MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Use of sensor data to support interRAI assessments of older adults living at home in New Zealand

Final Report

7 July 2020

Prepared for the New Zealand Ministry of Health

Authors: Inga Hunter and Caroline Lockhart

Massey University

Disclaimer

Suggested citation

Hunter, I.M. and Lockhart, C.A. (2020). Use of sensor data to support interRAI assessments of older adults living at home in New Zealand. Palmerston North: Massey University.

Executive Summary

Aim

The aim of this report is to present findings from research undertaken into the use of sensor data, available today, and mapped alongside current interRAI assessment data, to demonstrate the viability of data collected from sensors in a home (external) environment from a clinical setting. The rapid development of sensor use in health care provides an opportunity to combine sensor use in the home with interRAI health assessments to improve health outcomes.

Methods

A scoping review of published literature for sensor use in the home was conducted together with an environmental scan of commercial sensor systems available in NZ to determine what was already known about using sensors for health assessment and ascertain what new requirements, features, functionalities and processes are needed to make the best use of sensors in the home of older adults for health assessments. This was followed by a three-step modified Delphi method to map interRAI assessment items to sensor use to determine that such a mapping was possible, and to suggest potential sensors for use in the home of older adults.

Findings

The sensor literature review and environmental scan revealed that there is limited objective high-quality evidence to support the use of sensors in health care. That is not to say that sensors may not be useful in health care rather that the evidence is limited. The majority of evidence is either experimental, based on algorithm testing, with small sample sizes, or a pilot project. Some clinical trials exist but the number is small. Some clinical trials do not involve older adults, and none use sensors for health assessments for the older adults. Very few real-life RCTs exist, however as most of these are in recent years, this area is maturing. Therefore further research into real-life use of sensors to support care for older adults at home is needed.

Sensors

Sensors have a role in rehabilitation, monitoring of vital signs, monitoring of location and falls, aide memoirs for medication and activities of daily living, supporting activities of daily living, improving communication with informal carers and health providers. They may be of use in the psychosocial aspects of health as well as the physical aspects and have proved popular with some older adults. However, sensors have been shown to be of variable sensitivity and specificity, poorly designed, bulky, lack encryption of data, lack interoperability and have significant battery life limitations. In particular, sensor systems lack quality clinical validation. Interestingly, smart clothing can use miniature sensors and have high levels of reliability most likely due to good contact with skin. Ambient sensors may be able to be connected to a permanent power supply, but wearables ideally should last for long periods of time before needing recharging or battery changing but at the same time have to be small. This is a significant barrier to increased use of wearables but there is ongoing research to reduce power consumption and battery size of wearables or to provide alternative sources of power such as through body heat or motion or other electrophysiological processes.

Many health-related sensor systems are combinations of different sensors used together, as in ambient assistant living (AAL) systems. AALs used with wearables, and indeed with robots and multiple sensor deployment is the commonest use of sensors. Sensors can be used for short-term use and be removable, such as small motion detectors or wearables, or can be permanently installed in a home, such as cameras fixed to the wall or wired smoke detectors. This multiple use of sensors serves to increase the range and type of data collected and analysed and hence increase the range of purpose for sensors.

The majority of robotic sensor systems are still undergoing development so have not been extensively tested in real-life situations or demonstrated a positive impact on health outcomes. Robots can be divided into those that mainly provide companionship and close physical contact (pet or social robots) and those that have some functionality to move and manipulate objects in the environment (carry, move, pick up items, support ADLS, provide navigation or medication reminders).

Sensors do not have to be designed to be recognizable as sensors. Wearables can be inserted into items of everyday use, for example: necklaces, pendants, bracelets, rings, belts, socks, shoes have all been used in studies. Ambient sensors can similarly be inserted into other items usually seen in a home, for example smart plugs, smart light bulbs, gaming systems like Kinect and Wii, smoke alarms and could also be amusing – such as a sound sensor inserted in a rubber bath duck in the bathroom to detect water running.

Providing low cost, easy to use, adaptable, secure, culturally acceptable sensors that add value to existing everyday items and that can be selected by the older adult will increase compliance and acceptability by older adults.

interRAI data

Data input into interRAI health assessments is currently from multiple sources, in multiple formats, high volume, based on self-reported recall, on paper and time consuming to collate and enter into the online assessment form. A lack of operability prevents data that is in digital format from being used, with the exception of the NHI.

Sensors can be used to improve data input for interRAI assessments. Some assessment items are, however, complex and difficult. Those items that are most difficult for the assessor to access were also the same items where it would be difficult to introduce sensors to provide input data. In these situations, providing sensor data to the assessor who would then use their clinical judgement would enable the assessor to complete these items in a more efficient and effective manner. This report does not suggest that clinical judgement should be replaced with clinical decision support systems (CDSs), rather that data be presented in a more effective and efficient manner and of higher quality, to the assessor such that they may then use their clinical judgement with the aim that the outputs of the algorithms will be more accurate and hence the care planning leading to better health outcomes.

Sensors could play a role at any step in the assessment process, from pre-assessment, to providing support care and monitoring of health outcomes after the assessment is completed. Changes to the assessment process would increase efficacy and effectiveness of assessments.

Technical data concerning existing commercial sensors systems was absent from the public domain hence it was not possible to assess their ability to provide data for interRAI assessment.

A major theme of the literature review was that research studies conducted on sensor use are mainly experimental, with small sample sizes and based in residential care providing limited evidence that sensor use improves health outcomes. Of major concern though is that sensor systems lack quality clinical validation. They must be tested and validated by health providers in real-life situations. This could be addressed by supporting real-life clinical studies on the use of sensors in the care of the elderly.

Next steps

Based on work undertaken for this project, a 2-tier approach to a minimum sensor package for homes is recommended. If the older adult lives with others, then their needs and wishes such as privacy need to be taken into account.

Tier 1: this would consist of simple wearables, such as acclerometer, barometic pressure/altimeter, gyroscope in different designs plus simple PIR motion detectors appropriately located – opened door, moved into room, turned on light or radio plus self-competed online health assessments and screening tools by older adults and/or informal carers plus temporary ambient cameras could be installed for 3 days for improved assessment of iADLS and ADLs.

This can be be used for pre assessment data gathering and screening, leading to early identification for assessment, and early detection of declining health but also for a feeling of security, reduced loneliness and improved interaction with their support network. This would connect the informal network with the older adult so that a system was already in place for when/if the health of the older adult declines. Tier 1 would be scalable by the addition of wearable and ambient sensors as health needs change with more frequent screening tool use by health providers to detect early deterioration in health status.

Tier 2: this would consist of fixed ambient cameras or movement detection by radar or audio and continuous monitoring with selected wearables and ambient sensors based on a formal needs assesment by a registered health provider, such as occupational therapist or interRAI assessor. More complex data processing would be required which would include protection of privacy, pattern recognition and AI such as fuzzy logic and rules-based reasoning with alerts of abnormal events. Whilst data collection could be continuous, the processing output could be exception based, summarised, or otherwise aggregated for ease of viewing. Skin care concerns are more important in frailer older adults.

This tier would be for older adults with high levels of fraility, requiring support for iADLS and ADLS, cognitive problems, unstable health conditions, frequent falls, frequent ED visits or hospital admissions. Tier 2 adults may be willing to trade privacy for security and reassurance of help arriving from continuous monitoring.

Like Tier 1, Tier 2 can be be used for pre assessment data gathering and screening, leading to early detection of declining health but also would determine the level of support needed and ensure it was provided when needed. Again, like Tier 1, Tier 2 would provide a feeling of security, reduce loneliness and increase interaction with support network, and bring health providers in the circle of care. Both Tier 1 and Tier 2 would include checks to ensure informal carers are not being overwhelmed. Any changes to the interRAI health assessments or data input methods and process must have the aim not only of creating an end-to-end digital system with benefits such as reduction in transcription errors, having the right information at the right time, and time savings, but of improving health outcomes.

Limitations

The main limitation of the report is that sensors are a fast-moving area with new sensors being developed all the time. The sensors and their use discussed in the report could be superseded by future development. There was very little published research found on health assessments and sensors with older adults so findings presented may not be strictly applicable to the scope of the project as age and purpose of health assessments was removed to find published literature on sensors in health.

No observations of real time interRAI health assessments were conducted and no older adults and their informal carers, assessors and other data end users, such as hospital elder care services or primary care providers, were consulted in the preparation of this report. Arranging for this to occur would enable triangulation and increase the validity of the project findings, this may also reveal new findings.

Funding and Acknowledgments

We would like to thank the wonderful people who work for interRAI who kindly provided the interRAI manuals and explained how to use them.

We would also like to thank Ministry of Health, Emerging Health Technology and Innovation, Data and Digital for funding the project.

Finally, we would like to thank Professor Hans Guesgen, Chair in Computer Science, Massey University and Dr Dick Whiddett, Senior Lecturer, Massey University for participating in the expert panel in three-step modified Delphi method used for mapping assessment data to sensors.

Recommendations

It is recommended that the existing interRAI assessment process be enhanced by the use of sensors in the home (external) environment of older adults.

It is suggested that the following actions be taken:

1. Provide a digitally capable system end-to-end
    a. Ensure interoperability with existing datasets
    b. Increase use of digital technologies that can provide data other than sensors
    c. Increase digital and health literacy of assessors, older adults and their carers
    d. Ensure culturally acceptable system end-to-end
    e. Determine ownership/guardianship of data collected by sensors
2. Investigate specific sensor acceptance by older adults
    a. Ensure sensors selected meet user requirements and are scalable and flexible to permit personalisation
    b. Add value to existing everyday items and technologies
3. Make changes to the interRAI assessment process
    a. Introduce screening in primary care/home/informal carers
    b. Move timing of assessments in relation to health status/needs/stage of life
    c. Introduce self-assessments via tablet or similar
    d. Expand the assessor workforce
    e. Provide mechanisms for informal carers to warn if they are starting to feel overwhelmed
4. Use interRAI output data to provide care support and monitoring of health outcomes
5. Access commercial sensor systems for sensitivity/specificity/user acceptance/health outcomes supported
6. Deploy as two-tier system of sensors, with support for informal carers provided in both tiers
    a. Older adults with stable health conditions but need some support
    b. Frail older adults who need lots of support for ADLs and ambient monitoring for falls
7. Run pragmatic clinical trials for sensors in homes of older adults, starting with tier 1, or a pilot project with large sample size, for example, for improving medication adherenc

Contents

List of Figures

List of Tables

Background and Purpose

The purpose of this report is to present findings from research undertaken into the use of sensor data, available today, and mapped alongside current interRAI assessment data, to demonstrate the viability of data collected from sensors in a home (external) environment from a clinical setting.

The wider context for the project is that health care systems that succeed in preventing or delaying long term care in Aged Residential Care (ARC) facilities and acute hospital admissions of frail older people may substantially save on their public spending as demand for ARC is estimated to continue to increase (Broad et al., 2015). Older adults can have a higher quality of life and prefer to stay at home, with sensor support, as they age ('ageing in place') (Elers et al., 2018; Hrast, Sendi, & Kerbler, 2020; Wiles, Leibing, Guberman, Reeve, & Allen, 2012). However, moving into ARC can also improve health and wellbeing, especially for older adults with mental illness, loneliness, unstable health conditions or have a lack of, or overstressed, informal carers (such as family or friends) and not only do some older adults wait too long to access care, but access to care at the right level varies across New Zealand (NZ) (New Zealand Aged Care Association, 2018). Thus, ageing in place or moving into ARC can be a complex and difficult decision (Hrast et al., 2020) and accurate assessment for the type and level of health and disability support and care needed to continue to stay at home is therefore critical.

What is interRAI

The term "interRAI" refers to both a group of international researchers from more than 35 countries who have developed and validated health assessment instruments and is an acronym for a clinical international resident assessment instrument (interRAI New Zealand, 2016) and refers to the suite of more than twenty (20) health assessment tools (instruments), that provide input to electronic decision support software, to complete comprehensive clinical assessments for older adults.

This comprehensive and standardized assessment system consists of an assessment with 236 questions over 20 domains (which produces a minimum data set) and a set of Clinical Assessment Protocols (CAPs). Data is obtained from a variety of sources and then entered into the assessment system by an assessor using an online form. The data collected from an assessment is then subject to algorithmic processing which may trigger any from one to several CAPS. The assessment covers several functional, cognitive, health and social needs and current service use for an older adult. The CAPs contain guidelines to inform and focus on person-centered health and disability care and support, for example: the physical activities CAP includes personalised goals to increase level of exercise taken by the older adult. These goals include education, motivational barriers, step-by-step increases in activity and longer-term exercise goals (interRAI New Zealand, n.d.).

Thus, the overall purpose of interRAI health assessment is restorative care - to support continuity of health and disability care and to support decision making by health professionals.

In New Zealand, any person who wishes to receive funded health and disability support services must have an interRAI health assessment and you must be assessed as requiring such services.

A person cannot receive funded health and disability support services just because they would like to receive them (Ministry of Health, 2011).

History in NZ

New Zealand (NZ) was the first country in the world to adopt interRAI as the national older person health assessment software platform for both aged residential care and home/community care. It was first piloted in 2006, with subsequent phased implementation across New Zealand in two tranches - the DHB interRAI Implementation Project for home and community interRAI assessments (2008-2012) and the Comprehensive Clinical Assessment (interRAI) project introducing the Long Term Care Facilities assessment (LTCF) into Age Residential Care (ARC) (2011-2015) (Agreements for use of the interRAI assessment system (interRAI New Zealand, 2016; Meehan and McCreadie, 2016). See appendix 7 for a detailed timeline.

Five interRAI assessments are used in New Zealand. These are the Contact Assessment (CA) which includes the Emergency Department (ED) screener; the Home Care (HC) assessment; the Community Health Assessment (CHA) which may be combined with the Functional Supplement, and is used to identify individual needs and implement appropriate interventions or specialist referrals for clients with a suspected or known mental health condition); the Palliative Care (PC) assessment and the Long Term Care Facilities (LTCF) assessment. The CHA with the Functional Supplement is equivalent to a HC assessment. CA and HC assessments were the first assessments to be introduced into New Zealand and are the two most used in New Zealand.

The most appropriate assessment tool is selected based on the client status, urgency of care support, complexity of support needs, residential location and potential duration of care support which is determined by the clinical referral coordinator. Briefly a CA is screener tool to determine urgency, complexity and rehabilitation needs, and is used for home residents with non-complex needs or needing short-term Packages of Temporary Support (POTS) whilst waiting on a HC/HCA assessment (for example on discharge from hospital). The CA contains an Emergency Screener for use when an older adult presents to an Emergency Department (ED). A CA is used for home residents with low complex needs and a HC assessment for home residents with high complex needs or requiring an urgent assessment based on a CA assessment result. A HC assessment is also used when permanent residential care is being considered. PC assessments are reserved for people with palliative care. A LTCF assessment is used when a person is permanently in Aged Residential Care facility and may be being considered for upgrading into hospital-level care. For a chart outlining in more detail when each assessment is used, see 'Which interRAI assessment to use and when to use it' at (interRAI New Zealand, 2019b).

Completed assessment data was stored in two national data warehouses, but these have been merged in June this year, into single national software platform and feed into one central data warehouse. Output data from completed assessments is available via a data visualization tool and further data is available upon formal request from the data warehouse and Central Region's Technical Advisory Services (TAS). Output data is available for individual care planning (CAPs), local, regional and national health service development and planning, and research. Primary care providers may receive a copy relevant to their own patients. Of note is that the assessment outputs inform and support clinical decision making, they do not determine range, type or hours of care – this is determined by each District Health Board (DHB) based on their local resources and service guidelines.

interRAI in New Zealand is funded by the Ministry of Health, delivered by TAS interRAI services and is governed by the interRAI Governance Board. There is a royalty free agreement between interRAI International and the New Zealand Ministry of Health. Assessors work for the Needs Assessment and Service Coordination (NASC), which has centers and assessors located throughout New Zealand. Figure 1 shows the current status of interRAI assessments in New Zealand as of October 2019 (interRAI New Zealand, 2019a). For more information about interRAI New Zealand, see the extensive interRAI website at https://www.interrai.co.nz/about/.

Methodology

Introduction

This section describes the various steps and sources of information used for the project:

1. Determine scope of project
2. Ethics approval
3. Scoping literature review for sensor use for older adult health assessments
4. Review of InterRAI websites and assessment manuals
5. Analysis and categorization of input data for interRAI health assessments
6. Environmental scan of websites for Commercial sensor systems (mainly in NZ and Australia)
7. Review of outcomes and attendees at three workshops run by the Minitsry of Health in collaboration with Massey University during 2019
8. Mapping of assessment data to sensors
9. Identify other data sets that could potentially fill some data gaps
10. Determine model effectiveness for screening, ranking of items, prognostic indicators

Ethics

Although the project analyses literature and data, with no human participants, a low risk notification was submitted as the means of recoding research conducted by University staff. This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director (Research Ethics), email humanethics@massey.ac.nz.

Scope

The context for this project is limited to assessments for home-based health care where sensors may make a difference to the health status of the home resident. Therefore, the LTCF assessment and the Palliative Care assessment were excluded from the project scope as they would not be used in the context of this project. As the CHA with the addition of the functional supplement is equivalent to a HC assessment, the CHA tool was also excluded. Thus, this project examined the data inputs for the CA and HC assessment instruments (Hirdes et al., 2010; Morris et al., 2012). The interRAI Clinical Assessment Protocols (CAPs) inform and focus on person-centered care and support and are triggered by the interRAI assessment data. Hence CAPs fall out of scope as they are dependent on output data after algorithm processing of the input data (Morris et al., 2010).

Out of scope

The report focuses on interRAI health assessments, thus other forms of assessments, including inhouse primary care assessments and other international assessments are not considered in this project. Whilst this project is restricted to analysing the data inputted into assessments, the interRAI assessment system is part of a wider process from referral to care planning and review, therefore note has been taken where digital data and technology could be used in the wider process and recommendations made.

Much of the data inputted in the assessments is based on clinical judgement. This project seeks to examine the data required and does not attempt to replace clinical judgement with clinical decision support systems (CDSs), rather it seeks to present data in a more effective and efficient manner and of higher quality, to the assessor such that they may then use their clinical judgement on input data of higher quality with the aim that the outputs of the algorithms will be more accurate and hence the care planning leading to better health outcomes. Likewise, this project does not attempt to analyse the algorithms used or evaluate health outcomes from a care plan but recommends that these are considered in future work.

Data collection is very dependent on the users who provide the data, cultural-safe data collecting practices are critical, outside the scope of the project, but recommended as future work. Whilst this project looks at the use of sensors in the home, it does so from the perspective of providing higher quality data for assessments. Sensor acceptance is critical to the successful implementation of sensors in the home and we recommend that this also informs future work so that what works for assessments will also work for the older person. interRAI assessments do not collect biophysiological data apart from height and weight, therefore, sensors used as biosensors, detecting a wide range of clinical parameters, both for individuals and for public health surveillance are excluded.

Finally, interRAI has a governance Board and this report does not examine the role and function of the Board. We are aware that the Ministry of Health has commissioned some work around service design of interRAI from Tenzing Management Consulting and believe that this report will complement that work.

Scoping review of literature

A scoping review of published literature was conducted following the methodology of the Joanne Briggs Institute (Peters et al., 2020), the purpose being to determine that the Research Question had not already been answered in the published literature. Scoping reviews are appropriate for the identification of certain characteristics in diverse sources of evidence, in the mapping of these characteristics and to examine a broad area to identify gaps in the research knowledge base. This project seeks to identify, characterise and map the data types and sensor types, useable in the home of older adults, that could be used for interRAI home (health) assessments, checking a broad range of evidence to ensure these mappings have not already been identified in a curated space is the first step.

The project also seeks to identify a minimum sensor setup based on the mappings with pragmatic but not formal recommendations of practice based on a formal synthesis of high-quality evidence. Hence a scoping review rather than a systemic review is appropriate. In addition, this review of published and grey literature is not being conducted with a view to developing a clinical guideline or determining the effectiveness of an intervention, which are more appropriately addressed by a systematic review. Therefore, it is not necessary to assess the quality of the evidence included in the scoping review. Whilst a scoping review has a priori review protocol similar to a systematic review, a scoping review has a less restrictive inclusion and exclusion criteria than a systematic review and the elements in the PCC (Population, Concept and Context) framework may be used to assist with determining these criteria and the research question to be answered by the scoping review. Because of the broad nature of scoping review questions, scoping reviews are particularly useful for bringing together evidence from disparate or heterogeneous sources hence qualitative as well as quantitative study designs can be included along with grey literature. The selection of material follows the PRISMA format modified for scoping reviews (Tricco et al., 2018) and a standardised data extraction form was used to input the

characteristics (see Appendix 4). The PCC framework has been used to define the research question and the search parameters.

Research Question:

Undertake research into the use of sensor data, available today, and mapped alongside current assessment data to demonstrate the viability of data collected from sensors in a home (external) environment from a clinical setting.

Using the PCC framework, Population is defined as older adults using sensors for health and wellbeing in the home. "Older" rather than a set age is used to include all studies that recruited older adults as the age cut-off for older adults varies depending on each study plus there is disparity and health inequities with age and chronic disease between Maori and Pacifica peoples and the rest of the NZ population. Concept (the phenomena of interest) is the characteristics of available sensor types (with their data input/output types) and Context is 'assessment for health and wellbeing in health and disability care in the home' (and community).

PCC framework for scoping review

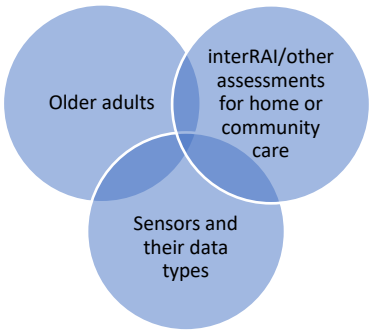


Figure 1: PCC framework

The following keywords plus synonyms were identified and used in Boolean searches. Health and Wellness/Wellbeing were not used as keywords, firstly because it is the broad context for the research, and secondarily, a search returned a result of 4,842,785 references. Including keywords from all circles in a Boolean search returned a result of 34,174, still far too many to search in a realistic and pragmatic manner. Hence the keywords Health and Wellness were excluded from the search terms but were used as inclusion criteria when selecting articles. Additional inclusion criteria are publication date: last 10 years 2010 – 2020, Language: English, available without payment.

Table 1: PCC search terms

Circle 1 (synonyms)	**Circle 2 (synonyms)**	**Circle 3 (synonyms)**	**Circle 4 (synonyms)**	**Circle 5 (synonyms)**
Health	interRAI	ageing/ aging	sensors	monitoring
Wellness	older adult assessment	Older adult	wearables	
		senior	Smart home or smart house	
			technology	
			IoT	
			assistive technology	
			pervasive technology	

The key word 'monitoring' was interesting as it returned different items when used as AND than when used as OR in the sensor circle 4 in the below table. Using monitoring as an action for sensor use was interpreted differently to using a monitoring sensor and gave different search results. Hence monitoring was placed in circle 5.

Using 'older adult', 'ageing', 'aging', or 'senior' did not impact on the references returned from the database search so the below Boolean query was used for the scoping review and returned 191 PubMed references (greater than for Cinahl or Web of Science which returned the same references, just fewer). Digital was removed as a synonym from circle 4 as it returned too many false results.

A similar search process was used with MeSH (Medical Subject Headings) Terms. The time frame was limited to the previous 5 years since most references found with the database search revealed that most studies over 5 years of age were not relevant to this project.

The references returned by both search strategies were reduced to 79 after elimination on non-relevant references (for example, not in humans, not health and wellbeing/wellness, paediatrics, biophysiological sensors for chronic disease and so on). See Appendix 2 for the Boolean and MeSH Terms searches and numbers returned in more detail.

Table 2: MeSH Terms used in Scoping Review, that align with PCC framework.

Medical Subject headings used in PubMed		
Healthy aging	interRAI or interrai – no records	Technology
Aged	Assessment – no MeSH terms	wearable technology
Health Services for the Aged	Assessment of health needs	assistive technology
	Rehabilitation	Ambulatory technology
		Wearable device
		Telehealth

interRAI articles in scoping review:

Both the database and MeSH Terms Boolean searches that looked for any references to interRAI with sensors for various actions with older adults' health and wellbeing (with synonyms) returned one reference only, thus demonstrating that this research question has not been answered.

This single reference that did include both interRAI and sensors, used an observational study to evaluate the classification of falls, using smart wrist-worn devices in community-dwelling older adults with the RAI-HC assessment tool (Yang, Hirdes, Dubin, & Lee, 2019).

Whilst there were research studies using data produced by the interRAI assessment process only two articles were found that looked at the input side of this process – both from the assessor's perspective (Smith, Whiddett, & Hunter, 2013; Vuorinen, 2019).

In an attempt to locate references that used health assessment data or sensors in real-life settings, searches for 'clinical trials' and for 'systemic review for health assessments' were added. This gave 3 relevant references for clinical trials and 2 systematic reviews for health assessments. Further clinical trial references were found for sensor technology by removing the 'older adult' so could be from any age group. Following citations of returned references found a few more clinical trial and systematic review references.

Findings and Discussion

Introduction to findings

The majority of the studies identified for older adults and sensor technology were conducted in experimental environments such as technology laboratories and were focused on improving algorithm processing of sensor data, and/or did not provide any health outcomes and/or were small pilot studies. However, where appropriate they are included as examples of potential sensor use. Information from clinical trials came the closest to real-life sensor use. The scoping literature review showed that the Research Question has not already been answered in the published literature.

The Findings and Discussion section is split into findings relating to sensors, findings relating to interRAI data input, and then the extent to which these can be mapped to each other. Problematic interRAI assessment items for sensor use are discussed and potential minumum sensor packages for older adults living at home are identified.

Sensor frameworks

There are different ways to classify sensors for health care assessments of older adults living at home - by purpose, device type, processing required, activities used with, health outcomes, location, length of use, cost and so on. Magnetic switches and passive infrared (PIR) motion sensors are very cheap and readily available whereas biosensors and robots can be very expensive and complicated to design, implement and use (Koceska, Koceski, Beomonte Zobel, Trajkovik, & Garcia, 2019; Uddin, Khaksar, & Torresen, 2018). Sensors can be simple or complex in design and can be used individually or together with other sensors thus the list of sensors available for use in home assessments is long. The range of sensors produced is rapidly expanding and new types of, and uses for sensors are being developed on an almost daily bases – a good example of this is the response to Covid-19 (Furberg, 2020).

Wearable, ambient or robotic sensors

One of commonest classification frameworks is to divide sensors into wearable, ambient sensors, or robotic, each of which can be further subdivided for example into fixed or mobile, temporary or permanent. Figure 4 lists different types of sensors identified from published and grey literature, including commercial sensor systems. Sensors are listed in no particular order. Smart phones, smart watches and gamification may use multiple sensors and data input screens.

Sensors do not have to be designed to be recognizable as sensors. Wearables can be inserted into items of daily use, for example: necklaces, pendants, bracelets, rings, belts, socks, shoes have all been used in studies. Ambient sensors can similarly be inserted into other items usually seen in a home, for example smart plugs, smart light bulbs, gaming systems like Kinect and Wii and smoke alarms. Embedded sensors could also be amusing – such as a sound sensor inserted in a rubber bath duck in the bathroom to detect water running - now called Hans after our colleague who had this idea during one of the modified Delphi method meetings.

The majority of robotic sensor systems are still undergoing development so have not been extensively tested in real-life situations (Bajones et al., 2019) or demonstrated a positive impact on health outcomes (Broadbent, Peri, Kerse, Jayawardena, Kuo, & Datta, 2014).

Table 3: Different types of sensors.

Ambient (embedded into daily environment)	Wearable (anywhere on-body)	Robotic (could include sensors from wearable and ambient)
Passive infrared (PIR) motion	Biosensors	Biosensors
Video	Accelerometer (tri-axial)	Tablet
Pressure	Barometic pressure/altimeter	Camera
Force	Gyroscope	Accelerometer
Smoke and flame	Velocity	Velocity
Humidity	Magnetic forces	Barometric pressure
Luminescence	Video (ego-centric)	Microphones
Sound	Microphones	Panic buttons
Water flow	Step counters	GPS trackers
Water temperature	Panic buttons	Movable 'arms', 'legs', 'limbs'
Floor sensors	Fitness trackers (Fitbit, etc)	
Pressure mat sensors	GPS trackers	
Radar sensors (both doppler and ladar)	Hearing aids	
Magnetic switches,	Pocket talker	
Temperature detectors	AR (MS Hololens)	
CO2 concentration sensors	Smart clothing (socks, shoes, vest, T-shirt	
Gas concentration sensors	Wearable tattoos	
Electricity use		
RFID	Sensors can be combined:	
Eye trackers	Smart wristband (combines activity tracker, sleep, heart rate)	
Kinect and Wii (creates silhouettes)	Smart phones (often contain some of these sensors)	
Vibration and vibro-tactile	Smart watches (also can contain multiple sensors)	
Contact detection	Gamification using sensors, apps and data input screens	
Visitor-counting		
silicon photomultipliers (SiPMs)		
360 degree lamp		
Float sensor (for toilet)	Biosensors can measure heart rate, body temperature, oxygen saturation, respiration rate, electrocardiogram, blood glucose, blood pressure, perspiration, heart sounds, electromyogram	
Human activity recognition (HAR)		

Refs: (Coiera, 2015; Elers et al., 2018; Geraedts, Zijlstra, Van Keeken, Zhang, & Stevens, 2015; Hassett et al., 2020; Koceska et al., 2019; Massé et al., 2015; Nguyen, Nebel, & Florez-Revuelta, 2016; Pantelopoulos & Bourbakis, 2010; Rohrbach et al., 2019; Siena, Byrom, Watts, & Breedon, 2018; Son & Kim, 2019; Stucki et al., 2014; Susnea, Dumitriu, Talmaciu, Pecheanu, & Munteanu, 2019; Taylor, Buchan, & van der Veer, 2019; Tedesco et al., 2019; Uddin et al., 2018; Webster & Celik, 2014; Yang et al., 2019).

Robots can be divided into those that mainly provide companionship and close physical contact (pet or social robots) and those that have some functionality to move and manipulate objects in the environment (carry, move, pick up items, support ADLS, provide navigation or medication reminders) (Bajones et al., 2019). The systemic review article by (Broadbent, 2017) is an excellent source of further information on robots, including the interesting concept of the Uncanny Valley – where feeling of unease and discomfort increase towards robots that look almost humanlike.

Pet robots such as Paro, a cute baby seal, have been used the most in clinical trials. Results show that Paro can be used to reduce loneliness and depression; reduce chronic pain; and reduce agitation, anxiety and stress and improve affect and social interaction for people with dementia (Jøranson, Pedersen, Rokstad, & Ihlebæk, 2015; Liang et al., 2017; Petersen, Houston, Qin, Tague, & Studley, 2017; Pu, Moyle, Jones, & Todorovic, 2020; Robinson, Macdonald, Kerse, & Broadbent, 2013; Robinson, Cottier, & Kavanagh, 2019).

Ambient assistant systems

Many health-related sensor systems are combinations of different sensors used together, as in ambient assistant living (AAL) systems. For home care support, the AAL would involve the older person's home.

Figure 2 shows the basic structure of an AAL, where one or more sensors are used to track the interactions and subsequent activities between the assisted person and the environment (Susnea et al., 2019). Sensor data can either directly inform about these activities (eg: number of steps taken) or can be used as surrogate data from which activities can be inferred (eg: the bathroom door opened, therefore someone entered the bathroom presumably to tend to personal hygiene needs). Data can be processed and analysed either within the sensor or by a central processing device. Note that upon detection of any anomaly or risk, the system can either issue a local warning/reminder or send alert messages to carers.

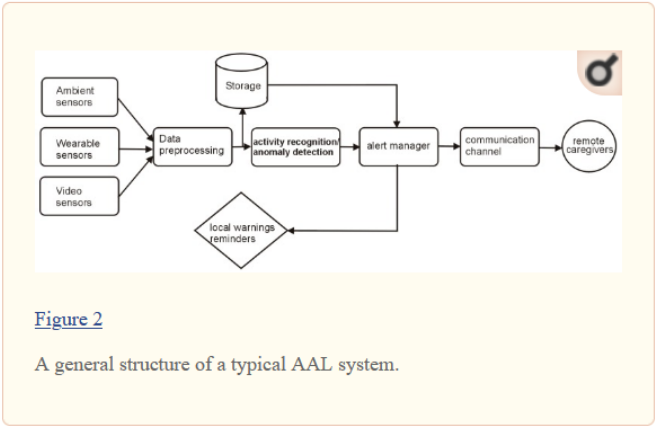


Figure 2: Basic structure of an AAL (Susnea et al., 2019).

Figure 3 shows simple schematic setup of AAL in an older person's home (Uddin et al., 2018).

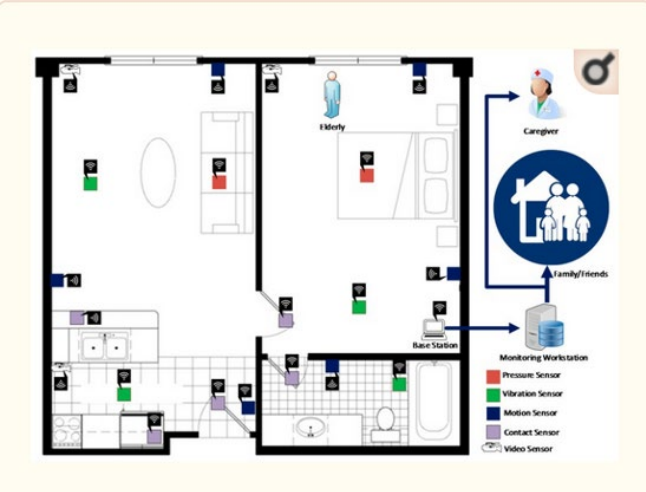


Figure 3: Simple schematic setup of a smart home for an older adult using different ambient sensors (Uddin et al., 2018).

AALs used with wearables, and indeed with robots and multiple sensor deployment is the commonest use of sensors. Sensors can be used for short-term use and be removable, such as small motion detectors or wearables, or can be permanently installed in a home, such as cameras fixed to the wall or wired smoke detectors.

This multiple use of sensors serves to increase the range and type of data collected and analysed and hence increases the range of purpose for sensors. Thus, a further classification is by purpose or action of the sensor.

Sensor purpose or goals of sensor use

A second framework for sensors is by the goals or purpose of using one or more sensors, be they wearable, ambient and/or robotic. Table 4 lists various goals/purposes from the published literature.

Table 4: Sensor purpose/goals of sensor use.

Ambient or wearable	Biosensors	Robots
Activities of daily living	Physiological (vital) signs recognition	Activities of daily living detection or assistance
Falls detection	Monitoring of chronic diseases	Videoconferencing
Falls location	Detection of acute clinical events	Falls detection
Sit-stand/Time to stand	Detection of worsening of clinical conditions	Medication reminders
Transfer detection		Alerts
Motion (bending, sitting, standing, walking, going up/down stairs)		Motion – detection or assistance
Footstep recognition		Lifting people
Gesture recognition		Entertainment
Facial emotion recognition		Cognitive training
Walking speed		Medication management
Medication management		Give and receive hugs
Event detection (any event or departure from normal)		
Alerts		
Sleep detection		
Personal security		
Home automation		

Refs: (Coiera, 2015; Elers et al., 2018; Geraedts et al., 2015; Hassett et al., 2020; Jøranson et al., 2015; Koceska et al., 2019; Massé et al., 2015; Nguyen et al., 2016; Pantelopoulos & Bourbakis, 2010; Rohrbach et al., 2019; Siena et al., 2018; Son & Kim, 2019; Stucki et al., 2014; Susnea et al., 2019; Taylor et al., 2019; Tedesco et al., 2019; Uddin et al., 2018; Webster & Celik, 2014; Yang et al., 2019) Liang et al., 2017; Petersen, Houston, Qin, Tague, & Studley, 2017; Pu, Moyle, Jones, & Todorovic, 2020; Robinson, Macdonald, Kerse, & Broadbent, 2013; Robinson, Cottier, & Kavanagh, 2019).

The taxonomy shown in figure 4 is particularly useful for examining sensor use for data input to interRAI assessments as it covers many of the interRAI assessments groupings, including support for the carer and family. This was developed by (Uddin et al., 2018) from their comprehensive review of surveys in the literature and the goals of the AAL joint Programme (AAL Europe, 2019).

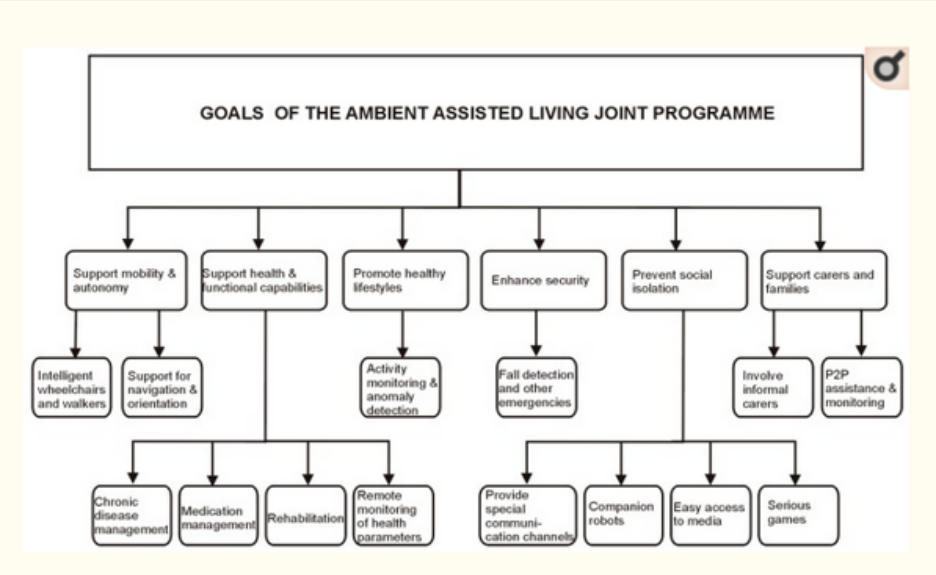


Figure 4: Taxonomy for AAL (Susnea et al., 2019)

Domains

A third framework is by domains as shown in figure 5 by (Uddin et al., 2018). The domain of ambient sensor could be expanded to include wearables and robots as the other three domains apply equally to them. The majority of studies into sensor use have focused on the feature extraction and machine learning domains with the aim of improving the sensitivity and specificity of the sensor for a given action or activity. The various algorithms for machine learning techniques and technical details of feature extraction are out of scope for this project but should not be ignored as a sensor is of no use in a clinical setting if it does not have sufficient sensitivity and specificity for the target events. The data produced by processing of sensor input data must be of an overall quality that is clinically usable and meaningful. This project is interested in target events, specifically those that provide input into an interRAI assessment.

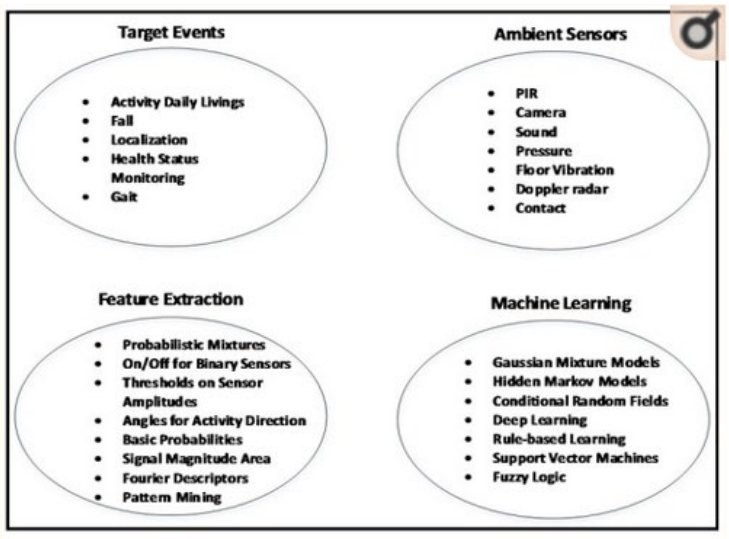


Figure 5: AAL domains (Uddin et al., 2018)

Socio-technical system

However, regardless of sensor classification or frameworks, a sensor used for interRAI health assessments for home care and support forms part of a socio-technical system that considers the human, social and home (and wider organisational) aspects as well as the technical aspects of the sensors (Coiera, 2015). The majority of studies in the published literature on sensors and older people consider the technical aspect only or use sensors in very controlled environments. Technology projects tend to fail due to human aspects, not technical aspects, hence it is difficult to extrapolate the findings of these studies to real-world situations.

Limitations of research on sensors in care support for older adults

The majority of studies are exploratory, in residential care, are pilot projects with small sample sizes or show minimal impact on health outcomes. Very few real-life RCTs exist, however as most of these are in recent years, this area is maturing. Therefore further research into real-life use of sensors to support care for older adults at home is needed.

One RCT involved 29 New Zealand residents in independent retirement village units and the iRobiQ or Cafero robot at home versus a non-robot control. The trial lasted 6 weeks. The robots measured blood pressure and pulse oximetry, and could provide entertainment (music and quotes) and Skype calls; iRobiQ also had medication reminders, and could send an alert to the nurse if medication was not taken or the older adult said they were unwell; Cafero provided cognitive exercises with memory games, a village map, and calendar reminders. While the robots were feasible and acceptable, they had no significant impact on adherence, depression or quality of life. Improvements in their reliability and functionality may increase their efficacy and ability to impact on health outcomes (Broadbent, Peri, Kerse, Jayawardena, Kuo, Datta, et al., 2014).

Environmental scan of Commercial Sensor Systems (CSS) available in NZ

Methodology

The environmental scan for commercial systems included a review of grey literature and product websites, identified from references in articles from the scoping review, from the NZ Technology Investment Network (TIN) report (Shanahan & Siew, 2020), from industry partners who attended any of the three workshops held by the Ministry of Health with Massey University in 2019 or who had expressed interest in our previous pilot study of using sensors in the homes of 5 older adults (Elers et al., 2018). The results of the environmental scan are summarised in a spreadsheet in Appendix 6.

Key Findings

There are many industry partners in the sensor system commercial space. Key findings from the environment scan include:

1. Lack of evaluation data – of technical, socio-technical and for health outcomes
2. Ownership/guardianship of data collected by commercial sensor systems lies with the commercial owners
3. Some CSS only used in ARC facilities
4. Most CSS use proprietary systems and will not ‘talk to’ sensors from other CSS

5. The basic model is the same – sensors, a central processing hub which may be located in the home/ARC or with the industry partner, a communication channel, ability to generate alerts
6. Some CSS provide the functionality to communicate with carers, others only with health providers, and some communicate with both
7. The funding model is 'pay subscription fee' +/- a cost for the sensors and any installation required
8. Some CSS provide sensors as part of other functionality – such as smartphones and smart watches
9. Some CSS consists of one device (such a fitness tracking device), others contain multiple sensors, both ambient and wearable
10. Robot sensor systems are popular in Japan and South Korea but are expensive and apart from lifting people in ARCs, thus sparing the backs of staff, do not provide many reproducible improved health outcomes
11. Pet therapy robot systems are fun and highly user acceptable but are of limited use for improved health outcomes to date

Summary of evidence for the use of sensors for health assessments for older adults - from literature review and environmental scan

In summary, the sensor literature review and environmental scan revealed that there is limited objective high-quality evidence to support the use of sensors in health care. That is not to say that sensors may not be useful in health care rather that the evidence is limited.

The majority of evidence is either experimental, based on algorithm testing, with small sample sizes, or a pilot project. Some clinical trials exist but the number is small. Some clinical trials do not involve older adults, and none use sensors for health assessments for the older adults.

Sensors have been shown to have a role in rehabilitation, monitoring of vital signs, monitoring of location and falls, aide memoirs for medication and activities of daily living, supporting activities of daily living, improving communication with carers and health providers. They may be of use in the psychosocial aspects of health as well as the physical aspects and have proved popular with some older adults.

Compliance may be an issue with the successful adoption of sensor monitoring, and the importance of personalisation of the suite of sensors implemented for the older adult and the carer, needs to be considered within this.

However, sensors have also been shown to be of variable sensitivity and sensitivity, poorly designed, bulky, lack encryption of data, lack interoperability and have significant battery life limitations. In particular, sensor systems lack quality clinical validation.

Review of interRAI health assessments

All interRAI health assessments are clinical assessments conducted by trained health professionals, usually registered nurses with an annual practicing certificate, working for NASC.

The interRAI assessment output data has been used for several research studies, particularly in New Zealand but not focused on the input of data and sensors (Beere, Keeling, & Jamieson, 2019; interRAI New Zealand, 2019a; Jamieson, Abey-Nesbit, Ahuriri-Driscoll, Keeling, & Schluter, 2018; Salahudeen & Nishtala, 2019; Schluter et al., 2016). Several presentations on New Zealand-based research using interRAI data were made recently at the Knowledge Exchange Forum (interRAI New Zealand, 2020b). Whilst requests for data are increasing, the data warehouse is underused for research (interRAI New Zealand, 2019a).

Interestingly, one randomised controlled trial investigated the effectiveness of inter RAI-HC compared to its predecessor, the Support Needs Assessment (SNA) found that, whilst interRAI-HC identified more unmet support needs than the SNA, it resulted in no improvement in health outcomes for the older person or their carer (Parsons et al., 2013).

New Zealand citizens or residents who are eligible for publicly funded health or disability services under the New Zealand Public Health and Disability Act 2000 are eligible for free (to the older adult) interRAI assessments. Some of the support services identified by the CAPS (such as household support such as cleaning) are only available to those who have a community services card.

A useful consumer resource '*Needs Assessment and Support Services for Older People: What you need to know*' is available (Ministry of Health, 2011). This consumer document provides information for consumers on how to access a needs assessment and home support services. Basically, anyone can contact a NASC to arrange (refer for) a healthcare assessment. This booklet describes the referral/self-referral process, needs assessment process, developing a care plan, coordinating support services and review (at least annually).

interRAI assessors in New Zealand completed approximately 127,000 assessments for older people during the 2018/19 year (figure 8).

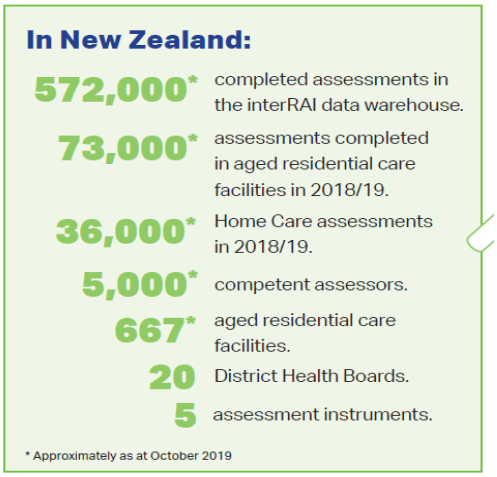


Figure 6: interRAI assessment in New Zealand.

Of these assessments, 35,950 were Home Care Assessments (28% of all assessments completed) and 17,023 were Contact Assessments (13% of all interRAI assessments). More than half (57%, 72,757) were Long Term Care Facilities (LTCF) assessments (72,757), an increase of 0.9% over the previous year (interRAI New Zealand, 2019a). Figure 7 shows assessment type by age, gender and ethnicity (interRAI New Zealand, 2019a).

Characteristic	Contact Assessment	Home Care Assessment	LTCF Assessment	Palliative Care Assessment	65+ population
Median age	81	83	85	78	
% male	34%	41%	35%	50%	47%
% female	66%	59%	65%	50%	53%
% Māori	5%	8%	4%	9%	7%
% non-Māori	95%	92%	96%	91%	93%

Figure 7: Characteristics of older people in different care settings, based on interRAI assessments 2018/2019.

The overall number of HC assessments was 3.9% (1,445) fewer than in the preceding year. TAS posited that this may be attributed to more Palliative Care assessments being completed. Likewise, fewer Contact Assessments were done in 2018/19 compared to 2017/18 – a drop of 992 (5.5%) but still more than in 2016/17 (interRAI New Zealand, 2019a).

13% of women and 8% of men aged 65+ have had at least one interRAI assessment, however the median age is 81 for CA and 83 for HC assessments and the majority of assessments are with the 85+ years cohort. (Data visualisation tool (interRAI New Zealand, 2020a)).

The tripling of LTCF assessments since 2014, now comprising just over half of all assessments combined with the median age of CA and HC assessments could represent an imbalance in the timing and purpose of assessments. The overall goal of interRAI assessments is restorative care however LTCF assessments are required for all older adults entered an ARC long-term facility. Assessor resources may be being allocated to LTCF assessment over CA or HC assessments, differing thresholds may exist for eligibility to ARC, or the assessments are being conducted at a late stage in the life span of an older adult, when the support package triggered by CAPS is residential care in ARC facilities.

In addition to an imbalance in the timing of assessments, there is regional variation in the availability of assessments (Figure 8).

Whilst the majority of assessments occur with older adults over the age of 65 years, interRAI assessments are not limited to those over 65 years of age, their use is based on need for health and disability support care not age. However, the availability of assessments to people aged under 65 years is not well known. Likewise, access to assessments is not based on any other demographic feature, such as ethnicity, gender, etc. For older adults aged 65+ years there is no disparity within ethnic groups ((Jamieson et al., 2018).

DHB and Region	CA	%	HC	%	LTCF	%	Grand Total
Northland	840	22%	1,248	33%	1,727	45%	3,815
Waitemata	3,612	35%	2,164	21%	4,458	44%	10,234
Auckland	2,870	27%	2,537	23%	5,395	50%	10,802
Counties Manukau	952	12%	3,130	40%	3,816	48%	7,898
Northern Region	**8,274**	**25%**	**9,079**	**28%**	**15,396**	**47%**	**32,749**
Waikato	1,135	12%	3,286	36%	4,766	52%	9,187
Lakes	438	17%	969	37%	1,187	46%	2,594
Bay of Plenty	910	14%	2,543	38%	3,178	48%	6,631
Tairawhiti	120	14%	374	44%	364	42%	8,58
Taranaki	239	6%	1,395	37%	2,172	57%	3,806
Midland Region	**2,842**	**12%**	**8,567**	**37%**	**11,667**	**51%**	**23,076**
Hawke's Bay	1,190	24%	1,789	36%	2,050	41%	5,029
MidCentral	410	9%	1,496	33%	2,568	57%	4,474
Whanganui	215	10%	898	43%	973	47%	2,086
Capital and Coast	593	7%	3,696	46%	3,769	47%	8,058
Hutt Valley	1,049	26%	1,254	31%	1,705	43%	4,008
Wairarapa	109	9%	430	37%	617	53%	1,156
Central Region	**3,566**	**14%**	**9,563**	**39%**	**11,682**	**47%**	**24,811**
Nelson Marlborough	383	8%	2,018	42%	2,405	50%	4,806
West Coast	147	20%	317	42%	289	38%	753
Canterbury	2,313	19%	3,202	26%	6,980	56%	12,495
South Canterbury	668	23%	1,154	40%	1,052	37%	2,874
Southern	1,428	15%	3,005	31%	5,305	54%	9,738
South Island	**4,939**	**16%**	**9,696**	**32%**	**16,031**	**52%**	**30,666**
New Zealand	**19,621**	**18%**	**36,905**	**33%**	**54,776**	**49%**	**111,302**

Figure 8: Number and percentage of completed assessments by DHB and region, 2015/16 (interRAI New Zealand, 2016)

Description of assessment process

The interRAI assessment is undertaken after the NASC assessor has received the referral and then collected all other available information on the client eg: from the referral, any available clinical notes in primary or secondary care including elder health or an ED screening, allied health if been an inpatient. This takes time and has the potential to delay assessments.

Contact Assessments (CA) over the telephone take on average 20-30 minutes to complete with the older adult +/- support person(s)/family member(s), the Home Care (HC) assessment takes on average 90 minutes conducted in person in the older adult's home followed by inputting the data into the online assessment form and then formulating a support plan. Travelling to home visits, especially in rural areas, also takes up assessor time. The assessor conducting an assessment may take notes (either on paper on a laptop/tablet) and then inputs information from the client into the online form when back at their office, it is rare for an assessor to complete an assessment into the interRAI online tool during the assessment. These time requirements make it difficult for an assessor to complete more than one HC per day impacting in assessment waiting times. Not everyone has a CA and the main assessment used is HC. A reassessment should happen annually (but is dependent on available resources) or when the clinical situation of the older person changes.

Covid-19 - changes to assessment process

The Covid-19 pandemic has resulted in some changes to the assessment process to reduce the risk of infection to the older adult and their assessor, and to enable assessors to continue to conduct assessments in self-isolation but able to work. It is unknown at this stage how many of these changes will stay post-Covid-19, however having demonstrated that these changes have been successful, it would seem logical that they be continued.

These changes include:

- A Covid-19 risk and clinical assessment for entry into ARC facilities has been included – the data inputs for this is not considered in this project.
- A CA may be used instead of a HC assessment for entry into ARC.

- More health professionals are able to conduct interRAI assessments (as long as this is within their scope of practice or under direction and delegation of an approved assessor and have undertaken training)
- HC can be done using video link rather than in-person at the older adult's home. CAs can still be done by telephone, or by video link if the older adult prefers. Specific protocols have been developed for conducting telephone and video-link assessments.
- Further detail can be found on the website Covid-19 information at https://www.interrai.co.nz/covid-19-info/

Steps in the assessment process

This assessment process is shown in the following simplified process diagram (figure 11). A more detailed diagram is shown in Appendix 4.

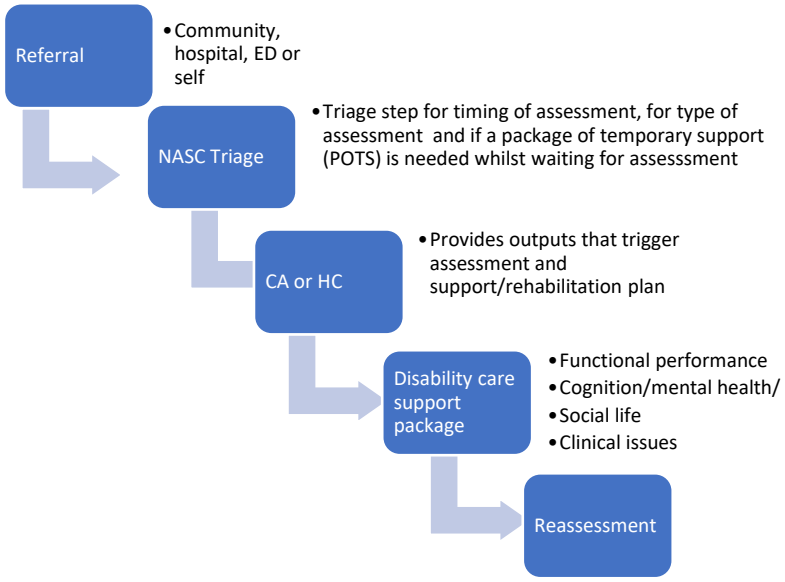


Figure 9: interRAI assessment process – simplified diagram.

A referrer can be anyone from a wide range of options, such as the older adult, a formal or informal carer, a health provider, friends or family members or an organisation such a hospital (either after inpatient stay or visit to ED). It is not a requirement that the General Practice for the older adult writes the referral letter. Information about a referral is received by a NASC in a variety of ways, including electronic if the referrer has the technology to do this – at present this usually is only an option for General Practice, ED and hospital referrals.

There is no national standard for data items to be included in a referral and hence referrals contain different amounts of data, of variable data quality, about the older adult. Therefore, the NASC assessor at the triage step, upon receipt of a referral, may have to contact the referrer or other people or agencies to collect more information before making a judgment about the urgency for assessment, the type of assessment needed or if a temporary disability support package is required pending a formal assessment. This takes assessor resources before the assessment even starts.

A referral can exit the assessment process after a CA or a HC if the data does not trigger a CAP, either because the need is not there (eg: older adult is too well), the implementation of a support package will not result in any improvement to the older adult's condition or there is no suitable support package (eg: severe dementia). This is an important consideration emphasizing again the need to time a referral for a health assessment such that an appropriate support package is possible and thus an improvement in, or maintenance of, health and wellness status will be possible.

This project focuses on the data inputs for a CA or HC assessment. However, during the exploration of the assessment process, steps in the assessment process where digital data and technology, including but not limited to sensors, could be usefully applied are identified and discussed briefly. The main focus of this section now is on the analysis of the data inputs to the CA (includes ED screener) and HC health assessments followed by a more detailed mapping of sensors to specific interRAI items.

Categorization of input data for interRAI health assessments

The data items were identified from the assessment forms and manuals for CA and HC assessments (Hirdes et al., 2010; Morris et al., 2012) and were entered into an MS Excel for PC spreadsheet and analysed within the following categories in table 2. The full list of items and their respective categories is attached in Appendix 5.

Table 5: categorisation of interRAI items.

Category	What is this
interRAI item name	Each piece of data required for an assessment.
Format of observation	Format of data item as presented to the assessor. Could be speech, text, numerical, visual, date, interRAI algorithm
Data type	Text, numerical, alphanumerical, yes/no. The assessor has to turn the format of the observation into a data type before coding it for entry into the assessment form*.
Notes for coding	Additional information about item and coding of item
Referrer/Health Provider	A source of data. Referrer was combined with health provider as one category for source of data. **
Hospital Staff	A source of data. Clinical staff working in a hospital
Hospital Notes	A source of data. Clinical notes from hospital stay or ED visit
Formal helper	A source of data. Registered home care provider
Older adult	The main source of data. The person having the assessment
Informal helper	A source of data. Family or friends as appropriate
Information prepopulated by other database	Is the data prepopulated into the assessment form from another database. Database identified, eg: NHI, hospital PAS, GP PMS or other PAS, laboratory or pharmacy database
Assessor	What action the assessor had to do with the data. Options were: check data presented to them, ask someone for data, observe to get data, use clinical judgement, calculate data, and then input data into the form or just input data (date, time, location and signature).
Data is objective or Subjective	Based on the content and origin of data to be inputted, determined to be objective, subjective or consists of both. For example, date is objective, pain level is subjective.***

Available now in digital format	Data is in digital format somewhere but is not currently pre-populating the assessment form.
Potential for digital format	An assessment of how easy it would be to generate in digital format
Multi-input with algorithm	The data category has multiple data inputs with some type of processing to produce a data item that is then entered into the assessment form. For example, the outcome of interRAI decision support algorithms or the assessor seeking data from multiple sources or parts of the assessment and then interpretation of the wider health status with clinical judgement.
Incorporate into 24 hr assessment	Data reflects health status items over the previous 24 hours
Incorporate into 3 Day assessment	Data reflects health status items over the previous 3 days
Incorporate into 30 days assessment	Data reflects health status items over the previous 30 days
Incorporate into 90 days assessment	Data reflects health status items over the previous 90 days
Incorporate into 180 days assessment	Data reflects health status items over the previous 180 days

Notes on above table 5:

*For example if the assessor observes and listens (visual and speech) to an older adult to determine if they can make themselves understood, they have to determine the most correct response from a list of text options – in this case, understood, usually understood, often understood, sometimes understood, rarely or never understood. This is then coded 0 (understands) – 4 (rarely/never understands).

** even though a referrer does not need to be a health provider, for the data content of a referral combining the referrer and health provider such as general practice as one option worked well for the analysis.

*** the rationale for dividing data into objective and/or subjective is that objective data is easier to convert to a digital format.

Potential for digital format

Some data items are easier to capture for input into the assessment form whereas others are much more complex and difficult to capture. Data items that require clinical judgement, are subjective, or are multi-input with algorithm (multiple data sources collated and processed) are difficult to capture and are also the most problematic to develop into a digital format. Simple objective data such as date, or NHI number are much easier to render in a digital format.

Assessment date, location, date assessment completed and electronic signatures for example can be system generated by the interRAI software, as can counted items such as number of ED visits, time since last hospital stay, last day of hospital stay, surgery in the last 90 days, number of GP visits, number of inpatient stays can be system generated by hospital PAS and GP PMS and passed to the assessment. The current manual method is exceedingly time-consuming and prone to data quality errors.

Some data item groupings such as Medications, Treatments and Procedures, Disease Diagnoses, and Demographics may already be stored in a digital format in clinical notes and databases. Likewise, smoking status is a key performance indicator and so should be recorded in all clinical notes and databases. Where these are digital, then the corresponding data items are already in a digital format.

As these data items are objective, easily defined and observed, if not already in a digital format, they could be stored in digital format with little effort.

General practice/primary care practices could conduct assessments of their older adult populations. If all providers were to use the same assessment tool online, then data could be shared in a digital format much more easily. Likewise, if the CA could be conducted by general practice nurses, the data would be available in a digital format, and pre-populated, for the NASC assessors to use for the more detailed HC assessment.

That said, there are several groups of items that could lend themselves to a digital format but would require more effort to render them such. Cognitive skills for daily decision making, functional status including capacity for (and performance of) activities of daily living (ADLs), instrumental activities of daily living (iADLS), mobility, mood and behavior are more likely to contain both objective and subjective elements or to be based on clinical judgement. These items are also more time consuming for the assessor to determine and code correctly. In addition, poor performance in these areas is linked to a greater risk for subsequent admission to ARC facilities for permanent care and increased informal carer burden (Mello et al., 2017; Mitchell, Harvey, Draper, Brodaty, & Close, 2017). Thus, accuracy of assessment is vital to ensure that appropriate disability support and care is provided where it can make a difference. Sensors can have a role to play here.

Informal helper (carer) status is a key element in determining need for ARC (Betini et al., 2017; Mello et al., 2017). If an informal helper (carer) is feeling overwhelmed, and no one else is available to step in, then home care can no longer be provided and permanent residence in an ARC facility is the outcome. Early identification and provision of increased support to informal helpers (carers) can delay admission to ARC facilities. Self-reporting of informal helper (carer) status via digital devices and apps or even via asynchronous communication such as texts or email, with NASC or their general practice, could be easily implemented and thus be available in a digital format for assessments.

Multiple sources of data input

As can be seen from the above table, there are multiple potential sources of data that could inform an assessment. An assessor may have to seek data from any of these sources, depending on the data item. This may involve ringing up different people or organisations, accessing paper-based hospital notes or databases, speaking with hospital or general practice staff, checking medications with a pharmacist, and so on.

All of the data sought from these multiple sources is unintegrated, in different data formats, of varying data quality, and mainly on paper. Even if the data is available in digital format, the databases do not have a high level of interoperability with interRAI assessment platform and manual mapping of items is needed – the exception here is the NHI database which does prepopulate some demographic data.

Having multiple sources of data impacts on data quality as the data not only may be of poor quality itself but may not have been validated before being provided to the assessor. Clinal evaluation requires a high level of data quality and resources must be applied to ensure that only high-quality data is used. The list of medications taken by an older adult is a good example of clinical data that must be correct. It can be very time consuming for the assessor to collate the uptodate list of medications from the medications in the home, the medications that the older adult says that they are taking, the medication listed in a hospital discharge summary, general practice or pharmacy printout and so on. The medication list must also include any over-the counter or natural remedies

taken by the older adult. The collated list must then be entered into the assessment form and include medication name, dose, unit, route of administration, frequency, and a drug code. A similar process is required with treatments ordered and to be initiated. As mentioned above, medications may already be in a digital format, and there is a national programme around electronic medication management (Health Quality & Safety Commission New Zealand, 2017). Digital sensors systems will form yet another source of data or replace several sources of data.

Multiple formats of data that determines data input

In addition to multiple sources of data inputs, the data that informs about the input data can be in a variety of formats – structured (eg: codes and limited standardized text), semi-structured (eg: free text) and unstructured (eg: audio, video). Speech (such as self-reported data in audio format), visual data (such as observed behaviors) and text-based data all require different detection and processing methods to be converted into the input data format requirements for an assessment form (usually this is text).

This is the place where digital sensor systems can have a major role to play in either creating, processing and directly inputting digital data or in presenting digital data to an assessor to use with their clinical judgement. Developing, or using, clinical decision support systems (CDSs) to support clinical decision making is outside the scope of this project.

Improving self-reported items and accuracy of recall

The older adult is the main source of the majority of the data that is inputted into an assessment form and may be retrospective in nature based on memory recall over the previous 24 hours to 3 months, for example, number of falls in the last 3 months or if the fall was between 31-90 days ago or within the last 30 days. Thus, high quality data relies on the accuracy of memory recall, reporting bias and cognitive ability of the older adult. Having data collected by sensors over the time frame would reduce this reliance of memory recall and validating data would reduce the potential for reporting bias and reliance on cognitive ability. Improved input data quality would flow through the assessment process to better inform the CAPS and thus more relevant and individualised person-centered disability support packages.

Self-completing of items on digital devices such as tablets using apps by the older adult in a timely manner would also improve data quality and have the additional benefit of presenting the data in a digital format. Items such as Social Relationships and Social Activities also would lend themselves to digital diaries or similar. Improving interoperability between digital devices and databases would enable this self-reported digital data to pre-populate the assessment form, or at the least, be presented to the assessor to use.

Providing a sensor system package or a way to record self-completed items on transfer of care from hospital or after an ED visit could enable data collection to occur prior to the assessment that is triggered by these events.

Screening

One problem identified earlier is that CA and HC assessments appear to be conducted late in the older person's life span. Often a referral is triggered by a significant health event, such as a fall with hip fracture, where full recovery may not be likely. interRAI assessments are conducted to determine care

packages to restore health and wellness and/or prevent decline so waiting until after a significant event has happened is too late. Screening at set milestones, such as age or presence of health condition, similar to the cardiovascular screening that occurs in general practice or the national breast and cervical screening programmes, would offer the opportunity to detect risks and appropriate support packages prior to a significant event occurring.

interRAI has several potential screening tools – the ED screener which is also available as a digital app to download, the Depression Rating Scale (DRS), IADL Capacity Hierarchy Scale and MAPLe Outcome Scale. The MAPLe Outcome Scale is calculated from 35 data items and generates 5 levels of likelihood that better care would be obtained in a setting other than home, a type of risk assessment for the need for residential care. Depression and poor performance with iADLs are indicators for ARC admission, thus using them as screening tools could enable early detection and treatment of depression or the provision of early support with iADLs. Depression in particular can be difficult to diagnose in older adults, especially if they also have dementia, and suicide is not uncommon amongst older adults (Conejero, Olié, Courtet, & Calati, 2018). These three scales could all be designed as apps for either self-assessment by the older adult, or for screening by carers or health providers. In addition, if used as digital screening tools then the data would be available in a digital format for the CA and HC assessments.

The ED app asks the following questions and returns an assessment of the urgency for assessment. This could be used by general practice or other primary care providers as a quick screening tool to decide if a referral is needed for a formal assessment, and to indicate to the NASC assessors how urgent the request is. If conducted at defined screening intervals it could enable earlier assessments and increase the use of interRAI assessments for its main purpose of providing restorative care and support rather than admission to ARC facilities. It could also reduce admissions to ARC facilities.

Table 6: ED Screener

1. Do you need any supervision or help to take a bath or shower? (includes transferring in/out)
2. Does someone help you make decisions about daily tasks?
3. Do you need any supervsion or help to dress and undress below the waist?
4. Do you need any supervision or help to move between locations on the same floor level?
5. Do you need any supervision or help to manage your personal hygiene?
6. ASK PERSON ONLY: In general how would you rate your health?
7. Do you have any conditions that make your health unstable?
8. ASK PERSON ONLY: In the last 3 days have you felt sad, depressed, or hopeless?
ASK FAMILY OR FRIENDS: In general do you feel overwhelmed by the person's illness/condition?

Family or friends feeling overwhelmed is asked with every question. Answering yes to this automatically allocates the highest urgency score. In fact, a screen could just involve this question and be directed at the informal helper (carer) in the form of a digital prompt. A Caregiver Wellbeing index (CWBI) based on the interRAI items that relate to informal carers was validated (Betini et al., 2018). This would be another option for screening in General Practice or the community.

Issues with increasing digital input and sensors use

Digital input

There are some barriers to increased digitalization of data input of interRAI assessments. Whilst the assessment data is inputted into an online form, a lack of digital skills for some assessors means that data may be collected at the older adult's home, noted on a piece of paper and then inputted into the online form back at the assessor's place of work.

Assessors have reported a lack of ready access to laptops or computers and having to wait to be able to input their assessments (Smith et al., 2013). Simple design flaws such as the font being too small to be easily legible contribute to frustration with the assessment system (Vuorinen, 2019). Training requirements together with the need to keep uptodate with changes in coding and items can be off-putting for some assessors (Vuorinen, 2019) and be a barrier to widening the pool of potential assessors.

Changing the data input format to pre-population with checking of data or use of tick boxes to indicate item has been updated may not be popular. Health professionals value the important of narratives (listening to their patients) and the relationship this has to empathy and compassion which can be undermined by technology (The Conversation, 2017). Narratives enhance the understanding of cultural contexts of health, which would be lacking with data pre-population (Greenhalgh, 2016).

Understanding why data is being collected, how it will be used, and providing the necessary training and resources not only increases user acceptance of the technology (Smith et al., 2013) but has the potential to improve use of data by home care providers and well as health outcomes for older adults (Elliott, Gordon, Tong, & Stolee, 2020). In addition, it could facilitate timelier referral from general practice and the community.

The quality of data in submitting databases and lack of interoperability is a barrier to acceptance of pre-population of data. The lack of a 'At a glance' view of reports or outcomes makes it very hard to show older adults and other appropriate people the data that has been inputted and to check the validity of that data. This also makes it very hard for GPs to see what is happening with their populations. As the interRAI assessment is not a living document, any changes in the older adult's circumstances mean that the information is no longer current.

A major issue to address with increased digitalisation is inequity. There are regional variations in interRAI assessments, digital and health literacy is lower for Māori and Pasifica, and access to digital technologies and communications is limited (Department of Internal Affairs, 2019). It is critical that increasing the use of digital data for interRAI assessments does not disadvantage already vulnerable groups.

Sensors

Sensors used for health care are basically an extension of telehealth where sensors are linked with mobile and ehealth applications to provide healthcare across time or distance (Coiera, 2015; Susnea et al., 2019). Therefore, sensors are only useful for data input for health assessments if they can meet the wider digital data and technology issues that exist for telehealth. Addressing these issues is out of scope for this project but mention is made of them so that they are not forgotten. These include technology-related barriers, organizational barriers, financial barriers, regulatory issues, legislation, and user adoption (Joshi, Thorpe, & Waldron, 2019). Specifically, in New Zealand, culturally-safe data collection, data ownership and governance must be addressed (Department of Internal Affairs, 2019).

Personalisation where sensors selection would be matched to the older adult's needs, capabilities, preferences and cultural norms is an area that needs research and development.

Sensors have been shown to be of variable sensitivity, specificity and reliability, poorly designed, bulky, lack encryption of data, lack interoperability and have significant battery life limitations (Pantelopoulos & Bourbakis, 2010). Interestingly, smart clothing can use miniature sensors and have high levels of reliability most likely due to good contact with skin (Pantelopoulos & Bourbakis, 2010).

Ambient sensors may be able to be connected to a permanent power supply, but wearables ideally should last for long periods of time before needing recharging or battery changing but at the same time have to be small. This is a significant barrier to increased use of wearables but there is ongoing research to reduce power consumption and battery size of wearables or to provide alternative sources of power such as through body heat or motion (Munos et al., 2016) or other electrophysiological processes (McSweeney, 2020; Pantelopoulos & Bourbakis, 2010).

Of major concern though is that sensor systems lack quality clinical validation. They must be tested and validated by health providers in real-life situations (Pantelopoulos & Bourbakis, 2010; Robinson et al., 2019).

As a start, there is a national standard for digitally sharing comprehensive clinical assessment reports created using the interRAI assessments released in 2013 by HISO. This could be more widely adopted (Ministry of Health, 2013). A service design review of interRAI is in progress so hopefully some of these issues will be addressed (Croskery, 2020).

Identify other data sets that could potentially fill some digital data gaps

The spreasheet in appendix 5 indicates data items where there is digital data available or potentially available. The databases that may contain digital data would include hospital electronic health record systems such as clinical portals, general practice practice management systems (PMS) and associated patient portals, ED systems, regional electronic medical record (EMR), electronic health records (EHR) and patient administration systems such as WebPAS and Health One, national systems such as the national data collections. Pharmacy and laboratory systems could also provide digital data. Allied health providers are starting to use electronic medical record systems and thus would be able to priovide digital data to interRAI. A standardised online referral template even if standalone from a PMS or EMR/EHR would increase the availability of digital data.

There are health assessments that can occur before an interRAI assessment that could provide digital data that could pre-populate or be used to inform an assessor if conducted through a digital system. Assessments by occupational therapists (OT) would be very informative for iADLs/ADLs data input – these are the most resource intensive parts of an interRAI assessment and are prone to subjective interpretation as items are often self-reported. Hence an OT assessment in the older adult's home would be very useful. Likewise, vision, hearing and dentals checks could be conducted prior to an interRAI assessment and provide the information to the assessors. Urgency of need for assessment may preclude pre-assessment assessments but for those of lower urgency, there may well be time to arrange for them to occur in a timely manner and the results be made available. Not only would this fill some digital data gaps but would save time in the assessment both for the assessor and the older adult.

Other steps in assessment process that could benefit from sensor data

The above discussion analyses input data for interRAI health assessments and highlights steps in the assessment process where sensors, digital technologies and digital data could be used. One final area is post-assessment in the support packages. For example, sensors that support especially iADLS and ADLS would be useful, as would sensors that provide support with medication adherence such as reminders. The majority of clinical trials using sensors are in the domain of rehabilitation eg: post-stroke, post-surgery post-hip fracture, and show user acceptance and some health outcomes - improved mobility (Hassett et al., 2020), reduced fear of falling (Kwok & Pua, 2016), improved patient-reporting daily functioning (Pol, Ter Riet, van Hartingsveldt, Kröse, & Buurman, 2019).

Mapping of assessment data to sensors

Mapping Methodology

A three-step modified Delphi method was used to establish consensus. 4 members of the Home Smart Home research team at Massey University who are experts in clinical, digital technology adoption, sensors and machine learning participated as the expert panel. In round 1, all input data items were reviewed (see spreadsheet) by the panel, focusing on those items categorised as having potential for digital format items. Round 2 consisted of a face-to-face meeting in which panel members were asked to consider the feasibility of each item for sensor output and to provide informed comments. Round 3 consisted of a final face-to-face meeting at which specific items were mapped to sensors. Problematic interRAI assessment items for sensor use were identified and a minimum sensor package was considered.

The following interRAI assessment items were excluded by logical deduction and discussion:

- Removed items that are clinical terms such as medications and clinical conditions
- Removed items already in digital format and prepopulating (demographics)
- Removed items that could be part of a standardized digital referral template: demographics, clinical conditions, medications, treatments to be initiated, allergies, reason for referral, expected living conditions, changes in living situations, smoking status, alcohol intake, Treatments and Procedures (Screening), if told to stop driving.
- The ED screener items were also removed a) most are in the CA or HC, b) non-biophysiological sensors are unlikely to be used in ED in any meaningful way.
- Data input items that are the result of interRAI algorithms were excluded as their input items were in CA and HC assessments and creating CDSS were ruled as out of scope. So, algorithm scores for assessment urgency, service urgency and rehabilitation were excluded as would be calculated by the interRAI software.
- Data items that could be system generated
- Data items that were clinical judgement or clinical observation – although these could be informed by sensor data (Discharge Potential and Overall Status, Urinary collection device)
- Items that would be more logical to collect via online self-completed forms: decision maker for personal Care and Property, Social Supports

Mapping results

The following data items remained: Cognition, ADL self-performance, Communication, Mood and Behaviour, Psychsocial wellbeing, iADL self-performance and capacity, Health conditions (falls, balance, and sleep), Skin Condition, Days and minutes of formal caregiving in the last 7 days (or since last assesment or adminision if less than 7 days) and hours of Infomal Care and Active Monitoring during last 3 days, physical restraint, Oral and Nutritional Status, Environmental Assessment.

These align quite well with the sensor purpose or goals of sensor use from the sensor review section of this report suggesting that the use of sensors is possible to support interRAI assessments.

How sensors could be used to inform interRAI assessments

The modified Delphi method produced a list of how sensors could be used with interRAI assessments.

- Tracking Outcomes
- As a complete assessment tool to measure patient wellness
- Include a sensor to assess and evaluate sensor data as a tool for a re-assessment.
- Psychosocial aspects eg, confidence, ability, activities, eg, cooking for oneself (affects nutrition, movement, cognition)
- For those at risk of going into ARC using sensors as part of the initial assessment
- Healthy homes (humidity, temperature, lighting)
- Sensors could provide input to part of the item if not the whole item, eg, 4 metre walk.
- Sensors could measure variables such as impact on carer/ caregiver distress, mood, loneliness, pain.
- Data-fishing – use sensors in a home and look at the whole data set produced to see what is relevant and useful.
- Falls
- Medication management
- ADLs
- 3 day assessment item - 3 day recall is difficult and questionable for accuracy
- 90 day assessment item recall also difficult and questionable for accuracy
- Screening with ED screener app, DRS and MAPLe outcome scales
- Self-monitoring

Detailed sensor to interRAI mapping

This list was then broken down into individual data items. Selection of sensors based on client need and preferences increases compliance, but also needs to determine what is possible based on the older adult's living conditions. If an older adult lives with others, then their needs and wishes such as privacy need to be considered. Tables 6-9 suggests sensors for specific interRAI assessment items.

As the field of sensor reseach and development is expanding rapidly, sensors are getting smaller and smarter, so new sensors as yet unknown may be able to be mapped in the future. Temporary e-tattoes are an example of futuristic weables. They use conductive ink and can be applied with water and washed off after a few days without damaging skin. Power is provided through electrophysiological processes so they do not need batteries (McSweeney, 2020).

Table 7: Sensor to interRAI item mapping

InterRAI items	What is assessed or measured	Potential sensor
Cognition	Making decisions and organising daily self-care activities, disordered thinking	Video – camera records activities then assessor can view the footage to determine if the older adult is making. Comparison to previous footage enables acute (1-2 days) or chronic (90 day) decline detection.
	Remembering	Games like 'Simon says' with lights, records length of light sequences. Online or app memory games. Follows audio instructions.
Communication	Ability to communicate with and understand others	Audio - Sound recording sensors – assessor listens to audio or audio can be processed with AI
Mood and Behaviour	Assessed over last 3 days. May be expressed verbally, nonverbally and/or through behaviours.	Video, can be used similar to that for cognition. Audio, can be used similar to communication. Changes in room lighting detected by luminescence sensors (depressed, dark room). Motion sensors and GPS – detect withdrawal from activities. Facial recognition of expressions. *These arethe most difficult items to assess.*
	Self-reported mood.	Visual representations of mood, eg: something the older adult uses changes colour, such as the border of the screen in a chat with family using VC.
	Wandering	GPS, and geo-fencing
Psychological welllbeing	The degree to which the older adult is involved in social activities, roles and pursuits/hobbies. Includes change. Length of time alone.	GPS tracking/mapping in relation to places of social activities. Digital diaries. Monitoring communication device use (land-line, mobile phone, VC, etc). Visitor-counting sensors, or using smiley face scales.
	Self-reported feels lonely	Audio – recording of older adult saying they are lonely
	Major life stressors in last 90 days	Digital diary
ADL (see seperate table)	Activities of daily living in last 3 days	ADLs and iADLs are composite assessments so multiple sensors may be required. Action may be inferred.
iADLS (see seperate table)	Instrumental activities of daily living in last 3 days, assessed for both performance and capacity.	Performance easier to detect. Capacity is the person's presumed ability, highly subjective, and requires a certain amount of speculation.
Falls/recent falls	Common use of sensors	Acclerometer, Gyroscope, floor sensors, force and pressure, sound, video, radar, event detection – detect and count instances
Balance/gait	Common use but not very successful	Acclerometers, pressure mats, video, floor sensors, fitness trackers, Kinect and Wii, AR,
Sleep		Sleep sensors in fitness trackers and smart watches
Skin condition		Camera and assessor views images, can track progress over time.

Amount of formal/informal caregiving		Event detectors, contact detection, video – count instances over relevant timeframe
Use of physical restraint	In last 3 days	Video, motion sensors in restraints
Pain	Highly subjective	Devices that support self-reporting such as visual analog scales (VAS), video to detect behaviour indicating experiencing pain, facila expression recognition
Continence	Urine and bowel, and use of pads	Smart clothing, such as moisture detecture sensors in underwear, pad/underwear sensors to monitor pad usage, flow sensors in urinary collection device
Oral and Nutritional status	Multiple ways to detect fluid intake, some may be inferred	Digital height and weight measuring instruments, water flow, motion sensor in fluid container, electricity use (smart plug) for kettle (infers cup of tea/coffee), fridge door motion sensor, smart fridges
Environmental Assessment	see seperate table	Multiple sensor options

Table 8: Sensor to iADLs item mapping

iADLS	May be inferred or by direct observation	
Meal preperation		Camera (ambient or egocentric), or inferred from ambient sensors such as fridge opening, oven turned on, cupboards opened
Ordinary housework		Sensors in dishwashers or washing machines, on washing brushes, on vacuum cleaners or brooms, on sheets (motion = changed)
Managing finances		Card tracking. Monitoring cash is more problematic.
Managing medication		RFID, pill counting, reminders, lid motion sensors.
Phone use	Is assisitive technology needed?	Large buttons, audio help, video for Skype, Zoom, FaceTime, etc
Stairs		Barometic pressure/altimeter, Accelerometer (tri-axial)
Shopping		Ego-centric camera
Transportation		Ego-centric camera, digital diary
Help with iADLs		Camera, self-reported

Table 9: Sensor to ADLs item mapping

ADLs	May be inferred or by direct observation – privacy issues critical here	
Bathing		Camera (note privacy issues), could be inferred from motion detector on bathroom door, humidity sensor (humidity increases with warm water use), circadian patterns of activity, water flow through taps, etc
Personal hygiene		Motion sensors in personal hygiene objects such as toothbrush, comb, shaving equipment
Dressing upper body		Camera, smart clothing
Dressing lower body		Camera, smart clothing
Locomotion		Walking frame with motion sensor, smart phone app with step counter, pedometers, etc. Wearables on person or wheelchair - Step counters (pedometers), Accelerometer (tri-axial), barometic pressure/altimeter, gyroscope. Audio, radar, movement around objects (AI)
	Walking around home or wheelchair	
	Timed 4 metre walk	Accelerometer (tri-axial), step counters, fitness trackers
	Distance walked/wheeled self	Accelerometer (tri-axial), step counters, fitness trackers
	Total hours of exercise	Accelerometer (tri-axial), step counters, fitness trackers
	Went out of house in last 3 days	Outside door motion sensor
Transfer toilet		Self-reported, camera (privacy issues), toilet seat sensors
Toilet use		Motion sensors on toliet door, toilet handle or seat
Bed mobility		Accelerometer (tri-axial), bed sensors
Eating		Camera or inferred from cupboards/fridge opening, smart fridge
Change in ADLs status in last 90 days		Calculate difference between 2 or more stored points in time
Help with ADLs		Camera, self-reported
Driving	Drove car in last 90 days	Car motion sensor

Adding value to exisiting devices

User acceptance and contination of use is increased if the sensor is passive, not requiring action by the older adult, low cost, can be used for other reasons, and is easy to use (Elers et al., 2018; Lawrie et al., 2018). Incorporating sensors into everday items adds value to existing devices and is thus an important design feature and a reason for the increase in research into smart clothing, smart watches and smart phones. Smart plugs, smart light bulbs, unobstructive motion detectors, water temperature sensors (can change the colour of the water based on temperature), pressure/force/vibration sensors incorporated into floor mats, carpets, and other forms of flooring, adding temperature/CO2/gas/smoke and flame sensors as combination smoke alarms. Sometimes though this can increase cost – for example smart fridges are more expensive than non-smart fridges.

Table 10: Sensor to Environmental item mapping

Environmental		
Home in disrepair		
Squalid condition		Pictures, or inferred from lack of housework
Inadequte heating or cooling		Temperature sensors, gas use, electricity use,
Lack of personal satety	Fear of personal attack	Motion sensors with lights, panic buttons, hearing aides,
Limited access to home or rooms	Can't climb stairs, can't manoeuvre well, also building issues	Accelerometer (tri-axial), barometic pressure/altimeter, gyroscope. Audio, radar, movement around objects (AI)
Finances	Has enough money to live on	Digital bank statements

Sensor systems (models) effectiveness - screening, item ranking, and prognostic indicators

This is very dependent on the type of sensors used, types of processing of sensor data by a central prcessing unit and if the input data can be converted to a digital format. Types of processing of sensor generated data is critical, such as pattern recognition and identification of abnormal events or converting images such as from video into more privacy-preserving outputs (for example, depixelation).

Problematic interRAI assessment items for sensor use include mood & behavior, indicators for iADLs and ADLS and informal helper status. Prognostic indicators and ranking of items can include screening algorithms which may get input from sensor data or self-completed digital questionnaires. Unfortunately, the most useful items for prognostic indicators are the harder items to be deteced by sensor sytems.

As significant volumes of data can potentially be collected using sensors, data produced by sensors is big data. As such it has the same problems as any form of big data – data formats that are structured, semi-structured and unstructured, and the 5 Vs - volume, velocity, value, variety and veracity (Joshi et al., 2019). The effectiveness of sensor sytems is dependent on how well these are managed.

Improving clinical outcomes

Any changes to the interRAI health assessments or data input methods and processes must have the aim not only of increasing digital data for input into these health assessments, but also of improving health outcomes.

Minumum sensor package for homes

Based on work undertaken for this project, a 2-tier approach to a minimum sensor package for homes is recommended. If the older adult lives with others, then their needs and wishes such as privacy need to be taken into account.

Tier 1: simple wearables - acclerometer, barometic pressure/altimeter, gyroscope in different designs plus simple PIR motion detectors appropriately located – open door, moved into room, turned on light or radio.

This can be be used for pre assessment data gathering and screening, leading to early identification for assessment, and early detection of declining health but also for a feeling of security, reduced loneliness and improved interaction with support network. This would connect the informal network with the older adult so that it is there for when health declines.

Simple wearables can be incorporated into items of daily wear such as shoes, bracelets, pendants, straps, and could potentially be located anywhere on the body. However care needs to be taken with direct skin placement as the skin of older adults may be thin, easily damaged and slow to heal. Incorporating sensors into favourite everyday items would increase continuation of use. Self-completed online health assessment questions and screening tools by older adults and/or informal carers could be used as well. Temporary ambient cameras could be installed for 3 days for improved assessment of iADLS and ADLs (these are assessed over the previous 3 days in an interRAI assessment). Screening tools and a standard referral form used by health providers would apply.

This tier would be for older adults who are basically well, may have health conditions but these are stable, have good support (informal carers) and who want reassurance that events such as falls would be detected and that support network/health providers would be notified. Devices used could be self-selected from an offered range of sensors. Communication could be by cellular or wifi, either included with the device or sent via a central processing unit.

Tier 1 would be scalable by the addition of wearable and ambient sensors as need changes with more frequent screening tool use by health providers to detect early deterioration in health status.

Tier 2: fixed ambient camera or movement (such as radar or audio) continuous monitoring with selected wearables and ambient sensors based on a formal needs assesment by a registered health provider, such as OT or interRAI assessor.

More complex data processing would be required which would include protection of privacy, pattern recognition and AI such as fuzzy logic and rules-based reasoning with alerts of abnormal events. Whilst data collection could be continuous, the processing output could exception based, summarised, or otherwise aggregated for ease of viewing. Skin care concerns are more important in frailer older adults.

This tier would be for older adults with high levels of frailty, requiring support for iADLS and ADLS, cognitive problems, unstable health conditions, frequent falls, frequent ED visits or hospital admissions. Tier 2 adults may be willing to trade privacy for security and reassurance of help arriving from continuous monitoring.

Like Tier 1, Tier 2 can be be used for pre assessment data gathering and screening, leading to early detection of declining health but also would determine the level of support needed and ensure it was

provided when needed. Again, like Tier 1, Tier 2 would provide a feeling of security, reduce loneliness and increase interaction with support network, and bring health providers in the circle of care. Both Tier 1 and Tier 2 would include checks to ensure informal carers are not being overwhelmed.

Next steps

This project has identified that the majority of research undertaken in the sensor/older adult space is experimental, in residential care, and are pilot projects with small sample sizes. Very few real-life RCTs exist, however as most of these are in recent years, this area is maturing. Therefore further research into real-life use of sensors to support care for older adults at home is needed.

One option would be a pragmatic clinical trial of home sensors and data mapping, to test Tier 1 and Tier 2, with engaged local service providers such as: Marion Kennedy centre, Alzheimer's Manawatu, Age concern, NSAC asssessors, MidCentral DHB, general practice and allied health providers.

A second option would be devloping pilot studies with large sample sizes in real-life situations with clincal validation. For example, as medication adherance disportionally affects the elderly (Yap, Thirumoorthy, & Kwan, 2016) investigating how digital data and technology could support medication adherence of older adults within their home, communicate with the older adults' informal support networks and their health care providers and integrate with existing electronic information sharing systems.

In addition, ongoing research into the wider aspects of digital technology use such as privacy, security, interoperability, improving digital and health literacy, and culturally appropriate technology use and data management/governance (including informed consent) and how they apply to sensors in the home is needed.

Limitations

The main limitation of the report is that sensors are a fast-moving area and new sensors are being developed all the time. The sensors and their use discussed in the report could be superseded by future development.

The project was a data analysis project. Observing a real time assessment and interviewing older adults and their informal carers, assessors and data end users such as hospital geriatric services or primary care providers would enable triangulation and increase the validity of the project findings, this may also reveal new findings.

Detail about available commercial sensors systems was limited to public company websites, there were no published evaluations of these systems found, therefore it was not possible to comment on their suitability of otherwise for use to support older adults living at home and for providing data for interRAI home assessments.

There was very little published research found on health assessments and sensors with older adults. Findings presented may not be strictly applicable to the scope of the project as age and purpose of health assessments was removed to find published literature on sensors in health. The project examined assessments for home, assessments for ARC and palliative care may produce different findings.

Conclusions

This report presents findings from research undertaken into the use of sensor data, available today, and mapped alongside current interRAI assessment data, to demonstrate the viability of data collected from sensors in a home (external) environment from a clinical setting.

The main findings are that data input is currently from multiple sources of data input, in multiple formats, based on self-reported recall, on paper and time consuming to collate and enter into the online assessment form. A lack of operability prevents data that is in digital format from being used, with the exception of the NHI.

Sensors can be used to improve data input for interRAI assessments. Some assessment items are complex and difficult. Those items that are most difficult for the assessor to assess were also the same items that would be difficult to introduce sensors to provide input data. In these situations, providing sensor data to the assessor who would then use their clinical judgement would enable the assessor to complete these items in a more efficient and effective manner.

Sensors could play a role at any step in the assessment process, from pre-assessment, to providing support care and monitoring of health outcomes after the assessment is completed. Changes to the assessment process would increase efficacy and effectiveness of assessments.

Technical data about existing commercial sensors systems, apart from what was included in their public websites, was absent from the public domain hence it was not possible to assess their ability to provide data for interRAI assessments.

Providing low cost, easy to use, adaptable, secure, culturally acceptable sensors that add value to existing everyday items and that can be selected by the older adult will increase compliance and acceptability by older adults.

A major theme of the literature review that research studies conducted on sensor use are mainly experimental, with small sample sizes and based in residential care providing limited evidence that sensor use improves health outcomes. This could be addressed by supporting real-life clinical studies on the use of sensors in the care of the elderly.

References

AAL Europe. (2019). Ambient Assisted Living Joint Programme. Retrieved from www.aal-europe.eu/about/

Bajones, M., Fischinger, D., Weiss, A., Puente, P. D. L., Wolf, D., Vincze, M., . . . Frennert, S. (2019). Results of Field Trials with a Mobile Service Robot for Older Adults in 16 Private Households. *J. Hum.-Robot Interact., 9*(2), Article 10. 10.1145/3368554

Beere, P., Keeling, S., & Jamieson, H. A. (2019). Ageing, loneliness, and the geographic distribution of New Zealand's interRAI-HC cohort. *Social Science & Medicine., 227*, 84-92.

Betini, R. S. D., Hirdes, J. P., Curtin-Telegdi, N., Gammage, L., Vansickle, J., Poss, J., & Heckman, G. (2018). Development and validation of a screener based on interRAI assessments to measure informal caregiver wellbeing in the community. *BMC Geriatrics, 18*(1), 310. 10.1186/s12877-018-0986-x

Betini, R. S. D., Hirdes, J. P., Lero, D. S., Cadell, S., Poss, J., & Heckman, G. (2017). A longitudinal study looking at and beyond care recipient health as a predictor of long term care home admission. *BMC Health Services Research, 17*(1), 709. 10.1186/s12913-017-2671-8

Broad, J. B., Ashton, T., Gott, M., McLeod, H., Davis, P. B., & Connolly, M. J. (2015). Likelihood of residential aged care use in later life: a simple approach to estimation with international comparison. . *Australian and New Zealand Journal of Public Health, 39*(4), 374-379.

Broadbent, E. (2017). Interactions With Robots: The Truths We RevealAbout Ourselves. *Annu. Rev. Psychol., 68*, 627-652. doi:10.1146/annurev-psych-010416-043958

Broadbent, E., Peri, K., Kerse, N., Jayawardena, C., Kuo, I., & Datta, C. (2014, October 27-29). *Robots in older people's homes to improve medication adherence and quality of life: A randomised cross-over trial.* Paper presented at the 6th International Conference on Social Robotics, Sydney, Australia.

Broadbent, E., Peri, K., Kerse, N., Jayawardena, C., Kuo, I., Datta, C., & MacDonald, B. (2014, 2014). *Robots in Older People's Homes to Improve Medication Adherence and Quality of Life: A Randomised Cross-Over Trial.* Paper presented at the Social Robotics, Cham.

Coiera, E. (2015). *Guide to Health Informatics* (Third ed.). Boca Raton, FL: CRC Press Taylor & Francis Group.

Conejero, I., Olié, E., Courtet, P., & Calati, R. (2018). Suicide in older adults: current perspectives. *Clinical interventions in aging, 13*, 691-699. 10.2147/cia.S130670

Croskery, T. (2020, June 24, 2020). [Discussion regarding interRAI].

Department of Internal Affairs. (2019). *The Digital Inclusion Blueprint, Te Mahere mō te Whakaurunga Matihiko.* Wellington: Department of Internal Affairs. Retrieved from digital.govt.nz

Elers, P., Hunter, I., Whiddett, D., Lockhart, C., Guesgen, H., & Singh, A. (2018). User Requirements for Technology to Assist Aging in Place: Qualitative Study of Older People and Their Informal Support Networks. *JMIR Mhealth Uhealth, 6*(6), e10741. 10.2196/10741

Elliott, J., Gordon, A., Tong, C. E., & Stolee, P. (2020). "We've got the home care data, what do we do with it?": understanding data use in decision making and quality improvement. *BMC Health Services Research, 20*(1), 251. 10.1186/s12913-020-5018-9

Furberg. (2020). How Wearable Sensors Can Change the Course of the COVID-19 Pandemic. Retrieved from https://www.rti.org/insights/how-wearable-sensors-can-change-course-covid-19-pandemic

Geraedts, H. A. E., Zijlstra, W., Van Keeken, H. G., Zhang, W., & Stevens, M. (2015). Validation and User Evaluation of a Sensor-Based Method for Detecting Mobility-Related Activities in Older Adults. *PloS one, 10*(9), e0137668-e0137668. 10.1371/journal.pone.0137668

Greenhalgh, T. (2016). *Health Evidence Network (HEN) synthesis report 49. Cultural contexts of health: the use of narrative research in the health sector*. Copenhagen: WHO Regional Office for Europe. Retrieved from https://www.euro.who.int/__data/assets/pdf_file/0004/317623/HEN-synthesis-report-49.pdf?ua=1

Hassett, L., van den Berg, M., Lindley, R. I., Crotty, M., McCluskey, A., van der Ploeg, H. P., . . . Sherrington, C. (2020). Digitally enabled aged care and neurological rehabilitation to enhance outcomes with Activity and MObility UsiNg Technology (AMOUNT) in Australia: A randomised controlled trial. *PLoS medicine, 17*(2), e1003029-e1003029. 10.1371/journal.pmed.1003029

Health Quality & Safety Commission New Zealand. (2017). Electronic Medicines Management. Retrieved from https://www.hqsc.govt.nz/our-programmes/medication-safety/projects/electronic-medicines-management/

Hirdes, J., Curtin-Telegdi, N., Poss, J. W., Gray, L., Berg, K., Stolee, P., & Costa, A. P. (2010). *interRAI Contact Assessment (CA) Form and User's Manual: A Screening Level Assessment for Emergency Department and Intake from Community Hospital.* (Version 9.2. Standard English Edition ed.). Massachusetts: interRAI.

Hrast, M. F., Sendi, R., & Kerbler, B. (2020). Housing choices of older people: Staying or moving in the case of high care needs. *Sustainability (Switzerland), 12*(7) 10.3390/su12072888

interRAI New Zealand. (2016). *National interRAI Data Analysis. Annual Report 2015/2016.* . Wellington: TAS. Retrieved from https://www.interrai.co.nz/assets/Data/91eb37834b/2015-16-National-interRAI-Data-Analysis-Annual-Report.pdf

interRAI New Zealand. (2019a). *Annual Report 2018/2019.* Wellington: TAS. Retrieved from https://www.interrai.co.nz/assets/9169ec695a/00-AR_interRAI_2019-FINAL_WEB.pdf

interRAI New Zealand. (2019b). Which interRAI assessment to use and when to use it. Retrieved from https://www.interrai.co.nz/assets/Documents/9e23ac64dd/Which-interRAI-assessment-to-use-and-when-to-use-it.pdf

interRAI New Zealand. (2020a). interRAI data. Retrieved from https://www.interrai.co.nz/data-and-reporting/

interRAI New Zealand. (2020b). NEWS. Retrieved from https://www.interrai.co.nz/news/

interRAI New Zealand. (2020c). Timeline. Retrieved from https://www.interrai.co.nz/about/timeline/

interRAI New Zealand. (n.d.). ABOUT. Retrieved from https://www.interrai.co.nz/about/

Jamieson, H. A., Abey-Nesbit, R., Ahuriri-Driscoll, A., Keeling, S., & Schluter, P. J. (2018). Profile of ethnicity, living arrangements and loneliness amongst older adults in Aotearoa New Zealand: A national cross-sectional study. *Australasian Journal on Ageing., 37*(1), 68-73.

Jøranson, N., Pedersen, I., Rokstad, A. M. M., & Ihlebæk, C. (2015). Effects on Symptoms of Agitation and Depression in Persons With Dementia Participating in Robot-Assisted Activity: A Cluster-Randomized Controlled Trial. *Journal of the American Medical Directors Association, 16*(10), 867-873. https://doi.org/10.1016/j.jamda.2015.05.002

Joshi, A., Thorpe, L., & Waldron, L. (2019). *Population Health Informatics. Driving Evidence-Based Solutions into Practice*. Massachusetts: Jones & Bartlett Learning.

Koceska, N., Koceski, S., Beomonte Zobel, P., Trajkovik, V., & Garcia, N. (2019). A Telemedicine Robot System for Assisted and Independent Living. *Sensors (Basel, Switzerland), 19*(4), 834. 10.3390/s19040834

Kwok, B. C., & Pua, Y. H. (2016). Effects of WiiActive exercises on fear of falling and functional outcomes in community-dwelling older adults: a randomised control trial. *Age Ageing, 45*(5), 621-627. 10.1093/ageing/afw108

Lawrie, S., Dong, Y., Steins, D., Xia, Z., Esser, P., Sun, S., . . . Smart Watch Activity Feedback Trial, C. (2018). Evaluation of a smartwatch-based intervention providing feedback of daily activity within a research-naive stroke ward: a pilot randomised controlled trial. *Pilot and feasibility studies, 4*, 157-157. 10.1186/s40814-018-0345-x

Liang, A., Piroth, I., Robinson, H., MacDonald, B., Fisher, M., Nater, U. M., . . . Broadbent, E. (2017). A Pilot Randomized Trial of a Companion Robot for People With Dementia Living in the Community. *Journal of the American Medical Directors Association, 18*(10), 871-878. https://doi.org/10.1016/j.jamda.2017.05.019

Massé, F., Gonzenbach, R. R., Arami, A., Paraschiv-Ionescu, A., Luft, A. R., & Aminian, K. (2015). Improving activity recognition using a wearable barometric pressure sensor in mobility-impaired stroke patients. *Journal of neuroengineering and rehabilitation, 12*, 72-72. 10.1186/s12984-015-0060-2

McSweeney, K. (2020). E-Tattoos Are Futuristic Healthcare Wearables. Retrieved from Now website: https://now.northropgrumman.com/e-tattoos-are-futuristic-healthcare-wearables/

Meehan B. and McCreadie M. (2016). Agreements for the use of the interRAI assessment system. https://www.interrai.co.nz/assets/Documents/ESS-Information-for-Managers/fa1b5c6120/interRAI-Governance-Board-Agreements-for-use-of-the-interRAI-assessment.pdf

Mello, J. d. A., Macq, J., Van Durme, T., Cès, S., Spruytte, N., Van Audenhove, C., & Declercq, A. (2017). The determinants of informal caregivers' burden in the care of frail older persons: a dynamic and role-related perspective. *Aging & Mental Health, 21*(8), 838-843. 10.1080/13607863.2016.1168360

Ministry of Health. (2011). *Needs Assessment and Support Services for Older People: What you need to know.* In. Retrieved from https://www.health.govt.nz/system/files/documents/publications/support-services-older-plev2.pdf

Ministry of Health. (2013). *HISO 10047 Clinical Document Architecture Templates for Comprehensive Clinical Assessments*. Wellington: Ministry of Health. Retrieved from https://www.health.govt.nz/publication/hiso-100472013-clinical-document-architecture-templates-comprehensive-clinical-assessments

Mitchell, R., Harvey, L., Draper, B., Brodaty, H., & Close, J. (2017). Risk factors associated with residential aged care, respite and transitional aged care admission for older people following an injury-related hospitalisation. *Archives of Gerontology and Geriatrics, 72*, 59-66. https://doi.org/10.1016/j.archger.2017.05.012

Morris, J. N., Berg, K., Björkgren, M., Finne-Soveri, H., Fries, B. E., Frijters, D., . . . K., S. (2010). *interRAI Clinical Assessment Protocols (CAPS): For Use with Community Assessment Instruments.* (Version 9.1. ed.). Massachussetts: interRAI.

Morris, J. N., Fries, B. E., Bernabei, R., Steel, K., Ikegami, N., Carpenter, I., . . . Belleville-Taylor, P. (2012). *interRAI Home Care Assessment Form and User's Manual.* (Version 9.1. Canadian Edition. ed.). Massachussetts: interRAI. www.interRAI.org

Munos, B., Baker, P. C., Bot, B. M., Crouthamel, M., de Vries, G., Ferguson, I., . . . Wang, P. (2016). Mobile health: the power of wearables, sensors, and apps to transform clinical trials. *Ann N Y Acad Sci, 1375*(1), 3-18. 10.1111/nyas.13117

New Zealand Aged Care Association. (2018). *Caring for our older Kiwis.* wellington: New Zealand Aged Care Association, . Retrieved from https://nzaca.org.nz/advocacy-and-policy/caring-for-our-older-kiwis/

Nguyen, T.-H.-C., Nebel, J.-C., & Florez-Revuelta, F. (2016). Recognition of Activities of Daily Living with Egocentric Vision: A Review. *Sensors (Basel, Switzerland), 16*(1), 72. 10.3390/s16010072

Pantelopoulos, A., & Bourbakis, N. G. (2010). A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), 40*(1), 1-12. 10.1109/TSMCC.2009.2032660

Parsons, M., Senior, H., Mei-Hu Chen, X., Jacobs, S., Parsons, J., Sheridan, N., & Kenealy, T. (2013). Assessment without action; a randomised evaluation of the interRAI home care compared to a national assessment tool on identification of needs and service provision for older people in New Zealand. *Health & Social Care in the Community, 21*(5), 536-544. 10.1111/hsc.12045

Peters, M., Godfrey, C., McInerney, P., Munn, Z., Tricco, A., & Khalil, H. (2020). Chapter 11: Scoping reviews. In M. Z. Aromataris E (Ed.), *JBI Reviewer's Manual*: JBI. 10.46658/jbirm-20-01

Petersen, S., Houston, S., Qin, H., Tague, C., & Studley, J. (2017). The Utilization of Robotic Pets in Dementia Care. *Journal of Alzheimer's disease : JAD, 55*(2), 569-574. 10.3233/JAD-160703

Pol, M. C., Ter Riet, G., van Hartingsveldt, M., Kröse, B., & Buurman, B. M. (2019). Effectiveness of sensor monitoring in a rehabilitation programme for older patients after hip fracture: a three-arm stepped wedge randomised trial. *Age Ageing, 48*(5), 650-657. 10.1093/ageing/afz074

Pu, L., Moyle, W., Jones, C., & Todorovic, M. (2020). The Effect of Using PARO for People Living With Dementia and Chronic Pain: A Pilot Randomized Controlled Trial. *Journal of the American Medical Directors Association* https://doi.org/10.1016/j.jamda.2020.01.014

Robinson, H., Macdonald, B., Kerse, N., & Broadbent, E. (2013). The psychosocial effects of a companion robot: a randomized controlled trial. *J Am Med Dir Assoc, 14*(9), 661-667. 10.1016/j.jamda.2013.02.007

Robinson, N. L., Cottier, T. V., & Kavanagh, D. J. (2019). Psychosocial Health Interventions by Social Robots: Systematic Review of Randomized Controlled Trials. *Journal of medical Internet research, 21*(5), e13203-e13203. 10.2196/13203

Rohrbach, N., Gulde, P., Armstrong, A. R., Hartig, L., Abdelrazeq, A., Schröder, S., . . . Hermsdörfer, J. (2019). An augmented reality approach for ADL support in Alzheimer's disease: a crossover trial. *Journal of neuroengineering and rehabilitation, 16*(1), 66-66. 10.1186/s12984-019-0530-z

Salahudeen, M. F., & Nishtala, P. S. (2019). A Systematic Review Evaluating the Use of the interRAI Home Care Instrument in Research for Older People. *Clinical Gerontologist, 42*(5), 463-484. DOI: 10.1080/07317115.2018.1447525

Schluter, P. J., Ahuriri-Driscoll, A., Anderson, T. J., Beere, P., Brown, J., Dalrymple-Alford, J., . . . Jamieson, H. A. (2016). Comprehensive clinical assessment of homebased older persons within New Zealand: an epidemiological profile of a national cross-section. *Australian and New Zealand Journal of Public Health, 40*(4), 349-355.

Shanahan, G., & Siew, D. (2020). *New Zealand HealthTech Insights Report: 2020.* . Retrieved from www.tin100.com

Siena, F. L., Byrom, B., Watts, P., & Breedon, P. (2018). Utilising the Intel RealSense Camera for Measuring Health Outcomes in Clinical Research. *Journal of Medical Systems, 42*(3), 53-53. 10.1007/s10916-018-0905-x

Smith, J., Whiddett, D., & Hunter, I. (2013). User experience of interRAI assessment tools in New Zealand. *Studies in Health Technology and Informatics, 192*, 744-748. DOI: 10.3233/978-1-61499-289-9-744

Son, H., & Kim, H. (2019). A Pilot Study to Test the Feasibility of a Home Mobility Monitoring System in Community-Dwelling Older Adults. *International journal of environmental research and public health, 16*(9), 1512. 10.3390/ijerph16091512

Stucki, R. A., Urwyler, P., Rampa, L., Müri, R., Mosimann, U. P., & Nef, T. (2014). A web-based non-intrusive ambient system to measure and classify activities of daily living. *Journal of medical Internet research, 16*(7), e175-e175. 10.2196/jmir.3465

Susnea, I., Dumitriu, L., Talmaciu, M., Pecheanu, E., & Munteanu, D. (2019). Unobtrusive Monitoring the Daily Activity Routine of Elderly People Living Alone, with Low-Cost Binary Sensors. *Sensors (Basel, Switzerland), 19*(10), 2264. 10.3390/s19102264

Taylor, J. K., Buchan, I. E., & van der Veer, S. N. (2019). Assessing life-space mobility for a more holistic view on wellbeing in geriatric research and clinical practice. *Aging clinical and experimental research, 31*(4), 439-445. 10.1007/s40520-018-0999-5

Tedesco, S., Sica, M., Ancillao, A., Timmons, S., Barton, J., & O'Flynn, B. (2019). Accuracy of consumer-level and research-grade activity trackers in ambulatory settings in older adults. *PloS one, 14*(5), e0216891-e0216891. 10.1371/journal.pone.0216891

The Conversation. (2017). Are our busy doctors and nurses losing empathy for patients? Retrieved from https://theconversation.com/are-our-busy-doctors-and-nurses-losing-empathy-for-patients-68228

Tricco, A., Lillie, E., Zarin, W., O'Brien, K., Colquhoun, H., Levac, D., . . . Straus, S. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine, 169* 10.7326/M18-0850

Uddin, M. Z., Khaksar, W., & Torresen, J. (2018). Ambient Sensors for Elderly Care and Independent Living: A Survey. *Sensors (Basel, Switzerland), 18*(7), 2027. 10.3390/s18072027

Vuorinen, M. (2019). Registered Nurses' experiences with, and feelings and attitudes towards, the International Resident Assessment Instrument for Long-Term Care Facilities in New Zealand in 2017. *Journal of Research in Nursing, 25*(2), 141-155. 10.1177/1744987119890651

Webster, D., & Celik, O. (2014). Systematic review of Kinect applications in elderly care and stroke rehabilitation. *Journal of neuroengineering and rehabilitation, 11*, 108-108. 10.1186/1743-0003-11-108

Wiles, J. L., Leibing, A., Guberman, N., Reeve, J., & Allen, R. E. S. (2012). The meaning of "aging in place" to older people. *Gerontologist, 52*(3), 357-366. 10.1093/geront/gnr098

Yang, Y., Hirdes, J. P., Dubin, J. A., & Lee, J. (2019). Fall Risk Classification in Community-Dwelling Older Adults Using a Smart Wrist-Worn Device and the Resident Assessment Instrument-Home Care: Prospective Observational Study. *JMIR Aging, 2*(1), e12153. 10.2196/12153

Yap, A. F., Thirumoorthy, T., & Kwan, Y. H. (2016). Medication adherence in the elderly. *Journal of Clinical Gerontology and Geriatrics, 7*(2), 64-67. https://doi.org/10.1016/j.jcgg.2015.05.001

Appendix 1: Abbreviations

5 Vs	volume, velocity, value, variety and veracity
ACF	Aged Care Facility
AAL	Ambient Assisted Living
ADLs	Activities of Daily Living
AI	Artificial Intelligence
AR	Augmented Reality
ARC	Aged Residential Care
CA	Contact Assessment
CAPs	Clinical Assessment Protocols
CCS	Commercial Sensor Systems
CDSS	Clinical Decision Support System
CHA	Community Health Assessment
CWBI	Caregiver Wellbeing Index
DHB	District Health Board
DRS	Depression Rating Scale
ED	Emergency Department
EHR	Electronic Health Record
EMR	Electronic Medical Record
GP	General Practice
GPS	Global Positioning System
HAR	Human Activity Recognition
HC	Home Care assessment
iADLs	instrumental Activities of Daily Living
interRAI	international Resident Assessment Instrument
LTCF	Long Term Care Facilities

MAPLe	Method for Assessing Priority Levels
MeSH	Medical Subject Headings
MoH	Ministry of Health
NASC	Needs Assessment and Service Coordination
NHI	National Health Index
NZ	New Zealand
OT	Occupational Therapists
RAI-HC	Resident Assessment Instrument-Home Care (the Canadian version of interRAI)
RCT	Random Controlled Trial
RFID	Radio Frequency Identification
PAS	Patient Administration System
PC	Palliative Care assessment
PCC	Population, Concept and Context
PIR	Passive Infrared sensor
PMS	Patient Management System
POTS	Packages of Temporary Support
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
SiPMs	Silicon PhotoMultipliers
SNA	Support Needs Assessment
TAS	Technical Advisory Services
TIN	Technical Investment Network

Appendix 2: Boolean phrases and MeSH Terms

Databases searched: PubMed, Medline, Cinahl

Search outcome by Boolean phrases

	(health OR wellbeing) AND (interRAI OR interrai OR "older adult assessment" OR geriatric OR ageing OR aging OR senior) AND (sensors OR wearables OR digital OR technology OR IoT OR iot OR IOT OR "internet of things" OR assistive OR "pervasive technology" OR "Smart home" OR "smart home" OR "smart house" OR "Smart house" OR monitoring)	34,174 Pubmed	512 Cinahl	
*	(interRAI OR interrai OR "older adult assessment") AND (ageing OR aging OR senior) AND (sensors OR wearables OR digital OR technology OR IoT OR iot OR IOT OR "internet of things" OR assistive OR "pervasive technology" OR "Smart home" OR "smart home" OR "smart house" OR "Smart house" OR monitoring)	8 Pubmed	2 Cinahl	5 web of Science (emailed) 1 using keywords
*	(interRAI OR interrai OR "older adult assessment") AND (ageing OR aging OR senior) AND (monitoring) AND (sensors OR wearables OR digital OR technology OR IoT OR iot OR IOT OR "internet of things" OR assistive OR "pervasive technology" OR "Smart home" OR "smart home" OR "smart house" OR "Smart house")	1 Pubmed	0 Cinahl	0 Web of Science
	("older adults" OR ageing) AND (monitoring) AND (sensors OR wearables OR technology OR IoT OR iot OR IOT OR "internet of things" OR pervasive technology OR Smart home OR smart house)	188 Pubmed	107 Cinahl 60 if use Abstract as filter	100 by keywords WoS
	("older adults" OR ageing) AND (sensors OR wearables OR technology OR IoT OR iot OR IOT OR "internet of things" OR pervasive technology OR Smart home OR smart house OR monitoring)	1303 Pubmed	1053 Cinahl 1223 if use abstract as filter	759 WoS Keywords
	(ageing OR aging OR senior) AND (monitoring) AND (sensors OR wearables OR technology OR IoT OR iot OR IOT OR "internet of things" OR pervasive technology OR Smart home OR smart house)	191 Pubmed	62 Cinahl 37 in last 5 years	95 by keywords WoS
	interRAI OR interrai (full free text, last 10 yrs, English, aged >45 yrs)	57 Pubmed	66 Cinahl	12 WoS

Adding clinical trial to above MeSH terms search	15, but only 3 relevant. Linked articles found another 25
Adding systematic reviews for health assessments in older adults, but neither included sensors	2, did not include sensors
Adding systematic reviews to older adult/technology (first search above)	10, 8 relevant. Linking from other references identified a further 12.

MeSH Heading Terms:

Medical Subject headings used in PubMed		
Healthy aging	interRAI or interrai – no records	Technology
Aged	Assessment – no MeSH terms	wearable technology
Health Services for the Aged	Assessment of health needs	assistive technology
	Rehabilitation	Ambulatory technology
		Wearable device
		Telehealth

Search outcome by MeSH terms

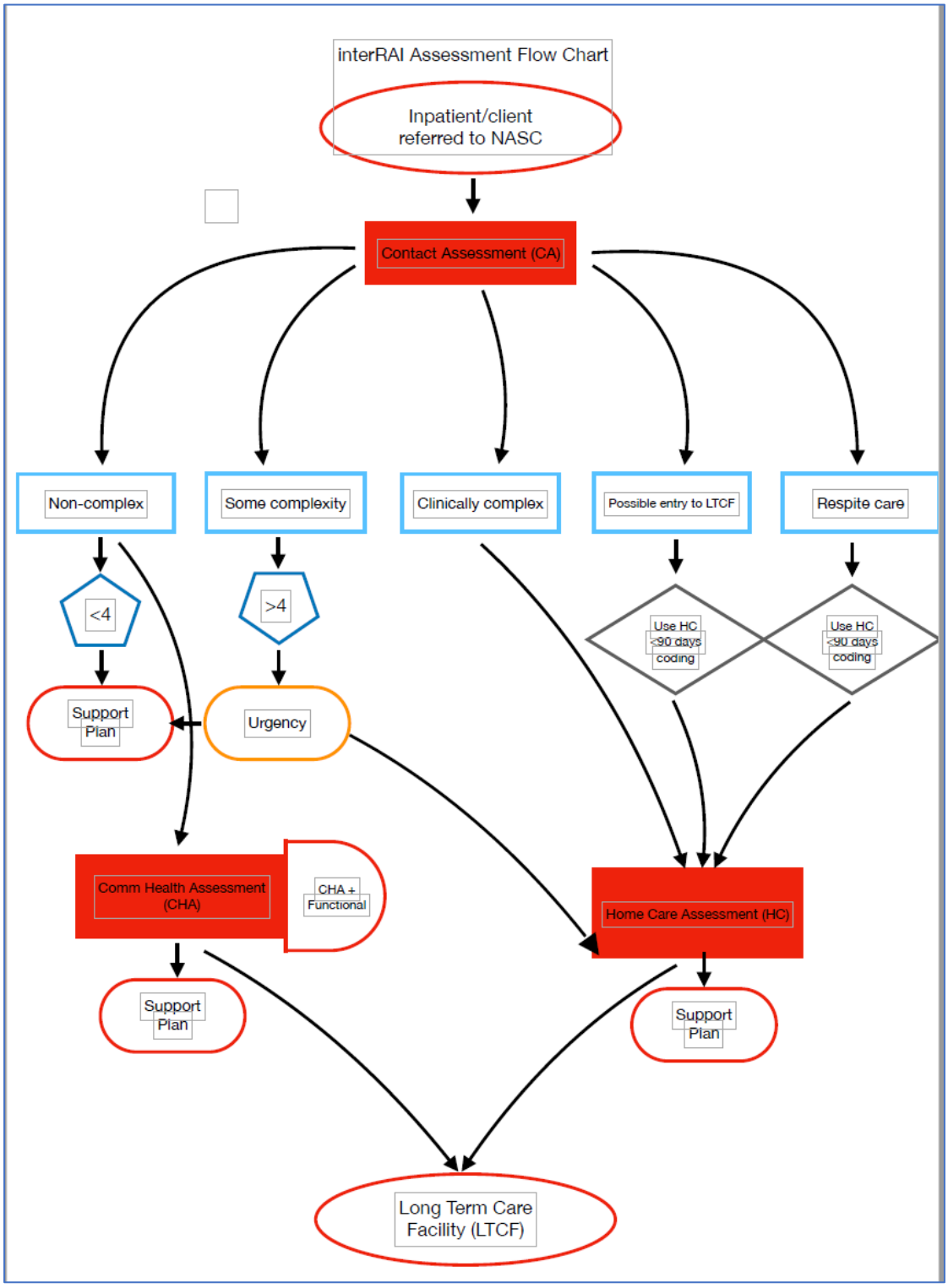
Search strategy ID	Boolean search terms	Number of returns
1	("health services for the aged"[MeSH Terms] OR "aged"[MeSH Terms]) OR "healthy aging"[MeSH Terms]	298,442
2	(("wearable electronic devices"[MeSH Terms] OR "self-help devices"[MeSH Terms]) OR ("ambulatory"[All Fields]) AND ("technology"[MeSH Terms] OR "technology"[All Fields]))) OR ("wearable electronic devices"[MeSH Terms] OR ("wearable"[All Fields] AND "electronic"[All Fields] AND "devices"[All Fields]) OR "wearable electronic devices"[All Fields] OR ("wearable"[All Fields] AND "device"[All Fields]) OR "wearable device"[All Fields]) AND ("2010/06/19"[PDat] : "2020/06/15"[PDat])	39,843
3	((Assessment[MeSH Terms]) OR Assessment of health Needs[MeSH Terms]) OR InterRAI[MeSH Terms] AND ("2010/06/19"[PDat] : "2020/06/15"[PDat	0
4	("rehabilitation"[MeSH Terms] AND ("2010/06/19"[PDat] : "2020/06/15"[PDat])	24873
1 and 2	(("health services for the aged"[MeSH Terms] OR "aged"[MeSH Terms]) OR "healthy aging"[MeSH Terms] AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND ((("wearable electronic devices"[MeSH Terms] OR "self-help devices"[MeSH Terms]) OR "ambulatory"[All Fields] AND ("technology"[MeSH Terms] OR "technology"[All Fields])) OR ("wearable electronic devices"[MeSH Terms] OR ("wearable"[All Fields] AND "electronic"[All Fields] AND "devices"[All Fields]) OR "wearable electronic devices"[All Fields] OR ("wearable"[All Fields] AND "device"[All Fields]) OR "wearable device"[All Fields]) AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND "2010/06/19"[PDat] : "2020/06/15"[PDat] AND ("2010/06/19"[PDat] : "2020/06/15"[PDat])	5517
1, 2 and 4	((((("health services for the aged"[MeSH Terms] OR "aged"[MeSH Terms]) OR "healthy aging"[MeSH Terms] AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate]))	762

	AND ((("wearable electronic devices"[MeSH Terms] OR "self-help devices"[MeSH Terms]) OR "ambulatory"[All Fields] AND ("technology"[MeSH Terms] OR "technology"[All Fields])) OR ("wearable electronic devices"[MeSH Terms] OR ("wearable"[All Fields] AND "electronic"[All Fields] AND "devices"[All Fields]) OR "wearable electronic devices"[All Fields] OR ("wearable"[All Fields] AND "device"[All Fields]) OR "wearable device"[All Fields]) AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND "2010/06/19"[PDat] : "2020/06/15"[PDat]) AND "2010/06/19"[PDat] : "2020/06/15"[PDat]) AND ("rehabilitation"[MeSH Terms] AND "2010/06/19"[PDat] : "2020/06/15"[PDat]) AND ("2010/06/19"[PDat] : "2020/06/15"[PDat])	
1, 2 and 4 open access	((((("health services for the aged"[MeSH Terms] OR "aged"[MeSH Terms]) OR "healthy aging"[MeSH Terms] AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND ((("wearable electronic devices"[MeSH Terms] OR "self-help devices"[MeSH Terms]) OR "ambulatory"[All Fields] AND ("technology"[MeSH Terms] OR "technology"[All Fields])) OR ("wearable electronic devices"[MeSH Terms] OR ("wearable"[All Fields] AND "electronic"[All Fields] AND "devices"[All Fields]) OR "wearable electronic devices"[All Fields] OR ("wearable"[All Fields] AND "device"[All Fields]) OR "wearable device"[All Fields]) AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND "2010/06/19"[PDat] : "2020/06/15"[PDat]) AND "2010/06/19"[PDat] : "2020/06/15"[PDat]) AND ("rehabilitation"[MeSH Terms] AND "2010/06/19"[PDat] : "2020/06/15"[PDat]) AND ("open access"[filter] AND "2010/06/19"[PDat] : "2020/06/15"[PDat])	444
Adding Clinical trials as MeSH term to 1, 2 and 4 open access	"clinical trials as topic"[MeSH Terms] AND (((((("health services for the aged"[MeSH Terms] OR "aged"[MeSH Terms]) OR "healthy aging"[MeSH Terms] AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND ((("wearable electronic devices"[MeSH Terms] OR "self-help devices"[MeSH Terms]) OR "ambulatory"[All Fields] AND ("technology"[MeSH Terms] OR "technology"[All Fields])) OR ("wearable electronic devices"[MeSH Terms] OR ("wearable"[All Fields] AND "electronic"[All Fields] AND "devices"[All Fields]) OR "wearable electronic devices"[All Fields] OR ("wearable"[All Fields] AND "device"[All Fields]) OR "wearable device"[All Fields]) AND ("2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND "2010/06/19"[PubDate] : "2020/06/15"[PubDate]) AND "2010/06/19"[PubDate] : "2020/06/15"[PubDate]) AND ("rehabilitation"[MeSH Terms] AND "2010/06/19"[PubDate] : "2020/06/15"[PubDate]) AND ("open access"[filter] AND "2010/06/19"[PubDate] : "2020/06/15"[PubDate])) AND ("open access"[filter] AND "2010/06/21"[PDat] : "2020/06/17"[PDat])	3 (15 returned but only 3 relevant – put in EndNote group Clinical trials
Adding clinical trials to 2		37

Appendix 3: Data extraction form template

Author	Year	Country of Origin	Title	Aim/Purpose	Sample/ setting	Research design	Pilot or BAU	Purpose of sensors	Sensors mentioned background	Sensor technology used	How was sensor used	Results	Health Outcomes	Article usefulness

Appendix 4: Assessment process flow chart



Appendix 5: Data inputs - spreadsheets

interRAI Contact Assessment (CA - black), ED Screener (black) & Home Care (HC - green) Assessment form	Measurement of observation										
interRAI item (consider INTENT of the item)		input to algoritm/clinical judgement or direct into interRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
Section A - Demographic Information (CA&HA)											
1. Name	text	text	text box	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	input/ check text
2. Sex	text	Male/Female/ gender fluid/ declines to answer	check box	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	input/ check text
3. Birthdate	text	date		provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
4. National Health Indientifier				provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
a. NHI number	text	alphanumerical		provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
b. Community Services Card (CSC)	text	numerical	if ineligible leave blank	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
c.. ACC claim number	text	alphanumerical	if ineligible leave blank	provided by ACC	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
5. Usual living arrnagement											
a. Domicile code	text	numerical	assigned by Statistics NZ	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
b. Postal code	text	numerical	assigned by NZ Post, code as 0000 if homeless, 1 if unknown, 2 if non-resident	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	check text
6. Driver's licence	text	No/Yes	0 no 1 yes	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	unknown	ask & check text
7. Ethnicity Level 2	text	text	Level 1 ethnicity made be derived from level 2 coding	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	ask & check text
8. Eligibility for publicly funded health services	text	alphabetical	tick a ll that apply	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	NHI, hospital PAS, GP - PMS, or other PAS	ask & check text
9. Primary language	text	three-letter alphabetical code	3-letter code eng/ mri / other (in language code Appendix)	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	no	ask & check text
10. Interpreter needed	text	No/Yes	0 no 1 yes	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	no	ask & check text
11. Reason for referral/ presentation	text	text	free text box	provided by referrer	if not already provided	if not already provided	if not already provided	self-reported	if not already provided	no	check text
12. Assessment Administration											
a. Location of intake or screen	text	text	12a inform 12b and identifies where interRAI CA assessment will take place	no	na	no	no	no	no	no	input data
b. Assessment module	text	text (Community/ Hospital Intake GO TO Section B/ED Screener GO TO Section F)	informed by 12a Either Community/Hospital - sections B,C ,D & E ED Screener use section F, G & H	no	na	no	no	no	no	no	input data
Section B - Intake & intial history (CA & HC manuals)											
1. Assessment Reference Date		date	End date of observation period (the last 24 hrs)	no	na	no	no	no	no	no	input data
2. Referral Details a.Treatments ordered to be initiated											
Administration of medication (other than IV)		text/time	based on time to first treatment, ordered, initiated or continued	provided by H provider	if not already provided	if not already provided	no	no	no	no	check text
Indwelling catheter		text/time	based on time to first treatment, ordered, initiated or continued	provided by H provider	if not already provided	if not already provided	no	no	no	no	check text
IV therapy		text/time	based on time to first treatment, ordered, initiated or continued	provided by H provider	if not already provided	if not already provided	no	no	no	no	check text
Oxygen therapy		text/time	based on time to first treatment, ordered, initiated or continued	provided by H provider	if not already provided	if not already provided	no	no	no	no	check text
Wound care		text/time	based on time to first treatment, ordered, initiated or continued	provided by H provider	if not already provided	if not already provided	no	no	no	no	check text
Other (specify)		text/time	Specify other and check box	provided by H provider	if not already provided	if not already provided	no	no	no	no	check text
b.Referral to initate or continue rehabilitation services		No/Yes	Specify initiation or continued service	provided by H provider	no	na	no	no	no	unknown	check text
c.Referral to initate or continue palliative services		No/Yes	Specify initiation or continued service	provided by H provider	no	na	no	no	no	unknown	check text
3. Expected living arrangement during service provision (see 14a)	speech	text	1 private care - 14, correctional facility, 15 other not listed	provided by referrer	if not already provided	if not already provided	no	self reported	could inform	no	ask
4. Expected residential /living status during service provision (see A13)	speech	text	If code has 1 digit, right justify & use a leading 0	provided by referrer	if not already provided	if not already provided	no	self reported	could inform	no	ask
5. Change in living situation	speech	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask
5. Feels person would be better living elsewhere (see A14c)	speech	text	0 no 1 yes 2 institution	no	no	no	no	self reported	could inform	no	ask
Section C - Preliminary Screener (CA) Cognition (HC)											no
Section C : Cognition HA assessment differs from CA from here											no
1.Cognitive skills for daily decision-making (in CA & ED)	speech & visual	text	based on evaluation of answers from C2 in CA	no	no	no	no	self reported	self reported	no	ask & use clin judgement
1. Cognitive skills for daily decision-making (HC)		text	0 indep 1 mod indep 3 min impaired 4 sev impaired 5 unconsciousness - if 5 SKIP TO SECTION G	no	no	no	no	self reported	self reported	no	ask & use clin judgement
2. Memory /Recall Ability											
a. short term memory OK	speech	text	0 memory okay 1 memory problem	no	no	no	no	self reported	no	no	ask
b. procedural memory OK	speech & visual	text	0 memory okay 1 memory problem	no	no	no	no	self reported	no	no	ask & observe
c. situational memory OK	speech & text	text	0 memory okay 1 memory problem	no	no	yes	no	self reported	yes	no	ask & check
3. Periodic disordered thinking or awareness											
a. easily distracted	speech	text	0 behaviour not present 1 behaviour present & 2 behaviour worsening	no	could inform	could inform	could inform	self reported	could inform	no	ask
b. episodes of disorganised speech	speech	text	0 behaviour not present 1 behaviour present & 2 behaviour worsening	no	could inform	could inform	could inform	self reported	could inform	no	ask
c. mental function varies over the course of the day	speech	text	0 behaviour not present 1 behaviour present & 2 behaviour worsening	no	could inform	could inform	could inform	self reported	could inform	no	ask
4. Acute change in mental status from person's usual functioning	speech & visual	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
7. ADL self-performance (0-1)											
a. Bathing	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
b. personal hygiene	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
c.. dressing upper body	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
c. dressing lower body	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
e. walking	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe

interRAI item (consider **INTENT** of the item)		input to algoritm/clinical judgement or direct into interRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
d. locomotion	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
g. transfer toilet	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
i. bed mobility	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
j. eating	speech, visual	text	CA 0 independent, 1 supervision, HC is 0 indep -6 totally depend & 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
3. Locomotion / Walking											
a. primary mode of locomotion indoors	speech, visual	text	HC 0 indep - 3 bedbound	na	na	na	na	na	na	no	ask
b. timed 4 metre walk (13 foot)	timed	text	99 not tested 88 refused to test 77 incomplete, record time in seconds use preceeding 0 single digit	na	na	na	na	na	na	no	observe
c. distance walked	speech	text	record distance walked 0 did not walk, 1(< 5m) - 5 (1+ km)	na	na	na	na	self reported	could inform	no	ask
d. distance wheeled self	speech	text	record distance wheeled 0 did not walk, 1(< 5m) - 5 (1+ km) + 8 does not have wheelchair	na	na	na	na	self reported	could inform	no	ask
4. Activity Level											
a. Total hours of exercise or physical activity in last 3 days	speech	text	1 none - 4 more than 4 hours	na	na	na	na	self reported	could inform	no	ask
b. in the last 3 days, no. of days went out of house or building he/she lives in	speech	text	1 did not go out - 1 not in last 3 days, 2 1-2 days, 3 3 days	na	na	na	na	self reported	could inform	no	ask
5. Physical function improvement potential											
a. person believes is capable of improved performance in physical function	speech	text	0 no 1 yes	na	na	na	na	self reported	could inform	no	ask & use clin judgement
b. care prof believes person capable of improved perf in physical function	visual	text	0 no 1 yes	na	na	na	na	na	na	no	check & use clin judgement
6. Change in ADL status compared to 90days ago or since last asmt if <90 (see G6)	speech	text	0 improved, 1 no change, 2 declined, 3 uncertain	na	na	na	na	self reported	could inform	no	ask
7.Driving											
a. Drove car in last 90 days (same as G7a)	speech	text	0 no, or does not drive 1 yes	na	na	na	na	yes	na	no	ask
b. if drove in last 90 days, assessor aware person suggested to stop driving (same as G7b)	speech	text	0 no 1 yes	na	na	na	na	yes	na	no	ask
9. Dyspnoea (same as **J4**)	speech	text	0, 1,2,3	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
4. Self-reported Health (same as **J1**)	speech	text	0, 1,2,3, or 8	na	na	na	na	self reported	na	no	ask
5. Instability of conditions											
a. Conditions/ diseases make cognition, ADL, mood, or behaviour patterns unstable (same as J7a)	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
b. Experiencing an acute episode or flare-up of a recurrent or chronic problem (J7b)	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
c. Endstage disease 6 or fewer months to live (only in HC)	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
6. Support Services may be required for this person (only in CA)	text	0 no 1 yes	PROGRESS TO C6 IS DETERMINED BY C1-C5a. C6 is based on answers in Sections A, B & C	na	na	na	na	na	na	na	calculate
DECISION POINT (CA) TO GO SECTIONS D & E OR TO E10 in CA		PROGRESS TO C6 IS DETERMINED BY C1-C5a	Calculation based on C1 to C6	na	na	na	na	na	na	na	calculate
Section D - Clinical Evaluation (CA)											
1. Change in decision-making compared to 90days ago or since last assessment if <90days (same as C5)	speech	text	improved, no change, declined, uncertain	could inform	could inform	na	na	self reported	could inform	no	ask
Section D: Communication and vision											
1. Making self understood (only in HC)	speech & visual	text	0 understood, 1 usually understands, 2 often, 3 sometimes, 4 rarely or never understands	na	na	na	na	self reported	could inform	no	ask & observe
2. Ability to understand others (Comprehension) D2 in CA & HC	speech & visual	text	0 understood, 1 usually understands, 2 often, 3 sometimes, 4 rarely or never understands	na	na	na	na	na	na	no	observe & use clin judgemt
3. Hearing	speech & text	text	0 adequate 1 minimal difficulty - 4 no hearing	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
4. Vision	speech & text	text	0 adequate 1 minimal difficulty - 4 no vision	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
3. Self-reported mood (same as E2)	speech	text	No/Yes, could not, would not answer	na	na	na	na	self reported	na	no	ask & listen
Section E: Mood and Behaviour (HC)											
1. Indications of possible depressed, anxious or sad mood											
a made negative statements	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
b. persistent anger with self or others	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
c. expressions, including nonverbal, of unrealistic fears	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
d. repetitive health complaints	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
e. repetitive anxious coplaints/concerns (non-health related)	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
f. sad, pained or worried facial expressions	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
g. crying, tearfulnass	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
h. recurrent statements something terrible is about to happen	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
i withdrawal from activities of interest	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
j reduced social interactions	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
k. expressions, including non verbal, of lack of pleasure in life	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
2. Self reported mood											
a. little interest or pleasure in things you normally enjoy	speech	text	0 not in last 3days 1 often but not in last 3 day, 3 daily in last 3days, 8 person could not respond	no	na	na	na	self reported	no	no	ask
b. anxious restless or uneasy	speech	text	0 not in last 3days 1 often but not in last 3 days, 3 daily in last 3days, 8 person could not respond	no	na	na	na	self reported	no	no	ask
c. sad, depressed or hopeless	speech	text	0 not in last 3days 1 often but not in last 3 days, 3 daily in last 3days, 8 person could not respond	no	na	na	na	self reported	no	no	ask
3. Behaviour symptoms											
a. wandering	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	no	could inform	no	ask & observe
b. verbal abuse	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	no	could inform	no	ask & observe

interRAI item (consider **INTENT** of the item)		input to algoritm/clinical judgement or direct into interRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
c. physical abuse	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	no	could inform	no	ask & observe
d. socially inappropriate or disruptive behaviour	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	no	could inform	no	ask & observe
e. inappropriate public sexual behaviour or public disrobing	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	no	could inform	no	ask & observe
f. resists care	speech & visual	text	0 not present 1 present but not in last 3 days - 3 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	no	could inform	no	ask & observe
Section F: Psychosocial well-being (HC)											
1. Social Relationships											
a. participation in social activities of long-standing interest	speech	text	0 never, 1 > 30days, 2 8-30days, 3 4-7days, 4 in last 3 days, 8 unable to determine	no	no	no	no	self reported	could inform	no	ask
b. visit with a long-standing relation or family member	speech	text	0 never, 1 > 30days, 2 8-30days, 3 4-7days, 4 in last 3 days, 8 unable to determine	no	no	no	no	self reported	could inform	no	ask
c. other interacation with long-standing social relation - phone email	speech	text	0 never, 1 > 30days, 2 8-30days, 3 4-7days, 4 in last 3 days, 8 unable to determine	no	no	no	no	self reported	could inform	no	ask
d. conflict or anger with family or friends	speech	text	0 never, 1 > 30days, 2 8-30days, 3 4-7days, 4 in last 3 days, 8 unable to determine	no	no	no	no	self reported	could inform	no	ask
e. fearful of a family member or close acquaintance	speech	text	0 never, 1 > 30days, 2 8-30days, 3 4-7days, 4 in last 3 days, 8 unable to determine	no	no	no	no	self reported	could inform	no	ask
f. neglected, abused, or mistreated	speech	text	0 never, 1 > 30days, 2 8-30days, 3 4-7days, 4 in last 3 days, 8 unable to determine	no	no	no	no	self reported	could inform	no	ask
2. Lonely	speech	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask
3. Change in Social activites in last 90days or since last asmt if < 90	speech	text	0 no decline 1 declined, not distressed, 2 decline & distress	no	no	no	no	self reported	could inform	no	ask
4. Length of time alone during the day (morning & afternoon)	speech	text	0 less than 1 hour, 1is 1-2 hours, 2 >2 hours but < than 8 hours 3 8 hours or more	no	no	no	no	self reported	could inform	no	ask
5. Major stressors in last 90 days	speech	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask
Section G: Functional Status (HC)		CODE SECTION FOR PERFORMANCE & CAPACITY									
1. IADL Self-Performance and Capacity		IADLs Coded for performance & capacity									
a. meal preparation	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	no	no	no	could inform	self reported	could inform	no	ask & use clin judgement
b. ordinary housework	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	no	no	no	could inform	self reported	could inform	no	ask & use clin judgement
c. managing medications	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & use clin judgement
C. managing finances (only in HC)	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	no	no	no	no	self reported	could inform	no	ask & use clin judgement
e. phone use (only in HC)	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	no	no	no	no	self reported	could inform	no	ask & use clin judgement
d. stairs	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & use clin judgement
g. shopping (only in HC)	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	no	no	no	could inform	self reported	could inform	no	ask & use clin judgement
h. transportation (only in HC)	speech	text	0 independent or set up help only, 1 supervision or dependent , 8 activity did not occur	no	no	no	could inform	self reported	could inform	no	ask
5. Change in IADL status as compared to 90 days ago (OR since last assessment if < 90 days) (same as D5 in CA)	speech	text	improved, no change, declined, uncertain	could inform	could inform	could inform	could inform	self reported	could inform	no	ask
7.Driving (see C7)											
a. Drove car in last 90 days (same as G7a)	speech	text	0 no, or does not drive 1 yes	no	no	no	no	yes	no	no	ask
b. if drove in last 90 days, assessor aware person suggested to stop driving (same as G7b)	speech	text	0 no 1 yes	no	no	no	no	yes	no	no	ask
Section H: Continence											
1. Bladder Continence	speech & text	text	0 continent - 5 incontinent, 8 did not occur	no	no	no	no	self reported	could inform	no	ask
2. Urinary Collection Device (excludes pads / briefs)	speech & text	text	0 none, 1 catheter, 2 indwelling catheter, 3 cystostomy, nephrostomy, ureterostomy	no	no	no	no	self reported	could inform	no	ask
3. Bowel Continence	speech & text	text	0 continent - 5 incontinent, 8 did not occur	no	no	no	no	self reported	could inform	no	ask
4. Pads or Briefs worn	speech & text	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask
Section I: Disease Diagnoses (same as D6 in CA) listed as D6a - D6e or as necessary	speech & text	text	Primary dx/reason for referral/receiving tmt/monitored/active tmt	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
1. Disease Diagnoses - listed I1A - I1U (21 items)	speech & text	text	0 not present 1 primary diagnosis 2 diagnosis present & active treatment 3 present & monitored	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
Section J: Health Conditions											
1. Falls (same as D7 in CA)	speech & text	text	0 no falls, one fall between 31 & 90days ago, one fall in last 30days, two or more falls in last 30days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
2. Recent Falls only in HC (followup only)	speech & text	text	0 no 1 yes BLANK= N/A- first assessment or < 30 days since last assessment	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
3. Problem Frequency (HC has(21 items)	speech & text	text	0 not present - 4 daily	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
Balance											
a. Difficult or unable to move self to standing postion unassisted	speech & text	text	0 no 1 yes BLANK= N/A- first assessment or < 30 days since last assessment	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
b. difficult or unable to turn self around and face the opposite direction	speech & text	text	1 no 1 yes BLANK= N/A- first assessment or < 30 days since last assessment	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check

interRAI item (consider **INTENT** of the item)		input to algoritm/clinical judgement or direct into InterRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
a. dizziness	speech & text	text	2 no 1 yes BLANK= N/A- first assessment or< 30 days since last assessment	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
d. unsteady gait	speech & text	text	3 no 1 yes BLANK= N/A- first assessment or< 30 days since last assessment	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
c. peripheral oedema CA only	**speech & text**	**text**	**0 not present - 4 daily**	**could inform**	**could inform**	**could inform**	**could inform**	**self reported**	**could inform**	**no**	**ask & check**
Sleep Problems											
o. difficulty falling asleep or staying asleep, waking too early, restless	speech & text	text	0 not present - 4 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
p. Too much sleep	speech & text	text	1 not present - 4 exhibited daily in last 3 days	could inform	could inform	could inform	could inform	yes	could inform	no	ask
5. Fatigue	speech & text	text	0 not present - 4 unable to commence normal day to day activities	could inform	could inform	could inform	could inform	**self reported**	could inform	no	ask & observe
9. Pain Symptoms											
a. Frequency with which person complains or shows evidence of pain (same as D9a in CA)	speech & text	text	0 not present - 3 exhibited in last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
b. Intensity of highest level of pain present (D9b)	speech & text	text	0 no pain - 4 excruciating pain	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
c. consistency of pain (only in HC)	speech & text	text	0 no pain - 3 constant	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
d. breakthrough pain (only in HC)	speech & text	text	0 no, 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
e. pain control (only in HC)	speech & text	text	0 no issue - 5 no therapuetic regime	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe
10. Smokes tobacco daily (same as I9a)	speech & visual	text	0 no, 1 not in last 3 days (but usually), 2 yes	could inform	could inform	could inform	could inform	self reported	could inform	unknown	ask & check
b.Alcohol - highest number of drinks in any 'single sitting' in **LAST 14 DAYS (only in HC)**	speech & observe	text	0 no days, 1 - 3= 5 or more days drunk	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
SECTION K. Oral and Nutritional Status											
11. Nutritional issues											
1. Height and Weight											
a. HT (cm)	speech & text	text	record	could inform	could inform	could inform	no	self reported	could inform	no	check
b. WT (kg)	speech & text	text	record	could inform	could inform	could inform	no	self reported	could inform	no	check
a. In LAST 3 DAYS, noticeable decrease in the amount of food usually eaten /fluids usually consumed	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & calculate
b. Weight loss of 5% or more in LAST 3 DAYS or 10% or more in LAST 180 DAYS	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & calculate
b. dehydrated	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	clinical judgement
c. Fluid intake reduced	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	clinical judgement
d. fluid output exceeds input	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	clinical judgement
e. decrease in amount of food or fluids usually consumed	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	clinical judgement
f. ate one or fewer meals AT LEAST IN 2 OF LAST 3 DAYS	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	clinical judgement
3. Mode of nutritional intake	speech & visual & text	text	0 normal - 9 activity did not occur	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & observe & check
4. Dental or Oral	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & observe
C. Special diet (only in CA)	**speech & text**	**text**	**0 no 1 yes**	**could inform**	**could inform**	**could inform**	**could inform**	**self reported**	**could inform**	**no**	**ask & calculate**
Section L: Skin Condition											
1. Most severe pressure ulcer	speech & visual & text	text	0 no ulcer 1 skin redness 2 any break in skin integrity - 4 skin exposing muscle &	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
2. Prior pressure ulcer	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
3. Presence of skin ulcer other than pressure ulcer	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
4. Major skin problems	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
5. Skin tears or cuts	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
6. Other skin conditions or changes in skin condition	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
14. Traumatic injury (only in CA)	**speech & text**	**text**	**no/yes**	**could inform**	**could inform**	**could inform**	**could inform**	**self reported**	**could inform**	**no**	**ask & check & observe**
7. Foot problems	speech & text	text	0 no foot problems - 3 foot problems prevents walking 4 foot problems & does not walk	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
Section M: Medications											
1. List of All Medications (using replacement page in manual)											
a. Name	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
b. dose	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
c. Unit	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
d. Route of administration	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
e. Frequency	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
f. PRN	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
g. Computer-entered drug code	speech & visual & text	text	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check & observe
2. Allergy to any drug	speech & text	text	1 no known allergy 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
3. Adherent with medications prescribed by physician	speech & visual & text	text	0 always adherent, 1 adherent 80% of time, adherent <80% of time 8 no medications prescribed	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
Section N: Treatments and Procedures											
1. Prevention											
a. Blood pressure meassured in the LAST YEAR	speech	text	1 no 1 yes	no	no	no	no	self reported	no	no	ask
b. Colonoscopy in the LAST 5 YEARS	speech	text	2 no 1 yes	no	no	no	no	self reported	no	no	ask
c. Dental exam in the LAST YEAR	speech	text	3 no 1 yes	no	no	no	no	self reported	no	no	ask
d. Eye exam in the LAST YEAR	speech	text	4 no 1 yes	no	no	no	no	self reported	no	no	ask
e. Hearing exam in the LAST 2 YEARS	speech	text	5 no 1 yes	no	no	no	no	self reported	no	no	ask
f. Influenza vaccine in the LAST YEAR	speech	text	6 no 1 yes	no	no	no	no	self reported	no	no	ask
g. Mammogram or breast exam in the LAST 2 YEARS (women)	speech	text	7 no 1 yes	no	no	no	no	self reported	no	no	ask
h. Pneumovax vaccine in LAST 5 YEARS, > age 65	speech	text	8 no 1 yes	no	no	no	no	self reported	no	no	ask
2. Treatments & Programs received/ scheduled (11 items)											
15. Treatments (11 items same as CA B2a -B2d)											
a. Indwelling catheter (same as B2a)	speech & text	text	0 not ordered - 3 daily in the last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
b. IV therapy (same as B2b)	speech & text	text	0 not ordered - 3 daily in the last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
c. Oxygen therapy (same as B2c)	speech & text	text	0 not ordered - 3 daily in the last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
d. Wound care (same as B2d)	speech & text	text	0 not ordered - 3 daily in the last 3 days	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
16. Time since last hospital stay (same as A15)	speech & text	text	0 no hospitalisation - 5 now in hospital	no	no	no	no	yes	no	no	ask, check &
3. Formal Care	speech & text	text	code days in first column, code minutes in second column (one digit per box)	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
4. Hospital Emergency Room Use, Physician visit											
a. inpatient with overnight stay	text	numerical	code admissions. Enter 0 in both boxes if no admission in last 90 days. single digit	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check

interRAI item (consider **INTENT** of the item)		input to algoritm/clinical judgement or direct into InterRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
b. Emergency room visit (excluding overnight stay)	text	numerical	code admissions. Enter 0 in both boxes if no admission in last 90days. single digit use leading 1	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
c. GP visit or assistant practitioner	text	numerical	code admissions. Enter 0 in both boxes if no admission in last 90days. single digit use leading 2	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
5. Physically restrained	speech & visual & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
Section O: Responsibility											
1. Decision-Maker for personal care and property	speech & text	text	1 person 2 other (acting on behalf of person)	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
18. Surgey in LAST 90 DAYS (only in CA)	speech & text	text	no/yes	provided by referrer	could inform	yes	could inform	self reported	could inform	no	ask & check
Section P: Social Support											
19. Two key informal helpers			code P1a - P1d for two helpers)								
a. Relationship to person (code for two helpers)	speech & text	numerical	1 - 9 relationship of helper (code for two helpers)	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
b. Lives with person (code for two helpers)	speech & text	numerical	0 no, 1 yes 6 mths, 2 yes more than 6	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
c areas of help within last 3 days IADL help	speech & text	numerical	0 no, 1 yes, 8 no informal helper	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
d. areas of help within last 3 days ADL	speech & text	numerical	0 no, 1 yes, 8 no informal helper	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
20. Informal helper status											
a. informal helper is unable to continue providing care	speech & text	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & listen
b. primary formal helper expresses distress, anger or depression	speech & text	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & listen
c. family/ friends report feeling overwhelmed by person's illness	speech & text	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & listen
3. Hours of Informal care and active monitoring in last 3 days	speech & text	text	Enter number of hours of care recived from all family, friends & neighbours	no	no	no	no	self reported	could inform	no	ask & check
4. Strong and supportive relationship with family	speech	text	0 no 1 yes	no	no	no	no	self reported	no	no	ask
Section Q: Environmental Assessment											
1. Home Environment											
a. disrepair of the home	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
b. squalid conditions	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
c. inadequate heating or cooling	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
d. lack of personal safety	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
e. limited access to home or rooms in home	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
2. Lives in an apartment/ house re-engineered accessible for disabilities	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
3. Ouside Environment	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
a. availability of emergency assistance	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
b. accessibility to grovery store without assistance	speech & visual	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask
c. availability of home delivery groceries	speech	text	0 no 1 yes	no	no	no	no	self reported	could inform	no	ask & check
4. Finances			0 no 1 yes [code with respect to paying for food, shelter, clothing, meds, heating,	no	no	no	no	self reported	could inform	no	ask
Section R: Discharge Potential and Overall Status											
1. One or more care goals met in last 90days or since last asmt if < 90days	speech & text	text	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
2. Overall self-sufficiency has changed significantly compared to 90days/asmt	speech & text	text	0 improved (skip to Section S) 1 no change (skip to Section S) 2 deteriorated IF PERSON HAS CODED AS DETERIORATED IN THE LAST 90 DAYS, SKIP ITEMS & GO TO SECTION S	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
3. Number of 10 ADL areas where person was indep prior to deterioration	speech & text	text	0 within last 7days 1 8-14days 2 15-30days 3 31-60days 4 .60days 8 no clear precipitating event	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
4. Number of 8 IADL performance areas person indep prior to deterioration	speech & text	text	0 within last 7days 1 8-14days 2 15-30days 3 31-60days 4 .60days 8 no clear precipitating event	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
5. Time of onset of precipitating event/problem related to deterioration	text	text	0 within last 7days 1 8-14days 2 15-30days 3 31-60days 4 .60days 8 no clear precipitating event	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
Section S: Discharge											
1. Last day of stay	text	date	*	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
2. Residential/ Living status after discharge (same as B4)	speech	text	If code has 1 digit, right justify & use a leading 0	provided by referrer	if not already provided	if not already provided	no	self reported	could inform	no	ask
Section T: Assessment Information											
1. Signature of person coordinating/completing assessment (same as E10.1	date	text	electronic signature	no	no	no	no	no	no	no	input data
2. date assessment signed as complete (same as E10.2)	date	numerical	auto-populated data NOTE date in E10 can differ to date in B1	no	no	no	no	no	no	no	input data
END OF HOME CARE ASSESSMENT											
Section E - Summary											
1. Algorithm Scores											
a. Assessment urgency	interRAI algorithm	numerical	1 least - 6 most urgent	could inform	could inform	could inform	no	yes	family as appropriate	no	ask, listen & calculate
b. Service urgency	interRAI algorithm	numerical	1 least - 4 most urgent	could inform	could inform	could inform	no	yes	family as appropriate	no	ask, listen & calculate
c. Rehabilitation	interRAI algorithm	numerical	1 least - 5 most urgent	could inform	could inform	could inform	no	yes	family as appropriate	no	ask, listen & calculate
2. Services required for this person	text & interRAI algorithm	numerical	no/ yes Review Sections A B C D & computer generated score in E1	no	no	no	no	no	no	no	calculate
			IF PERSON DETERMINED INELIGIBLE FOR SERIVCES GO TO E8								
3. Expected length of stay	text & interRAI algorithm	text	0 0-14days, 1 15-60days 2 61>days consolidate all info, use prof judgemt for ALOS	no	no	no	no	no	no	no	calculate & clin judgement
4. Requires short-term services (less than 60 days)	text & interRAI algorithm	text	no/yes for services prior to CA asmt OR expected services for less than 60 days	no	no	no	no	no	no	no	calculate & clin judgement
5. Assessment urgency	text & interRAI algorithm	text	0 not required, 1 >14 days, 2 8-14 days, 3 4-7days 4 1-3 days, 5 same day	no	no	no	no	no	no	no	calculate & clin judgement
6. Urgency of needed services											
a. Nursing	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	no	no	no	no	no	no	no	calculate & clin judgement
b. Personal support/ household management	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	no	no	no	no	no	no	no	calculate & clin judgement

interRAI item (consider **INTENT** of the item)		input to algorithm/clinical judgement or direct into InterRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
c. Physiotherapy	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
d. Occupational Therapy	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
e. Dietician services	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
f. Lab services. equipment, and medical supplies	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
g. Placement services	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
h. Social work	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
i. Speech language therapy	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
j. Other (specify)	text & interRAI algorithm	text	1 not needed, 1 72 or>hrs, 2 48 to<72hrs, 3 24 to<48hrs, 4 12 to<24hrs, 5 <12hrs	na	na	na	na	na	na	na	calculate & clin judgement
7. Client Group (example - NZ)	text & interRAI algorithm	text	1 acute 2 End of life 3 rehab 4 long-term support 5 maintenance 6 not categorised	yes	yes	yes	yes	yes	yes	yes	calculate & clin judgement
8. Type of communication at intake	text	text	no/yes a telephone, b in person c faxed/ written/ emailed	na	na	na	na	na	na	na	input data
9. Sources of information used to complete the interRAI CA											
a. Client	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
b. Spouse or partner	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
c. Child or Child-in-law	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
d. Other relative	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
e. Non-relative (e.g., neighbour)	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
f. Doctor	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
g. Staff at doctor's office	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
h. Other home care agency program -e.g., a different jurisdiction	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
i. Community support agency (specify)	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
j. Hospital	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
k. Other (specify)	speech & text	numerical	1 N/A, Code ONLY 1 PRIMARY source & 2 ALL APPLICABLE SECONDARY sources	na	na	na	na	na	na	na	input data
10.1. Signature of person coordinating/completing assessment	date	text	electronic signature	na	na	na	na	na	na	na	input data
10.2. date assessment signed as complete	date	numerical	auto-populated date NOTE date in E10 can differ to date in B1	na	na	na	na	na	na	na	input data
EMERGENCY DEPARTMENT SCREEENER											
Section F. Preliminary Screener			Section F Code PRE-MORBID (use 3 days) & ADMISSION SEPARATELY (24 hours) 2 CODES								
1. Screening reference date and time											
a. screening reference date	See B1	date	F1a & F1b set the end point for the observation period -time frame is last 24 hours	na	na	na	na	na	na	na	input data
b. Screening reference time	time	numerical	add time 24 hour clock	na	na	na	na	na	na	na	input data
2. Cognitive skills for daily decision-making	See C1	numerical	0 indep 1 any depend F2-F5 pre-morbid asmt use 3day prior onset acute illness/24 hrs	na	na	na	na	na	na	na	input data
3. ADL Self-performance											
a. bathing	See C2a	numerical	0 independent, or set up help only 1 supervision or any physical assistance	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
b. personal hygiene	See C2b	numerical	0 independent, or set up help only 1 supervision or any physical assistance	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
c. dressing lower body	See C2c	numerical	0 independent, or set up help only 1 supervision or any physical assistance	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
d. locomotion	See C2d	numerical	0 independent, or set up help only 1 supervision or any physical assistance	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
4. Dyspnoea	See C3	numerical	0 no SOB symptoms 1 SOB mod activities 2 SOB daily activities 3 SOB present at rest	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
5. Self-reported health	See C4	numerical	0 excellent 1 good 2 fair 3 poor or 8 could not (would not) respond	na	na	na	na	self reported	na	na	ask
6. Conditions/ Diseases make cognitive, ADL, mood or behaviour patterns unstable	See 5Ca & 5Cb	no/yes	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
7. Lives alone	See D19b	no/yes	0 no 1 yes	could inform	could inform	could inform	could inform	self reported	could inform	na	ask & observe
Section G. Clinical Evaluation											
1. Emergency Department Use	See D17	numerical	code no of visits in last 90days (not overnight stays) use leading 0 if <10, code both boxes	could inform	could inform	could inform	could inform	self reported	could inform	no	ask
2. Time since last hospital stay	See D16	numerical	0 no hosp within 90days 1 31-90days ago 2 15-30days ago 3 8-14days ago 4 in last 7days 5 in hosp	could inform	could inform	could inform	could inform	self reported	could inform	no	ask & check
3. Acute change in mental status from person's usual functioning	speech	No/ Yes	quick version of D1 & D2	could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
4. Self-reported mood											
a. little interest or pleasure in things you normally enjoy?	See D3 (different coding used) speech	numerical	0 not in last 3days 1 not in last 3days but often feels that way 2 in 1-2 of last 3days 8 no response	na	na	na	na	yes	no	no	ask
b. anxious, restless, or uneasy?	See D3 (different coding used)	numerical	0 not in last 3days 1 not in last 3days but often feels that way 2 in 1-2 of last 3days 8 no response	na	na	na	na	yes	no	no	ask

interRAI item (consider **INTENT** of the item)		input to algoritm/clinical judgement or direct into InterRAI	Notes for coding	Referrer/ H provider	Hospital staff	Hospital notes	Formal helper	Older Adult	Informal Helper	Information prepopulated by other databases	Assessor
c. sad, depressed or hopeless	See **D3** (different coding used) speech	numerical	0 not in last 3days 1 not in last 3days but often feels that way 2 in 1-2 of last 3days 8 no response	no	no	no	no	yes	no	no	ask
5. Mental status indicators											
a. hallucinations	speech	numerical	0 not present, 1present but not exhibited in last 24 hours, 2 exhibited in last 24 hours	could inform	could inform	could inform	no	yes	family as appropriate	no	ask, check & observe
b. delusions	speech	numerical	0 not present, 1present but not exhibited in last 24 hours, 2 exhibited in last 24 hours	could inform	could inform	could inform	no	yes	family as appropriate	no	ask, check & observe
6. Ability to understand others (comprehension)	See **D2**	numerical	0 understands 1 usually understands 2 oftern understands 3 sometimes understands, 4 rarely does	could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
7. Behaviour symptoms	speech	no/yes		no	no	no	yes	no	yes	no	ask
8. IADL capacity											
a. managing medications	See **D4c**	numerical	0 independent or set up help only 1 supervision or any assistance during task	no	no	no	no	yes	no	no	ask & speculate
b. stairs	See **D4b**	numerical	0 independent or set up help only 1 supervision or any assistance during task	no	no	no	no	yes	no	no	ask & speculate
9. Informal Helper Status											
a. primary informal helper expresses feelings of distress, anger or depression	See **D20** (different coding used form **D19b**)	numerical	0 no 1 yes add 8 for 'no informal helper'	no	no	no	no	yes	yes	no	ask & speculate
b. family or close friends report feeling overwhelmed by person's illness	See **D20** (different coding used form **D19b**)	numerical	0 no 1 yes add 8 for 'no informal helper'	no	no	no	no	yes	yes	no	ask & speculate
10. Falls	See **D7**	numerical	0 no falls 1 one or more falls in last 90 days	could inform	could inform	could inform	could inform	yes	could inform	no	ask
11 Pain Symptoms											
a. frequency with which person complains or shows evidence of pain	See **D5a**	numerical	0 no pain 1 present but not in last 3days 2 exhibited on 1-2 of last 3days 3 exhibited in last 3days	could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
b. intensity of highest level of pain present	See **D5b**	numerical	0 no pain 1 mild 2 moderate 3 severe 4 times when pain is excruciating	could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
12. Nutritional Issues											
a. In LAST 3 DAYS, noticable decrease in amount of food or fluids usually consumed	See **D11a**	no/yes		could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
b. weight loss of 5% or > in LAST 90 DAYS or 10% or > LAST 180 DAYS	See **D11b**	no/yes		could inform	could inform	could inform	could inform	yes	could inform	no	ask & observe
13 Traumatic Injury	See **D14**	no/yes		could inform	could inform	could inform	could inform	yes	could inform	no	ask
14. Treatments			G **14a** - G **14d** Treatments received or is scheduled to receive in the last 3 days								
a. indwelling catheter	See **D15a**	numerical	0 not ordered AND did not occur 1 ordered, not implemented, 1-2 of last 3days 3 daily in last 3days	could inform	could inform	could inform	no	yes	could inform	no	ask & check
b. IV therapy	See **D15b**	numerical	0 not ordered AND did not occur 1 ordered, not implemented, 1-2 of last 3days 3 daily in last 3days	could inform	could inform	could inform	no	yes	could inform	no	ask & check
c. oxygen therapy	See **D15c**	numerical	0 not ordered AND did not occur 1 ordered, not implemented, 1-2 of last 3days 3 daily in last 3days	could inform	could inform	could inform	no	yes	could inform	no	ask & check
d. wound care	See **D15d**	numerical	0 not ordered AND did not occur 1 ordered, not implemented, 1-2 of last 3days 3 daily in last 3days	could inform	could inform	could inform	no	yes	could inform	no	ask & check
Section H. Summary											
1. Algorithm Scores			Scores generated using interRAI software programme								
a. assessment urgency	interRAI algorithm See E1a	numerical	clinical team use professional judgement 1 least urgent - 6 most urgent for comprehensive asmt	no	no	could inform	no	no	no	no	calculate & clin judgement
b. service urgency	interRAI algorithm See E1b	numerical	clinical team use professional judgement 1 least urgent - 4 most urgent to initiate support services	no	no	could inform	no	no	no	no	calculate & clin judgement
2. Need for Comprehensive Geriatric Assessment	interRAI algorithm & text	No/yes	use information observed from CA and other information. Used for HC or acute care	could inform	could inform	could inform	no	no	no	no	calculate & clin judgement
3. Referrals		No/yes									
a. Needs assessment services	interRAI algorithm & text See E6	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
b. social work	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
c. occupational therapy	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
d. physiotherapy	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
e. speech-language therapy	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
f. dietician	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
g. specialised Geriatric Services	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
h. other specialist(s) services	interRAI algorithm & text	no/yes	See E6 & some different coding	no	no	no	no	no	no	no	calculate & clin judgement
4. Acuity Score (Country specific)	ED triage acuity score	numerical	1 immediately life-threatening - 5 less urgent	no	no	no	no	no	no	no	input data
5. Discharged to	See **B4** with less options	numerical	1 private hme 2 ARC 3 psych hosp 4 acute care 5 other 6 deceased CODE ONLY ON DISCHARGE	no	no	yes	no	no	no	no	check & clinical judgement
6. Emergency Department discharge date and time											
a. discharge date	See **E10. 1**	date	enter data and time on discharge from ED enter 0 in first box if day/month is a single digit	no	no	no	no	no	no	no	input data
b. discharge time	time See **F1**	time	use 24 hour clock	no	no	no	no	no	no	no	input data
7. 1. Signature of person coordinating/completing assessment	See **E10.1**	text	electronic signature	no	no	no	no	no	no	no	input data
7. 2. date assessment signed as complete	see E **10.2**	date	auto-populated date	no	no	no	no	no	no	no	input data

interRAI Contact Assessment (CA - black), ED Screener (black) & Home Care (HC - green) Assessment form interRAI item (consider INTENT of the item)	Measurement of observation	Data is objective/subjective	Available now In digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	incorp in 24 hour asmt	Incorp 3 day asmt	incorp in 30 days	Incorp 90 day asmt	incorp 180 days
Section A - Demographic Information (CA&HA)										
1. Name	text	objective	yes	yes	no	no	no	no	no	no
2. Sex	text	objective	yes	yes	no	no	no	no	no	no
3. Birthdate	text	objective	yes	yes	no	no	no	no	no	no
4. National Health Indientifier		objective	yes	yes	no		no		no	
a. NHI number	text	objective	yes	yes	no	no	no	no	no	no
b. Community Services Card (CSC)	text	objective	yes	yes	no	no	no	no	no	no
c.. ACC claim number	text	objective	yes	yes	no	no	no	no	no	no
5. Usual living arrnagement										
a. Domicile code	text	objective	yes	yes	no	no	no	no	no	no
b. Postal code	text	objective	yes	yes	no	no	no	no	no	no
6. Driver's licence	text	objective	unknown	yes	no	no	no	no	no	no
7. Ethnicity Level 2	text	objective	yes	yes	no	no	no	no	no	no
8. Eligibility for publicly funded health services	text	objective	yes	yes	no	no	no	no	no	no
9. Primary language	text	objective	unknown	yes	no	no	no	no	no	no
10. Interpreter needed	text	objective	unknown	yes	no	no	no	no	no	no
11. Reason for referral/ presentation	text	subjective	no	yes	no	no	no	no	no	no
12. Assessment Administration										
a. Location of intake or screen	text	objective	no	yes	no	no	no	no	no	no
b. Assessment module	text	objective	no	yes	no	no	no	no	no	no
Section B - Intake & intial history (CA & HC manuals)										
1. Assessment Reference Date		objective	unknown	yes	no	no	no	no	no	
2. Referral Details a.Treatments ordered to be initiated										
Administration of medication (other than IV)		objective	no	yes	no	no	no	no	no	no
Indwelling catheter		objective	no	yes	no	no	no	no	no	no
IV therapy		objective	no	yes	no	no	no	no	no	no
Oxygen therapy		objective	no	yes	no	no	no	no	no	no
Wound care		objective	no	yes	no	no	no	no	no	no
Other (specify)		objective	no	yes	no	no	no	no	no	no
b.Referral to initate or continue rehabilitation services		objective	unknown	yes	no	no	no	no	no	no
c.Referral to initate or continue palliative services		objective	unknown	yes	no	no	no	no	no	no
3. Expected living arrangement during service provision (see 14a)	speech	objective	no	yes	no	no	no	no	no	no
4. Expected residential /living status during service provision (see A13)	speech	objective	no	yes	no	no	no	no	yes	no
5. Change in living situation	speech	objective	no	no	no	no	no	no	yes	no
5. Feels person would be better living elsewhere (see A14c)	speech	subjective	no	no	no	no	no	no	no	no
Section C - Preliminary Screener (CA) Cognition (HC)										
Section C : Cognition HA assessment differs from CA from here										
1.Cognitive skills for daily decision-making (in CA & ED)	speech & visual	subjective	no	problematic	yes	no	yes	no	no	no
1. Cognitive skills for daily decision-making (HC)		subjective	no	problematic	yes	no	yes	no	no	no
2. Memory /Recall Ability										
a. short term memory OK	speech	objective	no	problematic	no	5 minutes	no	no	no	no
b. procedural memory OK	speech & visual	objective & subjective	no	problematic	no	immediate	no	no	no	no
c. situational memory OK	speech & text	objective	no	problematic	yes	immediate	no	no	no	no
3. Periodic disordered thinking or awareness										
a. easily distracted	speech	subjective	no	problematic	yes	no	yes	no	no	no
b. episodes of disorganised speech	speech	subjective	no	problematic	yes	no	yes	no	no	no
c. mental function varies over the course of the day	speech	subjective	no	problematic	yes	no	yes	no	no	no
4. Acute change in mental status from person's usual functioning	speech & visual	subjective	no	problematic	yes	no	yes	no	no	no
2. ADL self-performance (0-1)										
a. Bathing	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
b. personal hygiene	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
c.. dressing upper body	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
c. dressing lower body	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
e. walking	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no

interRAI item (consider **INTENT** of the item)		Data is objective/s ubjective	Available now in digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	incorp in 24 hour asmt	Incorp 3 day asmt	incorp in 30 days	Incorp 90 day asmt	incorp 180 days
d. locomotion	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
g. transfer toilet	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
i. bed mobility	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
j. eating	speech, visual	objective & subjective	no	yes	yes	no	yes	no	no	no
3. Locomotion / Walking										
a. primary mode of locomotion indoors	speech, visual	objective	unknown	yes	yes	no	yes	no	no	no
b. timed 4 metre walk (13 foot)	timed	ojjective	unknown	yes	no	no	no	no	no	no
c. distance walked	speech	objective	no	yes	yes	no	yes	no	no	no
d. distance wheeled self	speech	objective	no	yes	yes	no	yes	no	no	no
4. Activity Level										
a. Total hours of exercise or physical activity in last 3 days	speech	objective	no	yes	yes	no	yes	no	no	no
b. in the last 3 days, no. of days went out of house or building he/she lives in	speech	objective	no	yes	yes	no	yes	no	no	no
5. Physical function improvement potential										
a. person belives is capable of improved performance in physical function	speech	subjective	no	problematic	yes	no	no	no	no	no
b. care prof believes person capable of improved perf in physical function	visual	subjective	no	no	no	no	no	no	no	no
6. Change in ADL status compared to 90days ago or since last asmt if <90 (see G6)	speech	objective	no	no	no	no	no	no	yes	no
7.Driving										
a. Drove car in last 90 days (same as G7a)	speech	objective	no	no	no	no	no	no	no	no
b. if drove in last 90 days, assessor aware person suggested to stop driving (same as G7b)	speech	objective	no	no	no	no	no	no	no	no
3. Dyspnoea (same as J4)	speech	objective	no	yes	yes	yes	no	no	no	no
4. Self-reported Health (same as J8)	speech	subjective	no	yes	no	no	no	no	no	no
5. Instability of conditions										
a. Conditions/ diseases make cognition, ADL, mood, or behaviour patterns unstable (same as J7a)	speech & text	objective & subjective	no	yes	no	no	no	no	no	no
b. Experiencing an acute episode or flare-up of a recurrent or chronic problem (J7b)	speech & text	objective	no	yes	no	no	no	no	no	no
c. Endstage disease 6 or fewer months to live (only in HC)	speech & text	objective	no	yes	no	no	no	no	no	no
6. Support Services may be required for this person (only in CA)	text	objective	no	yes	yes	yes	no	no	no	no
DECISION POINT (CA) TO GO SECTIONS D & E OR TO E10 in CA		objective	no	yes	yes	yes	no	no	no	no
Section D - Clinical Evaluation (CA)										
1. Change in decision-making compared to 90days ago or since last assessment if <90days (same as C5)	speech	subjective	no	yes	yes	no	no	no	yes	no
Section D: Communication and vision										
1. Making self understood (only in HC)	speech & visual	objective & subjective	no	no	yes	no	no	no	no	no
2. Ability to understand others (Comprehension) D2 in CA & HC	speech & visual	subjective	no	no	yes	no	no	no	no	no
3. Hearing	speech & text	objective& subjective	yes	yes	no	no	no	no	no	no
4. Vision	speech & text	objective& subjective	yes	yes	no	no	no	no	no	no
3. Self-reported mood (same as E2)	speech	objective	no	yes	yes	no	yes	no	no	no
Section E: Mood and Behaviour (HC)										
1. Indications of possible depressed, anxious or sad mood										
a made negative statements	speech & visual	subjective	no	no	yes	no	yes	no	no	no
b. persistent anger with self or others	speech & visual	subjective	no	no	yes	no	yes	no	no	no
c. expressions, including nonverbal, of unrealistic fears	speech & visual	subjective	no	no	yes	no	yes	no	no	no
d. repetitive health complaints	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
e. repetitive anxious coplaints/concerns (non-health related)	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
f. sad, pained or worried facial expressions	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
g. crying, tearfulness	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
h. recurrent statements something terrible is about to happen	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
i withdrawal from activities of interest	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
j reduced social interactions	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
k. expressions, including non verbal, of lack of pleasure in life	speech & visual	objective & subjective	no	no	yes	no	yes	no	no	no
2. Self reported mood										
a. little interest or pleasure in things you normally enjoy	speech	subjective	no	yes	no	no	yes	no	no	no
b. anxious restless or uneasy	speech	subjective	no	yes	no	no	yes	no	no	no
c. sad, depressed or hopeless	speech	subjective	no	yes	no	no	yes	no	no	no
3. Behaviour symptoms										
a. wandering	speech & visual	objective & subjective	no	yes	no	no	yes	no	no	no
b. verbal abuse	speech & visual	objective & subjective	no	no	no	no	yes	no	no	no

interRAI item (consider **INTENT** of the item)		Data is objective/s ubjective	Available now In digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	incorp in 24 hour asmt	Incorp 3 day asmt	incorp in 30 days	Incorp 90 day asmt	incorp 180 days
c. physical abuse	speech & visual	objective & subjective	no	no	no	no	yes	no	no	no
d. socially inappropriate or disruptive behaviour	speech & visual	objective & subjective	no	no	no	no	yes	no	no	no
e. inappropriate public sexual behaviour or public disrobing	speech & visual	objective & subjective	no	no	no	no	yes	no	no	no
f. resists care	speech & visual	objective & subjective	no	no	no	no	yes	no	no	no
Section F: Psychosocial well-being (HC)										
1. Social Relationships										
a. participation in social activities of long-standing interest	speech	objective	no	no	no	yes	yes	yes	no	no
b. visit with a long-standing relation or family member	speech	objective	no	no	no	yes	yes	yes	no	no
c. other interacation with long-standing social relation - phone email	speech	objective	no	no	no	yes	yes	yes	no	no
d. conflict or anger with family or friends	speech	objective	no	no	no	yes	yes	yes	no	no
e. fearful of a family member or close acquaintance	speech	objective	no	no	no	yes	yes	yes	no	no
f. neglected, abused, or mistreated	speech	objective	no	no	no	yes	yes	yes	no	no
2. Lonely	speech	subjective	no	no	no	unknown	unknown	unknown	unknown	unknown
3. Change in Social activites in last 90days or since last asmt if < 90	speech	subjective	no	no	no	no	no	no	yes	no
4. Length of time alone during the day (morning & afternoon)	speech	subjective	no	no	no	unknown	unknown	unknown	unknown	unknown
5. Major stressors in last 90 days	speech	subjective	no	no	no	no	no	no	yes	no
Section G: Functional Status (HC)										
1. IADL Self-Performance and Capacity										
a. meal preparation	speech	subjective	no	yes	yes	no	no	no	no	no
b. ordinary housework	speech	subjective	no	yes	yes	no	no	no	no	no
c. managing medications	speech	subjective	no	yes	yes	no	no	no	no	no
C. managing finances (only in HC)	speech	subjective	no	no	no	no	yes	no	no	no
e. phone use (only in HC)	speech	subjective	no	yes	no	no	yes	no	no	no
d. stairs	speech	subjective	no	yes	yes	no	yes	no	no	no
g. shopping (only in HC)	speech	subjective	no	yes	yes	no	yes	no	no	no
h. transportation (only in HC)	speech	subjective	no	yes	yes	no	yes	no	no	no
5. Change in IADL status as compared to 90 days ago (OR since last assessment if < 90 days) (same as D5 in CA)	speech	subjective	no	yes	yes	no	no	no	yes	no
7.Driving (see C7)										
a. Drove car in last 90 days (same as G7a)	speech	objective	no	no	no	no	no	no	no	no
b. if drove in last 90 days, assessor aware person suggested to stop driving (same as G7b)	speech	objective	no	no	no	no	no	no	no	no
Section H: Continence										
1. Bladder Continence	speech & text	objective	no	yes	problematic	no	yes	no	no	no
2. Urinary Collection Device (excludes pads / briefs)	speech & text	objective	no	no	no	no	yes	no	no	no
3. Bowel Continence	speech & text	objective	no	no	no	no	yes	no	no	no
4. Pads or Briefs worn	speech & text	objective	no	no	no	no	yes	no	no	no
Section I: Disease Diagnoses (same as D6 in CA) listed as D6a - D6e or as necessary	speech & text	objective	expected	yes	yes	no	no	no	yes	no
1. Disease Diagnoses - listed I1A - I1U (21 items)	speech & text	objective	expected	yes	no	no	no	no	no	no
Section J: Health Conditions										
1. Falls (same as D7 in CA)	speech & text	objective	no	yes	no	no	no	yes	yes	no
2. Recent Falls only in HC (followup only)	speech & text	objective	no	yes	no	no	no	yes	no	no
3. Problem Frequency (HC has(21 items)	speech & text	objective & subjective	no	problematic	no	no	yes	no	no	no
Balance										
a. Difficult or unable to move self to standing postion unassisted	speech & text	objective & subjective	no	yes	no	no	no	yes	yes	no
b. difficult or unable to turn self around and face the opposite direction	speech & text	objective & subjective	no	yes	no	no	no	yes	yes	no

InterRAI item (consider **IN TENT** of the item)		Data is objective/subjective	Available now in digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	Incorp in 24 hour asmt	Incorp 3 day asmt	Incorp in 30 days	Incorp 90 day asmt	Incorp 180 days
a. dizziness	speech & text	objective	no	no	no	no	no	yes	yes	no
d. unsteady gait	speech & text	objective & subjective	no	yes	no	no	no	yes	yes	no
c. peripheral oedema CA only	**speech & text**	**objective**	**no**	**yes**	**no**	**no**	**yes**	**no**	**no**	**no**
Sleep Problems										
o. difficulty falling asleep or staying asleep, waking too early, restless	speech & text	subjective	no	yes	no	no	yes	no	no	no
p. Too much sleep	speech & text	subjective	no	no	no	no	yes	no	no	no
5. Fatigue	speech & text	objective & subjective	no	no	no	no	yes	no	no	no
9. Pain Symptoms										
a. Frequency with which person complains or shows evidence of pain (same as D9a in CA)	speech & text	subjective	no	problematic	yes	no	yes	no	no	no
b. Intensity of highest level of pain present (D9b)	speech & text	subjective	no	problematic	yes	no	yes	no	no	no
c. consistency of pain (only in HC)	speech & text	subjective	no	problematic	yes	no	yes	no	no	no
d. breakthrough pain (only in HC)	speech & text	subjective	no	problematic	yes	no	yes	no	no	no
e. pain control (only in HC)	speech & text	subjective	no	problematic	yes	no	yes	no	no	no
10. Smokes tobacco daily (same as J9a)	speech & visual	objective	yes	yes	no	no	no	no	no	no
b.Alcohol - highest number of drinks in any 'single sitting' in **LAST 14 DAYS (only in HC)**	speech & observe	objective	no	yes	no	no	no	no (in last 14 days)	no	no
SECTION K. Oral and Nutritional Status										
11. Nutritional issues										
1. Height and Weight										
a. HT (cm)	speech & text	objective	yes	yes	no	no	no	no	no	no
b. WT (kg)	speech & text	objective	yes	yes	no	no	no	no	no	no
a. In LAST 3 DAYS, noticeable decrease in the amount of food usually eaten /fluids usually consumed	speech & text	objective & subjective	no	yes	no	no	yes	no	no	no
b. Weight loss of 5% or more in LAST 3 DAYS or 10% or more in LAST 180 DAYS	speech & text	objective & subjective	no	yes	yes	no	yes	no	no	no
b. dehydrated	speech & text	objective & subjective	no	problematic	yes	no	yes	no	no	no
c. Fluid intake reduced	speech & text	objective & subjective	no	problematic	yes	no	yes	no	no	no
d. fluid output exceeds input	speech & text	objective & subjective	no	problematic	yes	no	yes	no	no	no
e. decrease in amount of food or fluids usually consumed	speech & text	objective & subjective	no	problematic	yes	no	yes	no	no	no
f. ate one or fewer meals AT LEAST IN 2 OF LAST 3 DAYS	speech & text	objective & subjective	no	problematic	yes	no	no	no	no	no
3. Mode of nutritional intake	speech & visual & text	objective	no	yes	no	no	no	no	no	no
4. Dental or Oral	speech & visual	objective & subjective	no	no	no	no	no	no	no	no
C. Special diet (only in CA)	**speech & text**	**objective**	**no**	**yes**	**no**	**no**	**no**	**no**	**no**	**no**
Section L: Skin Condition										
1. Most severe pressure ulcer	speech & visual & text	objective	no	yes	no	no	yes	no	no	no
2. Prior pressure ulcer	speech & text	objective	no	yes	no	no	yes	no	no	no
3. Presence of skin ulcer other than pressure ulcer	speech & text	objective	no	yes	no	no	yes	no	no	no
4. Major skin probems	speech & text	objective	no	yes	no	no	yes	no	no	no
5. Skin tears or cuts	speech & text	objective	no	yes	no	no	yes	no	no	no
6. Other skin conditions or changes in skin condition	speech & text	objective	no	yes	no	no	yes	no	no	no
14. Traumatic injury (only in CA)	**speech & text**	**objective**	**no**	**yes**	**no**	**no**	**yes**	**no**	**no**	**no**
7. Foot problems	speech & text	objective	no	yes	no	no	yes	no	no	no
Section M: Medications										
1. List of All Medications (using replacement page in manual)										
a. Name	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
b. dose	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
c. Unit	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
d. Route of administration	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
e. Frequency	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
f. PRN	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
g. Computer-entered drug code	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
2. Allergy to any drug	speech & text	objective	yes	yes	no	no	yes	no	no	no
3. Adherent with medications prescribed by physician	speech & visual & text	objective	yes	yes	no	no	yes	no	no	no
Section N: Treatments and Procedures										
1. Prevention										
a. Blood pressure meassured in the LAST YEAR	speech	objective	no	yes	yes	no	no	no	no	no
b. Colonoscopy in the LAST 5 YEARS	speech	objective	no	yes	yes	no	no	no	no	no
c. Dental exam in the LAST YEAR	speech	objective	no	yes	yes	no	no	no	no	no
d. Eye exam in the LAST YEAR	speech	objective	no	yes	yes	no	no	no	no	no
e. Hearing exam in the LAST 2 YEARS	speech	objective	no	yes	yes	no	no	no	no	no
f. Influenza vaccine in the LAST YEAR	speech	objective	no	yes	yes	no	no	no	no	no
g. Mammogram or breast exam in the LAST 2 YEARS (women)	speech	objective	no	yes	yes	no	no	no	no	no
h. Pneumovax vaccine in LAST 5 YEARS, > age 65	speech	objective	no	yes	yes	no	no	no	no	no
2. Treatments & Programs received/ scheduled (11 items)										
15. Treatments (11 items same as CA B2a -B2d)										
a. Indwelling catheter (same as B2a)	speech & text	objective	yes	yes	no	no	yes	no	no	no
b. IV therapy (same as B2b)	speech & text	objective	yes	yes	no	no	yes	no	no	no
c. Oxygen therapy (same as B2c)	speech & text	objective	yes	yes	no	no	yes	no	no	no
d. Wound care (same as B2d)	speech & text	objective	yes	yes	no	no	yes	no	no	no
16. Time since last hospital stay (same as A15)	speech & text	objective	yes	yes	no	no	no	no	yes	no
3. Formal Care	speech & text	objective	yes	problematic	problematic	no	yes	no	no	no
4. Hospital Emergency Room Use, Physician visit										
a. inpatient with overnight stay	text	objective	no	yes	yes	no	no	no	yes	no

interRAI item (consider **INTENT** of the item)		Data is objective/subjective	Available now in digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	incorp in 24 hour asmt	Incorp 3 day asmt	incorp in 30 days	Incorp 90 day asmt	incorp 180 days
b. Emergency room visit (excluding overnight stay)	text	objective	no	yes	yes	no	no	no	yes	no
c. GP visit or assistant practitioner	text	objective	no	yes	yes	no	no	no	yes	no
5. Physically restrained	speech & visual & text	objective	no	no	no	no	yes	no	no	no
Section O: Responsibility										
1. Decision-Maker for personal care and property	speech & text	objective	no	yes	no	no	no	no	no	no
18. Surgey in LAST 90 DAYS (only in CA)	speech & text	objective	yes	yes	no	no	no	no	yes	no
Section P: Social Support										
19. Two key informal helpers										
a. Relationship to person (code for two helpers)	speech & text	objective	no	problematic	no	no	no	no	no	no
b. Lives with person (code for two helpers)	speech & text	objective	no	problematic	no	no	no	no	no	no
c areas of help within last 3 days IADL help	speech & text	objective	no	no	no	no	no	no	no	no
d. areas of help within last 3 days ADL	speech & text	objective	no	no	no	no	no	no	no	no
20. Informal helper status										
a. informal helper is unable to continue providing care	speech & text	objective & subjective	no	yes	no	no	no	no	no	no
b. primary formal helper expresses distress, anger or depression	speech & text	objective & subjective	no	yes	no	no	no	no	no	no
c. family/ friends report feeling overwhelmed by person's illness	speech & text	objective & subjective	no	yes	no	no	no	no	no	no
3. Hours of informal care and active monitoring in last 3 days	speech & text	objective	no	yes	yes	no	no	no	no	no
4. Strong and supportive relationship with family	speech	objective	no	no	no	no	no	no	no	no
Section Q: Environmental Assesssment										
1. Home Environment										
a. disrepair of the home	speech & visual	objective & subjective	no	no	no	no	no	no	no	no
b. squalid conditions	speech & visual	objective & subjective	no	no	no	no	no	no	no	no
c. inadequate heating or cooling	speech & visual	objective & subjective	no	yes	no	no	no	no	no	no
d. lack of personal safety	speech & visual	objective & subjective	no	no	no	no	no	no	no	no
e. limited access to home or rooms in home	speech & visual	objective	no	no	no	no	no	no	no	no
2. Lives in an apartment/ house re-engineered accessible for disabilities	speech & visual	objective	no	no	no	no	no	no	no	no
3. Ouside Environment	speech & visual	objective	no	no	no	no	no	no	no	no
a. availability of emergency assistance	speech & visual	objective	no	no	no	no	no	no	no	no
b. accessibility to grovery store without assistance	speech & visual	objective	no	no	no	no	no	no	no	no
c. availability of home delivery groceries	speech	objective	no	yes	no	no	no	no	no	no
4. Finances		objective	no	no	no	no	no	no	no	no
Section R: Discharge Potential and Overall Status										
1. One or more care goals met in last 90days or since last asmt if < 90days	speech & text	objective	no	problematic	no	no	no	no	yes	no
2. Overall self-sufficiency has changed significantly compared to 90days/asmt	speech & text	objective & subjective	no	problematic	no	no	no	no	yes	no
3. Number of 10 ADL areas where person was indep prior to deterioration	speech & text	objective	no	problematic	no	no	no	no	yes	no
4. Number of 8 IADL performance areas person indep prior to deterioration	speech & text	objective	no	problematic	no	no	no	no	yes	no
5. Time of onset of precipitating event/problem related to deterioration	text	objective	no	yes	no	no	no	no	yes	no
Section S: Discharge										
1. Last day of stay	text	objective	no	yes	no	no	no	no	no	no
2. Residential/ Living status after discharge (same as B4)	speech	objective	no	yes	no	no	no	no	yes	no
Section T: Assessment Information										
1. Signature of person coordinating/completing assessment (same as E10.1	date	objective	no	problematic	no	no	no	no	no	no
2. date assessment signed as complete (same as E10.2)	date	objective	no	problematic	no	no	no	no	no	no
END OF HOME CARE ASSESSMENT										
Section E - Summary										
1. Algorithm Scores										
a. Assessment urgency	interRAI algorithm	objective & subjective	no	yes	yes	yes	no	no	no	no
b. Service urgency	interRAI algorithm	objective & subjective	no	yes	yes	yes	yes	no	yes	no
c. Rehabilitation	interRAI algorithm	objective & subjective	no	yes	yes	yes	no	no	yes	no
2. Services required for this person	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1	based on E2	based on E3	based on E4	based on E5
3. Expected length of stay	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1	based on E1	based on E1	based on E1	based on E1
4. Requires short-term services (less than 60 days)	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1	based on E1	based on E1	based on E1	based on E1
5. Assessment urgency	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1a	based on E1	based on E1	based on E1	based on E1
6. Urgency of needed services										
a. Nursing	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
b. Personal support/ household management	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1

interRAI item (consider **INTENT** of the item)		Data is objective/subjective	Available now In digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	incorp in 24 hour asmt	Incorp 3 day asmt	incorp in 30 days	Incorp 90 day asmt	incorp 180 days
c. Physiotherapy	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
d. Occupational Therapy	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
e. Dietician services	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
f. Lab services. equipment, and medical supplies	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
g. Placement services	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
h. Social work	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
i. Speech language therapy	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
j. Other (specify)	text & interRAI algorithm	objective & subjective	no	yes	yes	based on E1b	based on E1	based on E1	based on E1	based on E1
7. Client Group (example - NZ)	text & interRAI algorithm	objective & subjective	no	yes	yes	yes	yes	yes	yes	yes
8. Type of communication at intake	text	objective	unknown	yes	yes	no	no	no	no	no
9. Sources of information used to complete the interRAI CA										
a. Client	speech & text	subjective	no	problematic	no	no	no	no	no	no
b. Spouse or partner	speech & text	subjective	no	problematic	no	no	no	no	no	no
c. Child or Child-in-law	speech & text	subjective	no	problematic	no	no	no	no	no	no
d. Other relative	speech & text	subjective	no	problematic	no	no	no	no	no	no
e. Non-relative (e.g., neighbour)	speech & text	subjective	no	problematic	no	no	no	no	no	no
f. Doctor	speech & text	subjective	no	problematic	no	no	no	no	no	no
g. Staff at doctor's office	speech & text	subjective	no	problematic	no	no	no	no	no	no
h. Other home care agency program -e.g., a different jurisdiction	speech & text	subjective	no	problematic	no	no	no	no	no	no
i. Community support agency (specify)	speech & text	subjective	no	problematic	no	no	no	no	no	no
j.Hospital	speech & text	subjective	no	problematic	no	no	no	no	no	no
k. Other (specify)	speech & text	subjective	no	problematic	no	no	no	no	no	no
10.1. Signature of person coordinating/completing assessment	date	objective	no	problematic	no	no	no	no	no	no
10.2. date assessment signed as complete	date	objective	no	problematic	no	no	no	no	no	no
EMERGENCY DEPARTMENT SCREEENER										
Section F. Preliminary Screener										
1. Screening reference date and time										
a. screening reference date	See B1	objective	yes	yes	no	yes	no	no	no	no
b. Screening reference time	time	objective	yes	yes	no	yes	no	no	no	no
2. Cognitive skills for daily decision-making	See C1	objective	no	no	no	yes	yes	no	no	no
3. ADL Self-performance										
a. bathing	See C2a	objective	no	yes	yes	yes	yes	no	no	no
b. personal hygiene	See C2b	objective	no	yes	yes	yes	yes	no	no	no
c. dressing lower body	See C2c	objective	no	yes	yes	yes	yes	no	no	no
d. locomotion	See C2d	objective	no	yes	yes	yes	yes	no	no	no
4. Dyspnoea	See C3	objective	no	yes	yes	yes	yes	no	no	no
5. Self-reported health	See C4	objective	no	yes	yes	yes	yes	no	no	no
6. Conditions/ Diseases make cognitive, ADL, mood or behaviour patterns unstable	See 5Ca & 5Cb	objective	no	yes	yes	yes	yes	no	no	no
7. Lives alone	See D19b	objective	no	yes	yes	yes	yes	no	no	no
Section G. Clinical Evaluation										
1. Emergency Department Use	See D17	objective	no	yes	yes	no	no	no	yes	no
2. Time since last hospital stay	See D16	objective	no	yes	yes	no	no	no	yes	no
3. Acute change in mental status from person's usual functioning	speech	subjective	no	no	no	no	no	no	no	no
4. Self-reported mood							yes			
a. little interest or pleasure in things you normally enjoy?	See D3 (different coding used) speech	subjective	no	yes	yes	yes	yes	no	no	no
b. anxious, restless, or uneasy?	See D3 (different coding used) speech	subjective	no	yes	yes	yes	yes	no	no	no

interRAI item (consider **INTENT** of the item)		Data is objective/s ubjective	Available now In digital format	Potential for digital format	Multi-input item algoritm/clinical judgement output	incorp in 24 hour asmt	Incorp 3 day asmt	incorp in 30 days	Incorp 90 day asmt	incorp 180 days
c. sad, depressed or hopeless	See D3 (different coding used) speech	subjective	na	yes	yes	yes	yes	na	na	na
5. Mental status indicators										
a. hallucinations	speech	subjective	na	problematic	na	yes	na	na	na	na
b. delusions	speech	subjective	na	problematic	na	yes	na	na	na	na
6. Ability to understand others (comprehension)	See D2	subjective	na	problematic	na	na	na	na	na	na
7. Behaviour symptoms	speech	objective	na	problematic	na	na	yes	na	na	na
8. IADL capacity										
a. managing medications	See D4c	objective & subjective	na	na	no	na	na	na	na	na
b. stairs	See D4b	objective & subjective	na	yes	no	na	na	na	na	na
9. Informal Helper Status										
a. primary informal helper expresses feelings of distress, anger or depression	See D20 (different coding used form D19b)	subjective	na	na	na	na	na	na	na	na
b. family or close friends report feeling overwhelmed by person's illness	See D20 (different coding used form D19b)	subjective	na	na	na	na	na	na	na	na
10. Falls	See D7	objective	na	yes	na	na	na	na	yes	no
11 Pain Symptoms										
a. frequency with which person complains or shows evidence of pain	See D9a	subjective	na	yes	na	na	yes	na	na	na
b. intensity of highest level of pain present	See D9b	subjective	na	yes	na	na	yes	na	na	na
12. Nutritional Issues										
a. In LAST 3 DAYS, noticable decrease in amount of food or fluids usually consumed	See D11a	objective & subjective	na	yes	na	no	yes	na	na	na
b. weight loss of 5% or > in LAST 90 DAYS or 10% or > LAST 180 DAYS	See D11b	objective & subjective	na	yes	na	no	yes	na	na	na
13 Traumatic Injury	See D14	objective	na	na	na	na	na	na	na	na
14. Treatments										
a. indwelling catheter	See D15a	objective	yes	yes	na	na	na	na	na	na
b. IV therapy	See D15b	objective	yes	yes	na	na	na	na	na	na
c. oxygen therapy	See D15c	objective	yes	yes	na	na	na	na	na	na
d. wound care	See D15d	objective	yes	yes	na	na	na	na	na	na
Section H: Summary										
1. Algorithm Scores										
a. assessment urgency	interRAI algorithm See E1a	objective & subjective	na	problematic	yes	na	na	na	na	na
b. service urgency	interRAI algorithm See E1b	objective & subjective	na	problematic	yes	na	na	na	na	na
2. Need for Comprehensive Geriatric Assessment	interRAI algorithm & text	objective & subjective	na	problematic	yes	na	na	na	na	na
3. Referrals										
a. Needs assessment services	interRAI algorithm & text See E6	objective & subjective	na	yes	yes	na	na	na	na	na
b. social work	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
c. occupational therapy	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
d. physiotherapy	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
e. speech-language therapy	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
f. dietician	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
g. specialised Geriatric Services	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
h. other specialist(s) services	interRAI algorithm & text	objective & subjective	na	yes	yes	na	na	na	na	na
4. Acuity Score (Country specific)	ED triage acuity score	objective	na	na	yes	na	na	na	na	na
5. Discharged to	See B4 with less options	objective	na	yes	yes	na	na	na	na	na
6. Emergency Department discharge date and time										
a. discharge date	See E10. 1	objective	na	problematic	na	na	na	na	na	na
b. discharge time	time See F1	objective	na	problematic	na	na	na	na	na	na
7. 1. Signature of person coordinating/completing assessment	See E10.1	objective	na	problematic	na	na	na	na	na	na
7. 2. date assessment signed as complete	see E 10.2	objective	na	problematic	na	na	na	na	na	na

Appendix 6: Commercially available sensors - spreadsheet

INDUSTRY PARTNERS (2019)	PRODUCTS	Website
Precision Driven Health	Health data analytics, machine-learning models from consumer devices, genetic testing, MBIE-funded research partnership	www.precisiondrivenhealth.com/
MediMap Limited	MEDI-MAP cloud based medication management, aged care, mental Health, rehab, addiction & community care	www.medimap.co.nz/
APAC Essence Health Care & Smart Home Technology Grou	Digital analytics, audit & assurance, 3D modelling, Smart Living, Smart Care, Smart Security	www.essence-grp.com/
Securely	Securely. Medical Alarms, personal alarms and home security.	www.securely.nz/
Ventures & BeSure Solutions	Digital **solutions** to reduce carer stress, patient care, practice ownership, patient information systems & health service design.	https://www.ventures.health.nz/
Webtools Customer Management Software	NADIA mobile app - reporting & task management, Web app, FHIR integration,	https://www.webtools.nz/
Toniq Health.Retail.Software	1CHART, cloud-based electronic medication mgmt, Phamacy dispensing software, retail software	www.toniq.co.nz. www.1chart.nz
Stanley Healthcare	Cloud mgmt, fall detection, alarms & alerts, emergency call, senior living, temp/humidity monitor, tags, locators	http://www.stanleyhealthcare.com/
Tunstall	Telehealth, medical alarms & alerts, nursing service, repsite care, rehab, needs assessment, disabilty support	https://www.tunstallhealthcare.com.au/
Sektor	Medical carts	https://www.sektor.co.nz/
GPSOS Mobile Personal Security Technology	Geo fence, GPS monitoring, mobile emergency tracker, personal alarm,	www.gpsos.co.nz
Augen (NZ) Ltd, Augen Software Group	Web, mobile, desktop, database, middleware & enterprise software development	https://www.augensoftwaregroup.com/
Chiptech Ltd	EVE personal alarms, smartware, telecare, hardware & software	https://www.chiptech.co.nz/
Spark Health	Homecare medical, telehealth, interactive health information	https://www.sparkdigital.co.nz
Vodafone	Healthpoint & Vodafone partnership	https://www.vodafone.co.nz/readybusiness/digital-insights/healthpoint/
Selwyn Foundation	Charitable Trust -residential care, retirement villages, respite care for seniors	https://www.selwynfoundation.org.nz/
Vensa Health	Patient portal, Txt2remind	https://www.vensahealth.com/
CNS - Computer & Network Solutions	IT service provider, sources software & hardware for organisation management & security	https://www.cns.co.nz/
Cure8health	Practice management software using FHIR and SNOMED, personal EHR	http://www.cure8health.com/
Sofihub	Personal interactive alarm, medication reminders, carer notification, GPS tracker	https://www.sofihub.com/
ADT Security	Interactive security, NevaAlone - personal alarm, home security	https://www.adtsecurity.co.nz/
ILI Limited - Integrating Lifestyle Innovations	Home/Office Automation & Smart Care (Hardware & software)	http://www.smartlifecare.co.nz/
Smartlife NZ	Smartlife NZ integrated smart home systems, apps, security, media	https://www.smartlife.nz/
Sonnar (works with BlindLowVisionNZ (Blind Foundation)	Voice apps, mobile apps, sound design, web development, Alexa Voice apps	www.sonnar.nz
QVisual NZ/Aus Ltd, MimoCare/MimoCool	Tele monitoring - elderly care monitoring, remote monitoring mgmt system	https://www.mimo-care.com/

ORGANISATION & PRODUCT	DESCRIPTION	File transmission method - Wifi, Bluetooth, Z waves, Cloud, infrared, cellular	Website
Care A-NZ	Telemedicine NZ (Telemdicine, video conferencing)		https://www.careanz.co.nz/about.html
SnugPersonal health care -disease & medication management, personal h record	intergrates phone with carers & H profs, wearables, medical devices, blood glucose monitors	SMS, Cloud-based	https://snughealth.com.au/
Care Monitor	Shared care planning & medication management & patient engagement	integrates phones, wearables, medical devices, Cloud-based	https://caremonitor.com.au/features
Vocera Smartbadge	Vocera Smartbadge (Smartphones & wearables, Clinical software and alarms, Voice recognition, wireless wearable	lithium-ion polymer battery, bluetooth, uses in-house wireless local area network (WLAN), Genie	https://www.vocera.com/au
Medirecords iHealth for cloud based remote monitoring	Clinical and Practice management apps for patients/carers and medical practices	Cloud-based	https://www.medirecords.com/
BioInteelliSense - medical grade Biosticker on-body wearable sensor 30 days RPM	temp, resp rate, gait anlaysis, fall detection, sleep, body position	wireless, Qualcomm 5G chip, cellular connectivity	https://healthtechinsider.com/2020/01/28/wearable-monitors-vital-signs-for-30-days-video/
mHealth patch to monitor Covid 19, speech and resp rate.	Remote Patient Monitoring	high-bandwidth, tri-axis accelerometer	https://mhealthintelligence.com/news/researchers-create-mhealth-patch-to-monitor-covid-19-patients-at-home
Walk With Path (Parkinson's disease)	projects light in a line to step over and keep walking momentum	laser light transmitter,	https://walkwithpath.com/
Path Feel, insole with vibrational feedback (MS patients)	amplification of foot touching shoe when walking	app on smartphone records and sends data	https://walkwithpath.com/what-is-path-feel/
c/net mHealth patch (reusable)	attaches to base of throat, monitors movement, breathing, heart rate & temp, speech & swallowing		https://mhealthintelligence.com/news/researchers-create-mhealth-patch-to-monitor-covid-19-patients-at-home
TennCare - mHealth program - mhealth app	measures medication adherence, RPM. Ingestible sensor, wearable patch monitring physiological signs, mhealth app		https://mhealthintelligence.com/news/tennessee-uses-mhealth-to-improve-care-management-for-medicaid-membe
Industries from TIN - NZ Technology Investment Network			Industries from TIN - NZ Technology Investment Network
Avice - wearable measures muscule preformance	Mobile phone app uses smart algorithm. Rechargable battery in wearable, Kinesology tape	Bluetooth, wifi or mobile data	https://www.avicewearables.com/contact
BeSure - Passive monitoring alarm	Passive monitoring. Long life batteries. Carer notification (works with Dementia Auckland)	No mobile, wifi, or internet required	http://www.besuresolutions.com/
Chiptech - Wearable alarm	SIM with 3G data, GPS location, Fall detection, battery wireless charging, hands-free two-way speaker	RFID tag, contact ID reporting via CSV over cellular data, 3G, GPS, Cloud connection	https://www.chiptech.co.nz/
IMeasureU / (Vicon) IMU Step, CaptureU, IMU Sensor	Accelerometers, intertial sensor, Synchronised sensors, virtual cameras	Algorithms	https://imeasureu.com/
KYND Wellness tool	app meaures employee health and wellness app (COULD BE ADAPTED FOR CARERS)	app	https://www.kyndwellness.com/
MEDIMAP Medication Management (Industry Partner)	electronic medication charting, administration, prescription integration with PMS, escript	Internet, or offline mode for tablet for internet or power outage	https://medimap.co.nz/
MELON - health self-management tools	measures physical and emotional health	app	https://www.melonhealth.com/
Netsoft Health Solutions- scheduling software, financial integration, rosters	**Works with MoH, ACC and interRAI (software may be custmonised)**	mobile GPS, app	https://www.netsoft.net.nz/new-zealand-healthcare-solutions
Quoralis - Fallcast wearable	predicts & prevents falls in elderly, software and hardware	Uses mains power for control panel. Has own 3G network, stored in the Cloud	https://www.quoralis.com/
MIMOCARE Predictive Care -home sensors contact fromHome Smart Home	**detects trends (in 6 minute intervals) in activity levels and predicts falls** (can be monitored by family)	small battery powered sensors	https://www.mimo-care.com/
SHI Global Go Well Health - interactive care plans	post op, injury, rehab, prevention programs, self- management programs	agile Cloud-based platform	http://www.shiglobal.com/
SiliconCoach - Video anaylysis Pro 8	assess physical performance, rehab, professional development and learning (worth watching)	Windowds, 7, 8.1 or 10 operating systems. Camera, screen monitor, Ultrastudio recorder	https://www.siliconcoach.com/about
Spritely - monitors movement & falls & medication management	free video calling, medication delivery, wireless vital sign recording	software, wireless, Wifi, Cloud - based storage managed by Amazon	https://spritely.co.nz/product/
Webtools (INDUSTRY PROVIDER) software	Awhina app for health & disability workers, task & workflow mgmt	web-based platform, apps	https://www.webtools.nz/

Appendix 7: Timeline for interRAI in New Zealand

TIMELINE

Since 2002, interRAI has expanded and developed and is now the primary needs assessment instrument in aged residential and home care in New Zealand.

2003

The New Zealand Best Practice Guidelines – Assessment Processes for Older People **identified interRAI assessments as the best assessment instruments** to meet the objectives in the 2002 Health of Older People Strategy.

- 2003 New Zealand Best Practice Guidelines - Assessment Processes for Older People
- 2002 Health of Older People Strategy

2004

Five District Health Boards (DHBs) **pilot the interRAI home care assessment** to identify implementation requirements. A key finding is the importance of consistent training.

2007

All **DHB Chief Executives support** national implementation of the interRAI assessments for home and community.

2008

Start of the **interRAI National DHB Implementation Project (2008-2012)**. Implementation is phased and DHBs take individual responsibility for implementation – subject to agreed national criteria.

2010

DHBs, in conjunction with the New Zealand Aged Care Association, agree to support a project, to run from 2011 until 2015, to voluntarily **introduce interRAI assessments in Aged Residential Care**.

2012

All DHBs are using interRAI for assessing older people's support needs for home and community support services.

Associate Minister of Health announces that interRAI would become the **mandatory assessment instrument for all Aged Residential Care providers** from July 2015. New Zealand is now the first country in the world to have use of these home and community, and residential care tools nationwide.

2015

The Central Region's Technical Advisory Service (TAS) becomes the **national service provider for interRAI in New Zealand**, and the interRAI Services business group is created within TAS.

2017

The **Palliative Care assessment is introduced** as an alternative for home care assessors to be used with clients living in the community and with a terminal condition or prognosis.

Source: (interRAI New Zealand, 2020c)