to make audio recordings of (parts of) the session for use in future intervention or supervision sessions. These audio recordings are stored on the device and are only accessible to the CHW.

**Web interfaces for monitoring and supervision**

The web interfaces allow individuals with supervisory roles access to the system. The information shown to these individuals varies slightly based on the objective to show only the most pertinent information. Those that are responsible for the running of the intervention at a high level (Trial Managers or their equivalent in the health system) see aggregate data on a per-patient level (see Figure 5), whereas clinical supervisors see more detailed information for each patient related to the clinical care in which one of their CHWs is involved.
The PROACTIVE system was tested in a pragmatic two-arm pilot study in two family health units in the Northern area of São Paulo city, Brazil. Eligible participants were aged 60 years and older. Exclusion criteria were: not having depression as assessed by the PHQ-9 (PHQ-9<10); complete deafness; terminal illness; high risk of suicide; or incapability of communication (for example, cognitive impairment and mental illness either relayed by a family member or detected by the researcher).

Prior to the intervention commencing, CHWs were trained and provided with an overview of the intervention, session contents, how to use the technological support platform, psychosocial techniques to deliver the intervention, and ways to engage with patients. The training programme consisted of three full days of intensive training delivered by two psychologists. During the intervention, the system was used for a total of 17 weeks by 11 CHWs who cared for a total of 33 patients with 15 individuals in a low-intensity (8 sessions) and 18 in a high-intensity group (11 sessions). Overall, 19 patients completed all sessions within the timeframe available.
Upon completion of the pilot, 8 of the 11 carers involved in the intervention participated in a qualitative assessment of the system in which the System Usability Scale (SUS,[37]) and the Technology Acceptance Model (TAM,[38]) were used to elicit the CHW's perception of usability of the system. The questions and Portuguese translations of the SUS are shown in Table 1, with responses provided on a 5-point Likert scale ranging from Strongly Disagree (coded as 0) to Strongly Agree (coded as 4).

Table 1: Questions used for the System Usability Scale questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Portuguese Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I think that I would like to use this system frequently</td>
<td>Eu gostaria de usar este aplicativo com frequência.</td>
</tr>
<tr>
<td>2</td>
<td>I found the system unnecessarily complex</td>
<td>Eu achei o aplicativo mais complexo do que o necessário.</td>
</tr>
<tr>
<td>3</td>
<td>I thought the system was easy to use</td>
<td>Eu achei que o aplicativo era fácil de usar.</td>
</tr>
<tr>
<td>4</td>
<td>I think that I would need the support of a technical person to be able to use this system</td>
<td>Eu precisei de apoio de outra pessoa para usar o aplicativo.</td>
</tr>
<tr>
<td>5</td>
<td>I found the various functions in this system were well integrated</td>
<td>Achei que funções do aplicativo estavam bem integradas.</td>
</tr>
<tr>
<td>6</td>
<td>I thought there was too much inconsistency in this system</td>
<td>Eu acho que havia muita inconsistência no aplicativo (o aplicativo parava com frequência).</td>
</tr>
<tr>
<td>7</td>
<td>I would imagine that most people would learn to use this system very quickly</td>
<td>Eu imagino que a maioria das pessoas aprenderia a usar o aplicativo muito rapidamente.</td>
</tr>
<tr>
<td>8</td>
<td>I found the system very cumbersome to use</td>
<td>Achei o aplicativo muito complicado de usar.</td>
</tr>
<tr>
<td>9</td>
<td>I felt very confident using the system</td>
<td>Eu me senti muito confiante usando o aplicativo.</td>
</tr>
<tr>
<td>10</td>
<td>I needed to learn a lot of things before I could get going with this system</td>
<td>Eu preciso aprender um monte de coisas antes de poder usar o aplicativo.</td>
</tr>
</tbody>
</table>
The questions and Portuguese translations of the TAM questionnaire can be found in Table 2. The responses to the TAM questionnaire are provided on a 7-point Likert scale ranging from Extremely Unlikely (coded as 1) to Extremely Likely (coded as 7).

Table 2: Questions used for the Technology Acceptance Model questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Perceived Usefulness</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Using PROACTIVE in my job would enable me to accomplish tasks more quickly.</td>
<td></td>
<td>Usar o PROACTIVE no meu trabalho me permitiu realizar tarefas mais rapidamente.</td>
</tr>
<tr>
<td>2</td>
<td>Using PROACTIVE would improve my job performance.</td>
<td></td>
<td>Usar o PROACTIVE melhorou meu desempenho no trabalho.</td>
</tr>
<tr>
<td>3</td>
<td>Using PROACTIVE in my job would increase my productivity.</td>
<td></td>
<td>Usar o PROACTIVE no meu trabalho aumentou minha produtividade.</td>
</tr>
<tr>
<td>4</td>
<td>Using PROACTIVE would enhance my effectiveness on the job.</td>
<td></td>
<td>Usar o PROACTIVE aumentou minha eficácia no trabalho.</td>
</tr>
<tr>
<td>5</td>
<td>Using PROACTIVE would make it easier to do my job.</td>
<td></td>
<td>Usar o PROACTIVE tornou meu trabalho mais fácil.</td>
</tr>
<tr>
<td>6</td>
<td>I would find PROACTIVE useful in my job.</td>
<td></td>
<td>Eu achei que o PROACTIVE foi útil no meu trabalho.</td>
</tr>
<tr>
<td>7</td>
<td>Learning to operate PROACTIVE would be easy for me.</td>
<td></td>
<td>Aprender a mexer no PROACTIVE foi fácil para mim.</td>
</tr>
<tr>
<td>8</td>
<td>I would find it easy to get PROACTIVE to do what I want it to do.</td>
<td></td>
<td>Quando precisei fazer algo no PROACTIVE, consegui fazer sem problemas.</td>
</tr>
</tbody>
</table>
Additionally, data were gathered on aspects of the CHW's experience with technology, such as whether they were smartphone owners, users of Whatsapp or Facebook, played computer games, and used personal computers or tablets in their daily lives. Health workers' perceived level of difficulty of dealing with technological appliances was scored on a 4-item scale, from ‘No difficulty’ (scored as 1) to ‘Can’t handle technology’ (scored as 4).

For the analysis of results, we calculated the SUS score in the usual way, which involves summing the scores on all positive elements of the questionnaire (i.e. all odd numbered statements), summing the scores on all negative elements (even numbered statements) and subtracting the latter sum from the first. By adding 20 to the result and subsequently multiplying the total by 2.5, the overall score will be on a scale of 0-100. Rather than interpreting the score as a percentage score, it should be seen as a percentile rank with a SUS score of 68 as the mean score [39].

Results from the TAM questionnaire were analysed as the Perceived Usefulness, calculated as the mean score of questions 1-6 of the TAM questionnaire, and Ease of Use, calculated as the mean score of the questions 7-12 of the TAM questionnaire.
Results

The mean overall SUS score was 65.63, which in previous studies has been associated with an overall rating of between ‘OK’ and ‘Good’ [40]. Mean ratings of the responses to the individual items are shown in Error: Reference source not found. These show that, whereas agreement with the positive aspects of the SUS (the odd-numbered questions) is always higher than neutral (a score of 2), agreement with the negative aspects of the SUS questionnaire (the even-numbered items) is higher than neutral for questions 4 and 6. From the questionnaire wording, this indicates that users experienced aspects of the system as inconsistent and expected to need assistance for further use of the system.

The mean scores for Perceived Usefulness and Ease of Use were 5.38 (SD 1.68) and 5.58 (SD 1.28) respectively, which indicates mildly positive views on Perceived Usefulness and Ease of Use. Of note for Perceived Usefulness is that the participants performed tasks with the app they had never performed before and their frame of reference did not allow comparison with a past experience without use of the app. In that respect, the Ease of Use responses are of greater interest as they give an insight in usability experiences. Three items on this scale received mean scores below 5.5 (an arbitrary cut-off point). These items relate to learning to operate (question 7), using correctly (question 8) and becoming skilful (question 11) at use of the app.

To put this in perspective, Figure 7 and Figure 7 show plots of the relationships between SUS and Ease of Use respectively versus the users reported difficulty in using technology. These figures suggest that lower scores for SUS and Ease of Use can partly be explained by the participants' level of difficulty with use of technology. This in turn suggests that the Ease of use improvements may be realised through a combination of modifications to the app and the ability to gain more experience in
its use. It is acknowledged that these results were obtained in a pilot study from a group of only eight participants, thus limiting their statistical value.
Discussion

Principal Results

Feedback obtained during the pilot and the qualitative software validation performed with end users provided important insights in the extent to which the high-level requirements identified for the system were implemented successfully.

Requirement 1: Guidance

In the usability assessment some of the users indicated they found the system inconsistent and expected to require technical assistance during normal use of the system. Whereas these results may partly stem from bugs encountered and resolved during the pilot, they do indicate that further guidance is required. Solutions may be to hide part of the interface, such as the list of pages in a chapter displayed on the left-hand side of the screen by default and more extensive logging of use of the application, such that issues can be identified automatically. For example, longer than expected or usual activity on a particular screen of the app may indicate that users encountered issues with the content presented on the screen and such findings can be discussed in supervision meetings.
**Requirement 2: Decision Support**

Decision support was visible to end-users in the form of recommendations on the course of action after three initial sessions resulting in the patient being allocated to a high (8 more sessions) or low intensity (5 more sessions) intervention, questionnaires on suicidality, and advice to discuss patients that did not show progress (based on trends in PHQ-9 responses) with supervisors. The algorithm for allocation to low or high intensity treatment was not disclosed to the health workers, so they could not influence the allocation of patients to the second phase of treatment. As the questionnaire on suicidality opened automatically, all patients who needed this assessment received it.

**Requirement 3: Supervision**

Whereas in a full-scale trial or clinical roll-out of this intervention, CHWs will be supervised by the clinical supervisors who normally have supervisory responsibilities for these CHWs, during the pilot, supervision was performed by research psychologists who conducted the pilot study. Data captured by the system was used to discuss the progress of patients and to make suggestions for future sessions.

The functionality to make audio recordings of sessions was added to the application during the pilot upon request. For simplicity and ethical considerations, it was decided not to send the resulting audio files to the server. Hence, reviews can only be done face-to-face with the CHW, who is the only person with access to the files created on the device. It would be worth considering whether the benefits that could be derived from making the audio files available on the server would weigh up against potential issues around privacy. It may also be possible to implement a consent mechanism for audio uploads to the server on a per-user or per-instance basis. A further consideration is that the storage of audio data would require more server storage capacity, but this should not be a limiting factor with modern servers.
Requirement 4: Accountability

Accountability functionality was enabled by the patient data gathered during intervention sessions, but also by logs relating to session timing and appointments. The app logged when a session was started and finished and kept track of appointments made with the patient. It also allowed the CHW to make note of missed appointments and the reasons. These data proved invaluable during the pilot in several ways. For example, the patient responses gathered during sessions allowed automated content selection during interventions and the generation of patient specific prompts to CHWs, thus providing robust support to the latter in following protocols and procedures. The data on scheduled, completed and missed sessions provided valuable information on patient progress and potential barriers to their involvement in the intervention. For (trial) supervisors, the logged data were presented in such a way that these individuals obtained a high-level overview of the intervention delivered by CHWs and progress of their patients, thus allowing timely corrective action when required.

During the pilot the geo-location of a session was not recorded and CHWs were also not prevented from accessing a session for a patient when there was no future appointment for that patient. Though this may be seen as overly rigid, there may be merit in locking the app for a user until shortly before the next scheduled appointment. This would prevent inadvertent data logging for a user (for example due to briefly accessing the next session in the app when merely intending to review the session the next patient will receive) and would also encourage CHWs to maintain complete diaries of patient visits.

Treatment recommendations and warnings regarding a lack of progression or suicidality were displayed both in the app and in the supervisors’ web interface. For full accountability, a protocol should be implemented that requires CHWs and their supervisors to indicate that the recommendations and warnings have been reviewed and followed up.
**Requirement 5: Record Keeping**

The patient data logged in the sessions were used to personalise subsequent sessions, thus facilitating CHWs to provide a contextualised intervention. This in turn enabled sessions to be conducted efficiently (for example, the medical questionnaire can be reviewed and updated very quickly) and allowed an objective review of progress (through reviewing homework agreed on in a previous session and by allowing read-only access to tabular and graphical representations of PHQ-9 response, mood ratings and homework completion on a session basis). Additionally, aggregate information derived from the data gathered during sessions, provided supervisors a good insight in patient progress and allowed for timely intervention where required.

Although, where possible, data input was structured and made quicker using drop-down lists and other multiple-choice widgets, some elements of the intervention required considerable free-text input. We provided keyboards for this purpose and though this may suit some users, others may find such input difficult on a tablet device.

**Requirement 6: Training Environment**

Though generally positive, the responses to items 3 and 7 on the SUS scale regarding ease of use and learning rate respectively, indicate that users were not always confident in using the system. Requests for an interface with ‘dummy’ patients for each of the sessions (which was implemented during the pilot) support our belief that these shortcomings can be remedied with improved in-app training facilities.

**Requirement 7: Automated Communication**

During the pilot, automated communication was limited to patient specific warnings being shown in the web interfaces for supervisors and researchers. Such automated communications should be extended to automated emails to supervisors and, where necessary, to routine care health providers involved in the care of patients that make use of the system to fully comply with accountability requirements.
Requirement 8: User-initiated Communication

Due to time constraints, user-initiated communications were not implemented during the pilot study, but CHWs were able to contact supervisors using the devices normal phone app and Google Hangouts. A Whatsapp group was used frequently for communication amongst CHWs and researchers involved in the trial. The limited implementation of this user-initiated communication in the pilot study version of the system does not seem to have had a negative effect on the good relationship between healthcare workers in a team, but this is likely due to the fact that these healthcare teams were already well-established within the Brazilian healthcare system.

Requirement 9: Delivery in the community

Mobile delivery of the intervention in patients’ homes was facilitated using the mobile intervention interface on Android tablets that contained data for all the patients under the care of a given CHW using the device. Most tablets were shared by, normally, two CHWs and the protocols required users to synchronise their devices prior to leaving the community health centre. In a few instances, this sharing resulted in CHWs using a different tablet that did not contain the data for their patients. A login in the app with subsequent synchronisation would have resulted in all data being downloaded, but this was not always performed, on occasion resulting in CHWs not being able to perform the session as planned. Although the tablets were equipped with Subscriber Identification Module (SIM) cards, a connection to the system’s servers may not always be available at a patient’s home. For this reason, it is desirable to implement a procedure within the app that unobtrusively ensures the data for the CHW using the tablet is indeed available on the device.

Limitations

The timelines and resources available for the development of the system were considerably challenging and for this reason choices had to be made in regard to the implementation of the requirements identified in the Methods section. Shortcomings in this regard were identified in the previous section and form the starting point for further development.
A further limitation related to the usability testing of our system concerns the limited number of users who provided their feedback (8 of the 11 users during the pilot). These numbers do not allow for a robust quantitative analysis of results obtained from the SUS and TAM questionnaires. Nevertheless, the qualitative analysis of their responses has provided invaluable feedback for further development of the system.

**Conclusions**

In this paper we proposed a set of high-level software requirements for ICT systems supporting task-shifted interventions based on the recommendation framework proposed by Campbell and Scott [27]. These software requirements were used to develop an ICT system for the support of a depression intervention provided by community health workers without specialised mental health training. The system consists of an app used by community health workers to provide a structured intervention to older adults in the city of São Paulo's (Brazil) poorer neighbourhoods and web interfaces that allow the various stakeholders to monitor and supervise the intervention remotely. The intervention app was built using a purpose built, Application Programming Interface that allows direct interaction between the graphical user interface and an underlying data source. The advantage of this approach is that new functionality can be rapidly added by defining the user interface alone. As a result, future development can be performed by users with limited experience in app development.

The system was used in a pilot randomised controlled trial with 11 community health workers treating 33 patients. Subsequent to the pilot, eight of these community health workers participated in a user experience assessment of the app. The System Usability Scale and Technology Acceptance Model were used to elicit information on usability, perceived usefulness and ease of use. Results from these assessments and insights gained during the pilot were used to assess the high-level software requirements we proposed. Our overall conclusion is that these high-level requirements adequately captured the functionality required to enable the CHWs to provide the intervention
successfully. Nevertheless, the analysis of results indicated some improvements are required for the system to be useable in a task-shifted intervention. The most important of these are more extensive access to a training environment, access for supervisors to meta-data such as duration of sessions or exercises to identify issues, and a more robust and human-error proof approach to availability of patient data on the mobile devices used during the intervention. Given the rapidly increasing number of task-shifted interventions which are delivered by CHWs in low-and-middle income countries, ICT solutions are a promising avenue to provide the support and accountability required in the performance of their demanding tasks.

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**Conflicts of Interest**

None declared.

**Abbreviations**

API: Application Programming Interface

CHW: Community Health Worker

ICT: Information and Communications Technology

LMIC: Low-Middle Income Countries

WHO: World Health Organisation
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