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Co-Creation Of A Digital Patient Health Hub To Enhance Education And Person-Centred Integrated Care Post Hip Fracture: A Mixed Methods Study Protocol

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Complete List of Authors:	Yadav, Lalit; The University of Adelaide, Center for Research Excellence in Frailty and Healthy Ageing, School of Medicine ; Royal Adelaide Hospital, Orthopaedic and Trauma Gill, Tiffany; The University of Adelaide, School of Medicine, Faculty of Health and Medical Sciences Taylor, Anita; Royal Adelaide Hospital, Orthopaedics and Trauma Jasper, Unyime; The University of Adelaide, Center for Research Excellence in Frailty and Healthy Ageing, School of Medicine De Young , Jen; Royal Adelaide Hospital, Orthopaedics and Trauma Visvanathan, Renuka; The University of Adelaide, Center for Research Excellence in Frailty and Healthy Ageing, School of Medicine ; The Queen Elizabeth Hospital, Aged and Extended Care Chehade, Mellick; The University of Adelaide, Center for Research Excellence in Frailty and Healthy Ageing, School of Medicine ; Royal Adelaide Hospital, Orthopaedics and Trauma
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Authors

*Lalit Yadav[1 2], Tiffany Gill[3], Anita Taylor[2], Unyime Jasper[1], Jen D Young[2], Renuka Visvanathan[1 4], Mellick Chehade[1 2]

1. Center for Research Excellence in Frailty and Healthy Ageing, School of Medicine, the University of Adelaide, Australia
2. Department of Orthopaedics and Trauma, Royal Adelaide Hospital, Adelaide, Australia
3. School of Medicine, Faculty of Health and Medical Sciences, the University of Adelaide, Australia
4. Aged and Extended Care, The Queen Elizabeth Hospital, Adelaide, Australia

Email address of authors:
Lalit.yadav@adelaide.edu.au
Tiffany.gill@adelaide.edu.au
Anita.taylor@sa.gov.au
Unyime.jasper@adelaide.edu.au
Jen.deYoung@sa.gov.au
Renuka.visvanathan@adelaide.edu.au
Mellick.chehade@adelaide.edu.au

*Corresponding author;
School of Medicine, Faculty of Health & Medical Sciences | University of Adelaide
Discipline of Orthopaedics & Trauma
Level 5G, 581, Royal Adelaide Hospital
North Terrace, Adelaide SA 5000
T:+61 870 742006
Email: lalit.yadav@adelaide.edu.au

Abstract

Introduction

Adequate health literacy skills are important for providing informed consent, understanding disease condition, and/or surgical procedure and adhering to post-hospital discharge instructions. Older people with hip fractures often require long term care and a crucial aspect is the provision of quality health information to patients and their carers to support continuity of care. If patients are well informed about their health condition and caring needs, particularly post-hospital discharge into the community setting, this may support recovery and improve quality of life. As internet and mobile access reach every household, it is possible to deliver a new model of service utilising a digital education platform as a personal health hub where both patients and their providers of care can establish a more efficient information integration and exchange process.

Methods and analysis

This study aims to engage patients, their carers and healthcare providers using a mixed methods approach. Quantitative methods will explore health literacy and ehealth literacy among older people with hip fractures admitted to the two public tertiary care hospitals in Adelaide. Qualitative methods will provide an understanding of aspects of content and context required for the digital health platform to be

developed in order to deliver quality health information. The study will use appropriate theoretical frameworks and constructs to guide the design, analysis and overall conduct of the research study.

Ethics and dissemination

The study has been approved by the Human Research Ethics Committee of the Central Adelaide Local Health Network and the University of Adelaide Human Research Ethics Committee. The scope of the study intends to ultimately empower patients and their carers to improve self-management and to better utilise coordinated services at the community level. This could prevent further falls including associated injuries or new fractures); reduce new hospital admissions; and improve confidence and engagement by limiting the psychologically restrictive "fear of falls". . Findings from the study will be published in suitable peer review journals and disseminated through workshops or conferences, involving all the stakeholders and encourage further feedback on the research conducted.

Article summary

Strengths and limitations

- The proposed study will use a mixed methods approach which will provide a unique perspective on our understanding of the entire hip fracture care pathway, through a combination of the distinct strengths of each methodology
- The study intends to utilise a combination of different and relevant theoretical frameworks to guide the design and analysis of study findings. This will enrich the collected data and interpretation of the study results, reflecting a realistic operational scenario for development of the potential intervention
- Involvement of patients and carers is a key feature in the design of this study

- A quantitative survey with limited sample size and considering only two hospital settings could be a major limitation of the study as the study findings may not be generalisable
- Similarly, considering only hip fracture patients may not be a true representation of health or ehealth literacy among older people

Key words

mixed methods, hip fracture, digital health, health literacy, patient education, patient and public involvement

Word count

3026

Introduction

Management of hip fracture in older adults poses significant challenges to delivering quality health care due to multiple medical, social and isolation issues, including frailty [1, 2]. Worldwide, hip fractures are projected to increase from 1.7 million in 1990 to 6.3 million in 2050 due to significant increases in ageing and life expectancy [3-5]. In 2000, an estimated 9 million osteoporotic fractures occurred worldwide and the annual costs for treatment have been assessed to be around $20 billion in the USA and €30 billion in the European Union [6], with 72% of this cost incurred for the management of hip fractures. Following a hip fracture, use of health services extends beyond the initial hospitalization for at least 1 year, with much of the healthcare costs attributable to subsequent long-term care [7-10]. Such patients are at high risk of complications with devastating outcomes, loss of independence, decreased mobility and reduced quality of life [11]. Post-discharge, most of these patients attend orthopaedic outpatient departments (OPD), which are located in hospitals and where access can be difficult, as patients rely on family or ambulance services to attend. For falls prevention they need to access services generally located in the community, and

General Practitioners for management of existing co-morbidities. This leads to often disconnected pathways of care contributing to discontinuation of appropriate care due to lack to integration between the different services. The difficulty related to continuing care could also be due to low empowerment among older people with hip fractures or consumers of health services, in general [12]. Patients and their carers may lack the skills to understand complex instructions related to medication, self-monitoring and self-management, follow-up schedules and prevention behaviours. Adequate health literacy skills are important for understanding surgical procedures, informed consent and adhering to post-surgical instructions. Health literacy is a patient factor that can be influenced by both patient skill level, as well as by the information, communication and education provided to them. [13]. Therefore, a single integrated care plan management system is needed that empowers the patient and their carers for both home and community management [14-15]. To be successful, the plan must adopt a systematic approach to ensure that individuals with one or more long-term conditions, and their health and care providers, have more productive and equal conversations, focused on what matters most to the individual [16]. With the advancement of modern information technology, it should be possible to seamlessly integrate the provision of different services for older people with hip fracture from acute hospital (tertiary) care to community rehabilitation and management through provision of quality health information. There is an imperative to reorient services to the community so that they can be delivered closer to the patients and in closer partnership with the consumer and primary/aged care services.

This study aims to develop a 'model of care' by using digital health solution that will allow delivery of high quality and patient-centred information, integrated into the

existing process delivered within the community setting. The system will incorporate a co-creation approach involving patients and their carers, primary/aged care clinicians, physiotherapist, dietician, and hospital-based clinicians. The objectives of the proposed study are firstly, to understand the eliteracy level of patients with hip fractures in terms of their current use of technology in accessing health information and their likelihood of using such systems through their computers or mobile telephones and other applications (context). Secondly, to explore specific health information requirements (content) for people with hip fractures, particularly after their discharge from the acute hospital setting, from the perspective of patients and their carers; clinicians and residential care providers. Thirdly, to determine important factors that need to be considered at the time of designing digital health educational platform for the patients with hip fractures (system).

Methods

Study design

The proposed study will be using pragmatic design including mixed research methods and a participatory approach through engagement of patients, their carers and healthcare providers [17]. Previous research clearly states that the ultimate success of health-related technologies depends on whether the intended users (e.g. patients) find the developed applications useful [18]. The process of co-creation allows end-users to directly influence how the technologies take shape in order to increase ultimate usability. Evidence indicates that involving end-users throughout the technology development process, substantially reduces development time and allows easy translation of technologies to practice, as usability problems are identified and resolved before the systems are launched [19-20]. The study will be conducted at two

hospital sites in Adelaide; the Royal Adelaide Hospital (RAH) and the Queen Elizabeth Hospital (TQEH).

Theoretical framework

This study will be using theoretical frameworks to guide the process of design, development and conduct of the study in real-world setting. These are the National Institute for Health and Care Excellence (NICE) guideline on hip fracture management; World Health Organization's guideline on community-level interventions to manage declines in intrinsic capacity through an integrated care approach for older people (WHO-ICOPE); Health Behaviour Change Support Systems (HBCSS); and integrated- Promoting Action on Research Implementation in Health Services (i-PARIHS) [21, 22-24].

According to the recently available NICE guideline on hip fracture management; good quality advice, reassurance, information and education were highlighted by patients as an important factor in the recovery process [22]. Examining older people from the perspective of their intrinsic capacity and the outside environment in which they live helps to understand why health services should be oriented towards the most relevant outcomes that affect older people on a day-to-day basis. Further, this approach could eliminate unnecessary treatments, reduce polypharmacy and associated side-effects and hopefully improve the overall quality of life of older people. The WHO-ICOPE guideline recommends evidence-based interventions to manage common declines in capacity among older people. These conditions were recommended because they express reductions in physical and mental capacities, as

outlined in a WHO framework on healthy ageing and are strong independent predictors of mortality and care dependency in older age [21]. The WHO-ICOPE framework will guide this proposed research study in terms of developing more comprehensive and holistic educational content for the post-hospital discharge setting and not just restricted to the specifics of a hip fracture injury.

The study intends to utilise concepts from a contemporary theoretical framework around computer mediated communication and persuasive roles. This research domain is termed a Health Behaviour Change Support System (HBCSS) [23]. A HBCSS hasbeen defined as a socio-technical information system that forms, alters, or reinforces attitudes, behaviours or acts of complying, without using deception or coercion [23, 25]. The three intertwined components of a HBCSS are content, system, and context. Content within a HBCSS is often referred to as text or video; System is the technological mode and features used to deliver the content; and Context is related to the specific organisational context or setting in which the proposed technological solution is desired to be implemented. [23]. Due to the complex nature of a HBCSS and as it is still evolving as a research discipline, there is a need to combine established theoretical frameworks such as i-PARIHS to further understand the implementation context and guide the design and development of the proposed research study [24, 26].

According to i-PARIHS, successful implementation involves facilitation of Innovation, Recipients and Context, taking account of them together and how they interrelate with each other. The construct of "Innovation" not only includes explicit knowledge available through evidence but also tacit, practice-based knowledge,

which is considered to be influencing when it comes to implementation. The construct of "Recipient" includes those people who are affected by and influence implementation process and outcomes at both individual and collective team levels. "Context" exists as different layers at micro, meso and macro, and is further defined in terms of resources, culture, and leadership. It goes beyond local context to wider organisational, health system or external policy influences [24].

Quantitative Method

Inclusion and exclusion criteria

Consecutive patients aged 65 years and above with a hip fracture injury admitted to either of the two public tertiary care centres in South Australia [Royal Adelaide Hospital (RAH) and The Queen Elizabeth Hospital (TQEH)], and who could carry out the activities of daily living independently prior to hospital admission, will be invited to participate in the study. Those patients giving written informed consent will be recruited in the study. Those patients who are highly dependent upon medical care who may be unable to give consent, according to the treating clinician's discretion, will be excluded from the study.

Sample size and questionnaire

Approximately, 100 participants will be recruited from the two hospital sites. This sample size is based upon realistic consideration around recruitment of participants in the given setting and timeframe, and can be presented as a representative snapshot of the people admitted with hip fracture in these two hospitals. A published study on health literacy among elderly patients with a heart failure was also considered to

justify our sample size as a surrogate [27]. A structured survey questionnaire has been developed primarily to assess health literacy and ehealth literacy using a validated 14-item health literacy scale [28] and electronic health literacy scale [29]. Frailty status of the participants will be assessed through a validated Modified Fried Frailty Phenotype [30]. The last section of the questionnaire consists of information around hospital hip fracture care and management. The variables in the dataset have been recommended as part of the Australia New Zeeland hip fracture registry and the Global Fragility Fracture Network [11]. The required information in this section can be extracted from the patient hospital records and admission data. Approximately 20-30 minutes will be required to complete the survey questionnaire (Appendix-1).

Statistical analysis plan

Data will be analysed to assess primarily general health literacy and ehealth literacy among older people with hip fracture among the population admitted to the two hospitals in Adelaide, South Australia. Apart from frequencies of basic demographic information, current use of information technology for accessing health information and the likelihood of using the future technological solutions will also be analysed. The participants will be classified into two groups, non-frail and or frail and the differences in the data between the two groups will be analysed using Student's t-test or Chi-square test and also separately for each sex. In addition, multivariable logistic regression analysis will be carried out, adjusted for age, sex, body mass index, education.

Qualitative Method

The qualitative component of this phase of the study will consists of in-depth interviews (IDI) and focus group discussions (FGD) conducted with healthcare providers from different disciplines, patients, their carers, and aged care providers. Healthcare providers include orthopaedic and geriatric consultants, residents and nursing staff, physiotherapist, dietician and fracture liaison nurse. Approximately, 15 IDIs and 4 FGDs will be conducted. An interview schedule has been prepared each separately for patients, their carers and healthcare providers. (Appendix 2 to 4) and also separate FGD guides for healthcare providers and patients along with their carers. (Appendix 5 & 6). Views of patients, along with their carers, will be explored around specific health information requirements (content) for people with hip fractures, particularly after their discharge from the acute hospital setting. Simultaneously, this component will help determine important factors that need to be considered at the time of designing an ehealth educational platform.

The audio recording will be transcribed verbatim and analysed according to thematic framework. The researcher will start analysing the data simultaneously with progressing data collection. Different themes emerged from the analysed data will then be compared and interpreted according to the constructs of HBCSS theoretical framework for better insights. [20].

Data Management and ethical consideration

The proposed study has been approved by the Human Research Ethics Committee of the Central Adelaide Local Health Network [HREC/18/CALHN/687], site specific assessment for RAH [SSA/19/CALHN/59 and Governance approval reference no. 11183] and TQEH [SSA/19/CALHN/57 and Governance approval reference no. 11184] and the University of Adelaide [HREC reference no. 33383]. Before recruiting

the study participants, the research personnel will discuss he study with the help of a participant information sheet (PIS). This will cover in detail the participation requirements, any benefits, confidentiality and data protection, the written informed consent process and the opportunity to withdraw from the study at any stage in the project.

Confidentiality and data security

Any information obtained in connection with this research project that can identify study participants will remain confidential. The collected information will only be used for the purpose of this research project and it will only be disclosed with participant's permission, except as required by law. The IDIs and FGDs recordings will be transferred from the audio recording device onto the secure server, soon after the data collection is completed. The data will be deleted from the collection device after ensuring all of the data have been successfully transferred to the secured server drive. The transferred recording on the server will be de-identified and only accessible to the researchers working on this study project.

The proposed study will adhere to the ethical principles of respect for study participants, research merit and integrity, justice and beneficence by putting appropriate mechanisms in place, as stated above, throughout the conduct of the study.

Data availability statement

The de-identified survey results, interview transcripts and audio files collected as part of this study will be available to access through relevant repository

Patient and public involvement

Older people including former patients with hip fractures or their family members and representatives from residential aged care providers were involved in the early conceptualisation phase through a consumer research showcase event. This event was hosted by Multicultural Aged Care South Australia (MACSA) and Centre for Research Excellence in Frailty and Healthy Ageing, School of Medicine, the University of Adelaide. One of the authors (LY) lead the discussion with the event participants to understand the direction of this research process and influenced the study design. Further, the study steering group will also include representation from patients, consumer group and residential aged care provider to guide the conduct of the study at each phase and will be closely monitored.

Discussion

Hip fractures in older age require multidisciplinary integrated care and are often regarded as surrogate marker on how the health system deals with frail, older patients [31]. A qualitative study conducted in Sweden demonstrated that following an event of hip fractures, patients not only have restricted mobility but also lose their confidence and self-efficacy due to the complex recovery process consisting of both physical and psychological strain. The study concluded that even after four months post-surgery, the previously healthy and independently-living felt hip fractures affected their day-to-day life [32]. Another study by the same group of authors revealed that due to exposure to the ward culture at the time of acute hospital admission, these patients become passive and insecure about their future life situation. The study further suggests these patients believe in recovery but lack psychological support to regain pre-fracture status [33].

Patients get confused as they find it difficult to navigate the health care system due to poor care coordination leading to adverse health outcomes and wastage of consumer resources .Often patients and their carers are interested in being involved in the decision-making process about the management of their condition. Increasingly, emphasis has been given to provide solutions which assist patients with more information and enable them to actively participate in their care process. Some of these solutions include a patient navigator, consumer engagement, process mapping, decision aids, and clinical pathways [34]. According to Kastner et al , management of conditions like osteoporosis which often lead to hip fractures, require complex interventions; of which patient education appears to be the most important component [35]. Educating patients require provision of good quality health information to encourage patient participation in healthcare and ensure that patients have greater power, protection and choice in key aspects of their care [36]. Also, patient information is a key component of effective self-management [37].

Patient education centres around the assumption that patients who are better informed about their condition and management will be more likely to adopt positive health behaviours [38] and will therefore improve, maintain or slow deterioration of their health status. However, this view-point of patient education does not acknowledge the role of patient opinions and choices and implies that health professionals set the education agenda and define optimal health behaviours [39]. Thus, the attitude, beliefs and behaviours are considered to be important factors in influencing information needs of the patients, in addition to contextual factors and the format of educational resources [40]. In a recent study by Brookes, over 228,000 comments posted to the

National Health Service (NHS) choice website were evaluated both quantitatively and qualitatively through a computer-assisted program. The study suggested patients' perception around possible improvement areas within various aspects of NHS service provision. High priority was given to the interpersonal aspect of healthcare provider interaction as well as system/organisational issues in coordinating services [41].

With the advancement of modern information technology (IT), it should be possible to integrate seamlessly the provision of desired educational information for older people with hip fracture from acute hospital (tertiary) care to community rehabilitation and management.

Conclusion

As the global penetration of mobile devices achieves universal access, it is timely to upgrade and optimize supporting health system technologies and pathways of information provision. There is scope for improvement and health systems are beginning to focus their technological development around patient-centered and integrated care approaches. Now is the time to tackle gaps and supplement the irreplaceable human elements of patient navigation with mobile and/or computer applications. Technological advancement should consolidate relevant information in a broad-reaching manner, with real-time support to patients and their carers in their journey from diagnosis to follow up [34]. Technology could also potentially empower and build the capacity of primary health care providers to integrate care that channels expertise to the patient and brings specialty consultations closer to the community. Furthermore, technology helps to engage patients through improved communication and fostering self-management skills for their chronic conditions [42]. For success, it

must adopt a systematic approach to engage people with chronic disease conditions and complex care needs, along with their care providers, and ensure they have an equal say in the matters about the management of their disease condition [16].

Author contributions

LY, TG, RV, AT and MC contributed in the study conceptualisation, following iteirative process of discussion. LY in routine discussion with TG conducted the background literarure search around theoretical framework and methodology to guide the conduct of the pragmatic study approach. LY write the initial first draft under the guidance of MC, RV and TG. The draft was reviewed and critical inputs were provided by TG, AT, UJ, JY, RV and MC. This final version of the manuscript incorporates comments and edits from the authors and approved by all.

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Competing interests statement

The authors declare that they have no competing interests.

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Appendix-1: Survey Questionnaire

Section-I: Demographics		
SR No	Variables	Response options
1	Age (Years)/Date of Birth	
2	Sex	Male ☐ Female ☐
3	Education	Primary ☐ Secondary ☐ Technical ☐ Bachelors ☐ Masters or above ☐ Other ☐ If other, please specify_____ Not stated ☐
4	Previous occupation (*Codes)	Professionals ☐ Clerical & administrative ☐ Technicians and trade workers ☐ Managers ☐ Community & personal service workers ☐ Labourers ☐ Sales workers ☐ Machinery operators & drivers ☐ Others ☐ Please specify_____ Not stated ☐
5	Current employment status	Full time paid employment ☐ Part time paid employment ☐ Volunteer, full time ☐ Volunteer, part time ☐ Family carer, full time ☐ Family carer, part time ☐ Retired, not working ☐ Other ☐ Please specify _____
6	Language spoken at home and ethnicity	English Mandarin Arabic Cantonese Vietnamese Italian Other Please specify _____ Ethnicity_____
7	Family composition	Living with spouse or partner ☐ Living alone ☐ Living with children or relative ☐ Other ☐ Please specify_____
8	Access to own computers and smartphone	Yes☐ No ☐ If Yes, please specify Computer ☐ smartphone ☐

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Appendix-1: Survey Questionnaire

		Tablet ☐
9	Access to internet	Yes ☐ No ☐ If Yes, please specify the instrument, you have, has access to the internet Computer ☐ Smartphone ☐ Tablet ☐
10	If you do not have your own computers or smartphone, can you access computer or smartphone of other family member or friend with ease and whenever you want?	Yes ☐ No ☐
11	How would you define your current use of internet and/or mobile applications?	Rarely use ☐ Restricted to email ☐ Social media ☐ Use of mobile applications ☐ Please specify_____ Health information ☐ Please specify_____ Never used/don't know ☐
12	If given a chance and support, do you intend to learn about internet use in accessing useful health information, through your computer or smartphone?	Yes ☐ No ☐

Section-II: Frailty score		
1	***Weight loss***	Weight____Kg Height_____Mts BMI_____kg/m^2
2	***Weakness*** Prior to the fracture, does your health now limit you in lifting or carrying groceries which you might previously do during a typical day?	Yes, limited a lot ☐ Yes, limited a little ☐ No, not limited at all ☐
3	***Exhaustion*** Prior to the fracture, how much of the time during the past 4 weeks, did you feel worn out?	All of the time ☐ Most of the time ☐ A good bit of time ☐ Some of the time ☐ A little of the time ☐ None of the time ☐
4	***Slowness***	Yes, limited a lot ☐

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Appendix-1: Survey Questionnaire

	Prior to the fracture, does your health now limit you in walking 100 meters which you might previously do during a typical day?	Yes, limited a little ☐ No, not limited at all ☐
5	***Low activity*** Prior to the fracture in the last two weeks, have you considered walking for sport, recreation or fitness?	Yes ☐ No ☐

Section-III: The 14-item Health Literacy Scale						
When you read instructions or leaflets from hospitals or pharmacies, how do you agree or disagree about the following?						
		Strongly disagree	Disagree	Not sure	Agree	Strongly agree
1	I find characters that I cannot read					
2	The print is too small for me (even though I can wear glasses)					
3	The content is too difficult for me					
4	It takes long time to read them					
5	I need someone to help me read them					
If you are diagnosed as having a disease and you have little information about the disease and its treatment, how do you agree or disagree about the following?						
6	I collect information from various sources					
7	I extract the information I want					
8	I understand the obtained information					
9	I tell my opinion about my illness to my doctor, family or friends					
10	I apply the obtained information to my daily life					
If you are diagnosed as having a disease and you can obtain information about the disease and its treatment, how do you agree or disagree about the following?						
11	I consider whether the information is applicable to me					
12	I consider whether the information is credible					
13	I consider whether the information is valid and reliable					
14	I collect information to make my healthcare decisions					

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Appendix-1: Survey Questionnaire

Section-IV: electronic Health Literacy Scale						
I would like to ask you for your opinion and about your experience using the Internet for health information. For each statement, tell me which response best reflects your opinion and experience right now.						
		Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I know what health resources are available on the Internet					
2	I know where to find helpful health resources on the Internet					
3	I know how to find helpful health resources on the Internet					
4	I know how to use the Internet to answer my questions about health					
5	I know how to use the health information I find on the Internet to help me					
6	I have the skills I need to evaluate the health resources I find on the Internet					
7	I can tell high quality health resources from low quality health resources on the Internet					
8	I feel confident in using information from the Internet to make health decisions					

Section-V: Hospital admission data		
1	Side of hip fracture	Right ☐ Left ☐
2	Fracture type	Intracapsular undisplaced ☐ Intracapsular displaced ☐ Intertrochanteric ☐ Subtrochanteric ☐ Other ☐ If other, Please specify_____
3	Pre-fracture residence	Home ☐ Institution ☐ Acute care ☐ Unknown ☐
4	Pre-fracture mobility	Freely mobile without aids ☐ Mobile outdoors with one aid ☐ Mobile outdoors with two aids or frame ☐

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Appendix-1: Survey Questionnaire

		Some indoor mobility but never goes outside without help ☐ No functional mobility ☐ Unknown ☐
5	ASA grade	Normal healthy individual ☐ Mild systemic disease that does not limit activity ☐ Severe systemic disease that limits activity but is not incapacitating ☐ Incapacitating systemic disease which is constantly life threatening ☐ Moribund- not expected to survive 24 hours with or without surgery ☐ Unknown ☐
6	Pre-fracture bone protection medication	Yes ☐ No ☐
7	Date of admission to orthopaedic care	____/_____/_____
8	Operation performed	No operation performed ☐ Cannulated screws ☐ Sliding hip screw ☐ Intra-medullary nail ☐ Hemi-arthoplasty ☐ Total hip replacement ☐ Other ☐ If other, please specify_____
9	Date of surgery	_____/_____/_____
10	Pressure ulcers	Yes ☐ No ☐
11	Physician/Geriatrician involvement	Physician ☐ Geriatrician ☐ Not seen ☐
12	First day mobilisation	Yes ☐ No ☐ No operation performed ☐
13	Discharge destination	Home ☐ Institution ☐ Acute care ☐ Rehabilitation ☐ Dead ☐ Unknown ☐
14	Date of discharge	___/____/_____
15	Length of stay (days)	
16	Bone protection medication at discharge	Commenced ☐ Continued ☐ Discontinued ☐

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Appendix-2: In-depth interview schedule: Patients

Thank you for consenting to be part of this research and agreed to express your opinion. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Hospital ID:_____ Date of admission_____

Address_____

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to you and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help you recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel right kind of health information will help you recover well and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4: What areas of health information you are interested in knowing now and once you get discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

Probe: usability, functionalities,

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Appendix-4: In-depth interview schedule: Healthcare providers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Designation_____Department/Hospital_____

Date of consent_____

Context

Question-1: What is your experience, in general, with older people with hip fractures admitted to the hospital or attending clinic/consultation for treatment?

Probe: physical status, gender, education level, empowerment, priority, recovery needs, care pathway, role of carer

Question-2: What is your perspective, particularly around health literacy in this group of population?

Probe: health information needs/areas, existing provision, difficulty in accessing, possible improvement solutions, ehealth

Content

Question-3: In your opinion, what are the important areas of health information for patients recovering from a hip fracture injury after their discharge from the hospital?

Probe: clinical recovery, functional improvement, WHO ICOPE, multiple medical conditions, other issues

Questiona-4: In your opinion, do you think there is a need or scope for improving the quality of health information for this group of patients? Do you have any possible suggestions or solutions in this direction?

Probe: barriers and facilitators, role of carers and community providers (health and social care), different platforms including ehealth or IT solution

System

Question-5: Can you please recollect from your previous experience of coming across any electronic platform used for patient education and/or service delivery? Or any comment in general about the use of IT/ehealth solutions?

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Appendix-4: In-depth interview schedule: Healthcare providers

Probe: setting, usage and function, challenges, possible learning and suggestive improvements

Questiona-6: Can you please elaborate factors, in your opinion, needs to be taken into consideration while designing an ehealth platform for such group of patients?

Probe: system functionalities, patient response, existing system integration

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Appendix-5: Focus group discussion guide: Patient and carers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to you or your family member/relative and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help you and your family member/carer recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel and also as a carer, around right kind of health information will help better recovery and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4:What areas of health information you are interested in knowing now and after you or your family member/relative gets discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

Probe:usability, functionalities,

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Appendix-6: Focus group discussion guide: HCPs

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Context

Question-1: What is your experience, in general, each of you have with respect to your disciplinary area of practice while coming across older people with hip fractures admitted to the hospital or attending clinic/consultation for treatment?

Probe: physical status, gender, education level, empowerment, priority, recovery needs, care pathway, role of carer

Question-2: What is your perspective, particularly around health literacy in this group of population?

Probe: health information needs/areas, existing provision, difficulty in accessing, possible improvement solutions, ehealth

Content

Question-3: In your opinion, what are the important areas of health information for patients recovering from a hip fracture injury after their discharge from the hospital?

Probe: clinical recovery, functional improvement, WHO ICOPE-elaborate, multiple medical conditions, other issues

Questiona-4: In your opinion, do you think there is a need or scope for improving the quality of health information for this group of patients? Do you have any possible suggestions or solutions in this direction?

Probe: barriers and facilitators, role of carers and community providers (health and social care), different platforms including ehealth or IT solution

System

Question-5: Can you please recollect from your previous experience of coming across any electronic platform used for patient education and/or service delivery? Or any comment in general about the use of IT/ehealth solutions?

Probe: setting, usage and function, challenges, possible learning and suggestive improvements

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Appendix-6: Focus group discussion guide: HCPs

Questiona-6: Can you please elaborate factors, in your opinion, needs to be taken into consideration while designing an ehealth platform for such group of patients?

Probe: system functionalities, patient response, existing system integration

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Co-Creation Of A Digital Patient Health Hub To Enhance Education And Person-Centred Integrated Care Post Hip Fracture: A Mixed Methods Study Protocol

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Title: Co-Creation Of A Digital Patient Health Hub To Enhance Education And Person-Centred Integrated Care Post Hip Fracture: A Mixed Methods Study Protocol

Authors

*Lalit Yadav[1 23], Tiffany K Gill[3], Anita Taylor[2], Unyime Jasper[13], Jen D Young[2], Renuka Visvanathan[13 4], Mellick Chehade[1 23]

1. National Health and Medical Research Council Center for Research Excellence in Frailty and Healthy Ageing, Adelaide Medical School, the University of Adelaide, Australia
2. Department of Orthopaedics and Trauma, Royal Adelaide Hospital, Adelaide, Australia
3. Adelaide Medical School, Faculty of Health and Medical Sciences, the University of Adelaide, Australia
4. Aged and Extended Care, The Queen Elizabeth Hospital, Adelaide, Australia

Email address of authors:
Lalit.yadav@adelaide.edu.au
Tiffany.gill@adelaide.edu.au
Anita.taylor@sa.gov.au
Unyime.jasper@adelaide.edu.au
Jen.deYoung@sa.gov.au
Renuka.visvanathan@adelaide.edu.au
Mellick.chehade@adelaide.edu.au

*Corresponding author;
Adelaide Medical School, Faculty of Health & Medical Sciences | University of Adelaide
Discipline of Orthopaedics & Trauma
Level 5G, 581, Royal Adelaide Hospital
North Terrace, Adelaide SA 5000
T:+61 870 742006
Email: lalit.yadav@adelaide.edu.au

Abstract

Introduction

Older people with hip fractures often require long term care and a crucial aspect is the provision of quality health information to patients and their carers to support continuity of care. If patients are well informed about their health condition and caring needs, particularly post-hospital discharge into the community setting, this may support recovery and improve quality of life. As internet and mobile access reach every household, it is possible to deliver a new model of service utilising a digital education platform as a personal health hub where both patients and their providers of care can establish a more efficient information integration and exchange process. This protocol details proposed research which aims to develop a 'model of care' by using digital health solution that will allow delivery of high quality and patient-centred information, integrated into the existing process delivered within the community setting.

Methods and analysis

This phase of the study uses a pragmatic mixed methods design and a participatory approach through engagement of patients, their carers and healthcare providers from multiple disciplines to inform the development of a digital health platform. Quantitative methods will explore health literacy and ehealth literacy among older people with hip fractures admitted to the two public tertiary care hospitals in Adelaide, South Australia. Qualitative methods will provide an understanding of aspects of content and context required for the digital health platform to be developed in order to deliver quality health information. The study will use appropriate theoretical frameworks and constructs to guide the design, analysis and overall conduct of the research study.

The scope of the study intends to ultimately empower patients and their carers to improve self-management and to better utilise coordinated services at the community level. This could prevent further falls including associated injuries or new fractures; reduce new hospital admissions; and improve confidence and engagement by limiting the psychologically restrictive "fear of falls".

Article summary

Strengths and limitations

- The proposed study will use a mixed methods approach which could provide a unique perspective around patient educational and information needs during the hip fracture care pathway, through a combination of the distinct strengths of each methodology
- The study intends to utilise a combination of different and relevant theoretical frameworks to guide the design and analysis of study findings. This will enrich the collected data and interpretation of the study results, reflecting a realistic operational scenario for development of the potential intervention
- Involvement of patients and carers is a key feature in the design of this study
- A quantitative survey considering only two hospital settings could be a limitation of the study as the study findings may not be generalisable to the wider Australian context or internationally.

Key words

mixed methods, hip fracture, digital health, health literacy, patient education, patient and public involvement

Word count

3335

Introduction

Management of hip fracture in older adults poses significant challenges to delivering quality health care due to multiple medical, social and isolation issues, including frailty [1, 2]. Worldwide, hip fractures are projected to increase from 1.7 million in 1990 to 6.3 million in 2050 due to significant increases in ageing and life expectancy [3-5]. In 2000, an estimated 9 million osteoporotic fractures occurred worldwide and the annual costs for treatment have been assessed to be around $20 billion in the USA and €30 billion in the European Union [6], with 72% of this cost incurred for the management of hip fractures. Following a hip fracture, use of health services extends beyond the initial hospitalization for at least 1 year, with much of the healthcare costs attributable to subsequent long-term care [7-10]. Such patients are at high risk of complications with devastating outcomes, loss of independence, decreased mobility and reduced quality of life [11]. Post-discharge, most of these patients attend orthopaedic outpatient departments (OPD), which are located in hospitals where access can be difficult, as patients rely on family or ambulance services to attend. For falls prevention they need to access services generally located in the community, and General Practitioners for management of existing co-morbidities. This often leads to disconnected pathways of care contributing to discontinuation of appropriate care due to lack to integration between the different services. The difficulty related to continuing care could also be due to low empowerment among older people with hip fractures or consumers of health services, in general [12]. Patients and their carers may lack the skills to understand complex instructions related to medication, self-monitoring and self-management, follow-up schedules and prevention behaviours. Adequate health literacy skills are important for understanding surgical procedures, informed consent and adhering to

post-surgical instructions. Health literacy is a patient factor that can be influenced by both patient skill level, as well as by the information, communication and education provided to them. [13]. Therefore, a single integrated care plan management system is needed that empowers the patient and their carers for both home and community management [14-15]. To be successful, the plan must adopt a systematic approach to ensure that individuals with one or more long-term conditions, and their health and care providers, have more productive and equal conversations, focused on what matters most to the individual [16]. With the advancement of modern information technology, it should be possible to seamlessly integrate the provision of different services for older people with hip fracture from acute hospital (tertiary) care to community rehabilitation and management through provision of quality health information. There is an imperative to reorient services to the community so that they can be delivered closer to the patients and in closer partnership with the consumer and primary/aged care services.

The proposed research aims to develop a 'model of care' by using digital health solutions that will allow delivery of high quality and patient-centred information, integrated into the existing process delivered within the community setting. The research will be conducted in different phases incorporating a co-creation approach involving patients and their carers, primary/aged care clinicians, physiotherapists, dieticians, and hospital-based clinicians through iterative and process learning. This first phase of the study, would inform the development of a prototype, a digital health platform (Phase 2). This will be further pilot tested for usability in the next stage (Phase 3). Thus, this study protocol paper exclusively deals with the detailed methods for the first phase [Fig 1]. The objectives of this phase of the study are firstly, to understand the eliteracy level of patients with hip fractures in terms of their current

use of technology in accessing health information and their likelihood of using such systems through their computers or mobile telephones and other applications (context). Secondly, to explore specific health information requirements (content) for people with hip fractures, particularly after their discharge from the acute hospital setting, from the perspective of patients and their carers; clinicians and residential care providers. Thirdly, to determine important factors that need to be considered at the time of designing digital health educational platform for the patients with hip fractures (system) including potential barriers and facilitators around future use of such rechnologies.

Methods

Study design

The proposed study will be using pragmatic design including mixed research methods and a participatory approach through engagement of patients, their carers and healthcare providers [17]. Previous research clearly states that the ultimate success of health-related technologies depends on whether the intended users (e.g. patients) find the developed applications useful [18]. The process of co-creation allows end-users to directly influence how the technologies take shape in order to increase ultimate usability. Evidence indicates that involving end-users throughout the technology development process, substantially reduces development time and allows easy translation of technologies to practice, as usability problems are identified and resolved before the systems are launched [19-20]. The study will be conducted at two hospital sites in Adelaide; the Royal Adelaide Hospital (RAH) and the Queen Elizabeth Hospital (TQEH).

Theoretical framework

This study will be using theoretical frameworks to guide the process of design, development and conduct of the study in real-world setting. These are the National Institute for Health and Care Excellence (NICE) guideline on hip fracture management; World Health Organization's guideline on community-level interventions to manage declines in intrinsic capacity through an integrated care approach for older people (WHO-ICOPE); Health Behaviour Change Support Systems (HBCSS); and integrated-Promoting Action on Research Implementation in Health Services (i-PARIHS) [21, 22-24].

According to the recently available NICE guideline on hip fracture management; good quality advice, reassurance, information and education were highlighted by patients as an important factor in the recovery process [22]. Examining older people from the perspective of their intrinsic capacity and the outside environment in which they live helps to understand why health services should be oriented towards the most relevant outcomes that affect older people on a day-to-day basis. Further, this approach could eliminate unnecessary treatments, reduce polypharmacy and associated side-effects and hopefully improve the overall quality of life of older people. The WHO-ICOPE guideline recommends evidence-based interventions to manage common declines in capacity among older people. These conditions were recommended because they express reductions in physical and mental capacities, as outlined in a WHO framework on healthy ageing and are strong independent predictors of mortality and care dependency in older age [21]. The WHO-ICOPE framework will guide this proposed research study in terms of developing more comprehensive and holistic educational

content for the post-hospital discharge setting and not just restricted to the specifics of a hip fracture injury.

The study intends to utilise concepts from a contemporary theoretical framework around computer mediated communication and persuasive roles. This research domain is termed a Health Behaviour Change Support System (HBCSS) [23]. A HBCSS has been defined as a socio-technical information system that forms, alters, or reinforces attitudes, behaviours or acts of complying, without using deception or coercion [23, 25]. The three intertwined components of a HBCSS are content, system, and context. Content within a HBCSS is often referred to as text or video; System is the technological mode and features used to deliver the content; and Context is related to the specific organisational context or setting in which the proposed technological solution is desired to be implemented. [23]. Due to the complex nature of a HBCSS and as it is still evolving as a research discipline, there is a need to combine established theoretical frameworks such as i-PARIHS to further understand the implementation context and guide the design and development of the proposed research study [24, 26].

According to i-PARIHS, successful implementation involves facilitation of Innovation, Recipients and Context, taking account of them together and how they interrelate with each other. The construct of "Innovation" not only includes explicit knowledge available through evidence but also tacit, practice-based knowledge, which is considered to be influencing when it comes to implementation. The construct of "Recipient" includes those people who are affected by and influence implementation process and outcomes at both individual and collective team levels. "Context" exists as different layers at micro, meso and macro, and is further defined in terms of resources,

culture, and leadership. It goes beyond local context to wider organisational, health system or external policy influences [24].

While there are some overlapping constructs or concepts in each of these frameworks in addition to some limitations with each, using multiple frameworks to guide different stages of the research process and explore applicable constructs/concepts from different perspectives will provide a clearer outcome of the study results.

Quantitative Method

Inclusion and exclusion criteria

Consecutive patients aged 65 years and above with a hip fracture injury admitted to either of the two public tertiary care centres in South Australia [Royal Adelaide Hospital (RAH) and The Queen Elizabeth Hospital (TQEH)], and who could carry out their activities of daily while living independently prior to hospital admission, will be invited to participate in the study. Activities of daily living will be extracted from the case records as this are examined by an orthogeriatric nurse as part of existing practice. Those patients giving written informed consent will be recruited in the study irrespective to their levels of e(health) literacy skills. Those patients who are highly dependent upon medical care who may be unable to give consent, according to the treating clinician's discretion, will be excluded from the study.

Sample size and questionnaire

Approximately, 100 participants will be recruited from the two hospital sites over a period of six months. This sample size is based upon realistic consideration around recruitment of participants in the given setting and timeframe, and can be presented as

a representative snapshot of the people admitted with hip fracture in these two hospitals. A published study on health literacy among elderly patients with a heart failure was also considered to justify our sample size as a surrogate [27]. A structured survey questionnaire has been developed primarily to assess health literacy and ehealth literacy using a validated 14-item health literacy scale [28] and electronic health literacy scale [29]. Frailty status of the participants will be assessed through a validated Modified Fried Frailty Phenotype. According to this phenotype, frailty is present when three or more of the following criteria are met: unintentional weight loss, weak grip strength, self-reported exhaustion, slowness and low physical activity level. On the other hand, when one or two of these criteria are met, respondents are classified as prefrail. However, for the purpose of this study, we will be using a dichotomous Frailty Phenotype; Non-frail (0–2 deficits, combining non-frail and prefrail categories) and Frail (3+deficits) [30]. The last section of the questionnaire consists of information around hospital hip fracture care and management. The variables in the dataset have been recommended as part of the Australia and New Zealand Hip Fracture Rregistry (ANZHFR) and the Global Fragility Fracture Network [11]. The required information can be extracted from the patient hospital records and admission data. Approximately 20-30 minutes will be required to complete the survey questionnaire (Appendix-1).

Statistical analysis plan

The quantitative data will be analysed to address the first objective of the study related to general health literacy and ehealth literacy among older people with hip fracture Apart from frequencies of basic demographic information, current use of information technology for accessing health information and the likelihood of using the future technological solutions will also be analysed. This will help determine the likely

scenario of usability of potential digital health educational platform. The participants will be classified into two groups, non-frail and frail and the differences in the data between the two groups will be analysed using Student's t-test or Chi-square test and also separately for each sex. In addition, multivariable logistic regression analysis will be undertaken, adjusted for relevant covariates (age, sex, body mass index, education).

Qualitative Method

The qualitative component of this phase of the study will consists of in-depth interviews (IDI) and focus group discussions (FGD) conducted with healthcare providers from different disciplines, patients, their carers, and aged care providers. Orthopaedic and geriatric consultants, residents and nursing staff, physiotherapist, dietician and fracture liaison nurse will be included. Approximately, 15 IDIs and 4 FGDs will be conducted. An interview schedule has been prepared separately for patients, their carers and healthcare providers. (Appendix 2 to 4) and separate FGD guides for healthcare providers and patients along with their carers. (Appendix 5 & 6). Views of patients, along with their carers, will be explored around specific health information requirements (content) for people with hip fractures, particularly after discharge from the acute hospital setting.This component will help determine important factors that need to be considered at the time of designing an ehealth educational platform including potential barriers and facilitators around future use of such technologies. Thus, addressing the second and third objectives of this phase of study.

The audio recording will be transcribed verbatim and analysed according to themes. The researcher will analyse the data simultaneously with data collection till data saturation is reached. Different themes which emerge from the data will then be

compared and interpreted according to the constructs of HBCSS theoretical framework [20].

Data Management, Ethics and Dissemination

The proposed study has been approved by the Human Research Ethics Committee of the Central Adelaide Local Health Network [HREC/18/CALHN/687], and the University of Adelaide [HREC reference no. 33383]. A participant information sheet (PIS) will be provided to potential participant prior to recruitment. This will the study,participation requirements, any benefits, confidentiality and data protection, the written informed consent process and the opportunity to withdraw from the study at any stage in the project. Findings from the study will be published in suitable peer review journals and disseminated through workshops or conferences.

Confidentiality and data security

Any information obtained in connection with this research project that can identify study participants will remain confidential. The collected information will only be used for the purpose of this research project and it will only be disclosed with participant's permission, except as required by law. The IDIs and FGDs recordings will be transferred from the audio recording device onto the secure server, soon after the data collection is completed. The data will be deleted from the collection device after ensuring all of the data have been successfully transferred to the secured server drive. The transferred recording on the server will be de-identified and only accessible to the researchers working on this study project.

Data availability statement

The de-identified survey results, interview transcripts and audio files collected as part of this study will be available to access through relevant repository.

Patient and public involvement

Older people including former patients with hip fractures or their family members and representatives from residential aged care providers were involved in the early conceptualisation phase through a consumer research showcase event. This event was hosted by Multicultural Aged Care South Australia (MACSA) and Centre for Research Excellence in Frailty and Healthy Ageing, Adelaide Medical School, the University of Adelaide. One of the authors (LY) lead the discussion with the event participants to understand the direction of this research process and influenced the study design. Further, the study steering group will also include representation from patients, consumer group and residential aged care providers to guide the conduct of the study at each phase and will be closely monitored.

Discussion

Hip fractures in older age require multidisciplinary integrated care and are often regarded as surrogate marker on how the health system deals with frail, older patients [31]. A study relating to consumers' perspective conducted in Sweden demonstrated that following an event of hip fractures, patients not only have restricted mobility but also lose their confidence and self-efficacy due to the complex recovery process consisting of both physical and psychological strain. The study further concluded that even after four months post-surgery, the previously healthy and independently-living felt hip fractures affected their day-to-day life [32]. Another study revealed that due to

exposure to the ward culture at the time of acute hospital admission, the patients become passive and insecure about their future life situation. This suggests patients believe in recovery but lack psychological support to regain pre-fracture status [33] or inadequate empowerment [34].

The aim of our proposed research is to develop a 'model of care' by using digital health patient education platform. The development of the digital health educational platform through an iterative process, across three phases. In each phase, patients, their carers including their family members and relevant healthcare providers will be engaged through a co-creation process.

Patients and their carers are interested in being involved in the decision-making process about the management of their condition. Increasingly, emphasis has been given to provide solutions which assist patients with more information and enable them to actively participate in their care process, including management of their expectations about the recovery process prior to hospital discharge [35-36]. Management of conditions like osteoporosis which often lead to hip fractures, require complex interventions; of which patient education appears to be the most important component [37]. Educating patients requires the provision of good quality health information to encourage patient participation in healthcare and ensuring that patients have greater power, protection and choice in key aspects of their care [38]. Also, patient information is a key component around effective self-management [39].

Patient education centres around the assumption that patients who are better informed about their condition and management will be more likely to adopt positive health behaviours [40] and will therefore improve, maintain or slow deterioration of their health status. However, this view of patient education does not acknowledge the role of patient opinions and choices, and implies that health professionals set the education agenda and define optimal health behaviours [41]. Attitudes, beliefs and behaviours are considered to be important factors in influencing information needs of the patients, in addition to contextual factors and the format of educational resources [42]. Our study design is based on utilising sound theoretical frameworks including clinical guidelines. Each framework contributes in a different manner to the process; the NICE and WHO-ICOPE guidelines will help to guide best practice around the development of information 'content' for the potential digital health solution. HBCSS will guide the development of digital health 'system' and i-PARIHS focuses on the 'process of implementation' from a health system perspective. There are some overlapping constructs between these frameworks alongside certain limitations. However, simultaneously, the study will also utilise existing knowledge around best practices from local healthcare providers' perspective in South Australia.

In a recent study by Brookes, over 228,000 comments posted to the National Health Service (NHS) choice website were evaluated both quantitatively and qualitatively through a computer-assisted program. The study suggested patients' perceptions for possible areas of improvement within various aspects of NHS service provision. High priority was given to the interpersonal aspects of healthcare provider interaction as well as system/organisational issues in coordinating services [43]. Similarly, by involving the user in a participatory design ensures consumers' requested functionalities can be

incorporated to optimise the usability of the potential solution and simultaneously empower healthcare providers [44].

A recent study demonstrates that older people with hip fractures can respond well to modern technological solutions utilised for health knowledge inspite of their limited use [45]. Technological advancement should consolidate relevant information in a broad-reaching manner, with real-time support to patients and their carers in their journey from diagnosis to follow up [35]. Technology can potentially empower and build the capacity of primary health care providers to provide integrated care that channels appropriate expertise to the patient and brings specialty consultations closer to the community. Furthermore, technology helps to engage patients through improved communication and fostering self-management skills for their chronic conditions [46]. For success, it must adopt a systematic approach to engage people with chronic disease conditions and complex care needs, along with their care providers, and ensure they have an equal say in the matters about the management of their disease condition [16]. With the advancement of modern information technology, it should be possible to integrate seamlessly the provision of desired educational information for older people with hip fracture from acute hospital (tertiary) care to community rehabilitation and management.

A modified PRISMA-P statement has been included as appendix-7

Author contributions

LY, TG, RV, AT and MC contributed in the study conceptualisation, following iterative process of discussion. LY in routine discussion with TG conducted the background literature search around theoretical framework and methodology to guide the conduct of the pragmatic study approach. LY write the initial first draft under the guidance of MC, RV and TG. The draft was reviewed and critical inputs were provided by TG, AT, UJ, JY, RV and MC. This final version of the manuscript incorporates comments and edits from the authors and approved by all.

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Competing interests statement

The authors declare that they have no competing interests.

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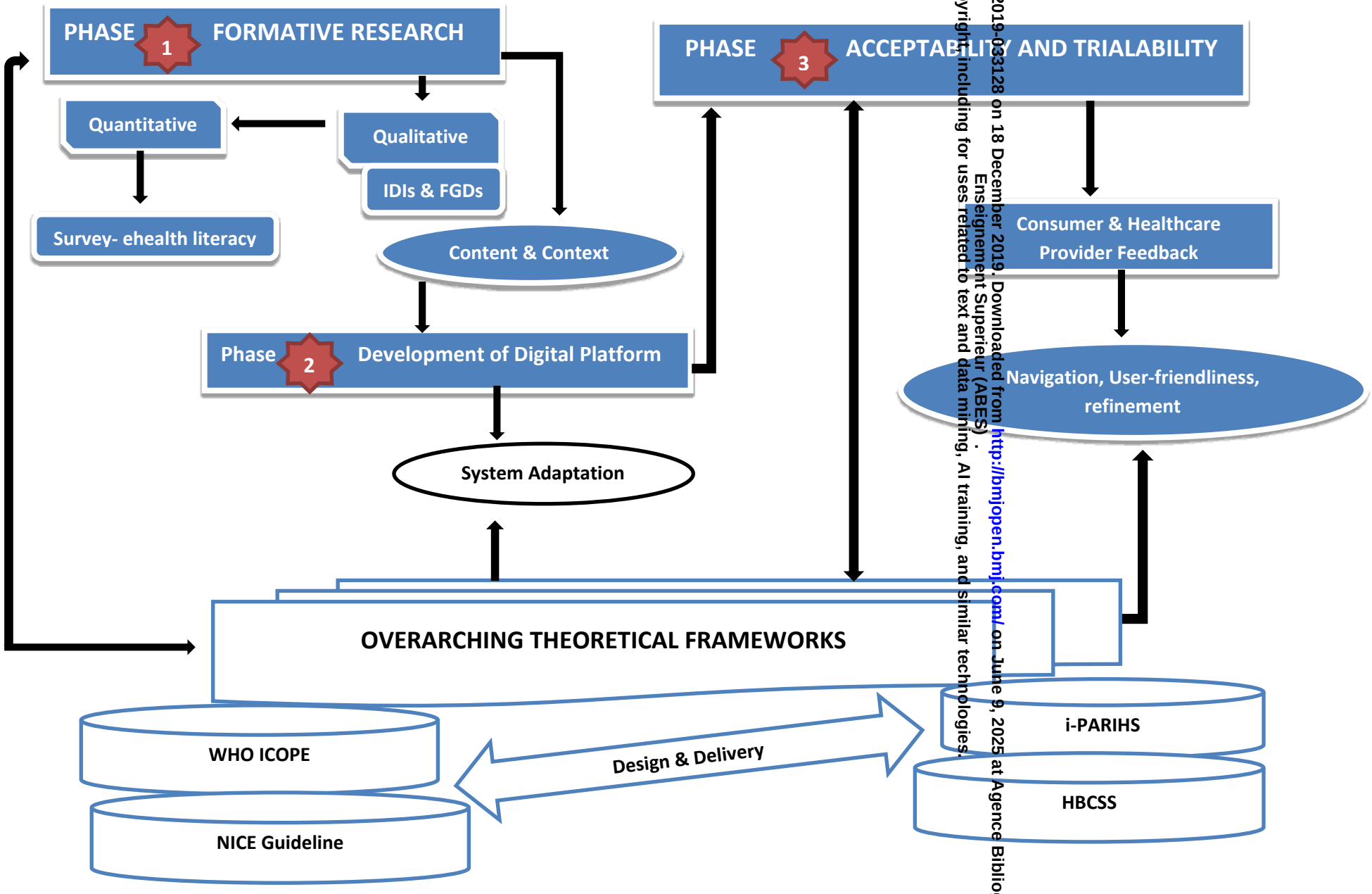
Figure 1

Figure 1: Conceptual Framework- Digital Health Patient Education Platform



**WHO ICOPE- WHO Integrated care for older people; NICE guideline- National Institute of Clinical Excellence for hip fracture management; i-PARIHS- Integrated promoting action on research implementation in health services; HBCSS- Health behaviour change support systems*

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Appendix-1: Survey Questionnaire

Section-I: Demographics		
SR No	Variables	Response options
1	Age (Years)/Date of Birth	
2	Sex	Male ☐ Female ☐
3	Education	Primary ☐ Secondary ☐ Technical ☐ Bachelors ☐ Masters or above ☐ Other ☐ If other, please specify_____ Not stated ☐
4	Previous occupation (*Codes)	Professionals ☐ Clerical & administrative ☐ Technicians and trade workers ☐ Managers ☐ Community & personal service workers ☐ Labourers ☐ Sales workers ☐ Machinery operators & drivers ☐ Others ☐ Please specify_____ Not stated ☐
5	Current employment status	Full time paid employment ☐ Part time paid employment ☐ Volunteer, full time ☐ Volunteer, part time ☐ Family carer, full time ☐ Family carer, part time ☐ Retired, not working ☐ Other ☐ Please specify _____
6	Language spoken at home and ethnicity	English Mandarin Arabic Cantonese Vietnamese Italian Other Please specify _____ Ethnicity_____
7	Family composition	Living with spouse or partner ☐ Living alone ☐ Living with children or relative ☐ Other ☐ Please specify_____
8	Access to own computers and smartphone	Yes☐ No ☐ If Yes, please specify Computer ☐ smartphone ☐

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Appendix-1: Survey Questionnaire

		Tablet ☐
9	Access to internet	Yes ☐ No ☐ If Yes, please specify the instrument, you have, has access to the internet Computer ☐ Smartphone ☐ Tablet ☐
10	If you do not have your own computers or smartphone, can you access computer or smartphone of other family member or friend with ease and whenever you want?	Yes ☐ No ☐
11	How would you define your current use of internet and/or mobile applications?	Rarely use ☐ Restricted to email ☐ Social media ☐ Use of mobile applications ☐ Please specify_____ Health information ☐ Please specify_____ Never used/don't know ☐
12	If given a chance and support, do you intend to learn about internet use in accessing useful health information, through your computer or smartphone?	Yes ☐ No ☐

Section-II: Frailty score		
1	***Weight loss***	Weight____Kg Height_____Mts BMI_____kg/m^2
2	***Weakness*** Prior to the fracture, does your health now limit you in lifting or carrying groceries which you might previously do during a typical day?	Yes, limited a lot ☐ Yes, limited a little ☐ No, not limited at all ☐
3	***Exhaustion*** Prior to the fracture, how much of the time during the past 4 weeks, did you feel worn out?	All of the time ☐ Most of the time ☐ A good bit of time ☐ Some of the time ☐ A little of the time ☐ None of the time ☐
4	***Slowness***	Yes, limited a lot ☐

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Appendix-1: Survey Questionnaire

	Prior to the fracture, does your health now limit you in walking 100 meters which you might previously do during a typical day?	Yes, limited a little ☐ No, not limited at all ☐
5	***Low activity*** Prior to the fracture in the last two weeks, have you considered walking for sport, recreation or fitness?	Yes ☐ No ☐

Section-III: The 14-item Health Literacy Scale						
When you read instructions or leaflets from hospitals or pharmacies, how do you agree or disagree about the following?						
		Strongly disagree	Disagree	Not sure	Agree	Strongly agree
1	I find characters that I cannot read					
2	The print is too small for me (even though I can wear glasses)					
3	The content is too difficult for me					
4	It takes long time to read them					
5	I need someone to help me read them					
If you are diagnosed as having a disease and you have little information about the disease and its treatment, how do you agree or disagree about the following?						
6	I collect information from various sources					
7	I extract the information I want					
8	I understand the obtained information					
9	I tell my opinion about my illness to my doctor, family or friends					
10	I apply the obtained information to my daily life					
If you are diagnosed as having a disease and you can obtain information about the disease and its treatment, how do you agree or disagree about the following?						
11	I consider whether the information is applicable to me					
12	I consider whether the information is credible					
13	I consider whether the information is valid and reliable					
14	I collect information to make my healthcare decisions					

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Appendix-1: Survey Questionnaire

Section-IV: electronic Health Literacy Scale						
I would like to ask you for your opinion and about your experience using the Internet for health information. For each statement, tell me which response best reflects your opinion and experience right now.						
		Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I know what health resources are available on the Internet					
2	I know where to find helpful health resources on the Internet					
3	I know how to find helpful health resources on the Internet					
4	I know how to use the Internet to answer my questions about health					
5	I know how to use the health information I find on the Internet to help me					
6	I have the skills I need to evaluate the health resources I find on the Internet					
7	I can tell high quality health resources from low quality health resources on the Internet					
8	I feel confident in using information from the Internet to make health decisions					

Section-V: Hospital admission data		
1	Side of hip fracture	Right ☐ Left ☐
2	Fracture type	Intracapsular undisplaced ☐ Intracapsular displaced ☐ Intertrochanteric ☐ Subtrochanteric ☐ Other ☐ If other, Please specify_____
3	Pre-fracture residence	Home ☐ Institution ☐ Acute care ☐ Unknown ☐
4	Pre-fracture mobility	Freely mobile without aids ☐ Mobile outdoors with one aid ☐ Mobile outdoors with two aids or frame ☐

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Appendix-1: Survey Questionnaire

		Some indoor mobility but never goes outside without help ☐ No functional mobility ☐ Unknown ☐
5	ASA grade	Normal healthy individual ☐ Mild systemic disease that does not limit activity ☐ Severe systemic disease that limits activity but is not incapacitating ☐ Incapacitating systemic disease which is constantly life threatening ☐ Moribund- not expected to survive 24 hours with or without surgery ☐ Unknown ☐
6	Pre-fracture bone protection medication	Yes ☐ No ☐
7	Date of admission to orthopaedic care	____/_____/_____
8	Operation performed	No operation performed ☐ Cannulated screws ☐ Sliding hip screw ☐ Intra-medullary nail ☐ Hemi-arthoplasty ☐ Total hip replacement ☐ Other ☐ If other, please specify_____
9	Date of surgery	_____/_____/_____
10	Pressure ulcers	Yes ☐ No ☐
11	Physician/Geriatrician involvement	Physician ☐ Geriatrician ☐ Not seen ☐
12	First day mobilisation	Yes ☐ No ☐ No operation performed ☐
13	Discharge destination	Home ☐ Institution ☐ Acute care ☐ Rehabilitation ☐ Dead ☐ Unknown ☐
14	Date of discharge	___/____/_____
15	Length of stay (days)	
16	Bone protection medication at discharge	Commenced ☐ Continued ☐ Discontinued ☐

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Appendix-2: In-depth interview schedule: Patients

Thank you for consenting to be part of this research and agreed to express your opinion. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Hospital ID:_____ Date of admission_____

Address_____

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to you and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help you recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel right kind of health information will help you recover well and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4: What areas of health information you are interested in knowing now and once you get discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

Probe: usability, functionalities,

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Appendix-3:In-depth interview schedule: Carers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Relationship with patient_____Hospital ID_____Date of admission_____

Address_____

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to your family member/relative and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help your family member/carer recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel, as a carer, around right kind of health information will help your family member/relative recover well and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4: As a carer, what areas of health information you are interested in knowing now and after your family member/relative gets discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

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Appendix-3:In-depth interview schedule: Carers

Probe: usability, functionalities,

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Appendix-4: In-depth interview schedule: Healthcare providers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Designation_____Department/Hospital_____

Date of consent_____

Context

Question-1: What is your experience, in general, with older people with hip fractures admitted to the hospital or attending clinic/consultation for treatment?

Probe: physical status, gender, education level, empowerment, priority, recovery needs, care pathway, role of carer

Question-2: What is your perspective, particularly around health literacy in this group of population?

Probe: health information needs/areas, existing provision, difficulty in accessing, possible improvement solutions, ehealth

Content

Question-3: In your opinion, what are the important areas of health information for patients recovering from a hip fracture injury after their discharge from the hospital?

Probe: clinical recovery, functional improvement, WHO ICOPE, multiple medical conditions, other issues

Questiona-4: In your opinion, do you think there is a need or scope for improving the quality of health information for this group of patients? Do you have any possible suggestions or solutions in this direction?

Probe: barriers and facilitators, role of carers and community providers (health and social care), different platforms including ehealth or IT solution

System

Question-5: Can you please recollect from your previous experience of coming across any electronic platform used for patient education and/or service delivery? Or any comment in general about the use of IT/ehealth solutions?

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Appendix-4: In-depth interview schedule: Healthcare providers

Probe: setting, usage and function, challenges, possible learning and suggestive improvements

Questiona-6: Can you please elaborate factors, in your opinion, needs to be taken into consideration while designing an ehealth platform for such group of patients?

Probe: system functionalities, patient response, existing system integration

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Appendix-5: Focus group discussion guide: Patient and carers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to you or your family member/relative and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help you and your family member/carer recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel and also as a carer, around right kind of health information will help better recovery and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4:What areas of health information you are interested in knowing now and after you or your family member/relative gets discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

Probe:usability, functionalities,

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Appendix-6: Focus group discussion guide: HCPs

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Context

Question-1: What is your experience, in general, each of you have with respect to your disciplinary area of practice while coming across older people with hip fractures admitted to the hospital or attending clinic/consultation for treatment?

Probe: physical status, gender, education level, empowerment, priority, recovery needs, care pathway, role of carer

Question-2: What is your perspective, particularly around health literacy in this group of population?

Probe: health information needs/areas, existing provision, difficulty in accessing, possible improvement solutions, ehealth

Content

Question-3: In your opinion, what are the important areas of health information for patients recovering from a hip fracture injury after their discharge from the hospital?

Probe: clinical recovery, functional improvement, WHO ICOPE-elaborate, multiple medical conditions, other issues

Questiona-4: In your opinion, do you think there is a need or scope for improving the quality of health information for this group of patients? Do you have any possible suggestions or solutions in this direction?

Probe: barriers and facilitators, role of carers and community providers (health and social care), different platforms including ehealth or IT solution

System

Question-5: Can you please recollect from your previous experience of coming across any electronic platform used for patient education and/or service delivery? Or any comment in general about the use of IT/ehealth solutions?

Probe: setting, usage and function, challenges, possible learning and suggestive improvements

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Appendix-6: Focus group discussion guide: HCPs

Questiona-6: Can you please elaborate factors, in your opinion, needs to be taken into consideration while designing an ehealth platform for such group of patients?

Probe: system functionalities, patient response, existing system integration

PRISMA-P Checklist

Section/topic	#	Checklist item	Information reported		Page number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title: Co-Creation Of A Digital Patient Health Hub To Enhance Education And Person-Centred Integrated Care Post Hip Fracture: A Mixed Methods Study Protocol					
Identification	1	Identify the report as a protocol	☒	☐	1
Ethics approval	2	Please provide the name of the Ethics Committee and reference numbers applicable	☒	☐	13
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	☒	☐	1
Contributions	3b	Describe contributions of protocol authors	☒	☐	18
Support					
Sources	4	Indicate sources of financial or other support for the study	☒	☐	18
INTRODUCTION					
Rationale	5	Describe the rationale for the review in the context of what is already known	☒	☐	5-6
Objectives	6	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	☒	☐	6-7
METHODS					
Study design, eligibility criteria, Method of data collection, and analysis	7	Any applicable study characteristics	☒	☐	7-12
Data management, ethics and dissemination	8		☒	☐	13
Data availability statement	9		☒	☐	14

Section/topic	#	Checklist item	Information reported		Page number(s)
			Yes	No	
Patient and public involvement	10		☒	☐	14
DISCUSSION					
Discussion	11		☒	☐	14-17

BMJ Open

Co-creation of a digital patient health hub to enhance education and person-centred integrated care post hip fracture: a mixed methods study protocol

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Title: Co-creation of a digital patient health hub to enhance education and person-centred integrated care post hip fracture: a mixed methods study protocol

Authors

*Lalit Yadav[1 23], Tiffany K Gill[3], Anita Taylor[2], Unyime Jasper[13], Jen De Young[2], Renuka Visvanathan[13 4], Mellick Chehade[1 23]

1. National Health and Medical Research Council Center for Research Excellence in Frailty and Healthy Ageing, Adelaide Medical School, the University of Adelaide, Australia
2. Department of Orthopaedics and Trauma, Royal Adelaide Hospital, Central Adelaide Local Health Network, SA Health, Government of South Australia, Adelaide, Australia
3. Adelaide Medical School, Faculty of Health and Medical Sciences, the University of Adelaide, Australia
4. Aged and Extended Care, The Queen Elizabeth Hospital, Central Adelaide Local Health Network, SA Health, Government of South Australia, Adelaide, Australia

Email address of authors:
Lalit.yadav@adelaide.edu.au
Tiffany.gill@adelaide.edu.au
Anita.taylor@sa.gov.au
Unyime.jasper@adelaide.edu.au
Jen.deYoung@sa.gov.au
Renuka.visvanathan@adelaide.edu.au
Mellick.chehade@adelaide.edu.au

*Corresponding author;
NHMRC Center for Research Excellence in Frailty and Healthy Ageing, Adelaide Medical School, University of Adelaide

Discipline of Orthopaedics & Trauma
Level 5G, 581, Royal Adelaide Hospital
North Terrace, Adelaide SA 5000
T:+61-8-7074-2006
Email: lalit.yadav@adelaide.edu.au

Abstract

Introduction

Older people with hip fractures often require long term care and a crucial aspect is the provision of quality health information to patients and their carers to support continuity of care. If patients are well informed about their health condition and caring needs, particularly post-hospital discharge into the community setting, this may support recovery and improve quality of life. As internet and mobile access reach every household, it is possible to deliver a new model of service utilising a digital education platform as a personal health hub where both patients and their providers of care can establish a more efficient information integration and exchange process. This protocol details proposed research which aims to develop a 'model of care' by using a digital health solution that will allow delivery of high quality and patient-centred information, integrated into the existing process delivered within the community setting.

Methods and analysis

This phase of the study uses a pragmatic mixed methods design and a participatory approach through engagement of patients, their carers and healthcare providers from multiple disciplines to inform the development of a digital health platform. Quantitative methods will explore health literacy and ehealth literacy among older people with hip fractures admitted to the two public tertiary care hospitals in Adelaide, South Australia. Qualitative methods will provide an understanding of aspects of content and context required for the digital health platform to be developed

in order to deliver quality health information. The study will use appropriate theoretical frameworks and constructs to guide the design, analysis and overall conduct of the research study.

The scope of the study intends to ultimately empower patients and their carers to improve self-management and to better utilise coordinated services at the community level. This could prevent further falls including associated injuries or new fractures; reduce new hospital admissions; and improve confidence and engagement by limiting the psychologically restrictive "fear of falls".

Ethics and dissemination

The study has been approved by the Human Research Ethics Committee of the Central Adelaide Local Health Network, SA Health, Government of South Australia and the University of Adelaide Human Research Ethics Committee. Findings from the study will be published in suitable peer reviewed journals and disseminated through workshops or conferences.

Article summary

Strengths and limitations

- The proposed study will use a mixed methods approach which could provide a unique perspective around patient educational and information needs during the hip fracture care pathway, through a combination of the distinct strengths of each methodology
- The study intends to provide an enriched data through interpretation of results, utilising different theoretical frameworks, including best practice clinical

guidelines, contemporary models of implementation science and behaviour change to guide the design and analysis of study findings.

- Involvement of patients and carers is a key feature in the design of this study
- A quantitative survey considering only two hospital settings could be a limitation of the study as the study findings may not be generalisable to the wider Australian context or internationally.

Key words

mixed methods, hip fracture, digital health, health literacy, patient education, patient and public involvement

Word count

3337

Introduction

Management of hip fracture in older adults poses significant challenges to delivering quality health care due to multiple medical, social and isolation issues, including frailty [1, 2]. Worldwide, hip fractures are projected to increase from 1.7 million in 1990 to 6.3 million in 2050 due to significant increases in ageing and life expectancy [3-5]. In 2000, an estimated 9 million osteoporotic fractures occurred worldwide and the annual costs for treatment have been assessed to be around $20 billion in the USA and €30 billion in the European Union [6], with 72% of this cost incurred for the management of hip fractures. Following a hip fracture, use of health services extends beyond the initial hospitalization for at least 1 year, with much of the healthcare costs attributable to subsequent long-term care [7-10]. Such patients are at high risk of complications with devastating outcomes, loss of independence, decreased mobility and reduced quality of life [11]. Post-discharge, most of these patients attend orthopaedic outpatient departments (OPD), which are located in hospitals where access can be difficult, as patients rely on family or ambulance services to attend. For falls prevention they need to access services generally located in the community, and general practitioners (GPs) for management of existing co-morbidities. This often leads to disconnected pathways of care contributing to discontinuation of appropriate care due to lack of integration between different services. The difficulty related to continuing care could also be due to low empowerment among older people with hip fractures or consumers of health services, in general [12]. Patients and their carers may lack the skills to understand complex instructions related to medication, self-monitoring and self-management, follow-up schedules and prevention behaviours. Adequate health literacy skills are important for understanding surgical procedures, informed consent and adhering to post-surgical instructions. Health literacy is a patient factor that can be influenced by

both patient skill level, as well as by the information, communication and education provided to them. [13]. Therefore, a single integrated care plan management system is needed that empowers the patient and their carers for both home and community management [14-15]. To be successful, the plan must adopt a systematic approach to ensure that individuals with one or more long-term conditions, and their health and care providers, have more productive and equal conversations, focused on what matters most to the individual [16]. With the advancement of modern information technology, it should be possible to seamlessly integrate different services for older people with hip fracture from acute hospital (tertiary) care to community rehabilitation and management through provision of quality health information. There is an imperative to reorient services to the community so that they can be delivered closer to the patients and in partnership with the consumers and primary/aged care services.

The proposed research aims to develop a 'model of care' by using a digital health solution that will allow delivery of high quality and patient-centred information, integrated into the existing process, delivered within the community setting. The research will be conducted in different phases, incorporating a co-creation approach involving patients and their carers, primary/aged care clinicians, physiotherapists, dieticians, and hospital-based clinicians through an iterative process . This first phase of the study, would inform the development of a prototype, a digital health platform (Phase 2). This will be further pilot tested for usability in the next stage (Phase 3). Thus, this study protocol paper exclusively deals with the detailed methods for the first phase [Fig 1]. The objectives of this phase of the study are firstly, to understand the eliteracy level of patients with hip fractures in terms of their current use of technology in accessing health information and their likelihood of using such systems

through their computers or mobile and other digital applications (context). Secondly, to explore specific health information requirements (content) for people with hip fractures, particularly after their discharge from the acute hospital setting, from the perspective of patients and their carers; clinicians and residential care providers. Thirdly, to determine important factors that need to be considered at the time of designing digital health educational platform for the patients with hip fractures (system) including potential barriers and facilitators around future use of such technologies.

Methods

Study design

The proposed study will be using pragmatic design including mixed methods research and a participatory approach through engagement of patients, their carers and healthcare providers [17]. Previous research clearly states that the ultimate success of health-related technologies depends on whether the intended users (e.g. patients) find the developed applications useful [18]. The process of co-creation allows end-users to directly influence how the technologies take shape in order to increase ultimate usability. Evidence indicates that involving end-users throughout the technology development process, substantially reduces development time and allows easy translation of technologies to practice, as usability problems are identified and resolved before the systems are launched [19-20]. The study will be conducted at two hospital sites in Adelaide; the Royal Adelaide Hospital (RAH) and the Queen Elizabeth Hospital (TQEH).

Theoretical framework

This study will be using theoretical frameworks to guide the process of design, development and conduct of the study in real-world setting. These are the National Institute for Health and Care Excellence (NICE) guideline on hip fracture management; World Health Organization's guideline on community-level interventions to manage declines in intrinsic capacity through an integrated care approach for older people (WHO-ICOPE); Health Behaviour Change Support Systems (HBCSS); and integrated-Promoting Action on Research Implementation in Health Services (i-PARIHS) [21, 22-24].

According to the recently available NICE guideline on hip fracture management; good quality advice, reassurance, information and education were highlighted by patients as an important factor in the recovery process [22]. Examining older people from the perspective of their intrinsic capacity and the outside environment in which they live helps to understand why health services should be oriented towards the most relevant outcomes that affect older people on a day-to-day basis. Further, this approach could eliminate unnecessary treatments, reduce polypharmacy and associated side-effects and hopefully improve the overall quality of life for older people. The WHO-ICOPE guideline recommends evidence-based interventions to manage common declines in capacity among older people. These conditions were recommended because they express reductions in physical and mental capacities, as outlined in a WHO framework on healthy ageing and are strong independent predictors of mortality and care dependency in older age [21]. The WHO-ICOPE framework will guide this proposed research study in terms of developing more comprehensive and holistic educational

content for the post-hospital discharge setting and not just restricted to the specifics of a hip fracture injury.

The study further intends to utilise concepts from a contemporary theoretical framework around computer mediated communication and persuasive roles. This research domain is termed a Health Behaviour Change Support System (HBCSS) [23]. A HBCSS has been defined as a socio-technical information system that forms, alters, or reinforces attitudes, behaviours or acts of complying, without using deception or coercion [23, 25]. The three intertwined components of a HBCSS are content, system, and context. Content within a HBCSS is often referred to as text or video; system is the technological mode and features used to deliver the content; and context is related to the specific organisational context or setting in which the proposed technological solution is desired to be implemented. [23]. Due to the complex nature of HBCSS and as it is still evolving as a research discipline, there is a need to combine established theoretical frameworks such as i-PARIHS to further understand the implementation context and guide the design and development of the proposed research study [24, 26].

According to i-PARIHS, successful implementation involves facilitation of innnovation, recipients and context, taking account of them together and how they interrelate with each other. The construct of "innovation" not only includes explicit knowledge available through evidence but also tacit, practice-based knowledge, which is considered to be influencing when it comes to implementation. The construct of "recipient" includes those people who are affected by and influence implementation process and outcomes at both individual and collective team levels. "context" exists as different layers at micro, meso and macro, and is further defined in terms of resources,

culture, and leadership. It goes beyond local context to wider organisational, health system or external policy influences [24].

While there are some overlapping constructs or concepts with certain limitations in each of the frameworks, a combination approach to guide different stages of the research process and exploring these constructs or concepts from different perspectives will provide robust understanding around study results.

Quantitative Method

Inclusion and exclusion criteria

Consecutive patients aged 65 years and above with a hip fracture injury admitted to either of the two public tertiary care centres in South Australia [Royal Adelaide Hospital (RAH) and The Queen Elizabeth Hospital (TQEH)], and who could carry out their activities of daily living, independently prior to hospital admission, will be invited to participate in the study. Activities of daily living will be extracted from the case records as this is examined by an orthogeriatric nurse as part of the existing practice. Those patients giving written informed consent will be recruited in the study irrespective to their levels of (e)health literacy skills. Those patients highly dependent upon medical care who may be unable to give consent, according to the treating clinician's discretion, will be excluded from the study.

Sample size and questionnaire

Approximately, 100 participants will be recruited from the two hospital sites over a period of six months. This sample size is based upon realistic consideration around recruitment of participants in the given setting and timeframe, and can be presented as a representative snapshot of the people admitted with hip fracture in these two hospitals. A published study on health literacy among elderly patients with a heart failure was also considered to justify our sample size, as a surrogate [27]. A structured survey questionnaire has been developed primarily to assess health literacy and ehealth literacy using a validated 14-item health literacy scale [28] and electronic health literacy scale [29]. Frailty status of the participants will be assessed through a validated Modified Fried Frailty Phenotype. According to this phenotype, frailty is present when three or more of the following criteria are met: unintentional weight loss, weak grip strength, self-reported exhaustion, slowness and low physical activity level. On the other hand, when one or two of these criteria are met, respondents are classified as prefrail. However, for the purpose of this study, we will be using a dichotomous Frailty Phenotype; Non-frail (0–2 deficits, combining non-frail and prefrail categories) and Frail (3+deficits) [30]. The last section of the questionnaire consists of information around hospital hip fracture care and management. The variables in the dataset have been recommended as part of the Australia and New Zealand Hip Fracture Registry (ANZHFR) and the Global Fragility Fracture Network [11]. The required information can be extracted from the patient hospital records and admission data. Approximately 20-30 minutes will be required to complete the survey questionnaire (Appendix-1).

Statistical analysis plan

The quantitative data will be analysed to address the first objective of the study related to general health literacy and ehealth literacy among older people with hip fracture. Apart from frequencies of basic demographic information, current use of information technology for accessing health information and the likelihood of using the future technological solutions will also be analysed. This will help determine the likely scenario of usability of potential digital health educational platform. The participants will be classified into two groups, non-frail and frail and the differences in the data between the two groups will be analysed using Student's t-test or Chi-square test and also separately for each sex. In addition, multivariable logistic regression analysis will be undertaken, adjusted for relevant covariates (age, sex, body mass index, education).

Qualitative Method

The qualitative component of this phase of the study will consists of in-depth interviews (IDI) and focus group discussions (FGD) conducted with healthcare providers from different disciplines, patients, their carers, and aged care providers. Orthopaedic and geriatric consultants, residents and nursing staff, physiotherapist, dietician and fracture liaison nurse will be included. Approximately, 15 IDIs and 4 FGDs will be conducted. An interview schedule has been prepared separately for patients, their carers and healthcare providers. (Appendix 2 to 4) and separate FGD guides for healthcare providers and patients along with their carers. (Appendix 5 & 6). Views of patients, along with their carers, will be explored around specific health information requirements (content) for people with hip fractures, particularly after discharge from the acute hospital setting. This component will help determine important factors that need to be considered at the time of designing a digital health educational platform

including potential barriers and facilitators around future use of such technologies. Thus, addressing the second and third objectives of this phase of study.

The audio recording will be transcribed verbatim and analysed according to themes. The researcher will analyse the data simultaneously with data collection until data saturation is reached. Different themes which emerge from the data will then be compared and interpreted according to the constructs of HBCSS theoretical framework [20].

Data Management, Ethics and Dissemination

The proposed study has been approved by the Human Research Ethics Committee of the Central Adelaide Local Health Network, SA Health, Government of South Australia [HREC/18/CALHN/687], and the University of Adelaide [HREC reference no. 33383]. A participant information sheet will be provided to potential participant prior to recruitment. This will include the study description; participation requirements, benefits, confidentiality and data protection, the written informed consent process and the opportunity to withdraw from the study at any stage in the project. Findings from the study will be published in suitable peer reviewed journals and disseminated through workshops or conferences.

Confidentiality and data security

Any information obtained in connection with this research project that can identify study participants will remain confidential. The collected information will only be used for the purpose of this research project and it will only be disclosed with participant's permission, except as required by the law. The IDIs and FGDs recording will be

transferred from the audio recording device onto a secure server, soon after the data collection is completed. The data will be deleted from the recording device after ensuring all of the data have been successfully transferred to the secured server drive. The transferred recording on the server will be de-identified and only accessible to the researchers, working on this study project.

Patient and public involvement

Older people including former patients with hip fractures, their family members and representatives from residential aged care providers were involved in the early conceptualisation phase through a consumer research showcase event. This event was hosted by Multicultural Aged Care South Australia (MACSA) and NHMRC Centre for Research Excellence in Frailty and Healthy Ageing, Adelaide Medical School, the University of Adelaide. One of the authors (LY) lead the discussion with the event participants to understand the direction of this research process and informed the study design. Further, the study steering group will also include representation from patients, consumers group and residential aged care providers to guide the conduct of the study at each phase and will be closely monitored.

Discussion

Hip fractures in older age require multidisciplinary integrated care and are often regarded as a surrogate marker of how the health system deals with frail, older patients [31]. A study relating to consumers' perspective conducted in Sweden demonstrated that following an event of hip fracture, patients not only have restricted mobility but also lose their confidence and self-efficacy due to the complex recovery process

consisting of both physical and psychological strain. The study further concluded that even after four months post-surgery, the previously healthy and independently-living felt hip fractures affected their day-to-day life [32]. Another study revealed that due to exposure to the ward culture at the time of acute hospital admission, patients become passive and insecure about their future life situation. This suggests patients believe in recovery but lack psychological support to regain pre-fracture status [33] or inadequate empowerment [34].

The aim of our proposed research is to develop a 'model of care' by using a digital health patient education platform. The development of this digital health educational platform will go through an iterative process, across the three phases. In each phase, patients, their carers including their family members and relevant healthcare providers will be engaged through a co-creation process.

Patients and their carers are interested in being involved in the decision-making process about the management of their condition. Increasingly, emphasis has been given to provide solutions which assist patients with more information and enable them to actively participate in their care process, including management of their expectations about the recovery process prior to hospital discharge [35-36]. Management of conditions like osteoporosis which often lead to hip fractures, require complex interventions; of which patient education appears to be the most important component [37]. Educating patients requires provision of good quality health information to encourage patient participation in healthcare and ensuring that patients have greater power, protection and choice in key aspects of their care [38]. Also, patient information is a key component around effective self-management [39].

Patient education centres around the assumption that patients who are better informed about their condition and management will be more likely to adopt positive health behaviours [40] and will therefore improve, maintain or slow deterioration of their health status. However, this view of patient education does not acknowledge the role of patient opinions and choices, and implies that health professionals set the education agenda and define optimal health behaviours [41]. Attitudes, beliefs and behaviours are considered to be important factors in influencing information needs of the patients, in addition to contextual factors and the format of educational resources [42]. Our study design is based on utilising sound theoretical frameworks including clinical guidelines. Each framework contributes in a different manner to the process; the NICE and WHO-ICOPE guidelines will help to guide best practice around the development of information 'content' for the potential digital health solution. HBCSS will guide the development of digital health 'system' and i-PARIHS focuses on the 'process of implementation' from a health system perspective. There are some overlapping constructs between these frameworks alongside certain limitations. However, simultaneously, the study will also utilise existing knowledge around best practices from local healthcare providers' perspective in South Australia.

In a recent study by Brookes, over 228,000 comments posted to the National Health Service (NHS) choice website were evaluated both quantitatively and qualitatively through a computer-assisted program. The study suggested patients' perceptions for possible areas of improvement within various aspects of NHS service provision. High priority was given to the interpersonal aspects of healthcare provider interaction as well as system or organisational issues in coordinating services [43]. Similarly, by involving

the user in a participatory design ensures consumers' requested functionalities can be incorporated to optimise the usability of the potential solution and simultaneously empower healthcare providers [44].

A recent study demonstrates that older people with hip fractures can respond well to modern technological solutions utilised for health knowledge inspite of their limited use [45]. Technological advancement should consolidate relevant information in a broad-reaching manner, with real-time support to patients and their carers in their journey from diagnosis to follow up [35]. Technology can potentially empower and build the capacity of primary health care providers to provide integrated care that channels appropriate expertise to the patient and brings specialty consultations closer to the community. Furthermore, technology helps to engage patients through improved communication and fostering self-management skills for their chronic conditions [46]. For success, it must adopt a systematic approach to engage people with chronic disease conditions and complex care needs, along with their care providers, and ensure they have an equal say in the matters about the management of their disease condition [16]. With the advancement of modern information technology, it should be possible to integrate seamlessly the provision of desired educational information for older people with hip fracture from acute hospital (tertiary) care to community rehabilitation and management.

Data availability statement

The de-identified survey results, interview transcripts and audio files collected as part of this study will be available to access through relevant repository.

Author contributions

LY, TG, RV, AT and MC contributed in the study conceptualisation, following iterative process of discussion. LY in routine discussion with TG conducted the background literature search around theoretical framework and methodology to guide the conduct of the pragmatic study approach. LY write the initial first draft under the guidance of MC, RV and TG. The draft was reviewed and critical inputs were provided by TG, AT, UJ, JY, RV and MC. This final version of the manuscript incorporates comments and edits from the authors and approved by all.

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Competing interests statement

The authors declare that they have no competing interests.

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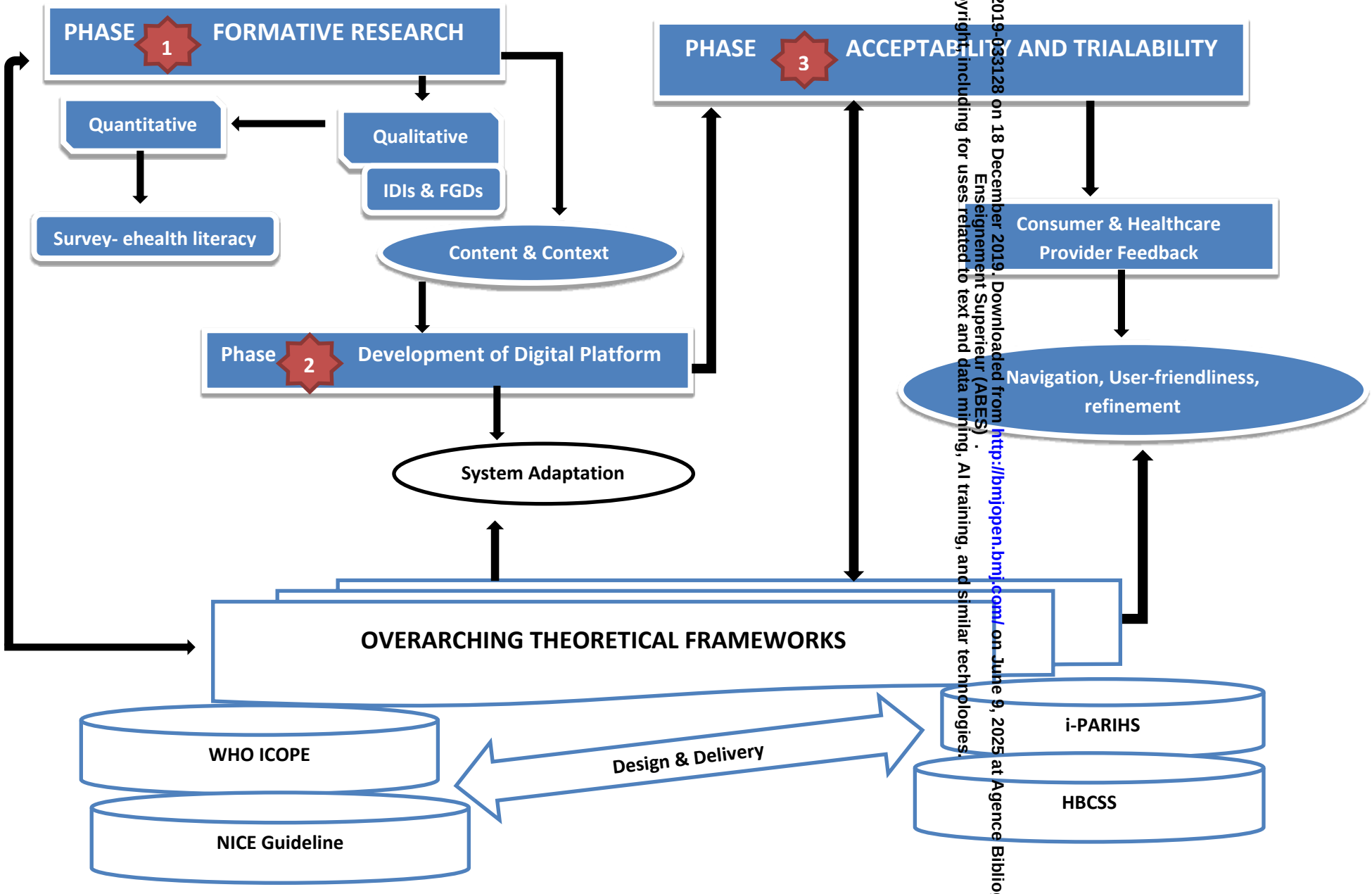
Figure 1

Figure 1: Conceptual Framework- Digital Health Patient Education Platform



**WHO ICOPE- WHO Integrated care for older people; NICE guideline- National Institute of Clinical Excellence for hip fracture management; i-PARIHS- Integrated promoting action on research implementation in health services; HBCSS- Health behaviour change support systems*

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Appendix-1: Survey Questionnaire

Section-I: Demographics		
SR No	Variables	Response options
1	Age (Years)/Date of Birth	
2	Sex	Male ☐ Female ☐
3	Education	Primary ☐ Secondary ☐ Technical ☐ Bachelors ☐ Masters or above ☐ Other ☐ If other, please specify_____ Not stated ☐
4	Previous occupation (*Codes)	Professionals ☐ Clerical & administrative ☐ Technicians and trade workers ☐ Managers ☐ Community & personal service workers ☐ Labourers ☐ Sales workers ☐ Machinery operators & drivers ☐ Others ☐ Please specify_____ Not stated ☐
5	Current employment status	Full time paid employment ☐ Part time paid employment ☐ Volunteer, full time ☐ Volunteer, part time ☐ Family carer, full time ☐ Family carer, part time ☐ Retired, not working ☐ Other ☐ Please specify _____
6	Language spoken at home and ethnicity	English Mandarin Arabic Cantonese Vietnamese Italian Other Please specify _____ Ethnicity_____
7	Family composition	Living with spouse or partner ☐ Living alone ☐ Living with children or relative ☐ Other ☐ Please specify_____
8	Access to own computers and smartphone	Yes☐ No ☐ If Yes, please specify Computer ☐ smartphone ☐

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Appendix-1: Survey Questionnaire

		Tablet ☐
9	Access to internet	Yes ☐ No ☐ If Yes, please specify the instrument, you have, has access to the internet Computer ☐ Smartphone ☐ Tablet ☐
10	If you do not have your own computers or smartphone, can you access computer or smartphone of other family member or friend with ease and whenever you want?	Yes ☐ No ☐
11	How would you define your current use of internet and/or mobile applications?	Rarely use ☐ Restricted to email ☐ Social media ☐ Use of mobile applications ☐ Please specify_____ Health information ☐ Please specify_____ Never used/don't know ☐
12	If given a chance and support, do you intend to learn about internet use in accessing useful health information, through your computer or smartphone?	Yes ☐ No ☐

Section-II: Frailty score		
1	***Weight loss***	Weight____Kg Height_____Mts BMI_____kg/m^2
2	***Weakness*** Prior to the fracture, does your health now limit you in lifting or carrying groceries which you might previously do during a typical day?	Yes, limited a lot ☐ Yes, limited a little ☐ No, not limited at all ☐
3	***Exhaustion*** Prior to the fracture, how much of the time during the past 4 weeks, did you feel worn out?	All of the time ☐ Most of the time ☐ A good bit of time ☐ Some of the time ☐ A little of the time ☐ None of the time ☐
4	***Slowness***	Yes, limited a lot ☐

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Appendix-1: Survey Questionnaire

	Prior to the fracture, does your health now limit you in walking 100 meters which you might previously do during a typical day?	Yes, limited a little ☐ No, not limited at all ☐
5	***Low activity*** Prior to the fracture in the last two weeks, have you considered walking for sport, recreation or fitness?	Yes ☐ No ☐

Section-III: The 14-item Health Literacy Scale						
When you read instructions or leaflets from hospitals or pharmacies, how do you agree or disagree about the following?						
		Strongly disagree	Disagree	Not sure	Agree	Strongly agree
1	I find characters that I cannot read					
2	The print is too small for me (even though I can wear glasses)					
3	The content is too difficult for me					
4	It takes long time to read them					
5	I need someone to help me read them					
If you are diagnosed as having a disease and you have little information about the disease and its treatment, how do you agree or disagree about the following?						
6	I collect information from various sources					
7	I extract the information I want					
8	I understand the obtained information					
9	I tell my opinion about my illness to my doctor, family or friends					
10	I apply the obtained information to my daily life					
If you are diagnosed as having a disease and you can obtain information about the disease and its treatment, how do you agree or disagree about the following?						
11	I consider whether the information is applicable to me					
12	I consider whether the information is credible					
13	I consider whether the information is valid and reliable					
14	I collect information to make my healthcare decisions					

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Appendix-1: Survey Questionnaire

Section-IV: electronic Health Literacy Scale						
I would like to ask you for your opinion and about your experience using the Internet for health information. For each statement, tell me which response best reflects your opinion and experience right now.						
		Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I know what health resources are available on the Internet					
2	I know where to find helpful health resources on the Internet					
3	I know how to find helpful health resources on the Internet					
4	I know how to use the Internet to answer my questions about health					
5	I know how to use the health information I find on the Internet to help me					
6	I have the skills I need to evaluate the health resources I find on the Internet					
7	I can tell high quality health resources from low quality health resources on the Internet					
8	I feel confident in using information from the Internet to make health decisions					

Section-V: Hospital admission data		
1	Side of hip fracture	Right ☐ Left ☐
2	Fracture type	Intracapsular undisplaced ☐ Intracapsular displaced ☐ Intertrochanteric ☐ Subtrochanteric ☐ Other ☐ If other, Please specify_____
3	Pre-fracture residence	Home ☐ Institution ☐ Acute care ☐ Unknown ☐
4	Pre-fracture mobility	Freely mobile without aids ☐ Mobile outdoors with one aid ☐ Mobile outdoors with two aids or frame ☐

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Appendix-1: Survey Questionnaire

		Some indoor mobility but never goes outside without help ☐ No functional mobility ☐ Unknown ☐
5	ASA grade	Normal healthy individual ☐ Mild systemic disease that does not limit activity ☐ Severe systemic disease that limits activity but is not incapacitating ☐ Incapacitating systemic disease which is constantly life threatening ☐ Moribund- not expected to survive 24 hours with or without surgery ☐ Unknown ☐
6	Pre-fracture bone protection medication	Yes ☐ No ☐
7	Date of admission to orthopaedic care	____/_____/_____
8	Operation performed	No operation performed ☐ Cannulated screws ☐ Sliding hip screw ☐ Intra-medullary nail ☐ Hemi-arthoplasty ☐ Total hip replacement ☐ Other ☐ If other, please specify_____
9	Date of surgery	_____/_____/_____
10	Pressure ulcers	Yes ☐ No ☐
11	Physician/Geriatrician involvement	Physician ☐ Geriatrician ☐ Not seen ☐
12	First day mobilisation	Yes ☐ No ☐ No operation performed ☐
13	Discharge destination	Home ☐ Institution ☐ Acute care ☐ Rehabilitation ☐ Dead ☐ Unknown ☐
14	Date of discharge	___/____/_____
15	Length of stay (days)	
16	Bone protection medication at discharge	Commenced ☐ Continued ☐ Discontinued ☐

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Appendix-2: In-depth interview schedule: Patients

Thank you for consenting to be part of this research and agreed to express your opinion. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Hospital ID:_____ Date of admission_____

Address_____

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to you and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help you recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel right kind of health information will help you recover well and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4: What areas of health information you are interested in knowing now and once you get discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

Probe: usability, functionalities,

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Appendix-3:In-depth interview schedule: Carers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Relationship with patient_____Hospital ID_____Date of admission_____

Address_____

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to your family member/relative and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help your family member/carer recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel, as a carer, around right kind of health information will help your family member/relative recover well and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4: As a carer, what areas of health information you are interested in knowing now and after your family member/relative gets discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

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Appendix-3:In-depth interview schedule: Carers

Probe: usability, functionalities,

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Appendix-4: In-depth interview schedule: Healthcare providers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Name:_____Age____/years Sex_____

Designation_____Department/Hospital_____

Date of consent_____

Context

Question-1: What is your experience, in general, with older people with hip fractures admitted to the hospital or attending clinic/consultation for treatment?

Probe: physical status, gender, education level, empowerment, priority, recovery needs, care pathway, role of carer

Question-2: What is your perspective, particularly around health literacy in this group of population?

Probe: health information needs/areas, existing provision, difficulty in accessing, possible improvement solutions, ehealth

Content

Question-3: In your opinion, what are the important areas of health information for patients recovering from a hip fracture injury after their discharge from the hospital?

Probe: clinical recovery, functional improvement, WHO ICOPE, multiple medical conditions, other issues

Questiona-4: In your opinion, do you think there is a need or scope for improving the quality of health information for this group of patients? Do you have any possible suggestions or solutions in this direction?

Probe: barriers and facilitators, role of carers and community providers (health and social care), different platforms including ehealth or IT solution

System

Question-5: Can you please recollect from your previous experience of coming across any electronic platform used for patient education and/or service delivery? Or any comment in general about the use of IT/ehealth solutions?

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Appendix-4: In-depth interview schedule: Healthcare providers

Probe: setting, usage and function, challenges, possible learning and suggestive improvements

Questiona-6: Can you please elaborate factors, in your opinion, needs to be taken into consideration while designing an ehealth platform for such group of patients?

Probe: system functionalities, patient response, existing system integration

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Appendix-5: Focus group discussion guide: Patient and carers

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Context

Question-1: Can you please recollect and narrate about the circumstances in which this injury occurred to you or your family member/relative and the journey so far?

Probe: fall/accident, place of residence, care seeking decision, carer and support available, reaching hospital, care in the hospital

Question-2: In your opinion, what are the important things that will help you and your family member/carer recover well after the discharge from this hospital?

Probe: carer support, residence, independence, quality of life, access to information, services

Content

Question-3: How important do you feel and also as a carer, around right kind of health information will help better recovery and what challenges you anticipate in accessing this information?

Probe: Prior experience, information leaflet/booklet, support-doctor/nursing staff/carer/friends, physical/disability concern

Questiona-4:What areas of health information you are interested in knowing now and after you or your family member/relative gets discharged from this hospital?

Probe: Any particular area of concern, in general for people in similar situation, WHO ICOPE- elaborate, different platforms, convenience

System

Question-5: How would you consider availability of health information, electronically?

Probe: current and likelihood to access, any example, challenges, motivation and optimism

Questiona-6: What would you recommend to the developers of electronic health education platform to consider for patients' hip fractures once they are discharged from the hospital?

Probe:usability, functionalities,

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Appendix-6: Focus group discussion guide: HCPs

Thank you for consenting to be part of this research. Through this interview, I wish to explore your perspective around potential development of an electronic health information education platform for older people with a hip fracture injury.

Context

Question-1: What is your experience, in general, each of you have with respect to your disciplinary area of practice while coming across older people with hip fractures admitted to the hospital or attending clinic/consultation for treatment?

Probe: physical status, gender, education level, empowerment, priority, recovery needs, care pathway, role of carer

Question-2: What is your perspective, particularly around health literacy in this group of population?

Probe: health information needs/areas, existing provision, difficulty in accessing, possible improvement solutions, ehealth

Content

Question-3: In your opinion, what are the important areas of health information for patients recovering from a hip fracture injury after their discharge from the hospital?

Probe: clinical recovery, functional improvement, WHO ICOPE-elaborate, multiple medical conditions, other issues

Questiona-4: In your opinion, do you think there is a need or scope for improving the quality of health information for this group of patients? Do you have any possible suggestions or solutions in this direction?

Probe: barriers and facilitators, role of carers and community providers (health and social care), different platforms including ehealth or IT solution

System

Question-5: Can you please recollect from your previous experience of coming across any electronic platform used for patient education and/or service delivery? Or any comment in general about the use of IT/ehealth solutions?

Probe: setting, usage and function, challenges, possible learning and suggestive improvements

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Appendix-6: Focus group discussion guide: HCPs

Questiona-6: Can you please elaborate factors, in your opinion, needs to be taken into consideration while designing an ehealth platform for such group of patients?

Probe: system functionalities, patient response, existing system integration