Dementia Ambient Care: Multi-sensor support to enable independent home-based living for people with dementia

Dr Louise Hopper, Dr Eamonn Newman, Prof. Alan Smeaton, & Dr. Kate Irving
Dublin City University (DCU), Ireland

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Presentation Outline

- Background
- The Dem@Care Project
- First @Home Pilot
  - Aims
  - Methodology
  - Results
  - Conclusion
- Next steps for Dem@Care @Home
Background

- Increasing prevalence of dementia worldwide means that we must focus on acceptable, cost-effective, home-based solutions to support people with dementia
- Information technologies and in particular ambient assistive technologies (AAL)
  - can support independent living & prolong community-based living, while delaying entry into long-term residential care [1-5]
  - can support diagnostics in lab or home setting [6-10]
  - with the ongoing participation of carers and healthcare professionals
- Dem@Care is a personalised healthcare system that aims to use sensor technology to support the independence of people with early to moderate stage dementia
The Dem@Care Project

3 Themes

- Diagnostics
- Enablement
- Safety

3 scenarios

- @Lab (France)
- @Home (Ireland)
- @Nursing Home (Sweden)

2 loops of care

Home-based loop
Between people with dementia and their caregivers
Sensor-based, context-sensitive, evolving, personalised
offer encouragement, warnings, alerts

Clinician loop
Faithful log of health-related information,
Summaries, trends, pattern analysis
Monitor improvement, stasis or warn clinician of deterioration
Supports care decisions
Data Collection in the Five Domains

Person with Dementia

- **SLEEP**
  - Night time sleep, awakenings, bed exits, Difficulty falling asleep, insomnia onset, day-time sleep and napping

- **MOOD**
  - Observed behaviour, physical stress levels, speech analysis, subjective mood reporting

- **PHYSICAL ACTIVITY**
  - Amount of physical activity in the home, outside the home, dedicated exercise, movement speed, distance travelled, activity intensity

- **ADL/IADL**
  - Meal/Drink preparation and consumption, daily tasks (e.g. watch tv, listen to music, read, hobbies, chores)

- **SOCIAL INTERACTION**
  - Face-to-face social contact, initiated and received phone contact, speech analysis
Dem@Care Sensor Toolbox

1. Ambient Video Cameras

- 2D

![Image of 2D camera]

- 3D

![Image of 3D camera and sensor]

![Diagram of zones and activities]
Dem@Care Sensor Toolbox

2. Wearable Video Camera

2D

3D

[Images of wearable video camera and examples of 2D and 3D sensor data]
Dem@Care Sensor Toolbox

3. Physiological Sensors  (Philips DTI-2 Bracelet)

4. Sleep Sensors (Lark Beddit, Withings Aura, Gear4 Sleep Clock)

5. Audio Sensors
Wearable Microphones and smartphone Apps
@Home: Aims and Methodology

- Research Questions
  - Is the system acceptable in the home, is it non-intrusive, and useful to people with dementia and their families?
  - Can the system optimise the functional status of the person with dementia as operationalised in the 5 domains?
  - How autonomous and independent is the person with dementia and can the deployment of this system support this autonomy?

- Multiple case study design, person centred, co-design
  - Initial assessment of acceptability and usability (n=5 dyads)
  - First pilot with 1 lead user for 6 months
  - Second and third pilots with increasing numbers of participants
### Openness to using Dem@Care

In 4 dyads, the person with dementia “abhors” or was “allergic to computers” and 3 would not consider their use at all.

In 3 dyads the carer was open to using technology, but 1 felt he was “managing fine” and felt strongly that no external help was needed.

Another carer has a “busy day” so he “would not wish to be disturbed during the day by the unit for any reason”.

1 dyad (younger – early onset dementia) had an open and exploratory attitude to technology, and were willing to try anything that might help their circumstances.

### Acceptability and Usability

All 5 indicated that it was difficult to give feedback without using the system.

All agreed that it must not incur extra hassle or work for the carer - 2 of 5 would NOT want interruptions (alerts) during the day.

Happy to accept wearable sensors but they must be comfortable and unobtrusive.

High level of acceptability for sleep sensor – seen as very useful.

But hesitant to accept cameras when others are living in the home.
First @Home Pilot: Recruitment Protocol

- Person living at home with early dementia - family caregiver
  - Initial semi-structured functional assessment interview
    - General questions to determine if there are concerns in an area
    - If yes, proceed to psychometric measures; If no, move to next domain

<table>
<thead>
<tr>
<th>Domain</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>PSQI, Epworth Sleepiness Scale, Insomnia Severity Index, Morningness - Eveningness Questionnaire, Scale of Older Adult’s Routine</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>Rapid Assessment of Physical Activity, Physical Activity Scale for the Elderly</td>
</tr>
<tr>
<td>Eating / IADL</td>
<td>Bristol ADL Scale (proxy), Everyday Competence Questionnaire, Mini-Nutritional Assessment</td>
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<tr>
<td>Mood</td>
<td>Geriatric Depression Scale</td>
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<tr>
<td>Social Interaction</td>
<td>Lubben Social Network Scale, De Jong Loneliness Scale</td>
</tr>
</tbody>
</table>
Case Study 1: Sean and Catriona

- Sean (Age 58) and Catriona are married and live with Sean’s mother in their own home outside Dublin. They have two dogs.
- Sean was a carpenter and Catriona works 4 days a week in administration.
- At the start of the study, Sean was just post-diagnosis.
- Sean is active and independent and has comorbid epilepsy, which is being successfully managed pharmaceutically.
- They have previously been involved in research with the DCU team, using the SenseCam technology to explore lifelogging.

- Sean’s mother is not currently aware of his diagnosis.
## Case Study 1: Assessment

<table>
<thead>
<tr>
<th>Domain</th>
<th>Needs</th>
<th>Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>PSQI score of 6 = pathological sleep issues Duration and latency good; disturbance, efficiency, overall quality poor</td>
<td>Gear4 Sleep Clock DTI-2 Actigraphy Bracelet</td>
</tr>
<tr>
<td>ADL / IADL</td>
<td>While general eating, cooking and chores are no problem for Sean, Catriona indicated that certain tasks may need support (CD Player)</td>
<td>Wearable Go Pro video Ambient video camera</td>
</tr>
<tr>
<td>Physical activity</td>
<td>No issues detected, although Sean indicated interest in having support in this area</td>
<td>DTI-2 Actigraphy Bracelet</td>
</tr>
<tr>
<td>Socialising</td>
<td>No issue detected, although both felt there may be a benefit from support in this area</td>
<td>Periodic psychometric measures</td>
</tr>
<tr>
<td>Mood</td>
<td>No issues detected</td>
<td>Periodic psychometric measures</td>
</tr>
</tbody>
</table>
Case Study 1: Sleep Assessment

- 180 days deployment; 152 days of usable data
- Some disruption in sleep duration evident on a day to day basis but very stable patterns over time (Figure 1)

Some variation in sleep interruptions evident on a day to day basis but again relatively stable patterns over time (Figure 2)

BUT, interruption levels quite high and some clear outliers that require further investigation

![Total Sleep (Hrs:Mins)](image1.png)

![Number of Interruptions](image2.png)

Figure 1. Average Monthly Sleep over 6 months

Figure 2. Average Monthly Interruptions over a 6 month period
Case Study 1: ADL / IADL

- Catriona laid out the jacket/camera with Sean’s clothes every morning
- Most successful data capture was for activities that formed a natural part of Sean’s day
  - Making breakfast, tea, watering plants, feeding birds
- Capturing specific activities like ‘playing a cd’ were not successful unless they took place under the direction of Catriona or the researcher
- 33.3 hours collected – 4.33 hours have been manually annotated and are being used to train location, activity, and object algorithms for a second pilot
  - Initial models show promising accuracy levels
  - Feed birds (95.98%), Water plant (85.5%), Talk on phone (74.7%), Prepare drug box (49.7%), Breakfast (45.6%), Meal (46.98%), prepare tea (39.1%)
Case Study 1: Physical Activity

Activity Levels

Energy Expenditure

Day

Week
First @Home Pilot: Key Issues

- Recruitment difficulties

- Sensors
  - Training period required – initial anxiety regarding sensor use
    - *Need to balance the idea of co-design and the introduction of an incomplete system with a person with dementia*

- Ethics
  - Third party data capture and privacy

- Need for functionality available in later prototypes
  - Lack of triangulated data (integrated feedback) limits the usefulness of the system for all end-users
  - Easy to use data transfer and analysis and automated feedback
  - Caregiver still required as primary source of support
Conclusions and Future Direction

- Analysis of sensor level data shows promising results although the real value of the Dem@Care system will come from the triangulation of data from various sensors, and the ability to subsequently identify improvement, stasis, and/or deterioration over time
- Perceived usefulness at meeting perceived needs, and easy to use technology that does not interfere with daily life is the key to acceptability
- Importance of the interaction with the researcher/therapist

Next Steps:
- Currently 2 lead users; a 3rd due to come on stream in November
- Recruitment difficulties and feedback from the first pilot have resulted in the designed a cognitive rehabilitation intervention (12 weeks) within which appropriate sensors will be introduced
References


Thank you for your attention

For further information:
www.demacare.eu
louise.hopper@dcu.ie

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