FINAL REPORT

The Person-Centred iHome – Stage 2

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Translating dementia research into practice

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iHome Project- stage 2

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Background

In optimal conditions health policies should be guided by available scientific evidence. Experts and administrators responsible for the design and implementation of health policies ideally would like to base their decisions on the best and the latest research. However, despite considerable progress in health research, it remains practically difficult to access and integrate knowledge from a variety of sources. Further, randomised controlled trials (RCTs) of new therapeutic methods or interventions are expensive and time consuming to conduct in the residential aged care setting. In many instances generalisation of results obtained from RCTs are limited due to small group sizes and strict selection criteria of participating consumers. As demand for health related knowledge increases, and in an environment of limited scientific evidence, compromises in health policy are constantly being made. The mistakes in policies are costly both in economical and social terms. Making use of existing data from RCTs to undertake computer-assisted intervention studies can be a more efficient and accurate way of determining the most effective approaches to care services. The iHome project set out to prepare the groundwork for computer assisted experiments of a typical aged care home service for people with dementia.

Aim of the project

The 2nd stage of the iHome project aimed to construct a 'typical' residential aged care home providing services for people with dementia, using data obtained from the researcher's recent RCT studies in dementia care.

Methods

iHome is a set of ideas representing essential activities and interactions in a typical aged care home developed into a computerised model. The AnyLogic programming toolset was used in the iHome project. This program has been tested in academic and commercial environments. Standard elements such as variables, parameters and statecharts are all graphically represented in the development environment. There is also a provision for collection of data at runtime and automatic parameter variation during virtual experiments. Models which are built using the AnyLogic platform are hierarchically organised. This type of encapsulation allows accurate representation of resident characteristics and removal of unnecessary details and complexities from the model. In fact the model itself is a tree of objects that encapsulate each other and run concurrently in a common environment.

iHome's Theoretical Framework

The framework for iHome is the person-centred model, which has proven to be an effective process for producing positive resident outcomes, including reduced agitation and improved quality of life and function in people with dementia. The concept of personhood (i.e. unique resident identity, history, beliefs, values and strengths) is the major outcome that is assessed in the person-centred model, and is associated with characteristics that comprise three interlinked constructs:

Subjective experiences of the person living in the facility, which includes their bio-psychosocial status and their behavioural responses to the socio-cultural context;

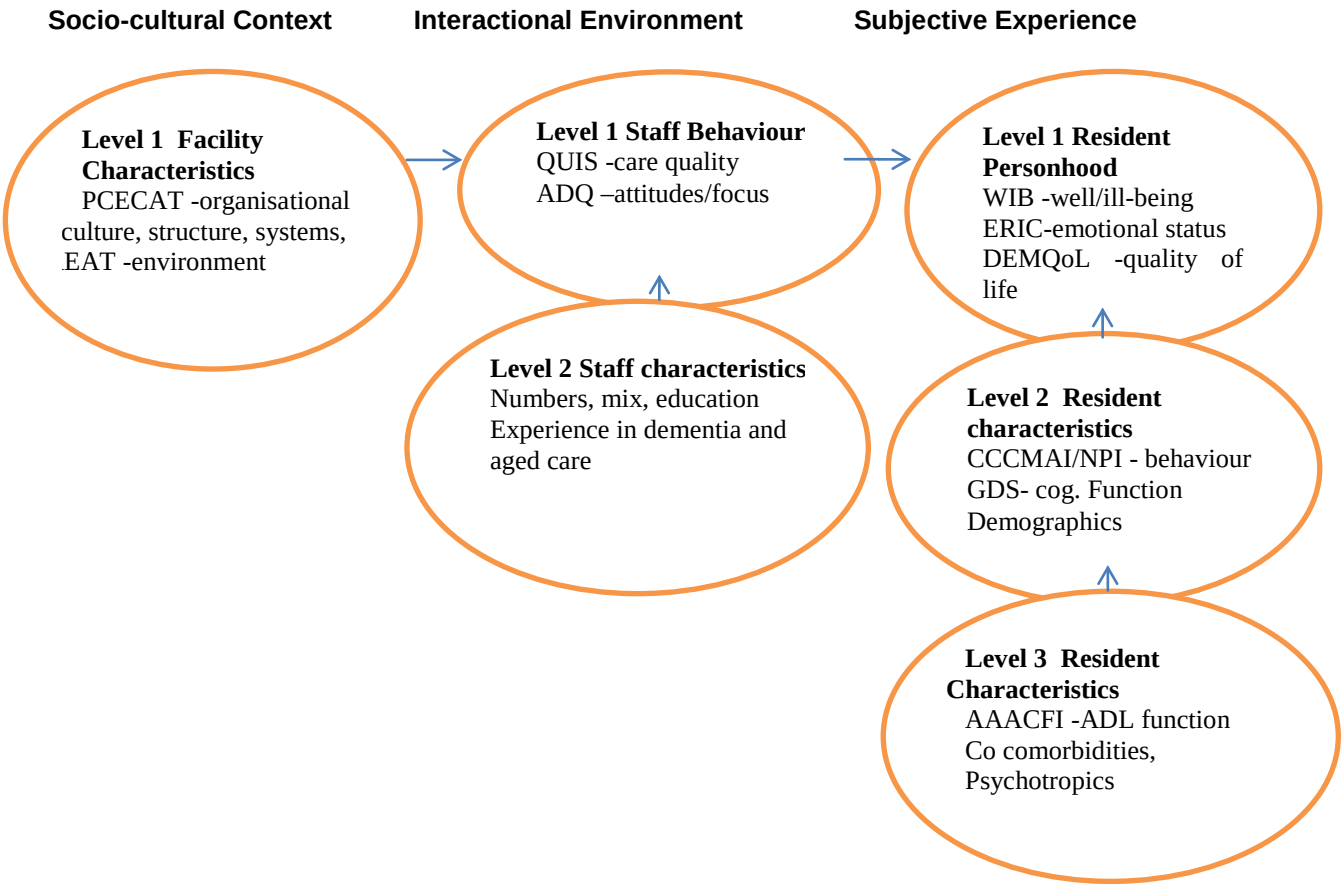
Socio-cultural context of the residential aged care facility, which includes the mission/philosophy, structure, systems and policies, the physical environment, management and staff decision-making processes, and the orientation of care services and recreation/lifestyle programs; and

Interactional environment of all who are involved in giving oversight and providing and receiving care and other services, and includes the direct care staff's attitudes, communication and behaviours towards the resident, nurse's and direct care staff's educational preparation, experience and skills for

aged care work, and whether the facility culture supports and hinders positive interactions between staff, residents and their families/friends.

Analyses of the combined RCT dataset with AnyLogic and Bayesian modelling have confirmed the project's theoretical framework assumptions (Figure 1) i.e. certain structural features of the aged care facility (Socio-cultural context), and the systems of care/lifestyle support and the care environment (Interactional environment) are associated with resident outcomes (Subjective experiences).These findings made intuitive sense to the project's Expert Advisory Group (EAG) comprising aged care consumers, providers, managers, staff and aged care policy advisors, who have endorsed the iHome framework.

Figure 1.



AnyLogic was used to initialise a small group of 24 virtual people designed to resemble real world residents with dementia. The AnyLogic software is built on the open-source Eclipse software development platform and offers an unrestricted Java programming environment. It is an advanced toolset for agent-based computer modelling and is used worldwide by academic researchers and consulting firms. AnyLogic offers libraries of programming components for model development and sets of advanced features to perform multiple virtual experiments and optimisation protocols.

The virtual residents designed using Any Logic have similar distribution of dementia characteristics as their real counterparts identified from our RCT studies, as well as rates of mortality, cognitive decline. The types of care services they receive during the course of their illness in the model are also typical of the way that different staff provide services to residents with dementia in a typical aged care home. These details were identified from staff and service data obtained from the RCT studies. To further advance iHome ideas, the next step was to implement a typical physical layout of residential aged care facility into the model. Physical environment plays very important role in the residential aged care and has the power to either enable or disable new programs or initiatives. Therefore understanding the role of the physical environment may be essential in predicting outcomes of policies which aim at optimisation of tasks and roles of carers and services. In this initial stage we aimed to implementing visual diagrams of rooms and corridors with hypothetical pathways through which residents move.

The nature of computerised (virtual) experimentation with the iHome model would occur in the same way as in conventional RCT studies. For example, the iHome model can be run at different times with different sets of parameters relating to resident, staff and service characteristics, eg in the morning shift when residents are being woken and given breakfast or personal care. The differences in outcomes for residents with different approaches and schedules of care service can be evaluated using traditional statistical approaches such as t-test, repeated measures ANOVA or similar tools, depending on complexity of experimental designs. Running these experiments via a computer program is far easier to do than in real life, and it avoids the ethical issues that will arise in real care situations if any substantial changes are made in to service delivery quality and levels.

Start time of the model is set up at midnight when the majority of residents are still lying in beds. As the time progresses some of the residents are getting up and moving around. In order to explore possibilities of modelling more complex patterns of behaviours a toggle switch may be implemented to allow opening and closing the doors. Individual pathways are made visible with on/off switch and 'icons' representing residents will be turning in the direction of movement. The choice of such a complex research tool was necessary in order to accommodate future demand for such project. For example with further funding iHome could model more complex behaviours. Virtual residents would be able to interact with each other within the environment and communication could be maintained by sending and receiving messages, changing parameters and triggering events.

The iHome model will allow service providers, researchers and policy makers to easily change essential parameters of their care model to suit specific service, policy research-based questions. As well, iHome will assist service providers to plan for workplace efficiencies, streamline service delivery and ensure that the home is able to meet the needs of residents with different needs more effectively.

<u>Outputs</u>

Base-model development

In preparation for the project, the iHome base model was developed. Ethical approval (UTS-HREC 2012024) was obtained to construct the base model and the computational system using the project team's person-centred aged care RCT data, including:

- 90 residential aged care facilities (high and low care) assessed for: organisational characteristics, culture and policies; systems operations, communication and management; policies, environment design and quality; care and recreation/lifestyle service quality (PCECAT[i]; EAT[ii]).
- 900+ persons living in residential aged care assessed for: function and health measurement (ACFI[iii]), comorbid illnesses, quality of life (DEMQOL[iv]), well-being (WIB[v];ERIC[vi]), agitated and other behaviour (CMAI[vii], NPI[viii]), and recreation activity participation[i];
- 700+ nurses, direct care workers and recreation/lifestyle staff assessed for: aged and dementia care attitudes, knowledge, skills and practices (ADQ[ix]), number, type and quality of care and interactions with persons receiving care and recreation activities (QUIS[x]), use of chemical and physical restraints in care (QUIS[x]).
- Continuous in-depth 24 hour observational assessments of the activities, interactions and responses of staff and residents in two residential aged care facilities of different sizes, locations and types (for profit/not for profit). Data collected on 12 persons with/without dementia with different co-morbidities, abilities and needs; 10 staff providing services to these 12 persons (nursing, personal care, recreation/lifestyle); and two managers who supervise these services.

Ensuring Data adequacy

The combined RCT data were re-analysed and compared with nationally available datasets for confirmation of key aged care facility, resident and staff characteristics. An additional extant person-centred study dataset was used to confirm the relevance of these characteristics. The combined RCT data sample of 90 aged care facilities and over 900 residents and 700 nurses & direct care staff were estimated to provide over 90% power to detect a medium effect size (Cohen's d=0.5) difference on continuous outcomes with the significance level set at two-sided 0.05[29], based on intra-class correlations on the additional study's outcome measures.

Active Agent construction

AnyLogic software was used to develop the iHome base model. AnyLogic has helped to gain insight into the complex interdependent processes occurring in residential care services by creating abstract representations of the managers, staff and residents called *active agents*. The active agent's behavior (main care drivers and reactions) are modelled in different care environments and connections are established between them during simulation, such as when giving personal care, administering medicines, facilitating leisure activities and providing meals. During computer simulation the resident and staff active agents will be represented by small icons depicted in the optional visualization interface and these move between locations as they do in real life. Time spent in each location undertaking activities strictly corresponds to our observational data[21]. These active agents have the ability to be modified according to their characteristics, such as having dementia and/or a need for high-level physical care and to different circumstances, in order to retain a history of their behaviours which will be embedded within each other.

Physical layout construction

AnyLogic was used to construct a three dimensional visual layout of a small (20 bed) non-purpose built mixed care unit located within an aged care facility using the extant RCT study data and the 24 hour observational data obtained from two aged care homes. iHome design comprises configurations of private and public rooms, corridors and utilities, walking distances and location of resident bedrooms in relation to dining, recreation and other common areas, secure outdoor spaces and nurses' stations that are found in many Australian aged care facilities that accommodate residents with/without dementia. In this 3D model the active agents are modelled to behave autonomously with their own set of rules that define them and what they do in these various spaces. Adjustments to the physical layout of iHome will occur during the experimental stage of the project in accordance with person-centred principles. The living environment will be adjusted to introduce features that are familiar to residents, will facilitate their engagement with a variety of indoor and outdoor activities, will provide a variety of private and community spaces, amenities and opportunities to take part in domestic activities and will be pleasantly stimulating. Manipulation of different aspects of the model during experimentation will determine changes in the active agents' actions, reactions and interactions with each other, within the typically-designed mixed care unit and the care unit with person-centred features.

Hierarchical State Chart construction

The agent-based computational model data have been converted into *hierarchical state-charts*, which provide the blueprint for the activities and responses of the virtual resident and staff participants. State-charts are compact visual representations of complex systems which allow for different behaviours (technical, biological or social) to be expressed without the necessity of including all of the structural elements that distinguish a real-life aged care unit.[32] These blueprints link the most frequently performed care staff activities (e.g. personal care, continence management, transfers, meals/drinks, conversation, recreation) and nursing activities (e.g. medication administration, assessment, documentation), with specific details concerning triggers for care/treatment, when/where provided, length of waiting time for care/treatment, time required for completion of care/treatment, and resident responses to care/ treatment and their quality of life indicators and function. Typical active agent behaviour has been confirmed in a pilot study by comparing these with the 24 hour continuous observational data of the 20 aged care residents with different characteristics and levels of need, and the 20 nurses and care staff attached to one person-centred aged care unit and to one task-centred aged care unit.

iHome Dataset References

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Conclusions

As virtual experimentation is a relatively new concept, it might have difficulty with initial acceptance. However conclusions drawn from virtual experiments can be compared to conventional RCTs. Previous work at the DCRC demonstrated that it is possible not only to conceptualise people with dementia using an agent-based model, but also that there is enough preliminary evidence in scientific journals to support such a model with data.

The representation of physical layout in iHome project was laborious and time consuming, due in part to theoretical difficulties experienced as there was no similar agent-based model available, and therefore no specific blueprint for constructing virtual residents within the RACF. However, the aim of the project was completed showing convincing visual representation of moving residents and staff. These preliminary results indicate that visualisation methods used in the model were appropriate to the aim e.g. showing movement of the residents and staff between locations.

This project requires further development and has intrinsic limitations. First, it is a simple model in which virtual residents have only characteristics represented internally by the statecharts. We expect that as the project grows and more knowledge is integrated into the model, residents' behaviours and other characteristics will become more complex as is the case with other projects describing virtual behaviours. Second, this model doesn't aspire to be a commercial product. The potential audience is defined as groups of researchers, clinicians and selected health managers. The visualisation methods are based on 2D graphics where residents are depicted by simple shapes. This could change if more elaborate graphical objects were employed to enhance background illustrations and icons representing residents. Third, it will be beneficial to do formal testing of the model both for its clinical accuracy and the effectiveness in information visualisation. The questions regarding natural or spontaneous recognition of icons by the end users as well as graphical elements used in animation remain to be agreed upon.

Despite these limitations and with further development effort iHome model could become a focal point for knowledge integration and knowledge transfer in the field of dementia research. Much of the success of this project will depend on (1) how much clinical and non-clinical knowledge about dementia care can be integrated into the model's logic, and (2) how well the chosen visualisation method 'tells' the story about the disease progression and associated care services.