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Evaluating the Use of Daily Care Notes Software for Older People with Dementia

Running head version: Evaluating the Use of Daily Care Notes Software

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Abstract

There has been little research to investigate the impact of software to support the care for older people with dementia care. This paper reports the evaluation of software adapted to support one key person-centred task for the care of older residents with dementia – recording and sharing daily care notes. The evaluation on the dementia wing of 1 residential home for over 6 months revealed that use of the software on mobile devices carried by the carers increased the number and volume of daily care notes recorded, but only for the types of content that were already being recorded by carers. Carers reported more advantages that resulted from daily care notes once in digital form than from the documenting task, as well as barriers to the use of mobile digital software to record daily care notes.

1. Introduction

Dementia is a condition related to ageing. The number of people with it worldwide is estimated at 47.8 million, a figure expected to double in the next 20 years. Moreover, the wider societal cost of dementia worldwide has been estimated to be US$818 billion annually, rising to US$2 trillion by 2029 [Prince et al. 2015]. The symptoms of dementia, such as loss of memory and communication skills [Graham & Warner 2009], create challenges to older people living with it – challenges that are best overcome through the delivery of regular professional care tasks. In advanced economies, this professional care is still delivered primarily in residential homes by paid carers who are typically busy women. However, currently, many of these carers are poorly paid and under-pressure to balance their care and administrative duties, and governments lack the resources to increase carer numbers and remuneration, with potential implications for the quality of delivered professional care. Discovering other means of increasing the quality of care given in such constrained environments is a recognised pressing issue [Sugihara et al. 2013].

Computer technologies have the potential to support improvements in the quality of the care delivered in residential homes. For example, Wallace et al. [2012] reported the use of digital devices designed as furniture pieces by residents, and Wan et al. [2016] described a new GPS-based monitoring system for dementia care. However, professional carers remain the single greatest influence on resident quality of life [Kitwood 1993], and bestow status to each older person in their care. Therefore, research reported in this paper sought to design and evaluate a new computer technology to support professional carers during tasks specific to the care for older people with dementia.

Person-centred care is one form of care of older people with dementia. It seeks an individualized approach that recognizes the uniqueness of and understands the world from the perspective of the person with dementia [Brooker 2007]. To

support carers to deliver better person-centred care, the authors previously deployed software on mobile devices for carers to use to support one essential person-centred care task – to record daily care notes about a resident in situ with that resident, then to share these notes with other carers. Recording daily care notes in situ can support carers to capture a more complete and personalised record of the needs, challenges, activities and states of each individual older person. The UK's National Institute of Clinical Excellence stipulated over a decade ago that individual care notes should be recorded and reviewed regularly [NICE 2006], and many countries now impose a legal obligation on residential homes to record a minimum number of daily care notes. However, few studies of the effect of mobile software on daily care note recording have been reported. Therefore, the authors designed and deployed new mobile devices and software to support more immediate, accurate and complete daily care note recording about each individual.

Although previous evaluations of this software in residential homes revealed its potential to support person-centred care tasks [Zachos et al. 2013, Pitts et al. 2015], each evaluation lasted no more than 2 months. Therefore, new research was undertaken. Results from these previous evaluations were used to improve and extend the software to support daily care note recording more effectively [Pitts et al. 2015]. Access to a new residential home was negotiated, and elements of its person-centred care practices were redesigned to incorporate use of the new mobile devices and software to record and share daily care notes. The authors then supported the residential home and some of its professional carers to use the mobile devices and software for over 6 months to record and share daily care notes, to investigate whether use of the devices and software increased the volume of daily care notes about each person, and/or changed the content of these care notes to be more person-centred. This paper reports that evaluation.

The next 2 sections review previous uses of computer technologies in dementia care, and describe the new software and hardware that was developed and adapted to support the person-centred care task. Sections 4 and 5 report the evaluation

method and results. The paper ends with threats to validity and conclusion from the evaluation, and implications for both further evaluations and revising the software to support carers to record and use daily care notes.

2. Related Work

Most computer technologies have been developed for people with dementia to interact with directly, for example the pervasive technologies reviewed in Mulvenna & Nugent [2010]. Cowans et al. [2004] reported early work that utilized interactive multimedia to stimulate long-term memory to prompt communication as part of reminiscence therapy for people with dementia. Cahill et al. [2007] argued that assistive technologies can make a significant difference to the lives of people with dementia and to their caregivers if delivered at home in a thoughtful, sensitive ethical way. And in the wider population, Hur [2016] reported that the adoption of computer technologies by older people for self-empowerment was dependent more on individual interests in these technologies, rather than on their other social and technology skills.

Moreover, some computer technologies have already demonstrated improvements to the quality of lives of people with dementia, as long as core usability problems are resolved [Hanson et al. 2007]. Wallace et al. [2012] described the use of computing devices designed as furniture pieces by older residents to provide notions of home, intimacy and possessions with which to develop a sense of personhood. And Thiry et al. [2013] reported work in which older people made personal digital timelines using technologies for memory designed to support creativity and the building of memory.

However, this paper argues that computer technologies have greater potential to support person-centred care tasks undertaken by the professional carers of these older people. The role of the carer to determine the quality of care and life experienced by older people is well established. Kitwood [1993] reported the

importance of communication and facilitation to maintain the wellbeing in older people with dementia. Indeed, the person-centred care approaches that Kitwood established 20 years ago emerged as a reaction to task-oriented care approaches, and build on Kitwood's notions of personhood [Brooker 2007], in which one human being bestows a standing or status upon another human being, in the context of relationship and social being. His approach necessitates recognition, respect and trust, based on relationships with human carers who undertake person-centred care tasks.

To support person-centred care tasks, models of person-centred care were applied to inform the design of the new digital support. One established model is VIPS [Brooker 2007], which stands for Values, Individuals, Perspectives and Support, and defines key elements of person-centred care that include the treatment of people as individuals, and looking at the world from the perspective of the person with dementia. Kitwood [1997] recognized the centrality of understanding the individual needs of people with dementia to give a focus for interventions, and described different routes with which carers could deepen their empathy toward people with dementia. These routes include listening carefully to what people say in everyday life, and learning from the behaviours of people. Daily care notes that are written from the perspective of the older person can encourage both empathy in the carers and carer development of improved observational skills to ensure more complete daily care notes – both important elements of person-centred care [NICE 2006].

And yet, perhaps surprisingly, there has been little research of the use of computing technologies directly by professional carers to support person-centred care tasks, in contrast to studies that only report carer perceptions of the imagined use of technologies for care (e.g. Mao et al. [2015]). Exceptions include Hayden et al. [2012], who reported that carers of people with dementia encounter obstacles of access, cost, and time that inhibit their use of computer technologies. Olsson et al. [2012] described how the use of computing technologies in homes has to meet the needs of the people with dementia and their carers. Providing early information

about these technologies to people with dementia and their relatives was shown to facilitate joint decision-making about their use. Powell et al. [2010] reported the challenges perceived by carers to introduce computer technologies into dementia care – challenges that included the need to balance power and autonomy whilst maximising safety, reduce personal contact, and to complement rather than replace care tasks.

There are also reports of carers using specific technologies effectively. For example, Pot et al. [2012] reported that carer use of GPS tracking technologies reduced carer worries about the people and their care, as well as enhanced the freedom of the people with dementia – conclusions also reported in Zwijsen et al. [2012]. Nurses also successfully used telecare technologies to instruct caregivers in domiciliary settings (e.g. [Solli et al. 2015]). However, neither of these technologies directly supported specific and important person-centred care tasks such as recording each resident's daily care notes.

Modern care and nursing practices frame the effective recording of daily care notes as contributing to, rather than distracting from good quality care. Indeed, documenting good records is tagged as a hallmark of good care, and careful, neat, and accurate records are indicators of a caring and responsible care professional [Stevens & Pickering 2010]. Next to hands-on care, the importance of keeping accurate records cannot be underestimated [Hoban 2005]. Each daily care note should capture the personalised record of each person's needs, challenges, activities and states, as well as positive and negative aspects of wellbeing and risk. Together, these notes enable an understanding of the world from the perspective of the person with dementia. Producing and reading them can encourage empathy in carers. And the notes provide the evidence for evaluating the effectiveness of care against these needs and challenges. Therefore, recording and using daily care notes was selected as one important person-centred care task to support with a mobile technology intervention.

Previous work undertaken by the authors have demonstrated that carers were willing and able to use mobile software to document daily care notes and to share these notes with other care professionals during their shifts [Zachos et al. 2013, Maiden et al. 2013, Pitts et al. 2015]. However, like other reported studies of technologies in residential care homes (e.g. Aloulou et al. [2013]), these studies took place over shorter time periods or with small numbers of participants, so the longer-term effects of the use of the software on the daily care notes were not studied. Therefore, in this paper, we report a new evaluation that explored the use of hardware devices and software in 1 residential home over 203 consecutive days.

3. The Software

Software was deployed on mobile and desktop computing technologies to support the professional carers in the residential home to capture and share daily care notes about individual residents.

The home's previous person-centred care process used hand-written paper daily care notes, as did most residential homes in the United Kingdom. These notes were recorded by carers during shifts to provide both an audit trail with which to investigate incidents, and a means for carers to detect patterns in, diagnose and determine underlying reasons for each resident's behaviours and states.

However, this paper-based process had obvious limitations. Carers found it difficult to produce complete daily care notes because the paper note sheets were difficult to edit and revise after writing. The sheets and pens were also inconvenient to carry throughout a shift, which meant that daily care note recording often took place away from the resident, and undermined the direct use of observational skills or empathy [Kitwood 1993]. And the completed daily care notes were stored away from the dementia wing in ring binder files that were difficult and time-consuming for carers to retrieve.

In contrast, mobile devices and software were identified as having the potential to support carers to record daily care notes in situ. If carried throughout a shift, the mobile devices could enable carers to observe the resident during care note recording, and even capture digital photographs and audio records to supplement the daily care note. Moreover, the mobile devices could provide direct access to all recorded daily care notes about each resident during the shift – access that could increase carer understanding of and empathy for the person with dementia.

We decided to implement the mobile support for capturing and reflecting on daily care notes about residents using the *Yammer* micro-blogging software installed on mobile iPod Touch devices and accessible through a browser interface on desktop computers. The use of this existing software met most of the residential home's requirements. These requirements were discovered through a simple process of prototype walkthroughs of previous versions of the *Yammer* software that had been configured for use to record daily care recording, and interviews with staff working in the residential home. The resulting requirements including the need to support mobile work, asynchronous communication between users, and posting messages of unlimited lengths of text, with or without attachments, which other users could respond or post other messages to. Care professionals then walked through new versions of the configured *Yammer* software to validate the requirements and their implementation.

A private and encrypted *Yammer* network was set up for the residential home, and user accounts with full access to the network were created for all carers and other staff who required access to daily care notes. A different user group was then generated for each resident in the home, and different carer and other professional staff users were given access rights to each resident. The left side of Figure 1(a) shows an example of a carer's landing page with the mobile client, showing all (fictional) residents on the wing – as well as a feature to view all communication in the home about all residents.

Different *Yammer* features were then co-opted to provide support for key daily care note activities for use by carers. The application presented the daily care notes about each resident to show the most recent daily care note at the top, thereby providing carers with simple access to a narrative of the recent care provided to each resident. This narrative was considered to be important to provide carers with a contextualised understanding of each daily care note, and hence increase the understanding of and empathy for the person describes with the notes. Figures 1(b) and 1(c) also depict 2 daily care notes about fictional resident *Annie Arnold*, with most recent written by carer *Rachel Radford* and previous one by carer *Simon Selston*.

To enter a new daily care note for that resident, the carer clicked the writing icon in the top-right corner of the screen, and the application opened a new screen in which to type the note, as shown in Figure 1(c). After posting the new daily care note, the application presented it to all carers of that resident as the most recent daily care note for that resident, see Figure 1(d). Carers were also able to use the application's reply feature underneath each presented daily care note to enter direct responses and comments to daily care notes that had been entered by other carers, to enable carer communication about a resident using the notes.
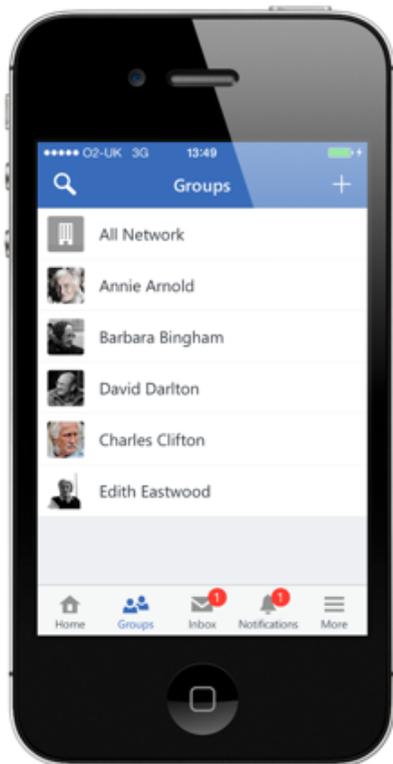
1(a)
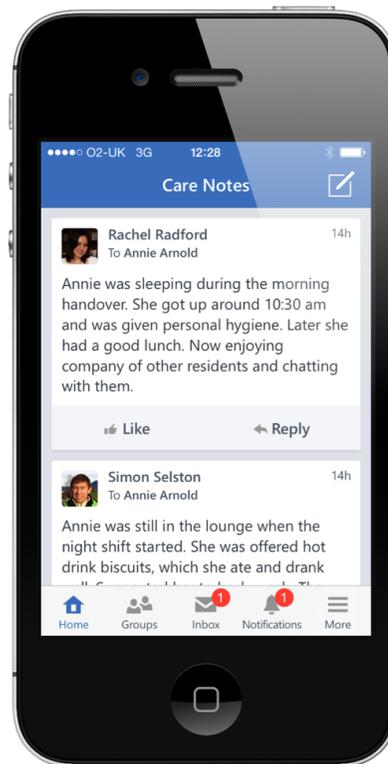
1(b)
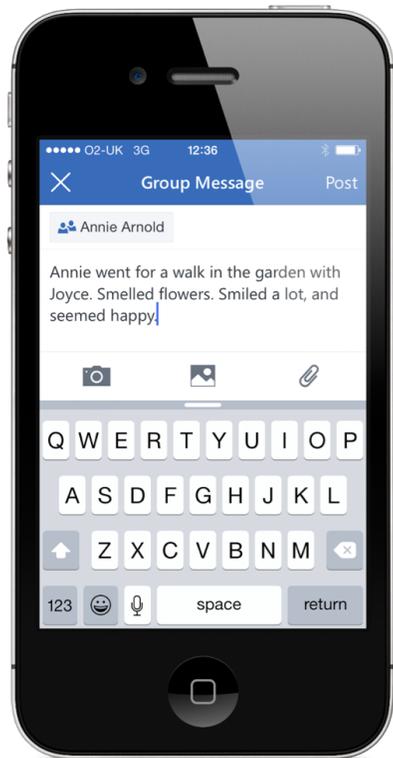
1(c)
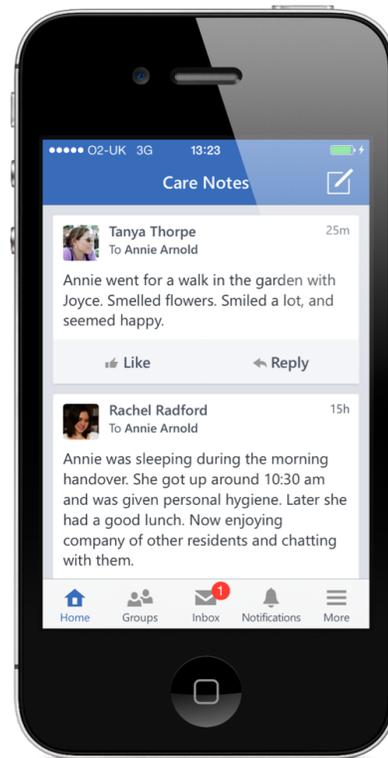
1(d)

Figure 1: (a) The landing page listing all groups in the network allocated to the user – the residents in the home that the carer is responsible for; (b) reading daily care notes about one resident; (c) how a carer enters a new daily care note for that resident; (d) the updated daily care note for the individual.

4. The Evaluation Method

A summative evaluation of the *Yammer* software took place over 203 consecutive days on 1 wing of a large residential home in South London that, at the time of the evaluation, was meeting all required UK Care Quality Commission national standards. The wing specialized in the care of older people with medium to severe dementia, and at the time of the evaluation had 13 residents. A total of 20 care staff, 18 female and 2 male, aged between 26 and 60, with on average over 6 years of work experience in their current roles, worked on the wing. Of these 20 care staff, 2 were team leaders, 10 were senior healthcare assistants and 8 were healthcare assistants. In the paper, we refer to all of these senior and healthcare assistants as carers, as all were responsible for delivering daily care to residents. All had volunteered to participate in the evaluation, and were free to withdraw from it at any time. Most were not United Kingdom citizens, and English was not their native language, which was typical of residential care workers in the United Kingdom at the time of the evaluation.

A unit manager supervised the residential home's dementia wing as a separate unit. The manager supervised a total of 4 team leaders, at least 1 of which were on shift at any time. The team leaders oversaw the care delivered in each shift, managed handovers between shifts, and liaised with other professional staff such as medical doctors. The team leaders also managed the care resources available for each shift through the planning of shift rosters, and delivered care to residents as needed. However, the 18 carers delivered most of the care to the residents. Each healthcare assistant was allocated up to 5 residents for whom they were directly responsible for the care of. The senior healthcare assistants had more responsibilities, which

included liaising with the professional staff, delegating work if the team leaders were not available, and administering medicines.

During the evaluation, the 2 team leaders and 18 carers used the *Yammer* software described in Section 3 to record daily care notes for the 13 residents, and to communicate these notes to other professionals in the residential home. For this reason, the evaluation method was extended to also gather data from other users who were 5 therapy staff including the head of department, 1 senior physiotherapist, 1 physiotherapist, 1 occupational therapy support practitioner, and 1 moving and handling advisor, and from 1 activity coordinator and 1 person-centered care facilitator. The *Yammer* software was made available over a period of 203 consecutive days to support daily care note recording, retrieving and sharing.

Furthermore, to provide some comparison data, the evaluation also investigated the use of the previous paper-based daily care note recording forms on the same dementia wing for the same 13 residents over the 46 days before the introduction of the *Yammer* software. For practical and ethical reasons associated with working with the residential home, it was not possible to delay the introduction of the *Yammer* software for more than these 46 days. Although shorter than the eventual 203 days of *Yammer* software use, it was predicted that data collected about the recorded daily care notes and their use over the 46 days would still provide valid baseline data for comparison.

4.1. The Previous Paper-Based Care Note Recording Process

All of the 18 carers were responsible for maintaining up-to-date and complete daily care notes about each resident. Each carer was required to complete the paper-based form shown in Figure 2, writing their name, the date and time and a short care note description in each row. This short description was expected to follow guidelines, which were to detect and report evidence of positive and negative wellbeing, as well as possible risks. All carers already had been trained to use these

guidelines. All completed paper forms were maintained in large ring binder files for each resident for use by all carers, team leaders, physiotherapists and activity coordinators. In a previous version of the process, the 4 team leaders were responsible for documenting the daily care notes, and carers would report their observations to the team leaders to document the notes.

		E1 – Daily Care Notes
FORM FOR:		**UNIT:**

Care Daily Records
- Daily notes must include the resident's engagement with activity, food and drink, using the toilet, washing and skincare. You must record the resident's well-being during these experiences, and what, if any, support was needed.
- Critical events - eg falls, GP visits, change in meds - must be recorded immediately
- Any experiences you did not witness first hand must be documented accordingly, for example. *"It was handed over by… that…"* or *"It was documented in the activity log by ……that … engaged in …with… and felt….."*

Date	Time	Report	Print name

Figure 2. The paper-based daily care note recording form used on the wing.

4.2. Use of the *Yammer* Software

All of the 18 carers and 2 team leaders were given up to 2 hours of face-to-face training on how to use the iPod Touch mobile devices and the *Yammer* software as configured for resident care note recording. Throughout the 203-day period, the carers and team leaders could contact a help desk manned by the researchers.

A total of 10 iPod devices running the mobile *Yammer* software were made available for use – this number was agreed with the unit manager to be sufficient

for every carer on shift at any time. A carer or team leader coming onto a shift would take a device and log on to *Yammer*, and log off and return the device at the end of the shift. During a shift, each device would log a carer off after a period of time without use, requiring the carer to re-enter the 4-digital PIN to use the device again. *Yammer* on all of the devices was pre-configured to enable the recording, reading and sharing of all care notes about each the 13 residents on the wing. Each device also provided the carers and team leaders with other software apps that come as standard on the iPod Touch, for example to take photographs and to record audio notes. Throughout the evaluation, the 2 team leaders were mandated to work with the *Yammer* software rather than the paper forms to record the daily care notes of the residents on the wing.

Moreover, the *Yammer* software with the same configuration on the mobile devices was set up and made available on the 1 desktop computer on the wing that had Internet access. Other care staff in the resident home – physiotherapists, activity coordinators and person-centred care facilitators – were given access to the care note records of the 13 residents through the software on these desktop computer.

4.3. Data Collection

Due to the duration and nature of the evaluation, the researchers could not be present to observe and collect data directly from carers. The researchers did not observe the carers at any period during the evaluation. The primary source of evaluation data was the corpus of daily care notes recorded in the *Yammer* software and with the paper forms in the earlier period.

Data were also collected from 3 different secondary sources. During use of the software, and according to shift patterns and availability, 1 researcher with previous research experience of evaluating digital technologies in residential care settings also conducted 5 semi-structured interviews with 10 care professionals associated with the wing who selected based on their availability at the time of the

interview. The 10 care professionals were 7 carers, 2 physiotherapists and 1 activity coordinator. The researcher asked 9 pre-agreed questions about use of the software to each pair together, in order to encourage constructive interaction [Mijake 1986] between the pair, and all responses were audio-recorded. The pre-agreed questions were:

1. How has the *Yammer* software evaluation been so far?
2. Tell me about your experience of using the *Yammer* software?
3. When do you use the *Yammer* software?
4. Where do you use the *Yammer* software?
5. Has introduction of *Yammer* software changed how you record daily care notes?
6. Has anything changed in terms of how you do your job based on using the Yammer software?
7. Do you make use of/read the daily care notes recorded by other carers? How? Why? Can you give me examples?
8. Did you used to read the daily care notes made by others when you used paper forms?
9. Tell me about the iPod devices – how are they working for you?

Furthermore, at the end of the evaluation period, the same researcher also ran 1 focus group with 2 the wing's 4 team leaders who were on shift when the focus group was scheduled. Due to the need to provide 24-hour period care, it was difficult for more than 2 team leaders to be available at any single time. During this focus group, the team leaders had access to all digital daily care notes entered by the carers during the evaluation by usage of 2 tablet devices, and were asked to comment on the daily care notes. The team leaders were free to generate the topics of the focus group. These topics were: limitations of the current paper-based processes on the wing; qualities of daily care notes reported with this process; limitations and poor practices of the carers; and the perceived consequences of

using the Yammer software how daily care notes were recorded. The focus group was also recorded for analysis.

Finally, also at the end of the evaluation period, 10 of the 18 carers who used the *Yammer* software completed a questionnaire about the use and impact of the software on their daily care work.

4.4. Data Analysis

Two analyses were undertaken on the digital daily care notes data related to the 13 residents on the wing documented with the *Yammer* software and the paper forms. The 1st analysis computed the totals and frequencies of individual daily care notes documented by the carers. The 2nd analyzed the content of the recorded daily care notes. An experienced analyst who worked for the Registered Nursing Home Association categorized each daily care note for the inclusion or otherwise of 6 different types of content that report observable information related to a resident, and 3 different types of content that report carer inferences about a resident. The 6 types of observable information were:

1. **Described resident behaviour**: for example: *sits to watch television in his room*;
2. **Described resident state:** based on direct observations, for example: *calm*, *happy*, *withdrawn*;
3. **Described carer intervention**: observed and/or reported interventions into a resident's care, for example: *rearranged pillows in lounge chair*;
4. **Descriptions of non-care work**: a description of observed and/or reported carer behaviour that does not include interactions with residents, for example *talking to the relatives of the resident*;
5. **Described challenging behaviour**: a description of an abnormal behaviour that threatens the physical safety of the person or others is likely to be

placed in serious jeopardy [Bromley & Emerson 1995], such as: *refusing to take medication*;

6. **Carer responses to challenging behaviour**: a description of one or more observed and/or reported carer responses, for example: *asked another carer to provide the medication*.

Another 3 types of content were treated as evidence of carer inferences:

7. **Attribution of meaning to resident behaviour or state**: a description of an attribution of meaning to a resident's behaviour, state or condition that could not be observed, for example: *suspect personal insecurities appear to underlie this behaviour*;

8. **Description of planned new solution to care situation**: a description of a planned new resolution to a monitoring situation or encountered challenging behaviour, for example: *recommend the removal of the reasons for personal insecurities during lunchtimes*;

9. **Description of other inferences about resident**: a description of other forms of explicit inference made about the resident, for example: *the resident is not always asleep when she appears to be*.

Each documented daily care note was categorized for the inclusion or otherwise of each type of content.

The interview and focus group transcripts and questionnaire responses were analyzed for responses related to 3 research questions presented in the next section. Content analyses of the interview and focus groups were undertaken to discover emergent themes, then these themes were associated with data analysis of the daily care notes and the 3 research questions.

4.5. Research Questions and Assumptions

Analyses of the data were used to investigate 3 research questions that were asked to investigate the effect of the use of the *Yammer* software to support the recording of daily care notes:

RQ1 Did use of the *Yammer* software increase the volume of daily care notes that was recorded per resident in each 24-hour period by the carers on the wing?

RQ2 Did use of the *Yammer* software increase the volume of daily care notes recorded by the carers on the wing that describes person-centred information?

RQ3 Did use of the *Yammer* software support person-centred care tasks more effectively than with the paper forms?

Research question RQ1 was asked to investigate the volumes of daily care notes recorded with the *Yammer* software, whereas research question RQ2 was asked to investigate the different types of content recorded with the software. The 3 research questions were predicated on the following 2 claims, which were assumed to be true throughout the period:

A1: There were no major changes in the collective health and/or care needs of the 13 residents. Such changes might have arisen from illnesses such as outbreaks of a stomach bug, and/or weather-related conditions such as a heat wave;

A2: There were no other changes in the daily care recording practices on the wing over the period of the evaluation.

In contrast, the potential impact of the software use on the care provided to the residents on the wing was not investigated. While the daily care notes were one important element of person-centred care in the residential home, many other elements beyond the scope of the evaluation were assumed to influence the quality of care given to the residents – elements such as care training, carer skills and the management leadership. Therefore, this research investigated one technology intervention into just one type of care task already known to improve person-centred care.

5. Evaluation Results

Prior to the introduction of the *Yammer* software, the 18 carers recorded daily care notes about these residents on the paper forms for 46 days, and no unusual events were reported. Our assumptions A1 and A2 were true throughout the period. The carers then replaced the paper forms with the *Yammer* software to record the daily care notes. All 18 carers used the *Yammer* software to record all daily care notes for 203 days. The carers did not report any objections to use of the *Yammer* software instead of the paper forms during the evaluation period. Again, assumptions A1 and A2 were true throughout this longer period.

All of the carers and the team leaders were regular smart phone users, and many reported that they preferred to use the iPod Touch devices over other forms of desktop technology because the devices enabled them to remain closer to the residents when recording daily care notes. During the interviews, one reported: "*I'm quite used to using iPhones, because I am an iPhone user, so it's quite easy for me*". However, some of the carers reported a usability problem associated with small size of the digital keyboard on the devices, and one stated a desire for a larger mobile device and/or desktop computer to use the software: "*I was working nights. And the [colleague] I was working with she could not use it [the iPod touch device] because it was too small for her. So she had to go back to using the computer. {...} So I*

think it [the device] is too small for some people to use it", and: "*If I'm in the office I usually log in on the computer. It's much easier. When I'm in the lounge I use the iPod. In my experience I didn't have any problem using it, because it's just like Facebook or similar to Facebook*". Likewise, another of the carers reported during one of the interviews that the text displayed on the iPod Touch screen was too small to read without reading glasses that were, otherwise, not needed during care work, and as a result preferred to use the software on the desktop computer. However, as there was only one such computer on the wing, lack of access to it sometimes impeded the recording of daily care notes, especially at the end of some care shifts. On the positive side, carers reported during the interviews that the time required to record the daily care notes reduced as their experiences with the software and devices increased, for example: "*and my typing is getting better and faster now to be honest*".

During the interviews, the carers also reported that recording daily care notes in a form that was more easily shared supported different types of care event. One such type was to prepare residents to go outside the residential home on trips: the digital access to the daily care notes provided the physiotherapists and activity coordinators with more timely and accurate access to information about each resident, in order to make the required adjustments to each resident's support. Another type of event was post-fall care. After resident falls, the physiotherapists were able to review the daily care note record to understand the circumstances for the fall more quickly and easily than with the paper forms, in order to adjust treatments accordingly with less time and effort.

5.1. The Recorded Daily Care Notes

The carers generated a total of 5410 daily care notes about the 13 residents with the *Yammer* software over the 203 days. The totals of the daily care notes generated with the *Yammer* software and with the paper forms in the shorter 46 days before the software's introduction are reported in Table 1. Unsurprisingly, more daily care

notes were recorded in the longer period with the *Yammer* software than in the shorter period with the paper forms.

Measure	Paper forms	*Yammer* software
Total number of daily care notes recorded	1058	5410

Table 1. The totals of daily care notes recorded with the Yammer software and in the earlier shorter period with the paper forms

Therefore, comparable measures such as the rates of daily care note recording and the volumes of notes recorded about each resident per day with the *Yammer* software and paper forms were investigated. Overall, the introduction of the *Yammer* software increased the average number of daily care notes recorded in each 24-hour period, see Table 2. An unpaired t-test revealed that there was a significant difference in the numbers of daily care records documented with the paper forms (Mdn=23, SD=3.51) and with the *Yammer* software (Mdn=27, SD=5.02) conditions; t=-5.20314, p<0.0001). Carers documented more daily care notes in each 24-hour period with the *Yammer* software, even though carers claimed to spend less time on the documentation task.

Measure	Paper forms	*Yammer* software
Average number of daily care notes recorded in each 24-hour period	23	26.7

Table 2. The average number of daily care notes recorded in each 24-hour period

Moreover, the introduction of the *Yammer* software increased the average number of words used to describe each daily care note, and the average total numbers of words about each resident in each 24-hour period, see Table 3.

Measures	Paper forms	*Yammer* software
Average number of words in each daily care note	34	41
Average number of words recorded in each per 24-hour period per resident	61.5	92

Table 3. The total numbers of words recorded in each daily care note, in each 24-hour period, and about each resident in each 24-hour period

An unpaired t-test revealed that there was a significant difference in the numbers of words used to document each daily care note with the paper forms (Mdn=30, SD=16.34) and with the *Yammer* software (Mdn=36, SD=27.50) conditions; t=-1.9603, p<0.0001). The average number of words recorded about each resident in each 24-hour period increased from 61.5 to 92 words – close to a 50% increase in the number of daily care record content from which to understand and empathize with the residents. During the semi-structured interviews, several carers reported changing the content recorded in the daily care notes because the notes were more likely to be read by colleagues with the *Yammer* software. For example, one stated: "*I think it's changed, because you know people will be reading it. So it's changed a bit*". The results revealed that improved access to daily care notes using the *Yammer* software might have motivated at least some of the carers to produce more daily care notes, to document the notes with more words, and to adapt the digital care note content.

Although the carers and other staff did not use the iPod Touch devices to record audio notes, several did initially use the devices to take photographs of residents and their activities. For example, one occupational therapist took a photograph of the smiling face of a resident at the end of a therapy session, and linked it to a care note as evidence of a positive outcome. However, the management team of the residential home decided that the use of photographs might contravene the existing legal contracts with the residents and their families, and the practice was stopped.

5.2. How Software Use Impacted on Daily Care Note Recording

The structured interviews with the 5 pairs of care professionals revealed that *Yammer* software use overcame a long-standing problem with the legibility of carer handwriting. For example, one of the carers reported: "*It's good because you're able*

to, you know all of us, the different handwriting sometimes it does not, you know sometimes we are unable to read the others' handwriting. So it's good in that form of way. Of writing daily notes". Use of the *Yammer* software appeared to increase the readability of the daily care notes.

The use of the iPod Touch device's spellchecker was also reported during the interviews to improve the clarity and accuracy of the daily care notes. One carer with dyslexia said that it was easier to write daily care notes in digital form, as the *Yammer* software allowed the carers to edit daily care notes during documentation - actions not possible with the handwritten notes on the paper forms. Again, the use of the *Yammer* software appeared to increase the readability of the daily care notes.

Some of the interviewed care professionals also reported that digital daily care notes were easier to search and retrieve than the paper forms stored in large arch-binder files, for example: "*I think it's a good thing because the care plans were too heavy. Because some [residents'] notes are so big that it's too heavy to carry all these around*". The daily care notes were also reported to be available to other carers, team leaders and other staff more quickly, for example: "*It's good, because if I want to know what [colleague name] writes about my resident yesterday which I'm [taking care of] today, I just go back and I see clearly that [the resident] had a bruise or that [the resident] didn't eat or you know, {..} and it's so clear. So that give me more time to do my job to say well [the resident] didn't eat yesterday so today I'm going to try giving him some extra*"; "*And if I was the one on duty, and I'm not there, they will go back to the location book, 'it's happened on this day, [carer's name] was on duty and [carer's name] is not here today but they can instead of waiting for me to ask me what happened if the information is there [they can retrieve it]. That is very good*". The care professionals reported being able to search using selected keywords such as *fall* and *bruise*, for example: "*There is a search button there, so for example if we are to look for [messages about] falls, just type falls and it does show up. So obviously it's easier to look for ... just with the key words you can search for residents who had a fall. And it's easier to follow what has been done when you are already type in the*

word". During the interviews, the daily care notes recorded with the *Yammer* software were also reported to be more easily traceable to the carer who recorded them, for example: "*another point is for instance we have four staff on duty, and if I want to know if somebody write their daily notes, the moment I put my password in I would see whoever write their daily notes. I won't have to go around and say [carer name] did you write? I will know exactly who write or who didn't write their daily notes*". Other advantages of the *Yammer* software reported in the interviews were that it was easier to identify residents for who daily care notes had not been entered during a shift, and to review a resident's situation before starting the care shift. Overall, the use of the *Yammer* software improved access to daily care notes that had already been documented.

During the later interviews, some of the carers reported that their use of the *Yammer* software evolved over the 203 days of the software's use. At the start, most carers carried the iPod Touch devices with them during their shifts, and used these devices to record daily care notes in the resident's lounge, so that the residents could be monitored. This pattern of behaviour resulted in most carers recording these daily care notes towards the end of each care shift, and only if a significant event such a fall or challenging behaviour, directly after that event. However, over time, some carers preferred to leave their mobile devices in the office during their shifts, and to return to the office periodically to use the devices to record daily care notes. Several different reasons for this change in behaviour were reported. One was the device impeded care work because it attracted the attention of residents. Another was carer fears of misplacing, losing or damaging the iPod Touch devices, even though researchers had provided reassurances at the start of the evaluation that device loss and damage were to be expected, and no penalties would apply. A third was that carers sometimes found it difficult to complete a daily care note without being interrupted by a resident. Not only did the carers occasionally lose their partially-completed notes and have to reenter them from scratch, but also the interrupts and distractions sometimes contributed to them entering daily care notes for the wrong resident.

Muller et al. [2012] previously reported that the introduction of new computer technologies into residential homes needed to be framed by important socio-technical themes such as sociality and trust. The interviews also revealed the importance of the additional confidentiality of the resident care notes made possible by the password-protected iPod Touch devices. One carer reported: "*I think it's confidential as well. Because you can write something in the daily care notes in the [hand written notes folder] and if you left it on this table here somebody could come in and somebody could open the book and they could read it. When you do it on the Yammer, without the password they can't get into it. They can't. It's very confidential. It's a good thing*". The use of the *Yammer* software was reported to improve the confidentiality and security of the daily care notes.

The care professionals also reported potential benefits to their communication with residents' relatives. Some of these relatives would telephone the wing without warning to request an update from the responding care professionals, and the mobile device provided the carer with accurate and up-to-date responses to relatives, thereby enhancing the relationships with relatives of the residents in their care. The use of the *Yammer* software supported carers to communicate with residents' relatives.

To conclude, the interviews with the carers revealed that the *Yammer* software supported the carers to access more well written, readable, shared and secure daily care notes that were at least some documented in situ with the residents.

5.3. Attitudes to the *Yammer* Software for Daily Care Note Recording

The questionnaire sought to elicit the attitudes of the carers towards use of the *Yammer* software and its advantages, to provide further insights as to why and how the carers used and benefited from the software. Table 4 reports the rating responses of the 10 carers available to answer the questionnaire statements about

the use of the *Yammer* software. Most of the carers rated statements about use of the software more positively than negatively. The ratings revealed that, in spite of the lower ratings given by carer C1, the use of the software enhanced the identification of problems and good practices with which to improve communication with relatives and others (Row 0, average rating 4.4), and led to better coordination of the communication with relatives and others (Row M, average rating 4.4). In contrast, not all carers found the *Yammer* software fun to use (Row B, average rating 3.5) or had worked well (Row A, average rating 3.4).

	Comment about Yammer software *The Yammer software…*	Carers who responded										Average rating
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	
A	has worked well	2	1	3	5	3	4	3	4	5	4	3.4
B	was fun to use	2	3	2	5	3	4	3	5	4	4	3.5
C	helped me to reflect on experiences at work	4	5	4	4	4	4	3	5	4	4	4.1
D	helped me to collect information relevant to reconstructing experiences from work	4	5	5	5	3	4	4	5	5	4	4.4
E	helped me by providing accurate information about my work	2	5	4	5	4	4	3	4	5	4	4.0
F	helped me providing information about related experiences	2	5	5	5	3	5	4	5	5	4	4.2
G	helped me to remember and reconstruct the experience/situation	2	4	4	5	3	4	3	5	5	5	4.0
H	guided me in capturing information about my work experiences	2	5	4	5	3	4	3	5	5	5	4.1
I	helped me by supporting of sharing of experiences	2	5	5	4	3	4	4	5	5	4	4.1
J	guided me in sharing experiences with others	4	3	4	4	3	4	3	5	4	4	3.8
K	helped me improve the daily notes I record	5	5	5	5	4	5	4	5	5	4	4.7
L	we could better coordinate the communication about residents between us	2	5	4	5	4	5	4	5	5	-	3.9
M	we could better coordinate the communication with relatives and amongst us	2	5	4	5	4	5	4	5	5	5	4.4
N	we could identify problems and good practice, by which	2	5	4	5	4	-	4	5	5	5	3.9

	we can communicate better with residents											
O	we could identify problems and good practice, by which we can communicate better with relatives and others	2	5	4	5	4	5	4	5	5	5	4.4

Table 4. The quantitative responses of the 10 carers, on 1-5 Likert scales, to questionnaire statements about the use of the Yammer software.

To conclude, the questionnaire responses from the 10 carers revealed that use of the *Yammer* software also enhanced the identification of problems and good practices with which to improve communication with relatives and others, and led to better coordination of the communication with relatives and others. The responses revealed that there was scope to improve the *Yammer* software and make it more fun to use, and even the 1 carer who gave the software the lowest ratings also gave a maximum rating for improving the daily care note record.

Next, the recorded content of the daily care notes was investigated systematically.

5.4. Content Analysis of the Daily Care Notes

Table 5 reports the totals of the 5410 daily care notes that contained that category of note content, and the percentage of the total number of daily care notes recorded that contained the category. For example, with the paper forms, a total of 956 separate daily care notes contained at least one description of resident behaviour, which was 90.4% of the total of 1058 daily care notes recorded on the paper forms.

Daily Care note content categories	Paper forms	*Yammer* software
1. Described resident behaviour	90.4% (956)	95.3% (5157)
2. Described resident state	75.9% (803)	84.4% (4564)
3. Described carer intervention	90% (952)	92.1% (4982)
4. Descriptions of non-care work	4.1% (43)	3.6% (195)
5. Described challenge behaviour	1.4% (15)	2.6% (140)
6. Carer responses to challenging behaviour	0.6% (6)	1.8% (100)

7. Attribution of meaning to resident behaviour or state	*0.1% (1)*	*0.2% (10)*
8. Description of planned new solution to care situation	*0%*	*0.2% (10)*
9. Description of explicit inference about resident	*0%*	*0.02% (1)*

Table 5. The totals of daily care notes containing each category of content, and percentage of the total number of daily care notes recorded that contained the category with the paper forms and the Yammer software.

Fisher tests were applied to investigate possible associations between the totals of daily care notes containing different types of care note content that were recorded using the paper forms and the *Yammer* software. The results revealed significant associations between use of the *Yammer* software and descriptions of resident behaviour ($p<0.0001$; FET); resident state ($p<0.0001$; FET); non-care work ($p=0.0208$; FET) and carer responses to challenging behaviour ($p=0.0013$, FET), but not for the other content categories. The results revealed that use of the *Yammer* software was associated with a greater number of daily care notes that contained descriptions of resident behaviour and state, non-care work, and responses to challenging behaviour. In contrast, the use of the *Yammer* software was not associated with a greater number of daily care notes that described sense making, care planning and other types of inference about residents.

The analyses also revealed several common patterns in the documented daily care notes. Consider the following 2 example daily care notes that were documented with the *Yammer* software:

"[Resident-A] had breakfast in the dining area. Ate well independently. Spent her morning doing puzzles with staff support. Leg elevation encouraged";

"[Resident-B] was at lounge with other residents hot drink biscuit served. He stayed at lounge on and off asleep body washed and dressed up this morning no concern".

Both were prototypical examples of many daily care notes that contained at least one description of a resident's state, of a resident's behaviour and of a care intervention. Of the 5410 daily care notes that were recorded, 93.8% contained these 3 types of content - most carers documented daily care notes that combined descriptions of a resident's behaviour and state and their own interventions.

In contrast, the following daily care note was not typical of the notes that were recorded. It also documented the resident's behaviours and state, but in addition the carer sought to attribute meaning to the resident's behaviour – the resident felt good when others tell him that he is liked:

"*[Resident-C] had meals in the dining area. Ate well independently. Likes to chat with staffs and other people he sees. He feels good when others are telling him that they like him….*"

However, only 10 of the 5410 daily care notes documented with the *Yammer* software recorded such attribution of meaning. The focus group at the end of the evaluation period with the 2 team leaders reported some possible reasons for this.

5.5. Results from the team leader focus group

At the start of the focus group, the 2 team leaders reported problems with previous paper-based process. Both estimated that they had spent 70% of their time on each shift on documentation tasks, and both reported that there was a lot of duplication of information that could be removed if the residential home's care information was digitized: "*If you come to our office, we have so many folders. We have nutritional folders, we have monitoring folders. So maybe [the carers] feel like it's too much for them, to carry everything and update everything and at the same time write in the daily notes*". Other paper forms still in use in the home included the nutrition form, dietician form, skin and turning chart, fall documentation, behaviour management,

doctor and nurse forms, therapy documentation, communication book for shift handovers, activity log and night monitoring log. According to 1 of the team leaders, these other types of form were possible places to record information associated to daily care. But referring to the digital daily care notes, she said: "*Maybe, if everything will be entered in just one place, maybe it will be easier {..} at the end of the day, before you go home you have to do your daily notes*". Both team leaders appeared to recognise the potential benefits to the residential care and its care from digitization of the daily care notes.

However, even though analysis of the daily care notes revealed that use of the *Yammer* software increased the volume of daily care notes recorded, the team leader's first reviews of these notes revealed that team leaders believed that most carers still included only a minimum level of information in each note. The team leaders provided different reasons for this. One reported motivational issues: "*Maybe because they want to finish early*", because the team leaders were aware that some carers chose to some daily care notes at the end of their shifts. Another reported a lack of observational skills that were exhibited by the carers. She reported "*They are not very observant*", "*They just write what is easy for them to write, they don't want to put more information because they don't want to be questioned about what else did you see*", and "*They are writing the same thing every day. And often there is no changes. If they could put "no changes" they would. In the old notes before person centered care they did write no changes. It's easy and simple*". Even if these comments were not accurate descriptions of all carer behaviour on the wing, they indicate the team leader's concerns about carer skills and motivations for daily care note recording.

One of the team leaders also reported a third reason for documenting only minimum information in the daily care notes – the politics of blame: "*they just write what is easy for them to write, they don't want to put more information because they don't want to be questioned about what else did you see*". Some carers were reported to be unwilling to record inferences and new problems, such as underlying reasons

for behaviour or a resident's bruises, directly in the daily care notes for fear of receiving blame for the problem. One of the team leaders reported: *"They play it safe"*. The other added: "*They are afraid to fill in any form really, because they don't want to get into trouble*", that carers were aware of the legal status of daily care notes, and would often seek team leader advice before recording. At least some of the daily care note recording appeared to be a negotiated process that depended on direct verbal communication between team leaders, carers and other professionals. The team leaders reported that this could sometimes impact on the usefulness of the daily care notes, because the notes lacked all required first-hand information recorded by the carer who had witnessed the people present.

Although the team leaders reported that the change implemented in the wing to make all carers responsible for documenting the daily care notes was positive, they also reported that the carers were taking longer to complete the documentation than the team leaders did. Both claimed that what took a team leader 10 minutes to complete might take a carer up to 1 hour to do. Reported reasons for this claim were a fear to write, and lack of familiarity with the forms, not familiar with the terms used in the forms. Moreover, the team leaders reported that the carers appeared to be uncertain who they were writing the daily care notes for, for example to audit the resident each day, or to understand what happened in the past.

Concluding, the low numbers of daily care notes that described sense making, care planning and other types of inference about residents documented with both the paper forms and the *Yammer* software can be explained by the team leader's observations about carer behaviour and possible reasons for this behaviour.

Overall, the team leader focus group revealed that digitization of the digital care notes had the potential to overcome limitations with the home's previous paper-based process, but carers were still perceived not to be documenting complete daily care notes for reasons that included a possible blame culture, a lack of observation skills in the carers, and carer motivation. This fear of blame, skills gaps and lack of

motivation might have contributed to no significant increase in new types of daily care note content arising from use of the *Yammer* software, and revealed that increasing the completeness of the daily care notes might require other socio-political interventions in the residential home beyond the digitization of recording tools.

5.6. The summarized advantages of the *Yammer* software

To summarize, the carers reported multiple advantages of *Yammer* software use over 203 days, over and above previous use of the paper forms. These advantages are summarized in Table 6.

The carers were familiar were smartphone technologies, which supported their use of the *Yammer* software on the iPod Touch devices
The carers were able to use the *Yammer* software as both a mobile app and a web application on a desktop computer, as required
The carers documented more daily care notes per 24-hour period with the *Yammer* software than with the paper forms
The carers documented daily care notes with more words with the *Yammer* software than with the paper forms
The carers documented almost 50% more words about each resident per 24-hour period with the *Yammer* software than with the paper forms
The carers documented more daily care notes with descriptions of residents' states with the *Yammer* software than with the paper forms
The carers documented more daily care notes with descriptions of residents' behaviours with the *Yammer* software than with the paper forms
The carers documented more daily care notes with descriptions of residents' challenging behaviours and carer responses to these behaviours with the *Yammer* software than with the paper forms
Some carers claimed that the time to document daily care notes with the *Yammer* software was less than with the paper forms
The daily care notes documented with the *Yammer* software were more readable
The daily care notes documented with the *Yammer* software were more accessible
The daily care notes documented with the *Yammer* software were easier to search for topics such as *falls* and *diet*
The daily care notes documented with the *Yammer* software enabled the carers to prepare for specific types of activity – activities such as external visits and rehabilitations from hospital
The daily care notes documented with the *Yammer* software enabled the carers to

prepare for each shift more effectively than with the paper forms
The daily care notes documented with the *Yammer* software were easier to review to detect missing daily care notes for individual residents
The daily care notes documented with the *Yammer* software were claimed to be more secure than the paper forms
The daily care notes documented with the *Yammer* software enabled the carers to discover care problems and to share good care practices more effectively
The daily care notes documented with the *Yammer* software enabled the carers to coordinate communication with the families of residents more effectively

Table 6. Summarized advantages of use of the Yammer software to document and use daily care notes

However, the results also revealed some limitations associated with the use of the mobile technologies and *Yammer* software. The small screen of the mobile device posed some usability problems for the user group of professional carers. Interruptions from residents during the documenting of a daily care note sometimes caused the partial note to be lost and/or recorded incorrectly. And over time, fewer daily care notes appear to have been recorded in situ with the residents, and the use of digital photographs was not permitted. But perhaps most importantly, the use of the *Yammer* software was associated with increases in care note content that carers already recorded in most paper forms, but not with increases of other types of care note content associated with person-centred care.

6. Conclusions and Discussion

The results reported in this paper describe the continuous and successful use of *Yammer* software on mobile devices and desktop computers by 18 carers and 2 team leaders on the dementia wing of 1 residential home over 203 days. It contrasts with existing studies that only report carer perceptions of the imagined use of technologies for care (e.g. Mao et al. [2015]) and shorter evaluation periods with earlier versions of the software [Pitts et al. 2015]. A requirements-led design process was undertaken prior to the evaluation to ensure that the computing technologies in homes met the needs of carers [Olsson et al. 2012], and

complemented rather than replaced care tasks [Powell et al. 2010]. The results from the evaluation were used to answer the 3 research questions:

RQ1 The use of the *Yammer* software did increase the volume of daily care notes that was recorded per resident in each 24-hour period by the carers on the wing;

RQ2 The use of the *Yammer* software did increase the volume of daily care notes recorded by the carers on the wing, but only for types of information that already had been recorded in large volumes using the paper forms;

RQ3 Use of the *Yammer* software supported some person-centred care tasks – accessing, reading and sharing daily care notes, responding to requests from relatives, and preparing activities such as trips and hospital returns – more effectively than with the paper forms. Furthermore, the reduction in time needed to document each daily care note might have allowed more time for other person-centred care tasks.

Compared to results reported previously [Pitts et al. 2015], the research revealed significant quantitative changes arising from the use of the *Yammer* software. However, the research also revealed barriers to the use and limits to the effectiveness of this mobile software in person-centred care tasks. Five key themes emerging from the research.

The first theme was the need for the software to be usable by professional carers. Professional carers belong to a user group with a wide age range and digital skills. Although the carers were familiar with the iPod Touch devices, the screen size of the devices when carers were not wearing glasses was a barrier to use. As Hanson et al. [2007] reported, usability problems needed to be resolved to demonstrate benefits to dementia care. Therefore, the availability of the *Yammer* software on multiple mobile and desktop platforms was critical to its successful use in the residential home, and appeared to overcome obstacles of access, cost, and time that

carers of people with dementia encounter inhibit their use of computer technologies [Hayden et al. 2012].

The second theme was that greater benefits for person-centred care appeared to arise from accessing and sharing more legible daily care notes, than from first documenting these daily care notes. Although some digital features, such as spellchecking, appeared to support the writing of digital care notes, most of the interviewed carers tended to report the downstream benefits that arose from accessing, reading and sharing daily care notes in digital form. Moreover, the carer's awareness that their daily care notes were more easily accessed and read was reported to be a key motivation for seeking to improve the quality of these notes, consistent with their role as caring and responsible care professionals [Stevens & Pickering 2010].

A third theme was use of the mobile devices to record daily care notes in situ did not happen as widely as predicted, and even decreased over the 203 days of use. In situ recording was predicted to support carers to capture a more complete and personalised record of the needs, challenges, activities and states of each individual older person with observational skills, and to develop more empathy with each resident. However, it is possible that the time needed to record daily care notes of, on average, over 90 words, was still too great to interleave with hands-on care activities. Some carers did report some that some time was saved by documenting digital care notes with the mobile devices. However, we conjecture that this timesaving was minimal when compared with the greater time that was saved to access, search and share the daily care notes.

The fourth theme was that effect of using the *Yammer* software to change the types of content of the daily care notes was limited. While use of the *Yammer* software significantly increased the volumes of daily care notes that were already being recorded in large numbers by carers, it did not encourage or support other types of care information. The results revealed different possible reasons for this, from carer

skills and motivation to fear of a blame culture and a lack of clarity about the different types of documentation in the home to use. Overall, however, the adoption of the *Yammer* software appeared to increase the volumes of care information that had been documented with the paper forms, but did not increase the capture of new types of information. Although some implications for new software capabilities that could change this behaviour are discussed at the end of the paper, the team leaders revealed that more training and up-skilling of the carers would have been needed to capture these new types of information.

A fifth theme was the emergent need to align the policies of the residential home with emerging benefits that digital technologies and daily care notes afford. The reported decision not to allow photographs to be attached to daily care notes, in spite of the potential benefits to person-centred care, arose due to a legal constraint that did not assume that photographs could be part of a daily care note record. We suspect that this situation is a common one in UK residential homes. Therefore, better alignment of policies, legal contracts and new digital technologies will be needed in the future.

Of course, the reported results were subject to different forms of threats to validity, and different conclusion, internal and construct validity threats [Wohlin et al. 2000] are reported. Threats to conclusion validity were concerned with issues that affected our ability to draw correct conclusions about the relations between the treatment and outcome [Wohlin et al. 2000]. One obvious threat is that only 2 of the 4 team leaders took part in the evaluation, and only 10 of the 18 professional carers were available to be interviewed. This self-selection in the participation and reporting created a potential bias towards results from staff with a more positive attitude to digital technologies and related changes to care practices. However, while we cannot discount this results bias, the residential home continued to use the software and hardware devices for another 6 months after the end of the evaluation, and extended use to all team leaders and care staff associated with the wing. Although there was no systematic data collection and analysis during these

additional 6 months, the research team continued to support use of the *Yammer* software and mobile devices in the home, and there were no critical incidents to indicate that all team leaders and care staff did not use the software and devices previously as during the 203-day evaluation.

A second obvious threat to conclusions validity was our reliance on just one experienced analyst from the care sector to categorize each daily care note for the inclusion or otherwise of 6 different types of content. Our original aim was for a minimum of 2 analysts to categorize all daily care notes independently. However, the logistical challenges to find and motivate analysts and provide each with regular access to the residential home to categorize notes were great. As a consequence, the content analysis of the daily care notes reported in Section 5.4 lacks validation, and the answer to research question RQ2 remain preliminary.

Threats to the internal validity of the study were influences that could have affected independent variables related to causality [Wohlin et al. 2000], for carers to record more complete daily care notes during the evaluation. One was external pressure, both implicit and explicit, from the team leaders and the home's management, to demonstrate good practices in the presence of external researchers. However, the results revealed more complete daily care notes at the end of the evaluation, indicating that other factors such as peer pressure from other carers might have been a greater influence. Another possible source of external pressure was the researcher visits to the residential home to collect data, but these visits were infrequent, and did not involve direct visits to carers during their care tasks with residents on the dementia wing. These mitigating circumstances, combined with the relatively long duration of the evaluation, provided us with confidence that the carers were primarily motivated to document daily care notes with the *Yammer* software in order to deliver person-centred care, rather than for other reasons.

Threats to the external validity were conditions that limited our ability to generalize the results of the study over 249 consecutive days on 1 wing of 1

residential home more widely [Wohlin et al. 2000]. We recognise that residential care takes place in diverse and complex contexts – different wings with different type of resident will impose different requirements and constraints on carer behaviour and needs, residential homes operate under different financial constraints on good care practices, and there are few standardised care practices across residential homes in the United Kingdom, let alone across national boundaries. Homes also operate under different regulatory practices – practices that can influence socio-technical themes such as trust [Muller et al. 2012], and often implement different care practice models. Therefore, the authors make no claim for the generalizability of the results to other residential and social care settings. Only a handful of published studies of software use in residential care are available, and we conjecture that this paper provides one new contribution to software design in an increasingly important health and social care setting.

Finally, the research deliberately did not investigate the effect of the software on resident care, because more effective recording and use of daily care notes are only some of the care tasks shown to deliver improved person-centred care. One obvious implication is that more controlled studies are needed, in order to investigate the effect of the use of more complete and comprehensive daily care notes available on a mobile software platform might have on the quality of care delivered to residents with dementia.

Although the authors make no claim for the generalizability of the results to other residential and social care settings, it is possible to offer 5 simple guidelines to care practitioners wishing to introduce or enhance the digital recording and sharing of daily care notes in residential homes:

1. Adopt and use digital technologies that were not developed to support care tasks. These technologies often have more capabilities, are better designed, and users such as care professionals are already familiar with them. These digital technologies include software applications for *scheduling* (for

example to manage complex staff rosters), *digital newsletter management* (for example to send relatives weekly summaries of a resident's health and well-being), *social media* (for example to engage residents more effectively in resident care), and *sense making* (for example to categorise and tag daily care notes automatically, in order to generate early warnings and meta-data for longer-term analysis of a resident's well-being). Furthermore, seek to interoperate your legacy care-specific technologies with these other technologies, which are likely to evolve and offer new capabilities more quickly than bespoke care management software;

2. The attitudes of care professionals towards new digital technologies can often be positive, in part because this use can enhance their professional standing – a result also reported in [Pitts et al. 2015]. Therefore, raise the profile of new digital technologies in your care work with all interested stakeholders. Collect evidence and argue for both the direct and indirect benefits of each technology's use on care quality. Direct benefits include reduced times to document and learn from daily care notes. Indirect benefits include increased carer morale and reduced staff turnover rates, which can be both increase the quality of care delivered;

3. When introducing the use of digital care note recording, claim and sell the downstream advantages of digital care notes to care professionals, based on evidence that you seek to support the claims. Digital daily care notes can be easier than paper notes for carers to access and to read. Large volumes of daily care notes in digital form are easier than paper notes for carers to search and attribute meaning to, for example to locate events, or to use to trace clients behind important incidents such as falls and unexpected admissions to hospital. And daily care notes in digital form are easier than paper notes to share and communicate with other care professionals, as the medium of the representation is easier to manipulate, especially with the wide range of digital technologies that are now available;

4. Use the digital daily care note as a single point of entry for different types of care information, to reduce the documentation workload on carers. Different

digital treatments can extract different meanings from the same atomic information chunk. For example, a digital daily care note that describes a person's routine from rising to eating breakfast can be analysed to generate insights into the person's mental health, physical health, emotional states and evolving needs. Future research to develop these digital treatments is outlined in the next section;

5. Align the policies associated with the use of the digital technologies with the wider policies of the residential home. Digital technologies afford new opportunities, so we recommend re-aligning policies associated with privacy, security and information access to exploit these new affordances effectively, rather than developing digital technologies with limited capabilities to work within existing policies. For example, redevelop residential home policies associated with privacy to allow for managed use of photographs and video as a form of more complete daily care note. Likewise, redevelop residential home policies associated with security to enable care professionals to access data about residents off-site, for example en route to begin a shift.

7. Future Work

Although the research reported in this paper revealed the successful uptake of mobile technologies in one residential home, and many reported advantages of this digital implementation, it generated as many questions as it answers about how to design for, motivate, support and train carers to document daily care notes with digital and mobile technologies. The results indicate at least the following future research directions and developments.

First, the research revealed benefits for daily care notes in digital form, once recorded, and that digitization supported the carers to capture more of the information about daily care that was already being recorded. Therefore, one challenge is to design how record other types of daily care content – content such as

might include sense making, inferences and reflections. More effective carer training and guidance can result in the capture of different content, but one new technical intervention might be more interactive prompts to request content such as sense making, inferences and reflections. The presentation of simple questions [Maiden et al. 2013] has been shown to be effective in care work, and could be incorporated into the interactive dialogue during daily care note recording. Likewise, similar questions could be asked about photographs and other non-text input captured using digital techniques.

Second, there is a need to overcome the poor design of care information recording forms, which has led to the same content being documented more than once. One principle that we are pursuing is called *single point of entry*. This principle requires that a carer document each element of care information only once, even if the element is then repurposed for different uses. In the reported evaluation, this was not possible, due to digitalization of only the daily care notes, and not other types of document such as skin charts or fall reports. Therefore, future research will seek to use the existing architecture to digitize most if not all of the forms, using daily care notes as the single point of entry.

Third, we are developing new capabilities to parse each daily care note, as implemented in [Zachos et al. 2013], subject each parsed note to a set of codified rules that infer most probable types of care event and situation described in each note, then prompt the carer with further questions about the event or situation type, to elicit a more complete note. This new style of more interactive daily care note recording, which has the potential transform form-filling into a meaningful dialogue, is only possible once digital support for daily care notes is embedded. The reported research is an important steppingstone towards delivering that vision.

Finally, another future line of work will be to investigate the potential effects of the software and device use during person-centred care tasks on the quality of care delivered to residents with dementia, both in the home described in the study and

elsewhere. We envisage that this research will be more qualitative and event-driven, investigating if and how affordances of the software and the devices might contribute to important care events and outcomes, such as going outside of the residential home on trips, and post-fall care.

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