D8.3

Initial Pilots Evaluation (Second Interim Report)

Dementia Ambient Care: Multi-Sensing Monitoring for Intelligent Remote Management and Decision Support

Dem@Care - FP7-288199

Deliverable Information

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Authors (Partner)		Louise Hopper (DCU), Emma Murphy (DCU), Joanna McHugh (DCU), Kate Irving (DCU), Alexandra Konig (CHUN), Stefan Sävenstedt (LTU), Basel Kikhia (LTU)
Responsible Author	**Name**	Louise Hopper
	Email	Louise.hopper@dcu.ie
Internal Reviewer(s)		Erik Schuijers (PENB)
EC Project Officer		Gerald Cultot
Abstract (for dissemination)		This second interim deliverable details the updated methods, protocols and initial results for evaluating the acceptability and usability of the Dem@Care system. The current status of the pilots and evaluation activities are described in relation to the DoW. Following this, the current evaluation status for the @Lab, @Nursing home and @Home studies are described in depth. Due to a delay in the completion and installation of the first prototype of the Dem@Care system the subsequent pilot evaluations have been delayed for each site. The delay is addressed with longer and continuous evaluation activities, which at the end will result to longer periods than initially foreseen. In this second interim deliverable, research questions, recruitment, clinical assessment, system acceptability, initial results, updated methods and protocols are presented. Potential issues related to the evaluation of the Dem@Care system have been identified and highlighted as important areas for further exploration during the course of evaluation and iterative design of the system.

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Executive Summary

This deliverable details the updated methods, protocols and initial results for evaluating the acceptability and usability of the Dem@Care system. The current status of the pilots and evaluation activities are described in relation to the DoW. Following this, evaluations for the @Lab, @Nursing home and @Home studies are described in depth. Due to a delay in the completion and installation of the first prototype of the Dem@Care system the subsequent pilot evaluations have been delayed for each site. Smaller, sensor-specific pilot studies are continuing in each site in the interim, and updated research questions, recruitment, clinical assessment, system acceptability, initial results, updated methods and protocols are presented in this second interim report.

The @Lab setting presents interim results for the first prototype of the Dem@care system focusing on certain aspects of system acceptability, protocols and sensor usability and feedback. This study aims to assess the usability and effectiveness of the Dem@Care system and explore if the system can add reliable diagnostic information to existing standardized diagnostic procedures. The @Lab site will compare data from individuals with early stage AD, individuals with MCI, and individuals from a healthy control group. The evaluation is based on data gathered from different sensors, in combination with audio and video data, while participants perform instrumental activities of daily living using standardized scenarios and data from conventional clinical assessments.

The @Nursing home section presents the current status of the pilot evaluation including research questions, evaluation setting, recruitment and potential issues related to system evaluation. Specifically, this second interim report presents issues observed during a short evaluation of a pilot test of the Gear4 sensor conducted in June 2013.

The @Home section presents the qualitative results of preliminary and assessment interviews of five users recruited for the @Home pilot. The two @Home lead users have been described in more detail in terms of their individual profiles and functional requirements. Updated protocols, and sensor toolboxes for each user are presented, potential issues for evaluation are outlined, and initial system acceptability and system usability results from sensor deployment with one lead user dyad are discussed. The results of a pilot of the Dem@Care system with 5 students/actors in the DCU community apartment in August 2013 are also presented.

Potential issues related to the evaluation of the Dem@Care system have been identified and highlighted as important issues for further exploration during the course of evaluation and iterative design of the system. This second interim deliverable describes the current status of evaluation methods procedures, deployment and results obtained to date from all three sites.

Abbreviations and Acronyms

AD	Alzheimer's Disease
DoW	Description of Work
WP	Work Package
PwD	Person with Dementia
Tx.x	Task x.x
Mx	Month X
DCU	Dublin City University
CHUN	Centre Hospitalier Universitaire de Nice
LTU	Lulea Tekniska Universitet
ADL	Activities of Daily Living
IADL	Instrumental activities of daily living
ICT	Information and communication technologies
EHPAD	Etablissement d'Hebergement pour Personnes Ages Dependantes (Nursing Home)
BPSD	Behavioural and Psychological Symptoms in Dementia
NPI	Neuropsychiatric Inventory
CDR	Clinical Dementia Rating Scales
NINCDS-ADRDA	National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association
Pilot@Lab	The pilot phase of the project as performed in the Lab setting
Pilot@Nursing home	The pilot phase of the project as performed in the Nursing Home setting
Pilot@Home	The pilot phase of the project as performed in the Home setting

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1 Introduction

This interim deliverable details the updated methods, protocols and initial results for evaluating the acceptability and usability of the first prototype of the Dem@Care system. The current status of the pilots and evaluation activities is described in relation to the DoW. Following this, the current evaluation status for the @Lab, @Nursing home and @Home studies are described in depth. While evaluation strategies are detailed in D8.2 for each site, evaluation strategies and protocols that have since been updated are also reported in this deliverable.

According to the DoW, the initial evaluation phase involves deploying the first Dem@Care prototype, in order to assess in a preliminary fashion, the usability, functionality and reliability of the system, and allow a further refinement of the functional requirements (to be described in D2.6). The second evaluation phase then assesses the external qualities of the Dem@Care prototype, and the third assesses the overall efficacy and impact of the Dem@Care system, including clinical considerations, factors related to enhanced quality of life for people with dementia, and their caregivers. D8.3 relates to milestone 4 in the DoW; the First Evaluated Prototype. This milestone should demonstrate 1) reliability of data collection, 2) sensor accuracy, 3) data analysis usefulness, and 4) understandable, easy to use feedback to people with dementia. Due to a delay in the completion and installation of the first prototype of the Dem@Care system the subsequent evaluations have also been delayed. The delay is addressed with longer and continuous evaluation activities, which at the end will result in longer periods than initially foreseen. In this second interim report, results achieved to date, updated protocols and potential issues regarding system evaluation for the 3 pilot sites are presented. We plan to provide an updated version of D8.3 by mid September covering the updated pilot evaluation results for all three sites.

While the three sites share the common aim of assessing and evaluating the efficacy of the Dem@Care system, they have significant deviations in their fundamental goals. The @Lab site aims to assess whether the Dem@Care system can enhance conventional assessment methods for the diagnosis of cognitive and neuropsychiatric symptoms and the ability to perform activities of daily living of people with dementia. The main goal of the @Nursing home scenario is to assess the Dem@Care system within a nursing home, how it aids the staff in maintaining the comfort and safety of residents with dementia. Finally the @Home setting aims to explore how Dem@Care technology can enable and maintain the independence of older adults with early stage dementia in their own homes, and also assist informal family caregivers with their role in this scenario.

Since the settings are diverse in many ways, with different patient groups who have different problems and priorities, the clinical challenges also vary. These differences in site-specific goals, clinical challenges and contexts lead to necessary differences in evaluation strategies and protocols. While the @Lab study performs mostly quantitative and controlled evaluation protocols, the @Nursing home and @Home sites will use multiple case study designs to maximize the rich information that can be obtained from a small sample size. Furthermore the case study approach employed for @Nursing home and @Home sites will collect contextual, longitudinal and ethnographic data that is not possible to observe in a laboratory setting. The dementia diagnoses for individuals also varies across sites; the @Home and @Lab settings

concentrate on earlier diagnosis while the @Nursing home setting will work with individuals with a more advanced diagnosis.

It is important to highlight that although each site has a very different aim and methodological approach to evaluation, the results from each setting will inform the others as a cyclical process. For example the results and experiences concerning the functions and usability of the system from the most controlled setting, the @Lab, can be transferred to the @Nursing home and the @Home settings. In this way the @Lab setting can make initial evaluations of sensors and functions in a highly controllable laboratory setting, and validate the sensor information with a large number of users. Resulting information and analysis can be transferred to the @Nursing home and the @Home settings, which are both testing the system in the same functional domains. Equally the contextual information and analysis from the case study approaches in @Nursing home and @Home sites can inform the more controlled procedures in the lab to help create a more naturalistic setting and enhance the diagnostic procedures. Furthermore, the @Home setting is unique in that the PwD will be expected to interact more directly with the sensors than they would in the @Lab setting where a clinical researcher is present, or in the @Nursing home setting, where a staff member is present. The @Home setting will therefore be able to evaluate the acceptability and usability of the Dem@Care system, and of each of the individual sensors, from the perspective of the PwD. A more detailed justification for the chosen methodologies for each site is also outlined in D8.2

In this present deliverable the evaluation protocols and initial results for each site are presented separately, however it is envisaged that as the prototype develops there will be more integrated discussion and analysis, as the results of each site will be compared to inform evaluations strategies and functional requirements for each site.

1.1 Progress in relation to the DoW

For the Task 8.3 ‘Pilot for Assisted Living in France (CHUN, LCS, CS)’ the DoW states that the initial pilot will involve short-term tests (between 1 – 1.5 hours) in a memory consultation centre in Bordeaux (15 participants) and in a memory consultation centre/ day care hospital in Nice (150 participants), which consists of monitoring individuals with dementia using the Dem@Care technology in order to provide during consultation a brief overview of their health status (cognition, behaviours, function) and to correlate the Dem@Care system data with the typical assessment tools. The pilot has in actuality been performed in the hospital in Nice, with three groups of participants: healthy controls, individuals with MCI, and individuals with AD. 50 participants per group are involved in the Lab-based pilot, which takes 9-12 months to complete. Furthermore the visit takes around 3 hours in total, rather than the 1.5 hours originally planned. Evaluation began in the memory clinic in Nice in June 2012 and 64 participants have been so far included in the study. Inclusion will continue throughout the three pilot phases targeting the total number of the DoW. The first evaluation of the integrated system will be carried out during the summer 2013 leading to the eventual modification of functional requirements.

For the task 8.4, ‘Pilot for Assisted Living in Ireland (DCU)’, the DoW states that the initial pilot will replicate the work conducted in Sweden and France, to include the university-based community apartment, which is a realistic showroom of a modern 3 roomed apartment in

DCU. The DCU community apartment will therefore be used as a troubleshooting facility to ensure that the sensors work together before deploying them to participants' homes. The results of a first pilot at DCU are presented. This pilot involved 5 actors/students in residence in the apartment, utilising the Dem@Care sensor system. A version of the HAR was also installed in the apartment in October 2013 (Certh) and these test results are also presented. In addition to piloting sensors and system in the DCU apartment, a participatory design method is put forward in D8.2, whereby 2 lead users are recruited early in the project to help co-design the Dem@Care system, through a series of interviews. This user centred design approach means that 'lead users' are involved from the very start of the project, with an active role in the design and customisation of the Dem@Care system. The results of these interviews are described in the current deliverable in addition to updated evaluation strategies and protocols for the @Home site. Finally, the Gear4, DTI-2, and GoPro sensors were deployed on a pilot basis with one lead user dyad in early November 2013. A preliminary evaluation of issues encountered to date is also presented.

The evaluation of the Dem@Care system will continue from the deployment of the first prototype until the end of the project and users will be recruited consecutively. Formal evaluation activities will occur when each of the three Dem@Care prototypes is ready. In between, targeted tests of usability and acceptability will be performed to inform the on-going iterative technical development.

2 @Lab evaluation

The Lab-based pilot is going to be used as a reference site to test Dem@Care technologies and to acquire clinical knowledge about the behaviour of dementia patients and interaction with Information Communication Technologies (ICT). The acquired expertise will be used to drive deployment of ICT solutions in terms of usability, functionality and reliability in the Nursing-Home and Home pilots. The three themes of enablement, diagnosis and safety permeate the three protocols. The lab-based research is primarily concerned with diagnoses.

The main goal of the @Lab site (carried out in a standard hospital memory consultation in a geriatric department) is to assess whether the Dem@Care system has any contribution to conventional assessment methods for the diagnosis of cognitive and neuropsychiatric symptoms and the ability of people with dementia to perform activities of daily living.

In order to assess the usability and effectiveness of the Dem@Care system in adding reliable diagnostic information to the existing standardized diagnostic procedure, we will compare data from individuals with early stage AD, individuals with MCI, and individuals from a healthy control group. The evaluation will be based on gathering data from different sensors, in combination with audio and video data, while participants are performing instrumental activities of daily living in standardized scenarios and data from conventional clinical assessments. The evaluation methodologies are selected to answer the specific research questions of each test setting.

Due to a delay in the installation process of the first prototype of the Dem@care system at the @Lab setting, the interim version of the deliverable D8.3 covers just certain aspects of system acceptability, the protocol, the sensors usability and feedback. For the final version, the system will have been tested with several participants and therefore users (technician, clinician and patient) will provide feedback and insights in order to evaluate the efficacy and usability of the initial pilot.

2.1 @Lab-specific research questions

The following research questions have been defined:

- Can the Dem@Care system be used to differentiate between early stage AD and related disorders from patients with mild to moderate stages of the disease and healthy elderly?
- Can the Dem@Care system assess the impact of behavioural disturbances, in particular apathy, and the completion of instrumental activities of daily living?
- Can the Dem@Care system assess the impact of cognitive decline based on speech and vocal characteristics?

- Can the Dem@Care system obtain data using actigraphy coupled with an audio-video setting that is comparable to data obtained with a conventional examination in the assessment of cognitive and neuropsychiatric symptoms of dementia?
- What is the acceptability among participants of using the Dem@Care system during a standard consultation in a memory centre?
- What is the acceptability of introducing a follow-up monitoring system based on the use of ICT within participants' own homes?

2.2 Participants: Recruitment Protocol

A total of 64 individuals aged 65 or older were recruited at the Nice Memory Research Center within the Dem@Care protocol, 17 patients diagnosed with AD, 26 patients diagnosed with MCI and 21 age-and education matched healthy controls. For the AD group, the diagnosis was determined using the NINCDS-ADRDA (National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association) criteria. For the MCI group, patients with a mini-mental state examination (MMSE) score higher than 24 were included using the Petersen clinical criteria. Subjects were not included if they had a history of head trauma with loss of consciousness, psychotic or major depressive disorder according to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition criterion, or aberrant motor activity (tremor, rigidity, Parkinsonism) as defined by the Movement Disorder Society Unified Parkinson Disease Rating Scale. Participants were administered a cognitive and behavioral examination after completing the video monitoring session. Global cognitive functioning was assessed using the MMSE. Other cognitive functions were assessed with the Frontal assessment battery, Trail Making Test (A and B), and the Free and Cued Selective Reminding Test. Neuropsychiatric symptoms were assed using the NPI and functions were assessed using the IADL scale (IADL-E) during a clinical interview with the caregivers if there was one available.

2.3 System Acceptability

Acceptability survey of participants

During the @Lab inclusion period, each participant was asked to fill out a questionnaire investigating the acceptability of the protocol and the sensors.

Generally, acceptability depends on how the system and the protocol were presented to the participants. It seemed of great importance to take sufficient time to explain to the user the potential benefits of system under evaluation.

Furthermore, it was very much appreciated to involve the caregiver, if present, in the assessment by making him/her watch the video of the evaluation in real time accompanied by explanations of the clinician.

Overall, preliminary results show that the scenario is well accepted and experienced as not too stressful. The majority of participants thought that it corresponded to situations of their every day life and perceived the use of the sensors as not too intrusive.

When it comes to wearing sensors at home to follow daily living activities, acceptability seems to be limited to just occasional use.

Does it help clinicians?

The protocol gives insight about possible problems in IADL, autonomy level and to which point the cognitive difficulties have an impact on the patients functionality.

Performance for the directed activities often serves as a good indicator for overall performance, particularly the counting backwards, double tasks, « Pataka »-task and the Walking Speed. Therefore, those tasks may serve as possible additional indicators for illness progression. Further analysis is needed to investigate the possible association.

The clinician often mentioned the importance of immediate feedback (so far just verbally to the patient and IPAD output with results to the clinician).

Here you can find the results of the survey in detail:

Results of acceptability questionnaire

[1] Context :

Questionnaire filled at the end of ecological evaluation by the participant with the presence of an experimenter.

I. Number of persons having filled the questionnaire

Control	MCI	AD	Total
15	18	11	44

II. Results by items

PROGRESS OF THE EVALUATION

(S1) Q1. All the tasks seemed to you:

Hard (1) -> (10) Easy

	<5	[5,7]	[8,9]	10
Control	0%	0%	60%	40%
MCI	11%	33%	33%	22%
AD	9%	36%	18%	36%
Total	7%	23%	39%	27%

Average : 7.8

Stressful (1) —> (10) Pleasant

	<5	[5,7]	[8,9]	10
Control	0%	0%	60%	40%
MCI	6%	50%	11%	28%
AD	9%	55%	9%	27%
Total	5%	34%	27%	32%

Average : 7.5

Corresponds to situations of your everyday life:

	Yes	No
Control	100%	0%
MCI	100%	0%
AD	73%	27%
Total	93%	7%

(S2) Q2. On the whole evaluation, you found:

a. The environment stressful :

	Yes	No
Control	0%	100%
MCI	0%	100%
AD	0%	100%
Total	0%	100%

b. The duration :

	Too long	Adapted
Control	7%	93%
MCI	22%	78%
AD	18%	82%
Total	16%	84%

(S3) Q3. Sensors' use during this evaluation :

a. Put under stress to You:

	Yes	No
Control	0%	100%
MCI	11%	89%
AD	0%	100%
Total	5%	95%

b. Modified your attitude:

	Yes	No
Control	0%	100%
MCI	17%	83%
AD	27%	73%
Total	14%	86%

(S4) Q4. Globally, have you understood well what was asked from you?

	Yes	No
Control	100%	0%
MCI	100%	0%
AD	100%	0%
Total	100%	0%

(S5) Q5. Did you understand well the interest of this evaluation ?

	Yes	No
Control	100%	0%
MCI	100%	0%
AD	100%	0%
Total	100%	0%

IN THE END

(S6) Q6. Would you be willing to participate again in this evaluation?

	Yes	No
Control	100%	0%
MCI	89%	11%
AD	91%	9%
Total	93%	7%

ACCEPTABILITY OF THE SENSORS

(S7) Q1. Would you agree to wear sensors to monitor your activities of daily living?

	Yes	No
Control	73%	27%
MCI	50%	50%
AD	55%	45%
Total	59%	41%

If yes : During how long

	Permanently	One Week	A Day	Occasionally
Control	9%	36%	36%	18%
MCI	11%	11%	44%	33%
AD	17%	33%	0%	50%
Total	12%	27%	31%	31%

If no : which are the reasons for your reluctance

	Too Intrusive	Be lacking comfort	Too visible	Too binding	Others
Control	50%	50%	25%	25%	25%
MCI	25%	25%	0%	0%	50%
AD	20%	0%	0%	20%	60%
Total	29%	24%	6%	12%	47%

(S8) Q2. Would you agree to have sensors installed at your home to monitor your activities of daily living?

	Yes	No
Control	60%	40%
MCI	33%	67%
AD	55%	45%
Total	48%	52%

If yes : During how long

	Permanently	One Week	A Day	Occasionally
Control	11%	44%	33%	11%
MCI	17%	17%	50%	17%
AD	0%	17%	0%	50%
Total	10%	29%	29%	24%

If no : which are the motives for your reluctance

	Too Intrusive	Be lacking comfort	Too visible	Too binding	Others
Control	33%	0%	17%	33%	33%
MCI	33%	0%	8%	25%	33%
AD	40%	20%	20%	20%	40%
Total	35%	4%	13%	26%	35%

DISCUSSION

(S9) Q4. If information meetings on the interest of these sensors were proposed to you, it would reassure you as for their use

	Yes	No
Control	80%	20%
MCI	71%	29%
AD	45%	55%
Total	67%	35%

(S10) Q5. If the use of these sensors were prescribed by your doctor, you would accept it?

	Yes	No
Control	100%	0%
MCI	65%	35%
AD	100%	0%
Total	86%	14%

2.4 Clinical assessment

The assessments carried out so far with the participants show that the groups are heterogeneous according to their diagnosis. The groups are age- and gender-matched. In the AD group, certain participants were not able to carry out the complete battery of neuropsychological tests. Therefore, some results are incomplete, and difficult to analyse. Confounding factors such as fatigue, stress or discomfort experienced during the evaluation may have influenced results as well the performance of participants and hence, will be addressed in the next functional requirements.

An overview of results of the different obtained test scores and sociodemographic information are presented in the following table.

Diagnosis	*N*	*Age*	*Gender F/M*	*MMSE*	*FAB*	*TMT A*	*TMT B*	*IADL scale total*	*NPI_total*
HC	15	74,86	11/4	28,2	16,3	44,7sec	110,1sec	7,2	3,7
MCI	15	75,46	8/7	25,6	13,6	67,3sec	208,9sec	6,5	4,5
AD	15	79,4	9/6	21,8	12,5	74,5sec	245,2sec	6	12,5

Table 1 Dem@Care: Preliminary results, Characteristics of participants

2.5 Ecological assessment of Instrumental Activities of Daily Living

For semi-directed activity tasks, preliminary analyses have been carried out with the data output of the video cameras, which was simply based on manual annotations.

The number of activities carried out correctly and completely showed the most significant differences between the three groups. Error rate and repetition of activities showed less differences as well as the kind of activity chosen by the different population. Hence, it can be concluded that it is worthwhile continuing analysing certain parameters in the future obtained automatically by the Dem@Care system to investigate differences in behavioural patterns between those three groups.

The obtained results show that with our created IADL scenario we were able to find group differences that are in line with literature demonstrating decline in functionality associated with dementia progression and detectable with the help of the @Lab protocol.

Diagnosis	*Nr. of activities started*	*Activities done correctly+ completely*	*Errors*	*Omission*	*Most activity done successfully*	*Less done successfully*	*Average Amount of activities (quantitative)*
HC	11,9	9,9	2	0,2	TV (15)	Correcting check (5)	22,5
MCI	9,2	6,4	2,8	2,1	Answer phone (12)	Account correction (2)	21,8
AD	6,3	3	3,3	4,7	Call psychologist (8)	Bus + bill correction (0)	16,2

Table 2 Overview of ICT data (manually annotated)

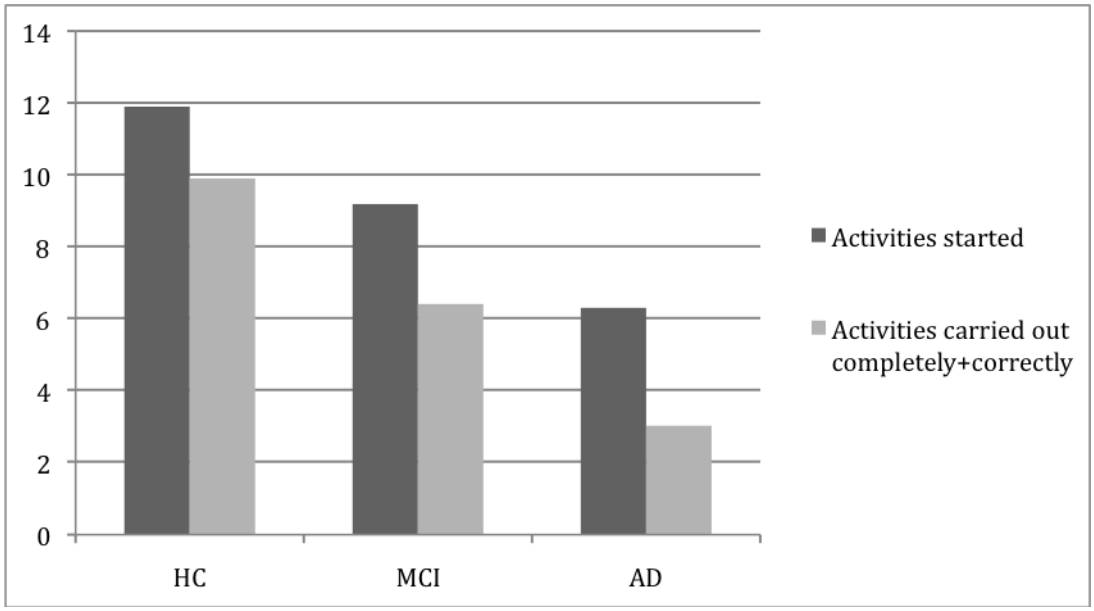

Figure 1 Amount of activities (qualitative data obtained by manual annotations of a clinician)

	Mean Difference	***p***	**Std. Error**
HC vs MCI	3,533*	,003	,965
HC vs AD	6,867*	,000	,965
MCI vs AD	3,333*	, 005	,965

** The mean difference is significant at the 0.05 level*

Table 3 Activities done completely and correctly *

	Mean Difference	*p*	Std. Error
HC vs MCI	2,733*	,022	,94393
HC vs AD	5,600*	,000	,94393
MCI vs AD	2,8666*	, 015	,94393

** The mean difference is significant at the 0.05 level*

Table 4 Activities started*

2.6 Validation of the protocol

In order to validate if the @Lab scenario can provide relevant information about a patient's cognitive status, correlations analysis between neuropsychological test scores and the obtained parameters have been carried out with significant results (presented in the following tables).

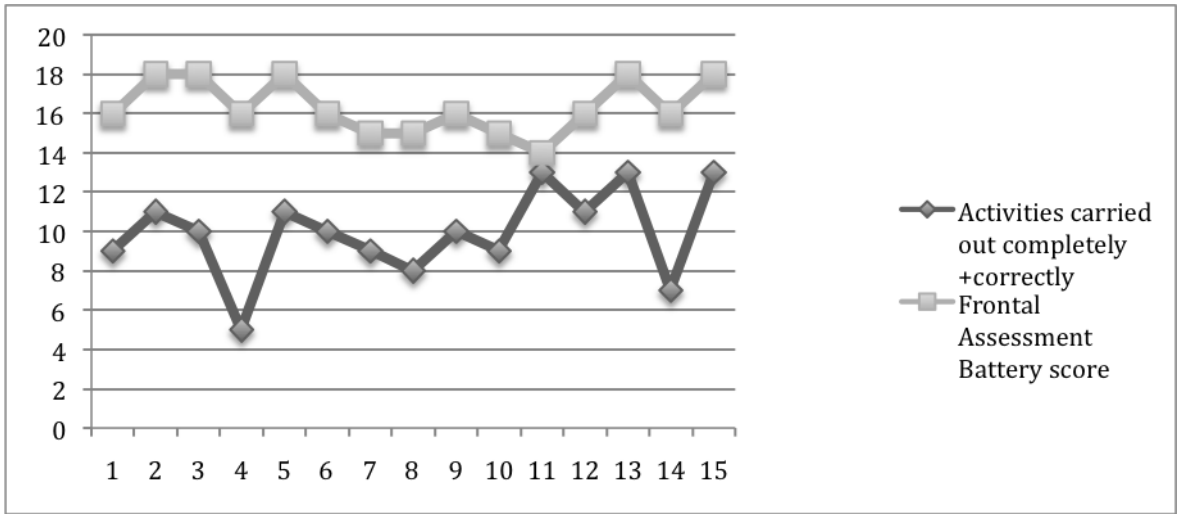

Figure 2 Healthy Controls

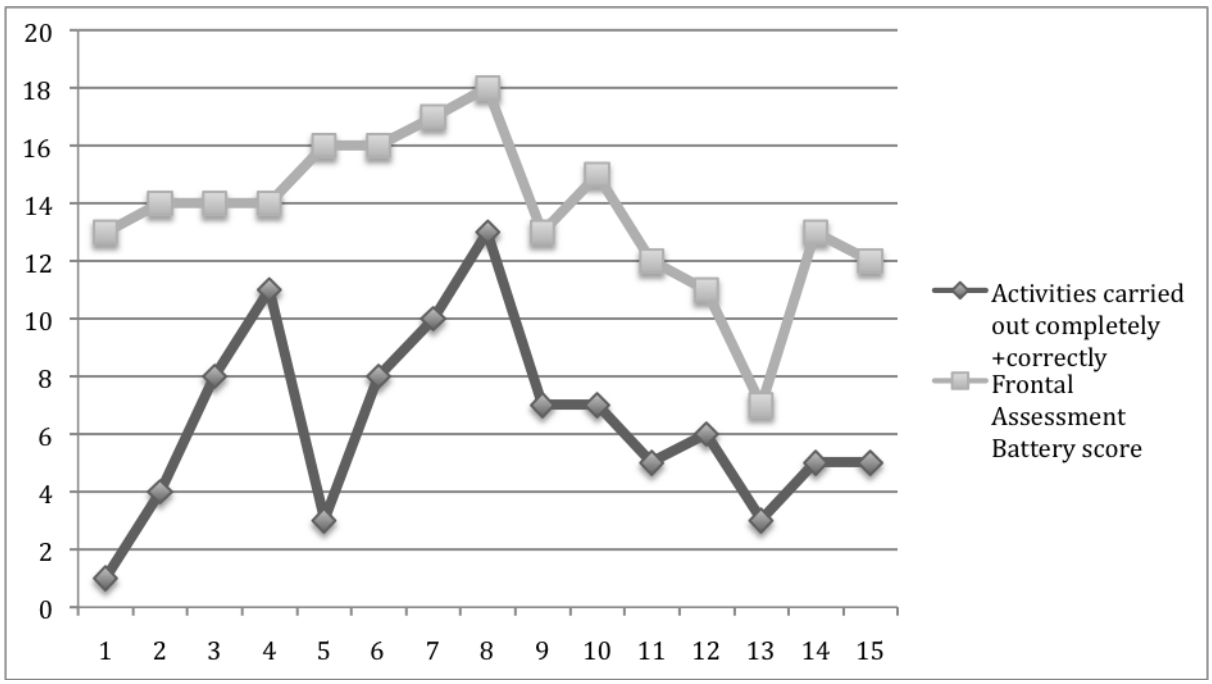

Figure 3 MCI patients

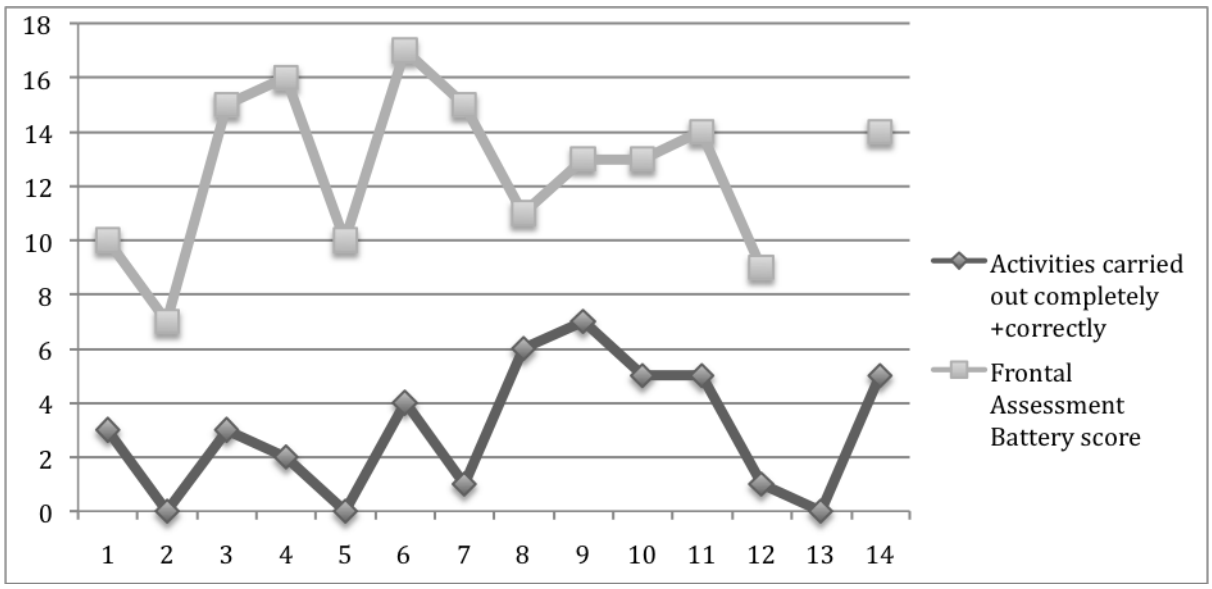

Figure 4 AD patients

			MMSE	FAB	Activities started	Act. Done Correctly+completely
Spearman's rho	MMSE	Correlation coefficient	1,000	,662*	,798**	,765**
	FAB	Correlation coefficient	,662*	1,000	,637**	,643**
	Activities started	Correlation coefficient	,798**	,637**	1,000	,921**
	Act. Done Correctly+completely	Correlation coefficient	,765**	,643**	,921**	1,000

***Correlation is significant at the 0.01 level (2-tailed)*

Figure 5 Non parametric correlations

In general, it can be concluded that the @Lab protocol is in line with neuropsychological test scores, and correlates with the MMSE and the FAB, both tools commonly used to assess cognition and the progress of dementia.

2.6.1 **Raised technical and clinical issues**

Technical issues raised:

- Data transfer (practical issue) is difficult, this has to be done manually due to large files, and therefore is time consuming, in particular for the Kinect videos.
- Lots of space is needed for storage of data, INRIA is trying to change format and to compress the files
- External access (needed to create a login and password for each partner)
- For Kinect data upload just possible picture-wise, not very practical, takes a long time
- Annotations are not always accurate and exact, this is problematic for activity recognition algorithms (comparison of ground truth and system results output)
- Kinect: data format is specific and not always straight forward to use
- Life duration of certain devices is very short, doesn't allow long term recording.
- Due to technical problems there is not always data available from all devices → for the analysis important to chose data from the most 'robust' device
- Sensecam: very slow image recording frequency, frame rate not useful for @Lab setting

- DTI-2: Technical partners provided the information that the sensor recordings were not synchronized and therefore difficult to analyse. The device seemed also not always to be worn the correct way, skin conductance was difficult to measure because the sensor was not close enough in contact with the skin. It seems that the device doesn't work with all wrist shapes

Clinical issues raised

- The current protocol is difficult to use in daily clinic, not practical, it needs a lot of preparation time, therefore it is not easy to integrate in clinical routine assessment procedures
- The whole assessment is too long, and the objective is, after the first analyses of the obtained data, to shorten and simplify the protocol by choosing just certain activities that seem significant to better integrate the protocol in clinical assessment
- Protocol helps to assess IADL functioning, but a scoring system that is easily applicable and understandable has still to be developed for automatization (for patients, caregiver and clinician feedback)

2.7 @Lab data collection

- 3-D Camera Kinect front+ lateral: approx. 1 Tera Byte
- 2-D camera front and Lateral: 189 GB
- Go-Pro: 180 GB
- Sense cam: 2,5 GB (low image frame rate)
- 2 Microphones (ambient and wearable): 21 GB
- Actigraph: DTI-2 : started later to be used, no data available for all participants : 200MB
- Clinical data (MMSE, NPI, FAB,…) mostly present for the 64 participants

2.8 System evaluation

For the final version of D8.3, we expect to cover the following aspects more in depths from three points of user view: technician, clinician and patient/caregiver.

1) Reliability of data collection

2) Sensor accuracy

3) Data analysis usefulness

4) Understandable, easy to use feedback to people with dementia

3 @Nursing Home evaluation

The evaluation protocol for the @Nursing home evaluation of the Dem@Care technology will assess the usability and effectiveness of it in the context of the Nursing home where the targeted user is a person with severe dementia who suffers from behavioural and psychological symptoms of dementia (BPSD). The evaluation of the first initial pilot equipment will focus on usability, including acceptability and usefulness, and a system evaluation. This evaluation will mainly use a qualitative approach. When it is agreed that a sufficient level of usability and functionality is reached, where the output of the system can provide valuable information to the staff members about the users in the five functional areas of daily activities/nutrition, sleep pattern, physical activities, social interaction, and mood/stress, the evaluation of effectiveness of the system will start. The test of the system will continue from the deployment of the first prototype until the end of the project and the users will be recruited consecutively. Formal evaluation activities will occur when each of the three Dem@Care prototypes is ready. In between, targeted tests of usability and acceptability will be performed to inform the on-going iterative technical development.

3.1 Research questions

Specific evaluations questions for the @Nursing home pilot are listed below. In the first pilot the focus will be on the two first listed research questions.

- What is the usefulness of the Dem@Care technology in this context?
- What is the usability of the Dem@Care technology in this context?
- Can the information from the Dem@Care sensor system support staff members reasoning when doing assessments status and evaluations of interventions among people with BPSD?
- Can support of people with BPSD be more effective with the support of the Dem@Care technology?

3.2 Setting

The evaluation of the first pilot to be tested will be conducted in a nursing home in Northern Sweden where the staff members are trained and familiar with using the NPI-NH instrument (Cummings & McPherson, 2001) in their daily work when assessing needs and evaluating care intervention for people with BPSD. This work approach is part of a national program for improving the quality of care of people with BPSD (**http://www.bpsd.se/**). The selected nursing home is a specialist care facility for people with dementia, where the residents live in their own one room apartment containing a sleeping and sitting area together with a bathroom.

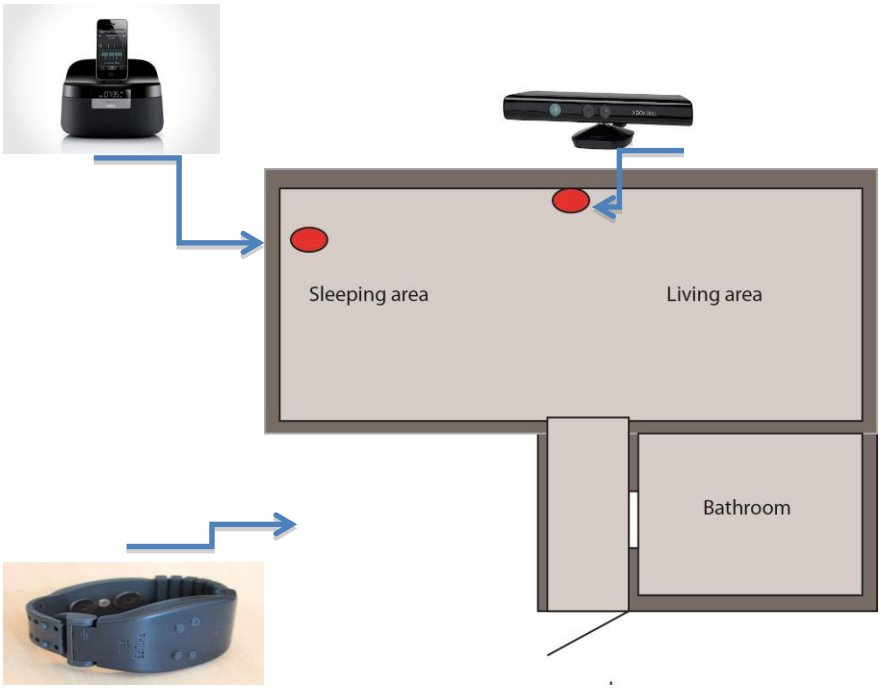

Figure 6: Sensors to be deployed in @Nursing home Pilot

In the first pilot we will test sensors that measures physical activity, anxiety, and stress as the Philips wearable sensor bracelet. The wearable Philips sensor will be carried during day time, also in the activities outside the apartment. There will also be a sleep sensor that can measure sleep patterns and a 3D camera measuring moments in the apartments (see figure 6). These sensors will be tested for usability, usefulness and acceptability. Usability will be tested against the domains of the NPI-NH instrument (see description of five functional areas, D2.2).

3.3 **Participants**

Four participants were recruited in May 2013 and they took part in some preliminary testing of usability and acceptability.

Par. #	Gender	Age	MMSE	Diagnosis	BPSD problems
A	M	92	NA	Alzheimer's Disease	Sleeping problems, difficult to wake up in the mornings, Anxiety often worried, Difficult with orientation
B	F	86	NA	Vascular dementia	Often awake during the nights, sleeps a lot during the days.
C	F	90	12/30	Vascular dementia	Often disturbed by other residents, worried in the afternoons, walks around a lot
D	F	93	N/A	Alzheimer's Disease	At time very agitated and worried, sleeping problems, wanders when worried.

3.4 Test of usability and usefulness

Only preliminary tests of the use of the sleep sensor were carried out with the participants during the first week of June 2013. The test had thereafter to be postponed until August due to scheduled holiday time for the staff, which made it difficult to carry out a structured evaluation. The preliminary data from the evaluation indicate that the sleep sensor worked well and was well accepted by all the participants. Since the sensor was tested independent of the Dem@care system there were some problems noted on handling the sensor equipment as remembering turning it on and off and of handling the application, which is related to the sensor.

The following issues were identified as a result of these preliminary tests:

- Sensor placement and general usability
    - As the device has to be placed at a maximum of 1.5 meters from the PwD, they are able to touch the device when they should not. In one case the PwD pulled the cable out and put it under their pillow.
    - The staff had to take the device away during the day and take it out and put it on the nightstand at night (to prevent the PwD from interfering with the device) with the consequence that they forget to take it from the closet at night.
    - Daytime sleep was not registered, which is a significant issue. There are several factors that made it hard to do this: (a) the PwD slept in the chair/sofa in the day room, and (b) the staff had to take the device away during the day and they did not have the time, or forgot, to take it out for naps during the day.
- Understanding of how the device should work
    - The nursing home staff had trouble understanding the manual even though a simplified version with relevant images has been included.
    - If something happened that was not exactly described in the manual, the staff often gave up and did not put the device on/off.
    - Before starting, the gender and age of the person should have been entered, but this was forgotten in one case.
    - A few of the staff felt comfortable with the device since they had a similar phone themselves and so they were not afraid to push the various buttons. However, there were a lot of other apps installed on one of the phones, which made it harder to know which was the correct app to use.
    - The app was also pretty complicated since it had many flaps (sv. Flikar) that were not of interest in the nursing home. If staff accidently pushed in the wrong place, they did not know how to get back to the correct place in the app. This has to be as simple as pressing a single button.
- Accuracy of Gear4 recordings

- The pilot was conducted with four people. In one case the staff forgot to put the device on for two of three nights. In two cases the data showed a pretty normal sleep pattern (a lot of light sleep and a little deep sleep), but how do we access that this is actually normal? Who will make this assessment? In terms of the 'Sleep Score', what norms are these data being compared to?
- In one case the PwD always slept until 10am and they were very hard to wake up before then. The registration showed that this person only had deep sleep after 7am.
- None of the test persons had sänggrindar, but if they had, would that have affected the registration?

3.5 System evaluation

For the final version of D8.3, we expect to have data both from an expert evaluation and a user evaluation. The evaluation will provide data from the perspective of experts, users, and staff members.

The evaluation is expected to provide data on acceptability of all sensors from the perspective of the users, the usefulness and usability of the system from the perspective of experts and staff members. From a technical perspective the following is of importance:

1) Reliability of data collection

2) Sensor accuracy

3) The usability of sensor data for assessing BPSD related problems.

4) Understandable, easy to use feedback to staff members.

4 @Home evaluation

4.1 @Home Evaluation Aims and Objectives

The @Home evaluation aims to assess the Dem@Care system in the private homes of individuals with mild to moderate stage dementia.

The specific research questions asked in the home are the following;

1. Is the system acceptable in the home, is it non-intrusive, and useful to the person with dementia and their family?
2. Are the functional requirements reflective of the reported needs of the person with dementia, as personally reported and reported by caregivers?
3. What is the functional status of the person with dementia as operationalised in the five domains, and can the system optimise status in these areas?
4. How autonomous and independent is the person with dementia, and can deployment of the system support this autonomy?

4.2 Recruitment

Participants were identified through the MemoryWorks clinic at DCU and through the Alzheimer Café, Glasnevin, Co Dublin. Participants were first contacted by someone they knew from the clinic or café, and then by the Dem@Care researcher, to introduce the project and make arrangements for a preliminary interview if accepted. Initially, five dyads were interviewed, and two agreed to continue as lead users. Dyad 3 were initially interested in being involved but the patient took an unexpected downturn, and dyad 4 felt that they were too technophobic to be involved in the research, although they did express a wish to be involved in future, non-technological, research. Dyad 5 felt that the research would be overwhelming for the individual with dementia, as her memory loss impacts on her functioning quite significantly. Both lead participants live at home independently, and have received a diagnosis of Alzheimer's disease with dementia of the Alzheimer type. The qualitative results from preliminary and assessment interviews are presented below. Pseudonyms are used throughout.

4.3 Preliminary Interviews

The home-based pilot evaluation results take the form of semi-structured interview data. These were preliminary interviews at the point of recruitment, which gathered some initial feedback on the Dem@Care system. Second interviews were conducted exploring the impact that the Dem@Care system may have on autonomy and independence, and specific feedback on initial screenshots and hardware from the Dem@Care system. Five caregiver-care recipient dyad interviews were conducted from February – March 2013, following the preliminary interview schedule (see Appendix A.1).

4.3.1 Dyad 1: Michael and Patricia

Michael lives alone in Dublin city centre, in the family home. His wife is alive but has sufficient physical limitations to have been moved to a local nursing home. Michael has seven children, all of whom visit regularly. Michael's primary caregiver is his daughter Patricia, who also lives in Dublin and has two children. Michael is very active and independent, attends day centres locally, and has care assistants visit his home 4 days a week. He receives Meals on Wheels also.

4.3.2 Dyad 2: Catriona and Seán

Catriona and Seán are married and live with Seán's mother in their own home outside Dublin. They have two dogs. Seán was a carpenter and Catriona still works 4 days a week in administration. Seán is just post-diagnosis, and has taken part previously in research with the DCU team, using the SenseCam technology to explore lifelogging. Seán is active and independent and has comorbid epilepsy, which is being successfully managed pharmaceutically.

4.3.3 Dyad 3: Stella and Paul

Stella and Paul live in North County Dublin in their own home in a rural setting. Stella is a former nurse, and Paul is a former engineer. Stella was diagnosed with Alzheimer's disease 6 years ago and has moderate dementia. Her communicative and social skills are preserved, although her short-term memory, executive functioning, episodic memory and orientation are all problematic. Stella and Paul receive support from a care assistant who visits 3 days a week, and their children who live abroad. Stella displays some significant agitation and sundowning. Paul is in good health but has poor sleep quality manifesting as short sleep duration and impaired sleep maintenance.

4.3.4 Dyad 4: Michelle and Jack

Michelle and Jack live in North County Dublin in their own home. Michelle is a former nurse, and Jack is a former civil servant. Both are retired. Michelle received her diagnosis 2 years ago and has very mild dementia, with little progression since diagnosis. She has a neurological history also, with a brain tumour excision in 1997 and resulting auditory damage in her left side. They have 4 children (2 live in America), 7 grandchildren, and a dog. Jack has a recent diagnosis of Parkinson's disease, which is being successfully managed.

4.3.5 Dyad 5: Aisling and Peter

Aisling and Peter live in North County Dublin in their own home beside Dublin City University. They have two children who are in the Dublin area, as well as two grandchildren who visit regularly. Both are retired. Aisling also has celiac disease which Peter helps her to manage. Aisling lacks insight about her dementia and has significant episodic and short-term memory failure, evident in her communication.

4.4 Preliminary System Acceptability

Preliminary recruitment interview protocol included items concerning the acceptability of the proposed system. These items were:

1) Do you currently use technologies to help in these (the 5 domains) areas? Would you consider doing so?
2) Following the technical presentation depicting the sensors available to support in these areas, participants were asked – "Do you think these sensors would be useful? Would you accept them in your home?"
3) Are wearable sensors acceptable?

4.4.1 Current attitudes towards technology & openness to using new technologies

Dyad 1: Michael described himself as being allergic to computers, and unlikely even to use mobile phones, as he thinks they encourage rude behaviour such as talking or texting while someone else is in the room. Patricia is a comfortable user of technologies, computers and mobiles and mobile technology, and is interested in what the study can do – she had recently seen a documentary about technology and healthcare and was very interested in getting her dad involved in the project. Michael is open to trying something new as long as it doesn't stress him too much.

Dyad 2: Catriona and Seán have previously been involved in using the SenseCam sensors for other DCU-based research projects, and are comfortable and interested in technology. Catriona uses computers daily in her work. Both Catriona and Seán have an open and exploratory attitude towards technologies, and are willing to try anything to see if it will help their circumstances.

Dyad 3: Paul is a former engineer and very interested in the potentials for sensor technology to help in dementia care. He admits he cannot get to grips with mobile technologies, although he has a high-spec laptop and uses the Internet frequently. He is not currently using technologies to help manage Stella's symptoms, but he has in the past thought about using commercially-available monitoring equipment to monitor her functioning and speech, with a view to later comparison to assess decline. He is really interested in the idea of an intelligent system automatically detecting and interpreting questions that Stella asks, and responding to them, and in the related concept of a system analysing Stella's level of agitation from her voice and offering a task to suit her in response. Stella is quite technophobic but happy to try things if Paul thinks they are a good idea. She is comfortable using the telephone and television, and kitchen appliances.

Dyad 4: Michelle does not currently use the telephone at all because she has hearing loss on her left side following an acoustic neuroma 16 years ago. She abhors computers – they used to have one in the home but got rid of it as they never used it. Jack is open to learning but Michelle fears that it stresses her out too much to learn new things, although she did previously complete an ECDL (European Computing Driver's License). Michelle does love using the television and has it on almost continually in the home. Disruptions throw her out quite a lot so she also stipulates that any system would have to be a quiet one, which didn't interrupt her during the day.

Dyad 5: Peter uses a PC regularly, but Aisling hates computers. She is happy to use the house phone, but will not use a mobile phone. Peter says he finds it difficult to imagine how technology could help them since he already does everything for Aisling himself. He feels that while Aisling is totally dependent on him, he can manage the household himself and feels strongly that they need no external help. Both Jack and Aisling admitted that they were finding it very difficult to conceptualise the system without being shown its components.

4.4.2 Usefulness and acceptability of the ambient sensors

Dyad 1: Michael found it quite difficult to understand the concept of the sensors without first seeing the units. Patricia was very positive about their use as long as they didn't incur extra hassle or work for her father or for the carers.

Dyad 2: Catriona and Seán found the SenseCam acceptable and very useful, as it improved Seán's quality of life and enabled daily review, so they are happy to accept ambient sensors into their home, although Seán's mother and the two dogs are there also, and they expressed concern that this might impact on sensor use.

Dyad 3: Paul and Stella were comfortable with the idea of ambient sensors, particularly the sleep related sensors. They note that it is impossible to give meaningful feedback until they have used the sensors for a while.

Dyad 4: Michelle notes that she gets very disoriented during the night in the house because it is dark, and that automatic lighting would help her quite a lot.

Dyad 5: Peter feels that using ambient sensors in the home would be pointless, since Aisling no longer does any chores around the house. Peter's primary concern was that he would not want any interruptions from the technology during the day.

4.4.3 Usefulness and acceptability of the wearable sensors

Dyad 1: Not discussed – it was difficult for Michael to understand the concept of sensors so we did not introduce the further concept of wearable sensors.

Dyad 2: Seán has previously used SenseCam technology and is comfortable with wearable sensors.

Dyad 3: Wearable sensors such as the DTI were deemed to be acceptable, but Paul questioned their comfort at night and whether they could be removed then. The WIMU appeared less acceptable as it would not be fiddleproof and may confused Stella – Paul refers to a time when Stella wore a 24 hour blood pressure monitor and kept taking it off and forgetting to put it back on – he would be concerned that this would happen again with the Dem@Care wearable sensors.

Dyad 4: Michelle was happy to consider using wearable sensors, but felt that she wouldn't be able to comment further until she had seen the units.

Dyad 5: Peter feels that Aisling would fiddle with the wearable sensors, and would not want to keep them on.

4.5 @Home Pilot Deployment – DCU Apartment

4.5.1 Aims and objectives

We have conducted a pilot evaluation of the Dem@Care system with five student volunteers in the DCU community apartment. The aims of this pilot evaluation are to explore the following:

1. System Installation: investigate the technical and practical issues related to the installation of the prototype system in a home environment.
2. System and Sensor Data: Explore the output of individual sensors and investigate the potential for integrated data capture to recognise and analyse relevant tasks in a home setting.
3. User Tasks: Evaluate the protocol and tasks that we have designed for our two lead @Home users to undertake (outlined in the interim version of D8.3) and explore any issues related to the comfort and interaction with Dem@Care sensors from the user's perspective.

The results and analysis from this community apartment installation and pilot evaluation will allow us to troubleshoot system issues and refine user tasks before deploying to lead users homes. We will then deploy full sensor toolboxes in the homes of the two @Home lead users.

4.5.2 System installation in the community apartment

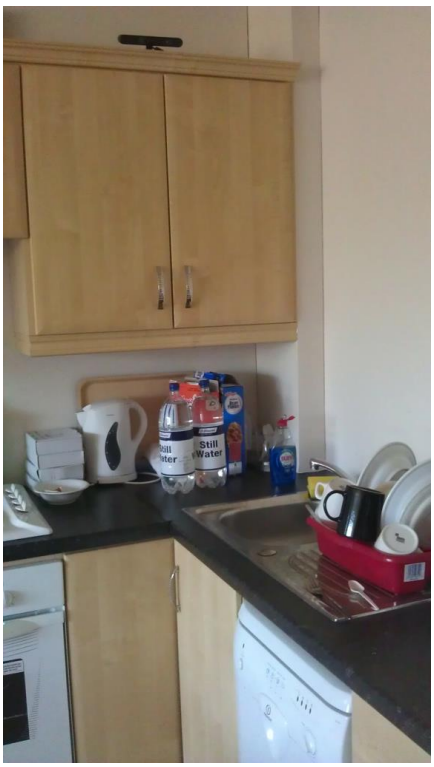

Figure 7: The Dem@Care system was installed in the community apartment in DCU in July 2013.

The following sensors were evaluated as part of the prototype system available at the time of the pilot evaluation:

- Go-Pro Camera
- Microphone
- DTI-2
- WIMU
- GEAR 4 Sleep Sensor

4.5.2.1 Planned system

It was originally planned that the initial @Home pilot, taking place in the Community Flat, DCU School of Nursing, would contain the following hardware and software components.

Components	Sensor
CAR	Asus Xtion
ORWC	GoPro
RRWC	GoPro
DTI2-SW	DTI2
OSA	Microphone
HAR	Kinect
WIMU-Analytics	WIMU
Gear 4	Gear4 + Iphone
SI	N/A
Technician Interface	N/A
WP6 Backend	N/A

Table 5 Proposed components for @Home Pilot

All equipment for this level of deployment has been purchased, and will be available for use in subsequent deployments.

4.5.2.2 Deployed system

Due to some issues in the configuration of the system not all hardware and software components were available for the deployment. The table below gives a list of the hardware actually used in the data collection period. The next section (Deviations) describes the issues that were encountered and efforts made to overcome them.

Components	Sensor
ORWC	GoPro
RRWC	GoPro
DTI2-SW	DTI2
OSA	Microphone
HAR	Kinect
WIMU-Analytics	WIMU
Gear 4	Gear4 + Iphone

Table 6 Actual components installed in @Home Pilot

4.5.2.3 Deviations from plan

1) WIMU

Data was not collected from the WIMU devices due to a power supply failure in one of them. Initial investigation suggests that the battery had reached the end of its life and was no longer able to hold a sufficient charge to power the device. The software for collecting WIMU data requires that three devices are transmitting simultaneously. If three devices cannot be detected, the software raises an alert and will not collect data.

Furthermore, the algorithms for body posture, etc, require data from three points on the body (lower leg, upper leg, and chest), so data collected from two devices would not have been valid.

The WIMUs were used in the pilot evaluation, in a non-functional state, since we could still determine information about wearability comfort and intrusiveness.

2) Asus Xtion; CAR / HAR

This system requires a separate computer running Linux, and the installation and configuration of a number of 3rd-party software libraries. Instructions for the installation were provided by INRIA / LCS. The installation consistently failed when testing the software provided by CAR, despite the fact that all previous stages had completed successfully.

Investigation of this problem is ongoing while this document is being prepared, so the root cause of the failure is not yet identified.

3) Technician's interface

The technician's interface was not used in the deployment as it was not available until a close to the scheduled start of the pilot. Since system control could be administered through the web service interface (using SOAP), this method was continued, rather than introduce a new aspect to the system evaluation. Furthermore, at this point, priority was begin given to the attempts to integrate the Asus camera to the system.

4.5.3 **Participants**

Five participants took part in the pilot evaluation in the community apartment in DCU (1 female, 4 male) between the ages of 19 and 22 (Average age: 20). All participants were PhD or intern students in the CLARITY centre or School of Nursing at DCU. While students and interns were involved in research related to sensor technology they were not familiar with the sensors under evaluation.

4.5.4 **Procedure**

As part of informed consent, participants were provided with information on the aims and objectives of the evaluation and related background to the Dem@Care project. Participants were also informed that we were interested in data related to the sensors only and their ability to complete tasks or cognitive function were not under evaluation.

Participants were introduced to each sensor that was included in the pilot evaluation by describing the purpose of the device and the type of data that it would capture.

Participants were asked to wear the GoPro Camera, Microphone, and DTI-2 bracelet for the duration of the evaluation. The GoPro Camera and Microphone were both attached to a jacket. For walking tasks participants also wore three WIMU sensors; one across their chest and two on one of their legs above and below the knee.

4.5.4.1 Directed daily living tasks

Participants were asked to complete the tasks outlined in table x in the community apartment. Tasks were designed to evaluate the Dem@care system's capacity to process and recognise the recorded tasks in the community apartment environment. Participants were requested to complete tasks in any order or timing that they wished to create a natural and more realistic home setting to test the Dem@Care system.

Directed Daily Living Tasks
Can you complete each activity in your own time and in any order that you wish:
Phone
Make a phone call to the following number (researcher's office number) and leave a message?
TV
Turn on the television and play a DVD?
Make a Snack
Can you make a cup of tea and have a biscuit?
Can you wash up your cup after your tea?
CD/Radio
Can you put on a CD and play track 9?
Can you tune the radio to RTE radio 1? (FM 88-90)
Sitting and Reading
Can you find the "PASTA" cookbook on the shelf?
Can you sit on the couch and read the recipe for "Porcini mushroom and walnut penne"?
Please feel free to ask any questions or voice your thoughts as you complete each activity.

Table 7: Directed Daily Living Tasks

4.5.4.2 Social interaction

There were no explicit tasks for social interaction for this pilot evaluation. However participants were encouraged to speak and ask questions while they were conducting daily living tasks in order to explore if the processed data from the Microphone can be used to investigate participant's levels of social interaction.

4.5.4.3 Physical directed tasks

In addition to the GoPro camera, microphone and DTI-2 sensors participants were asked to wear three WIMU sensors for the physical directed tasks. Two WIMU sensors were placed on one leg, one above and below the knee and one WIMU sensor was strapped around participants' torso. These physical tasks are replicated from the @lab setting (presented in table x).

Directed Physical Tasks	
S1_P1.1. Walking (mono task)	- Can you please walk across the room from this first point [marked with tape], and turn at the second point [piece of tape] then walk back to the first point? (total walking distance: 8m)
S1_P1.2. Counting backwards (mono task)	- Standing where you are can you count aloud backwards from 305 to 285? [or from 20 to 0 if they make counting mistakes after 2 attempts of the previous backwards counting]
S1_P1.3. Walking and Counting backwards (dual task)	Can you walk and count aloud backwards at the same time from 305 until the end of the walking task? [or from 20 to 0 for participants who are unable to count backwards from 305 to 285 during S1_P1.2]

Table 8: @lab Protocol for physical directed tasks (Source D8.2)

4.5.4.4 Sleep sensor user interaction and usability evaluation

At the time of pilot testing, the Gear 4 sleep sensor was the only sensor in the Dem@Care prototype system that had a user interface. We conducted a short usability evaluation on the device to explore if there were any significant issues of usability or learnability of the device. This was also a worthwhile opportunity to pilot our protocol for introducing new users to the device and demonstrating the main functions and features.

Sleep Sensor Tasks
The GEAR4 SleepClock monitors your movements while you sleep. The GEAR4 application tracks daily, weekly, monthly, and yearly sleep averages, providing you with information such as the number of hours you spent in bed, how many times you were interrupted when sleeping, and the time you took to fall asleep, plus the amount of time you spent in a deep sleep. Before you try out the sleep clock I will show you how to use the main features. **Demonstrate to user:** • How to set the alarm • How to send a reminder of when to go to sleep

• How to explore previous sleep stats • How to set the device before you sleep • How to stop the device when you wake up **User Tasks:** *As you use the application, can you explain what you are doing during each task? Please try to voice your thoughts if you encounter anything that surprises you or that you find easy or difficult during the tasks.* • Can you set the alarm for between 7 and 7.20am tomorrow morning? • Can you find an overview of your sleep patterns over the past year? • Can you send a reminder to go to sleep for 10pm tonight? *Imagine that it is the end of day and time to go to sleep for the night.* • Can you press the go to sleep button? [Wait 1 minute] *Imagine that it is now morning.* • Can you press the wake up button?

Table 9: Sleep Sensor Tasks

4.5.4.5 Post-task questions

Participants were asked open-ended questions on how they found wearing or interacting with each of the sensors. Participants were also asked to complete a system usability survey (SUS) for the GEAR 4 sleep sensor application.

4.5.5 Evaluation and usability results

4.5.5.1 User perspective

We fully acknowledge that the student volunteers participating in the pilot evaluation did not have any cognitive impairment or age related sensory or physical impairments, which are relevant to our @Home lead users. Furthermore all participants reported owning and being very familiar with touch screen devices, which will not be the case with our lead users. As the Dem@Care system at the time of testing did not have a user interface we were limited in how much user interaction data that we could collect.

In spite of these differences between user groups and lack of user interface it was considered a worthwhile opportunity to explore the perceived comfort of the sensors in the prototype system. It was also an opportunity to run a short usability evaluation on the GEAR 4 sleep sensor application to check that the interface did not have any obvious usability issues before introducing the interface to our end users.

In terms of IADL and physical activity tasks we were not interested in any clinical observation or analysis and the ability of participants to complete tasks was not part of the evaluation. Our main aim in the experimental design of the pilot was to evaluate the kind of data we could achieve from individual sensors and the Dem@Care prototype. We were therefore not interested in the task completion times or success for the IADL tasks or the

physical walking tasks. We were however interested in gathering qualitative data on participants general observations and perceptions of wearing the sensors for the duration of the evaluation.

4.5.5.2 Post-task user feedback on sensors

Go-Pro Camera

While participants did not find the camera obtrusive to wear, three participants reported that they were not sure if the device was capturing their hands especially when they were seated. One participant reported that he was aware of the camera for the duration of the evaluation.

Microphone

Four participants reported that the microphone was fine to wear and did not notice it for the duration of the experiment. One participant felt that the accompanying box (containing the wireless radio transmitter) was bulky.

DTI-2

Figure 8: DTI-2 sensor was difficult to fit to smaller wrists

Three participants reported that they did not notice wearing the DTI-2 sensor after it was fitted at the beginning of the evaluation. One participant had smaller wrists and had difficulty fitting the device as it was too big; it was necessary to pad the side of the device so that it was in contact with her wrist. Another participant commented that he found the device made his wrist hot and his skin sweat

WIMU Sensors

Four out of the five participants commented on the comfort and fit of the WIMU sensors. 3 participants felt that the straps were not secure and that the sensors might move during the walking task. One participant commented that they were obtrusive to wear during the task.

Figure 9. Screenshot from GoPro Camera illustrating the straps used to affix the WIMU sensors to leg and torso.

4.5.5.3 Usability evaluation of the GEAR4 sleep sensor

Users were able to complete all tasks with the Gear 4 sleep sensor and after a short introduction and demo of the GEAR 4 app and did not report any difficulties using the interface as they carried out the tasks.

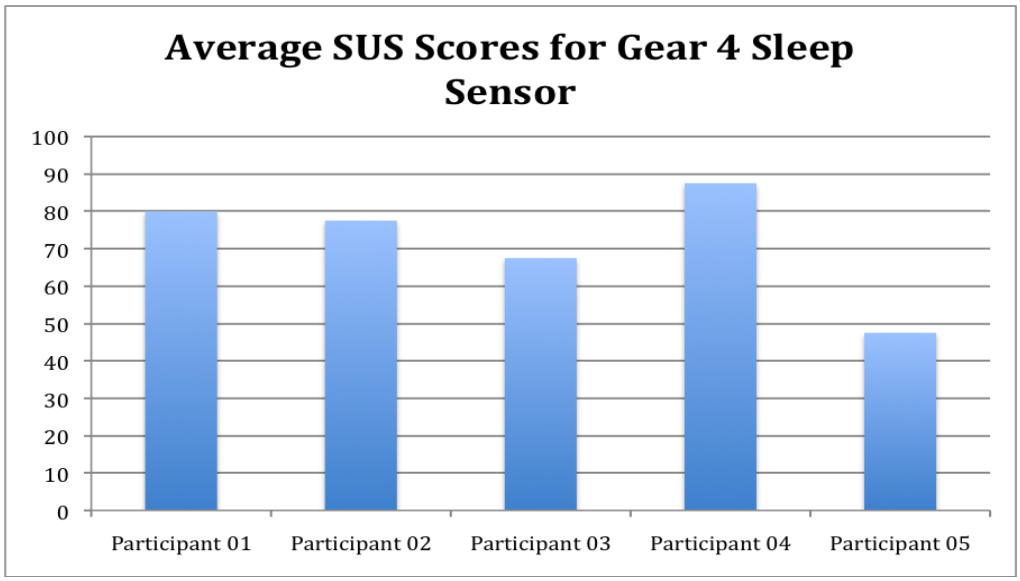

Figure 10: Average SUS Scores for Gear 4 Sleep Sensor

All users completed the system usability scale questionnaire (Brookes, 1996; Appendix A3). The average SUS scores for participants were quite high (Average: 72; Standard Deviation: 15). Participant 5 rated the system with a lower SUS score of 47. In response to an open ended question on the device he explained that he felt that the application controlling the sensor seemed unnecessarily technical and that an average user may not need all of the statistics on sleep that are available.

Figure 11 Gear4 Sensor set up in DCU Community Apartment

Participant 2 also stated that the application was a little complex and that it may take time to explore software as it is not too intuitive but he felt that after a demonstration it could be easily learned. The remaining participants found the GEAR 4 application interface easy to use and Participant 4 described it as fun to use.

4.5.6 @Home sensor data analysis and results

While we have access to data from individual sensors we have not yet conducted integrated analysis using the system. In the following section we outline the data that we have obtained from the pilot from each sensor and also the analysis that we plan to conduct using the Dem@Care system. Progress is currently underway to be able to use the Dem@Care system to integrate sensor data and enable more in depth analysis.

4.5.6.1 DTI-2

While we do not have an analysis of the DTI-2 data output there are a number of areas that we would like to explore from the pilot data when this is possible.

- Is output easily processed and compared for each measured area: movement, skin response, temperature and light?
- Can periods of rest be detected? And if so to what granularity movement vs. no movement or standing vs. sitting?
- Was there any noticeable change in skin conductance for different tasks. For example can we detect higher stress levels for participants during physically directed tasks as opposed to the IADL tasks? From observation participants did not seem as relaxed during the physically directed tasks so we are interested to explore whether this is apparent from the DTI-2 data.

4.5.6.2 Microphone

We have yet to process the voice recordings from the @home pilot trials using the Dem@Care system, however we have outlined the following issues for analysis. The @home pilot protocol was designed so that participants were asked to initiate conversation with the researchers during tasks. Some participants were more talkative than others and initiated more conversations. Firstly we plan to annotate the pre-processed wav recordings and to explore which participants initiated the most conversations. Following the processing stage we would like to explore if it possible to recognize patterns of speech over time or compare communication levels between audio samples for different participants?

Also we would like to investigate the processed audio to ascertain:

- Can other voices be distinguished from the person wearing the mic?
- Is there any distortion of voice with background noise such as radio, tv or music?

4.5.6.3 GoPro Camera

Figure 12 Screenshots from GroPro Camera; Participant making a phone call, participant changing a CD, participant making tea, participant washing up after tea

The above images are screenshots from recordings of participants using the GoPro camera and they illustrate that activities can be easily recognised using this device. Conducting the pilot evaluation has highlighted the importance of positioning the camera in an optimum position to capture tasks. Users expressed concern that the view was obscured when they were seated during the reading task. From the camera recordings this was the case for some users as when they sat sown the material of the jacket occluded the lens of the camera (see figure 13).

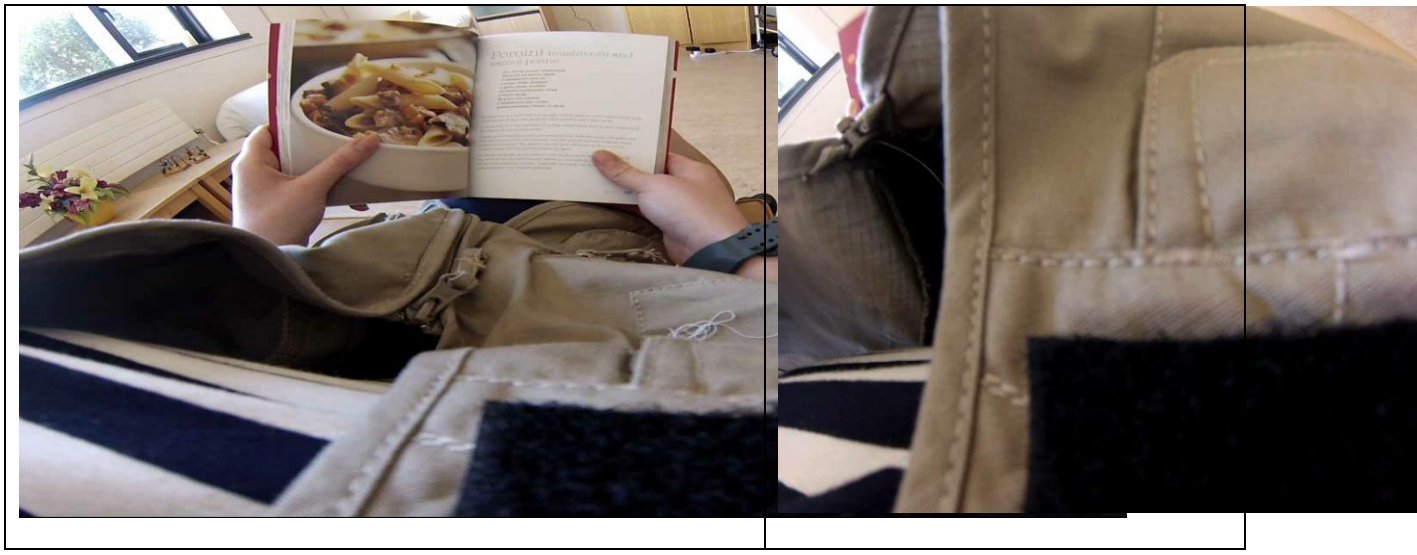

Figure 13 Participant reading; Camera lens occluded by jacket

4.5.6.4 WIMU Sensors

No data was collected from WIMU sensors in this pilot due to hardware failure. Users did give us feedback on the comfort of wearing these sensors. From user sensors should be affixed using elasticised straps to allow easier fitting ensure that they are more securely attached.

WIMU data will provide fine grained information about the movement of distinct body parts, which allows the WIMU software to identify particular types of motion such as standing, sitting, lying, etc. The WIMU software systems have algorithms that will show periods of activity and non-activity. We intend to compare this with the corresponding output from DTI-2 sensor. The WIMU sensors may provide information on particular movements or actions that would not be detected by DTI-2 due to its lower granularity. The DTI-2 data can be used to provide much longer periods of measurement than WIMU.

4.5.6.5 Gear 4 Sleep sensor

While users interacted with the Gear 4 sleep application interface it was not possible to obtain real sleep data due to the nature of the pilot evaluation with student participants. However the feedback regarding the usability of the application is useful to inform deployment to our lead users. Generally participants found the Gear 4 application on the iPad easy to learn and use following a demo and simple instructions. We are aware that these usability results may not necessarily transfer to our lead users due to differences in technical experience and cognitive impairments.

It is expected that actigraphy data from the DTI-2 wrist sensor will be correlated with Gear4 data. This will enable us to explore measurements from a clinical perspective; for example, to enable us to examine relationships between a participant's mobility and exercise and their sleep.

4.5.7 Conclusion

The data that collected from the evaluation in the community apartment has provided valuable insights into the installation and use of the Dem@Care system from both technical and user perspectives. An important issue that needs to be addressed before deploying is to make sure that any device that is deployed with our users can be fully understood and controlled by them. Further integrated analysis from this pilot test is currently in progress and will continue to inform the upcoming installation in the homes of our 2 lead users in Dublin.

4.6 @Home Pilot Deployment – Lead Users

4.6.1 Lead user requirements based on Assessment Interviews

Tables 10 and 11 give an overview of the activities and interests and areas that require support for the @Home lead users. These are based on functional assessment interviews conducted with lead users in June 2013. Full details of the assessment procedure and results for each lead user will be presented in more detail in D2.6.

@Home Lead User 1 Michael	
Michael is in his 80s and lives alone in Dublin city centre. Michael has seven children and a number of grandchildren, all of whom visit regularly. Michael's primary caregiver is his daughter Patricia, who also lives in Dublin and has two children. He attends day centres locally, and has care assistants visit his home 4 days a week. Michael receives Meals on Wheels every day.	
Activities and Interests	
Michael is active and independent and enjoys spending time with his family, listening to sport on the radio, going out to socialize.	
Requirements	
Sleep: Michael and his daughter have expressed interest in having support for sleep. They previously tried an under mattress bed sensor but did not find it useful as it raised so many alerts they felt that it was malfunctioning. *Daily living Tasks*: Michael and his daughter have expressed interest in having support in daily living tasks. Michael does not cook as he receives meals on wheels	

but is able to prepare hot drinks and snacks. He has described recently having difficulty operating his landline telephone. *Physical Activity and Exercise:* Michael would like support in the area of physical activity

Table 10: @Home Lead User 1, Interests and Requirements

@Home Lead User 2 Seán	
Seán is aged 58 and lives with his wife Catriona and with Seán's mother in their own home outside Dublin. They have two dogs. Seán was a carpenter Seán has recently received his dementia diagnosis and has comorbid epilepsy, which is being successfully managed pharmaceutically.	
Activities and Interests	
Seán is active and independent and enjoys walking his dogs, gardening, fishing, listening to music.	
Requirements	
Sleep: Both Seán and his spouse Catriona have trouble with sleep and would both like support in this area. *Daily living Tasks*: While Seán is very competent at daily chores such as cooking and cleaning, Catriona expressed concern that he was not listening to music any longer as he seems to have trouble operating the CD/DVD player. *Social Interactions*: Seán did not show any issues with social interaction in the assessment interviews but it is an area that he and Catriona have expressed an interest *Physical Activity and Exercise:* Seán is generally very active but would like to improve his fitness	

Table 11: @Home Lead User 2, Interests and Requirements

4.6.2 **Lead User Sensor Toolboxes**

We have devised a protocol for data collection using the sensors in each functional requirement area. While both lead users will use most of the same sensors there will be some personalisation to fit the tasks and capture data according to their individual requirements.

Sleep

For both lead users the Gear4 Sleep sensor will be installed beside their bed for the duration of the evaluation, as illustrated in the image below.

Figure 14 Gear4 Sensor set up in DCU Community Apartment

Daily living Tasks.

We propose using the GoPro camera to explore the kinds of tasks that both lead users are beginning to have difficult with. In addition we plan to install the ASUS Xtion sensor in the kitchen/living room area of both lead users. The GoPro camera is not suitable to be managed by lead users as it needs to be charged every 3 hours and the video needs to be downloaded regularly. We therefore propose that this camera would only be worn for short periods of time in the presence of the caregiver and the researcher will visit to recharge batteries and download video.

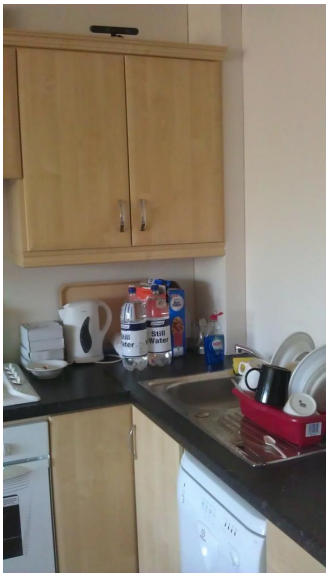

Figure 15 Left: Asus Xtion Sensor installed in Community Apartment at DCU; Right: View from Asus Xtion Sensor in Community apartment

For Michael this will entail wearing the GoPro camera when his daughter is visiting for approximately 30 minutes and conducting a series of tasks that he regularly undertakes such as making tea, making a phone call, listening to the radio. Michael has highlighted that he has had issues operating his landline phone we could try to create similar instructions or prompts in the same way and explore how this task changes for him over time.

Figure 16 Go Pro Camera and jacket

Seán will wear the GoPro to conduct regular tasks such as preparing a meal, making a phone call and operating the CD player. As Seán's spouse Catriona has highlighted that operating the CD player has become difficult for Seán this would be a helpful task to explore with the sensors. In order to help Seán complete this task we will create simple operation instructions. As this version of the Dem@Care system does not provide feedback, these instructions will be implemented as paper prototypes which could later be incorporated into more advanced versions of the user interface. An important consideration in preparing any instructions for Seán is that he has some difficulties with literacy.

Social Interactions

In order to monitor and support Seán's levels of communication and interaction we propose that he wear the Dem@Care microphone for short but regular periods of time. As this will require attaching the microphone we propose that Seán wear this at the same time as the Go Pro camera during the daily living tasks so that we embed both microphone and camera into the same jacket. While Seán is conducting these daily living tasks this will be a good time to monitor his communication and patterns of interaction.

Physical Activity and Exercise:

As the WIMU sensors may be cumbersome to wear for long periods due to their size and fit we propose following a protocol to assess walking movements for a short period of time in the presence of a researcher. We will follow the @lab protocol for physical directed tasks (presented in table 12). In addition to the WIMU sensors, the DTI-2 sensor will be worn by participants for this task. While dementia diagnosis is not an objective or focus of the @Home setting, we plan to conduct a cognitive assessment on lead participants so that we can validate protocols related to the @lab setting. For this purpose, we will run the Montreal Cognitive Assessment (MoCA) with lead users (see appendix A.2).

Figure 17 Left: Participant wearing WIMU sensors around her waist on her leg with DTI-2 sensor on her wrist (Source, Dem@care, 2013); Right Philips DTI-2 sensor

@Lab PHYSICAL DIRECTED TASKS	
S1_P1.1. **Walking** **(mono task)**	- *The as*sessor asks the participant to walk 4 meters across the room, to turn and then to come back (total walking distance: 8m)
S1_P1.2. **Counting backwards** **(mono task)**	- *The participant is standing and t*he assessor asks *him/her* to count aloud backwards*:* -> From 305 to 285 (to change tens and hundreds) one by one; or -> From 20 to 0 if they make counting mistakes after 2 attempts of the previous backwards counting.
S1_P1.3. **Walking and Counting backwards** **(dual task)**	- The assessor asks the participant to walk and count *aloud backwards simultaneously:* -> From 305 until the end of the walking tasks; or -> From 20 to 0 for participants who don't manage to count backwards from 305 to 285 during S1_P1.2

Table 12: @Lab Protocol for physical directed tasks (Source D8.2)

Directed Daily Living Task

During the same weekly visit the researcher will also ask the lead users to undertake a number of short daily living tasks. While some of these tasks will already have been undertaken with the caregiver it will be useful to run them again with a researcher to make sure we are getting full data capture from all of the sensors. For these tasks participants will be asked to wear the GoPro Camera, Mic, DTI-2 bracelet within the viewport region of the ASUS Xtion.

Participants will be asked if they can complete the following tasks in their own time:

1. Can you make a phone call to the following number and leave a message (researcher's mobile)?
2. Can you turn on the television/radio to see what programme is on?
3. Can you make a cup of tea?

Ambient/Constant Sensors
The following sensors will be installed constantly in lead user's homes. • Gear 4 Sleep Sensor –Installed in lead users' bedroom • Asus Xtion – Installed in kitchen/living room area • DTI-2 – While this is a wearable rather than ambient sensor we will ask participants to wear it as often as possible
Activities in the Company of Caregiver
Lead users will be asked to regularly perform certain tasks in the company of their spouse or caregiver (using CD player/radio, preparing a meal, preparing a meal) • GoPro Camera • Mic (Seán will wear the mic to explore social interaction) • DTI-2 Sensor • Asus Xtion
Directed Tasks with DCU researcher (adapted from Nice protocol)
Every week a DCU researcher will visit lead participants and ask them to complete physically directed tasks using the @lab protocol (Presented in Table 5). For this task participants will be monitored by the following sensors: • DTI-2 Sensor • WIMU sensors

- Asus Xtion

During the visit the researcher will also ask both lead users to complete a number of daily living tasks (using the phone, turning on the TV and making a cup of tea). For these tasks participants will be monitored by the following sensors:

- GoPro Camera
- Microphone (Seán will wear the microphone to explore social interaction)
- DTI Sensor
- Asus Xtion

Table 13: Overview of @Home Sensor Data Capture

4.6.3 Potential Issues with Lead Users for current Dem@Care Prototype

1. Michael is not familiar with technology and has never used any touch screen devices so there may be accessibility issues interacting with the SleepClock Application on the iPad/iPod device.
2. Michael wears a panic button on his wrist so we need to ensure he has no confusion between devices when wearing the Philips DTI sensor.
3. Seán has literacy difficulties, which may impact his ability to interact with written feedback.
4. While privacy is a crucial issue for all sensors and lead users it is also important that other members of the house can maintain privacy. This is of significant importance to Seán and Catriona as they share their living space with Seán's mother.

4.7 @Home Microsoft Kinect Sensor Installation – DCU apartment

The Microsoft Kinect sensor and accompanying HAR (human activity recognition) software was installed in the DCU community apartment by CERTH at the end of October 2013 (29/10 & 30/10). Two days of system testing were carried out to resolve any software issues that arose during the installation process, and to demonstrate the software use. Video samples were recorded and used to check validity of action descriptors, and ground-truth and annotation issues. As a result of this testing, some additional system functionality was created by CERTH.

1. Motion detection: the system now recognises when no-one is within sensor range. This causes the video recording to stop. It automatically restarts when a person comes back into view.
2. Automatically begins processing of the information recorded during the day at midnight. This allows the system to be deployed without the need for monitoring by caregivers.

3. Parallel processing to allow background data process and video recording to occur at the same time. This is important given the length of time that the background data processing takes.

Analysis from community apartment installation and subsequent evaluations will be used to pilot system and output before deploying to lead users homes.

5 System Evaluation

While each site is at a very different stage of data collection and analysis at the time of this interim reporting, we have identified issues and research questions related to the evaluation of the Dem@Care system that are relevant to all sites and will emerge as we analyse sensor data and the prototype develops.

5.1 Data

5.1.1 Collecting and Processing Data

- What is the process to adapt raw data to meaningful clinical information for each sensor?
- How could this adaptation process be improved to give more meaningful clinical feedback?
- Issues of privacy and anonymity for audio and video outputs and annotations. Users and clinicians need to be aware of the level that the data is stored in the system. If there is no real-time processing of sensor outputs for privacy, a procedure should be created so that data can be processed automatically without being viewed by a human operator.
- Ease of collection of data from each sensor. In @Nursing home and @Home settings the person that is retrieving data from sensors or the system may not be a technician and should give feedback to developers on any interaction or usability issues they encounter.

5.1.2 Combining Data from Sensors

- For analysis purposes it will be important to create ways of synchronising and presenting raw data from different sensors for comparison
- It is important to ensure that all devices are calibrated so that clinicians (and developers and technicians) can easily compare data from different sensors at the same point in time.

5.2 Participant Interactions and Preferences

Participant interaction and preferences are particularly important for @Home and @Nursing Home pilots where some data will be dependent on whether the participant or their spouse can operate or want to interact with the sensors. For example in this version of the Dem@Care prototype, the Gear4 sleep sensor requires user interaction. If the user is unable or does not want to use the interface we will not be able to collect data with this sensor. We can initially try to provide training for the participant but we may need to devise a method of automating the controls or using a different sensor or interface for this functional area.

5.2.1 Acceptability of sensors and overall system for Participants:

As the Dem@Care system will be developed using an iterative, user centred design approach it is crucial that feedback from users in relation to privacy and preference is carefully considered, as this will determine the overall acceptability and effectiveness of the system.

5.2.2 Usability of sensors and overall system for Participants

Usability issues such as ease of learning, ease of use and comfort of sensor devices and systems will have an impact on users perceptions of acceptability of the Dem@Care system.

5.2.3 Accessibility of sensors and overall system for Participants

While some participants with dementia involved in the project will have an early onset diagnosis, the majority of users will be over the age of 65. In addition to accessibility issues related to cognition, participant interactions should be inclusively designed to address age related declines in physical capabilities and sensory perception (Huppert, 2003). Dem@Care interfaces, systems and evaluation protocols need to consider:

- Vision: Visual Information. Feedback on Screen (i.e. Gear 4 sleep sensor App and later Dem@Care graphical interface system prototypes)
- Hearing: Auditory Feedback
- Manual dexterity: Pressing buttons, touchscreen, buttons for cameras
- Cognitive Load: Particularly interactions that rely on memory

5.3 System Flexibility

While the Dem@Care system will develop iteratively it should maintain flexibility of system to adapt to changes in a participant's:

- Behaviour
- Routine
- Environment/Context (location, noise)
- Functional Requirements

6 Conclusions

In this interim deliverable, the current status of evaluation methods, procedures, deployment and initial results for the three clinical partners in the Dem@Care project have been presented. Due to a delay in the completion and installation process of the first prototype of the Dem@Care system for all three settings, this version of deliverable D8.3 has focused on partial findings from the pilot evaluation of the Dem@Care system.

The @Lab site has presented results based on the acceptability of the system, clinical assessment and validation of the protocol. In the final version of D8.3, the integrated system will be tested with several participants and results related to all users (technician, clinician and patient) will provide insights in order to evaluate the efficacy and usability of Dem@Care system.

The @Nursing home section has presented the current status of the pilot evaluation including research questions, evaluation setting, recruitment and potential issues related to system evaluation.

The @Home section has focused on the qualitative results of preliminary and assessment interviews with five users recruited for the @Home pilot. The two lead users have been described in more detail to provide personas that illustrate their individual characteristics and functional requirements. The sensor toolboxes that will be deployed into the homes of lead users have been outlined with reference to users' individual profiles and functional requirements. @Home evaluation methods and protocols have been updated to reflect developments in the Dem@Care system and the functional requirements of our users. The system is currently being installed into the community apartment at DCU to troubleshoot issues related to installation and @Home evaluation protocols will be piloted with 5 student/actor participants. Results and analysis from the community apartment installation and pilot evaluations will inform system deployment to lead users' homes.

This interim deliverable is a presentation of the current status of evaluation methods, procedures, deployment and initial results across all three sites. Following the planned installation and deployment of the Dem@Care system during summer 2013, the final deliverable D8.3 will contain more detailed pilot evaluation results and analysis and implications for related functional requirements.

7 References

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A Appendix: Home

A.1. Preliminary interviews

These interviews were held in Feb-March 2013 as part of a co-design process in collaboration with WP3-WP6.

1. Introducing Dem@Care. Introducing the five functional domains we chose.
    a. Are these ideas meaningful to you?
    b. Did we miss any important areas? Hobbies & past-times?
    c. Do you currently use technologies to help in these areas? Would you consider doing so?
2. Technical presentation – these are the sensors we have available to support these areas.
    a. Do you think they would be useful? Would you accept them?
    b. Wearable sensors – acceptable?
3. Attitudes towards technology.
    a. General issues with technology – pro's and con's? confidence using technology? Current use/previous experiences of technology in other aspects of life?
    b. What is the role of technology/ what is required from technology in order for it to be useful?
    c. Spousal attitudes.
4. Hardware form
    a. Tablet size (10" or up to 24"?)
    b. Feedback on screen illustrations – is this the type of data you'd want to see? What is meaningful to you?
    c. Prioritisation – hierarchy of functionalities, by presenting paper cards and having the individual place them down in order of their importance, e.g.
        i. Would you be happy to be interrupted by a phone call if you were eating a meal?
        ii. Would you be happy to be interrupted bya phone call if you were engaged in a social call/ chatting with someone?
        iii. Would you be happy to be interrupted by a phone call if you were sleeping?
        iv. Would you be happy to be interrupted by an alert about the fridge being open, not having tidied up, etc., if you were eating/sleeping/speaking with someone?
        v. Would you be happy to be interrupted by the system providing feedback if you were preparing a meal?

vi. Would you be happy to be interrupted if you were awake at night to be told to return to sleep?

vii. Would you be happy to be interrupted during the day if you had not finished a meal?

viii. Would you be happy to be interrupted by the system, if the system could tell you were in a bad mood?

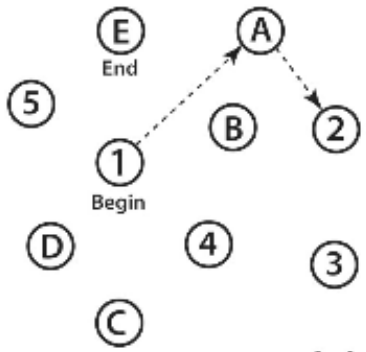
ix. Would you be happy to be interrupted by the system to answer some questions during your day/while eating/sleeping/chatting to someone?

A.2. **Montreal Cognitive Assessment**

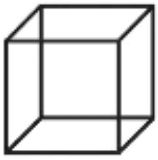
MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.1 Original Version

NAME :
Education : Date of birth :
Sex : DATE :

VISUOSPATIAL / EXECUTIVE — POINTS



Copy cube



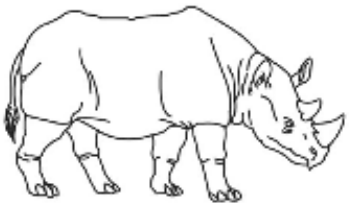
[ ] [ ]

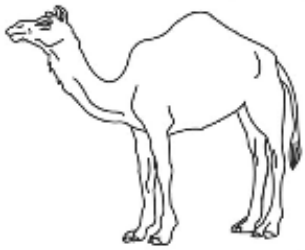
Draw CLOCK (Ten past eleven)
(3 points)

[ ] Contour [ ] Numbers [ ] Hands

__/5

NAMING





[ ] [ ] [ ]

__/3

MEMORY Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.).

Subject has to repeat them in the forward order [ ] 2 1 8 5 4

Subject has to repeat them in the backward order [ ] 7 4 2

__/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors

[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

__/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65

4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**

__/3

LANGUAGE Repeat : I only know that John is the one to help today. [ ]

The cat always hid under the couch when dogs were in the room. [ ]

__/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] _____ (N ≥ 11 words)

__/1

ABSTRACTION Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler

__/2

DELAYED RECALL

	Has to recall words WITH NO CUE	FACE [ ]	VELVET [ ]	CHURCH [ ]	DAISY [ ]	RED [ ]	Points for UNCUED recall only
Optional	Category cue						
	Multiple choice cue						

__/5

ORIENTATION [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

__/6

© Z.Nasreddine MD **www.mocatest.org** Normal ≥ 26 / 30

TOTAL __/30

Add 1 point if ≤ 12 yr edu

Administered by: _____

A.3. @Home System Usability Scale

System Usability Scale (Brookes, 1996)

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5