Healthcare Professionals Views on Technology to Support Older Adults Transitioning from Hospital to Home

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One of the challenges of an ageing population is the impact this has on healthcare systems, as living longer can potentially result in higher levels of frailty, chronic disease, dementia and other age-related illnesses. In turn, this may result in higher numbers of hospitalisations and longer hospital stays. Thus, understanding how to support safe and timely discharge of older adults from hospital to their home, and support a return to independence, is critical. Monitoring technology can play an important role in this. However, it is necessary to understand the key role of technology in transitional care as well as the facilitators and barriers to integrating such technology into practice. This paper explores these issues, by presenting a study that uses remote monitoring technology to support older adult patients transitioning from hospital to home. We present findings from evaluations with a range of healthcare professionals on the potential uses of such technology to support transitioning. We also highlight potential barriers and facilitators to integration within health systems.

1. INTRODUCTION

Worldwide, populations are ageing at a dramatic rate. Ageing populations present many opportunities for society. However, one of the challenges is the impact this has on healthcare systems, as living longer can potentially result in higher levels of frailty, chronic disease, dementia and other age-related illnesses. In turn, this may result in higher numbers of hospitalisations and longer hospital stays. In Ireland, 80% of delayed discharges of older people are due to patients waiting for nursing home placement or for a home care package to be arranged (O'Regan, 2015). Similarly AGE UK (2014) showed that older adults were waiting an average of 28.6 days in hosptial for a social care package to be put in place, with a hosptial bed costing around £1900 a week compared to around £530 for residential care. In the US, there is an 18% readmission rate to hospitals within 30 days of discharge and it is estimated that 76% of these are avoidable (Jencks, Williams & Coleman, 2009).

As such, there has been an increasing interest in how to support safe and timely discharge of older adults from hospital to home, and support a return to independence. With advances in sensor technology, opportunities are now emerging to embed unobtrusive monitoring of human behaviour into the home environment. Such systems can provide very powerful and meaningful information, recording patient improvements or challenges, following a hospital stay. However, it is critical to understand how such technology might be integrated into practice.

To explore issues around the potential of remote monitoring technology to support older adults in transitioning from hospital to home, we undertook a study whereby patients with mobility issues were recruited and monitored using various sensing devices over a period of 2-5 weeks in a transition hospital (TH) environment, as well as for 8 weeks in their own home post-discharge. Sensor-based data monitoring included activity levels, sleep, blood pressure and weight. Self-reported data was also captured through a short, tablet-based daily questionnaire. The data was automatically processed and presented to TH healthcare professionals (HCPs) via a web interface on a laptop, and to patients and their carers through mobile and tablet interfaces.

In this paper we present findings from interviews with 10 HCPs (including clinicians and management), the goal of which was to explore the

potential of techlogy to support the transition process. To provide rich context to the interview process, interviewees were presented with real data from patients who have taken part in the study. While our study is also evaluating patient and informal carer feedback in addition to changes in wellbeing over time, these findings are outside the scope of this paper. Our main contributions relate to (1) understanding the potential role of remote monitoring technology in supporting the transition process, (2) whether HCPs and healthcare management feel monitoring such information in hospital and home environments can mitigate risk of discharge and provide useful information to aid preparation of care plans and (3) understanding the barriers and facilitators to integrating such technology into healthcare practice and national health systems.

2. BACKGROUND AND RELATED WORK

Transition hospitals often act as 'step-down' facilities, where patients are transferred when they no longer need acute care services in a hospital, but are not yet capable of going home, due to the need for further rehabilitation, or lack of adequate supports. Recognition of the need to improve transitions from hospital to home is primarily being driven by a desire to support early discharge and reduce hospital readmissions. However, using technology to support this transition can also improve patient care, through more personalized care plan creation and the ability to monitor patient progress or decline following discharge.

While there are many studies investigating technology to monitor patients either in hospitals or their home, technology to support the transition from hospital to home has not yet been widely explored, particularly for older patients. However, several studies have researched the use of technology to support the transition for other populations. For example, BackHome (Sanchez, 2014, aims to support people with severe disabilities, focusing on brain-neural computer interfaces and other assistive technologies in both environments to support people through this transition. Hayes et al. (2011) examined the use of monitoring techlologies for supporting the transition of premature infants from hospital to home, tracking their behaviour and movement. They found that while monitoring technologies have the potential to bridge this transition, there is some way to go before such a system can be intergrated into healthcare practices.

Ostrovsky et al. (2014) emphasised that poor transitions are often a result of poor communication, with patients not comprehending the information provided by HCPs. They recommended that technology could support this transition, however consideration is needed in relation to patients' experience with technology, privacy and security, workflow integration, and liability. They suggest rigourous research is needed to address these challenges.

Claudio et al. (2015) describe a study to evaluate the usefulness and ease of use of wireless wearable technology to monitor patient vital signs in a hospital emergency department. They found that both patients and nurses thought favourably towards perceived usefulness, whilst patient feedback on ease of use was more favourable and less variable than nurses' feedback. However, the study only evaluated a 30-minute, once-off testing session with participants and thus is limited in terms of its utility to predict acceptance and engagement. Cook et al. (2013) used fitness monitors to measure the mobility of patients post-surgery to assess their recovery. They found an ease of integration of the devices into the health care practice, during the trial. Moreover, the data from the accelerometer devices showed a significant relationship between the number of steps walked in early recovery and the length of stay in the hospital. Similarly, Mansfield et al. (2015) used accelerometer devices in stroke rehabilitation to assess how daily feedback would influence inpatient progress. They found that patients who received feedback significantly increased cadence of daily walking compared to the control group. These studies highlight how monitoring technologies can be useful in the treatment and recovery of patients. Appelboom et al. (2014) stated that the promises of wearable monitoring devices to transform the healthcare delivery are multifold: helping clinicians to remotely and continiously monitor patient progress, identify patients most at need, and streamline patient-HCP communication.

Chiauzzi, Rodarte, and DasMahapatra (2015) noted clinical integration as one of the main challenges for the use of monitoring technologies in healthcare, where clinicians may not welcome additional pressures on their time with further data sources. Chiauzzi et al. suggests that patient-driven health-care, may be one path to the success towards widespread patient-HCP adoption. Self-monitoring can have very positive effects on patient recovery (Mansfield et al., 2015), health education and empowerment (Doyle et al., 2014), (Kendall, Morris & Tan, 2015). Within the home environment, remote monitoring technologies typically include ambient, wearable and/or physiological sensors. However, evaluation of their use and benefit often focus on single tools for chronic disease management (Ahuja, Ozdalga & Aaronson, 2015), blood pressure management (Kendall, Morris & Tan, 2015), sleep (Vandenberghe & Geerts, 2015), mobility (Cook et al., 2013), rather than examining how a suite of technology might be beneficial.

Remote monitoring technology has the potential to gather very rich datasets on behaviour, and can support both alerting and monitoring patterns over time. However, integrating the use of such technology into healthcare practice introduces numerous challenges, and requires the engagement of both HCPs and patients to ensure its usefulness and effectiveness (Glascock & Kutzik, 2006). Therefore, understanding stakeholder requirements, preferences and designing for these is necessary to increase the prospect of engagement. Furthermore, understanding how to implement the deployment of such technologies in practice, in both hospital and home environments, is critical. Our work begins to explore these issues.

3. OVERVIEW OF STUDY

The work presented in this paper represents one part of the larger study described in the Introduction. The goal was to gather initial feedback and opinions from HCPs as to the potential benefits of the system to support transitional care for frail older adults. To provide context on the patient profile, the age range of the 15 patients recruited as part of the study is 64-94, with a mean age of 83.

Data gathered during the study included Activity (step count, distance) measured with a pedometer, home activity (time inside/outside, room location) using ambient sensors, sleep (time in bed, bed exits, tosses and turns etc.) using an under-mattress bed sensor, blood pressure, weight and self-reported mood, sleep, falls, fear of falling and pain captured daily through a tablet device. Activity and sleep were recorded in both the hospital and home, and other data sources were collected within the home. Data from each of these sources is integrated into a purpose-built hardware agnostic data aggregation platform CABIE (Doyle et al., 2014) which normalizes the data, analyses it and sends it to the purpose-built Kiduku cloud (Inomata & Yaganuma, 2014) for visualization/feedback to clinical stakeholders. Data is visualized through two interactive applications, one for patients and one for HCPs. Patients are provided with a tablet, through which they monitor their blood pressure and weight, self-report and receive feedback (both data and education) through a web-based application.

HCPs within the two THs through which patients are recruited have access to a web-based interface displaying data for various patients in their care (Figures 1-3). Figure 1 shows the dashboard presented to HCPs on opening the application,

highlighting an overview of the patient's activity, sleep and vital signs over the previous week. HCPs can navigate to a particular date, or view the data in day or month view. Participant details are included and there is a section to write notes. It should be noted that while the data displayed in Figures 1-3 is from a patient within the study, personal details have been changed to ensure anonymity.

HCPs can view more detailed data by clicking any of the tiles. Data for Activity for a one week period is shown in Figure 2, which depicts walking data (daily step count and average weekly step count and distance) as well as time outside the home and time spent in various rooms of the house. As can be seen from the middle graph in Figure 2, this particular participant spent all of her time inside during this week, which was shortly following discharge.

Figure 3 shows detailed information on sleep over the course of one week including an average sleep score, sleep activity, heart rate and respiration rate and number of tosses and turns and bed exits.

HCPs did not actively use the system depicted in Figures 1-3 during the study, primarily because once a patient is discharged from the TH, governance of care transfers to community clinicians (the General Practitioner and/or the Public Health Nurse), and thus the TH HCPs cannot make decisions based on the data. The scope of the present study did support recruitment of community HCPs. However, for the purposes of the interviews, TH HCP participants interacted with the live system and real patient data.
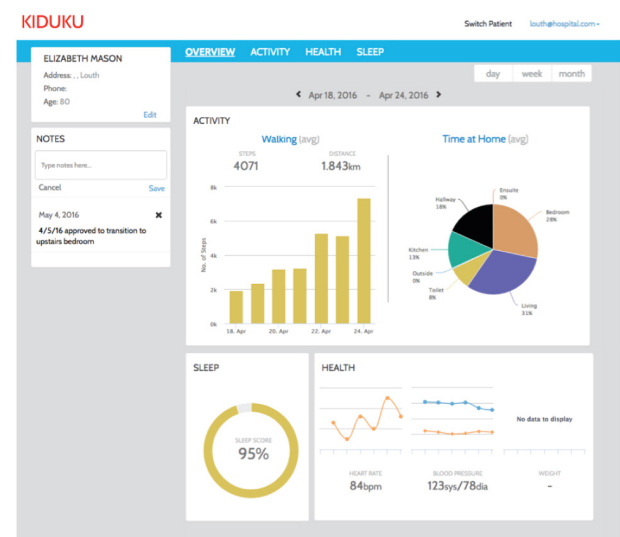

Figure 1: *Overview dashboard of HCP interface showing patient data over a one week period*
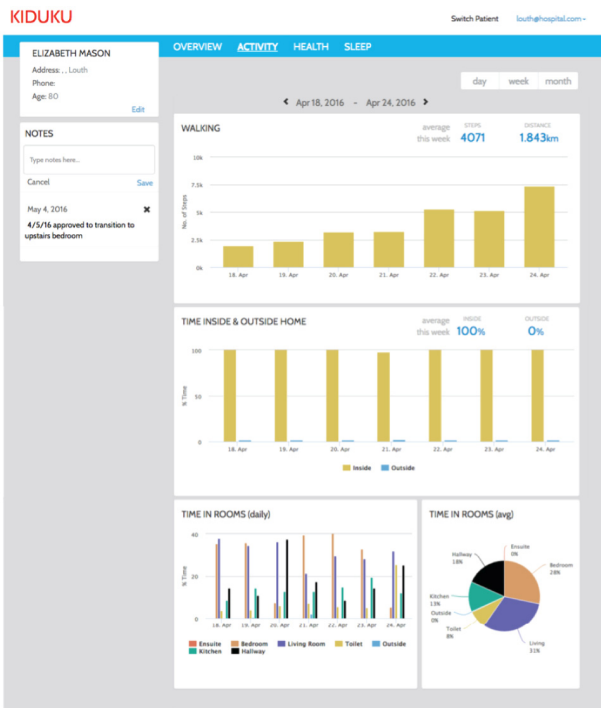
Figure 2: Activity data displayed on the HCP interface

Figure 3: Sleep data displayed on the HCP interface

3.1 Study Participants

HCPs within each TH are involved in both recruitment of patients and study evaluation. The HCPs are not members of the research team. Within the THs, the research team has primarily engaged with physiotherapists, occupational therapists (OTs), discharge coordinators and clinical nurse managers. To fully evaluate the potential of such technology across both hospital and community settings, community-based HCPs and health services managers have also taken part in evaluation interviews. A full list of participants from whom data was collected for the purposes of this paper is outlined in Table I.

Participant ID	Role
Phy1	TH Physiotherapist
Phy2	Community Physiotherapist
OT1	TH Occupational Therapist
OT2	TH Occupational Therapist
OT3	TH Occupational Therapist
CNM	TH Clinical nurse manager
DC	TH Discharge Coordinator
PHN	Public health nurse
Man1	TH Assistant Director
Man2	Health Service Manager for Innovation in geographical study area

Table I: HCP Study participants

3.2 Methodology

Interviews were conducted with a range of HCPs, as outlined in Table I. Phy2 and Man2 were interviewed alone, while other HCPs were interviewed in small groups – (1) Phy1 and OT1, (2) OT2 and Man1, (3) OT3, DC and CNM. The first part of the interviews assessed the HCP's role in caring for patients within the study, as well as their role in the discharge and follow up process and how this is normally planned. The second part of the interview involved a discussion guided by patient data from the study. Data was presented to the HCPs and they were asked about its utility, how/if it could be integrated into practice, how/if it could be useful to support self-care at home, as well as benefits and drawbacks. Interviews lasted an average of 40 minutes, and were typically conducted during the HCPs' lunch hour, due to difficulty of fitting into busy schedules. The interview protocol with Man2 and PHN were slightly different. Man2 was presented with data, but did not know the patients. This interview focused more on the potential benefits of such data from a health system perspective. The PHN (of one of the study participants) was not available for a face-to-face interview. However, a short interview was conducted over the phone after she had the opportunity to see the technology and data in the participant's home.

In terms of data presented, the focus of the interviews related to data from the first participant who completed the study, who was hospitalised for a stroke. This was to ensure all HCP feedback

related to the same data. Activity data was first presented to HCPs (walking data, time inside/outside and room location), alongside self-reported data including reported falls, fear of falling, mood etc. and questionnaire data (falls efficacy) for 3 time points within the study (start, middle and end). The data was presented alongside the dates of reported falls. Data for the total study period was shown, and then viewed more closely in month, week and day views. A similar format was used to present sleep and vitals data, with self-reported and questionnaire data displayed alongside sensor data. The purpose of this part of the interview was to explore how useful the data would be for different HCPs in different settings, how they would use it and what additional information might make it more useful.

This paper focuses on data collected during the interviews with HCPs. Other data being collected, such as sensor data, self-reported data and detailed interviews conducted with patients and their families regarding their experience and their use of the Patient Application, is outside the scope of this paper and will be reported on elsewhere. All audio data were transcribed verbatim. Analysis was conducted using NVivo v.11 for Mac. An emergent coding approach was used, whereby two of the authors reviewed a subset of the data independently and developed a list of coding categories. The categories were compared and a further iteration led to consolidation of codes. These codes were then applied to the full dataset.

4. STUDY FINDINGS

The analysis resulted in 3 main themes relating to the transition process, integration into health systems and benefits.

4.1 The Transition Process

A theme that arose in all interviews was the unique nature of the transition from hospital to home, particularly in terms of how this impacts patients and their families.

4.1.1 Impact on Patients and Family
The transition process was described by HCPs as "critical", "stressful" and "a big event". To try to ease the process, one TH have implemented a staged transition: "Before they go home for good, we do send them for a couple of hours, they come back and then we will send them for one night, then two nights" (Phy1). Staff felt that this made the transition "less dramatic" (OT1), as patients have the opportunity to "come back and let us know what kind of difficulty they have. So then we can correct the problems" (Phy1). TH staff felt that implementing the suite of technology in patient homes during this staged transition phase would be

very useful, particularly in terms of understanding their readiness for complete discharge. This is expanded in 4.2.1.

4.1.2 Care Plans for Transitioning
The discharge to home is carefully planned within each TH. In one, a specific discharge coordinator is in place to work with patients and their families to discuss practicalities of transitioning home, as well as to highlight services that are available in the community to assist: *"That's the whole idea of discharging them home with services. So I would link in with the public health nurse, and with the home supports and other services, be it meals on wheels, day care, physio or primary care"* (DC). In terms of care plans, it was noted how the existence or completeness of this may differ dependent on *"where they're* (the patient) *coming from, who the clinician is and how involved they are"* (Phy2). Both TH's develop a discharge report, which acts as a care plan. They make a referral to the PHN, who typically visits a couple of weeks post-discharge, and where further physiotherapy is required, referrals to community physiotherapists form part of the care plan. It was felt that the data generated could enhance the care plan. Phy2 noted that when patients transfer: *"It's not the same physios, OTs, nurses seeing people and often the reports aren't as comprehensive as you'd like. Something like this which is visual, comprehensive and includes this global picture.. that's definitely something I could see it* (the data) *being used for – where they were, where they are and where you want them to go"*.

4.2 Integration / Adoption into Health Systems

4.2.1 Potential Usage of Data
HCPs saw many uses of the data, from monitoring, to treatment planning and goal setting. Given that on discharge, patients are referred to the community, hospital HCPs felt the data might be more beneficial for community HCPs. Despite this, all hospital HCPs *did* see how it could be used in the TH setting. HCPs within the TH that implements the staged transition felt that the technology would be particularly useful in their assessment of the patient's readiness for full discharge. Phy1 noted: *"Most of the patients would be able to walk when they go home* (during the staged transition). *Most of them though sit in the wheelchair".* In this way, the activity data could be used to determine if the person is moving whilst home. OT1 felt that the self-reported data during this time would be particularly useful from an OT perspective: *"Where it does become beneficial is if you are seeing how do they feel when they go home".* Hospital HCPs also felt it would be useful for them even after a patient has been discharged. DC noted *"You would correlate it with what was going on here before they went, so I suppose that would be* (interesting)*".* Thus while initially TH staff were reluctant to view

the data in real-time due to governance issues, actually viewing the data during the interviews demonstrated ways in which it could be beneficial to support their work.

Within the community, it was felt the data would primarily be used by the public health nurse (PHN), during the 3-week post-discharge follow up and physiotherapists to whom discharged patients have been referred. Following a discussion regarding the types of data being recorded, the PHN felt that it would be useful to have this data prior to the home visit, as it would provide insight into how patients are coping following discharge and what services they might need to be referred to. Man2 felt that reviewing the data would be very useful for community geriatricians during their multidisciplinary team meetings.

4.2.2 Barriers to Integration / Adoption
A theme to emerge in all HCP interviews involved patient governance, or responsibility for looking at patient data collected within a home environment. In transitioning scenarios, this can become quite complex as a patient's pathway can include transitions from acute hospital, to a transition hospital to community services (medical and non-medical) whilst at home, and sometimes back to hospital. Thus, a wide range of HCPs are involved. HCPs questioned who might be responsible for reviewing and acting on data, and how this would be integrated into work practice when HCPs are already so busy. Another important issue where a gap became apparent is in patient follow-up post-discharge. While referrals are made to relevant services, ensuring these follow-ups happen needs coordination, given the current fragmentation of services.

This issue of data governance was raised during the interview with Man2 who noted: *"That's a really interesting question and its one we have to address. I think we'll only do that when we have walked through a few case studies* (of the study data). *But we need to work through that to see how we can do it"*.

Not surprisingly, it was felt another significant barrier to integration into healthcare practice would be resource related, particularly cost and HCP time. In terms of using the data day to day, OT2 said: *"I suppose the capacity for anything extra on top of what we're already doing, it's quite bad"*; while Man1 added: *"There's no point me promising something that we're not going to be able to.. because out there* (on the wards) *they are really struggling to keep on top of things.* Man2 noted: *"the clinicians I know want to help people though and they want people to be able to stay at home. If they can see the wins they will start to use it."* Man2 continued: *"when it's* (the technology) *refined and honed, it's easier to go in and say, this will help*

you. At that point we can take it nationally, to clinical leads. They'd be really interested in this". She felt that using the data to present case studies of the benefits for both patients and HCPs (e.g. *"to make better decisions or cut down on their workload"*) would encourage health systems and HCPs to find a way to *"carve out the time"* to use it. This was also evident in our experience of working with TH HCPs, who were initially slow to engage with the research team to recruit participants into the study. However, once the first participant was recruited, and HCPs could see data coming in, their attitudes changed and their resulting engagement was crucial to patient recruitment and retention.

Cost implications were discussed in detail with Man2. When provided with a rough overview of the cost of sensors and data gathering, she noted: *"It's not huge. There's no reason why you couldn't use 'intensive homecare package' money to buy this, if you had the right individual who was motivated and was at a high risk. That wouldn't be unreasonable"*. This indicates that integration of technology into home care packages post-discharge is something the health system would consider funding. It was highlighted however that this would be *"something you'd need to have a policy decision on"*.

A potential way to overcome the issue of lack of time was outlined by Phy2 who highlighted that in current work practices HCPs don't have time to read long patient reports. What works well in practice is a *"2-page synopsis to show progress over time, to show effectiveness of treatment or how they responded to treatment either positively or negatively, and any events that occurred in that time. So I think if you could print it out in a nice one or two page format, that would be useful"*.

4.2.3 Trust in Data
Towards the end of the interview, HCPs were asked whether they would trust the data, and a follow up question asked whether they would trust it enough to use it. The notion of trust in data had not arisen in any of the interviews before the interviewer raised it. When asked, OT1 said: *"That's a good point actually"*. While many of the HCPs noted that the data might not be 100% accurate, it was felt by all that it would provide a better overview or picture of how a person is doing than what is current practice. Phy2 commented: *"We rely very much on self-report and it's got to be more accurate than that. Especially around activity, people tend to vastly overestimate how much they do"*. She continued: *"I think the fact that you have so many time points and that you're measuring continually over a number of months, a long period of time, you'd hope on average you're getting a relatively stable picture of how the person's doing"*. OT1 also commented on how the longitudinal nature of the data would help to increase trust as overall it would provide a *"fair average"*.

HCPs noted that they might be slightly more concerned with the accuracy of data that was reliant on the patient providing it. For example, with regard to the self-report data gathered from patients through the PA, HCPs recognised its importance in terms of understanding the *"impact"* treatment or the transition process may have on patients, as well as having this data *"slightly more quantified"*. However, it was also questioned whether they would be *"honest"* with the answer.

All HCPs said they would trust the data enough to use it, particularly the activity and the vitals data (blood pressure, heart rate and weight). It was noted that the data would not replace face-to-face interactions with patients, so HCPs would not be relying solely on the data. Man2 wondered whether trust in data might reflect *"ignorance"* or lack of knowledge of technology amongst HCPs, an important point as it was noted during interviews that missing data points (e.g. for 3 days P1's bed sensor was unplugged resulting in no data for these dates) were not questioned by HCPs. This may be due to the longitudinal nature of data providing a good average. This requires further investigation and will form a key component of our future interviews with HCPs as part of this study.

4.3 Benefits

The most recurring theme throughout the HCP interviews related to potential benefits of the data.

4.3.1 Benefits of Specific Data
Activity was considered a very important and useful indicator of a person's wellbeing. Regarding the benefit of knowing time spent inside and outside the home, Phy2 commented: *"the challenges of being outside are different to the challenges of being inside"*. This data would be beneficial because a physiotherapist might want a patient to increase the time they are spending walking outside. It was also noted that being outside is *"a good marker of somebody's mood"* and that the data could act as a trigger to speak to the patient about why there are not going outside. Given that patients are transitioning, HCPs also want to know that they are increasing their walking over time (both while in the TH as well as at home), not only in terms of step count but *"increasing endurance"* (i.e. increasing the time spent walking in one go) as this is an important marker of improvement.

The OTs and physiotherapists felt that sleep data would be beneficial, primarily from a safety perspective. OT1 commented: *"Where it would come in handy is where you've got patients who are at risk of falls and shouldn't be mobilizing on their own, for example, getting up to go to the toilet during the night time"*. Phy1 added: *"This would definitely tell the family how many time they're trying to get out of the bed without supervision.*

They would be aware of that and try to be more conscious". Phy1 also highlighted that it would be useful information whilst the patient is still in the TH, as day staff don't usually know how much a patient is getting up at night. Phy2 said understanding why a person is getting up multiple times at night would be important for planning their care: *"It could be a medical issue. Maybe they need to go back to the doctor, you know habits of eating, drinking, medications and timing of them"*. Understanding the reasons behind bed exits could be explored as part of the self-reported data.

It was felt that blood pressure data would be of benefit to patients as well as to the public health nurse. Phy1 said: *"That's really helpful because most patients, they don't go to see the GP regularly. And they don't check their BP once after they go home"*. OT1 said: *"You gave the example there, he* (P1) *went to the GP because it* (bp) *was high. So if its making you aware then its prevention isn't it"*. Phy2 felt that having access to a patient's blood pressure over time could be used in terms of understanding their capabilities during rehab: *"It can be reassuring that if you want to up someone's activity level and push them a little harder, that you know they're medically quite stable"*.

The self-reported data was considered particularly beneficial: *"I think its one thing us interpreting what you see from the data, but what's really important is how the person* (patient) *reacts to it, how they feel about it. Some people might have a fall and their confidence might not be affected and that might not necessarily be a good thing, because they might be falling cos they're taking risks, they're over confident"* (Phy2). As OT1 noted above, self-reported data would be particularly beneficial during the staged transition process, allowing patients to report on how well they are coping during their time at home before discharge.

4.3.2 Benefits for HCPs / Health System
One of the primary potential benefits of such data for both HCPs and the health service in general is its ability to provide baseline data for a person in their natural, home environment, before admission or readmission to hospital. CNM said: *"That would be really helpful, especially if they live alone, at least you know regarding continence, regarding sleep, movement, falls. If someone was readmitted. We spend a lot of time trying to find out what the person's baseline was before they were admitted"*. Man2 said: *"I do think this kind of thing is very helpful. It's another tool to help them* (HCPs) *make good, considered decisions"*.

Another benefit related to having objective data to support a referral for particular services. For example, DC spoke about the difficulty in getting a carer for a patient between the hours of midnight and 8 in the morning, due to lack of resource. She

noted that having access to sleep data, showing restlessness and bed exits could be used *"to support your requests for calls at night"*. CNM noted that *"There are loads of disciplines that could link in with it* (the data)*. Even your GP visit"*. It was felt that having objective data would be useful in assuring family members that patients were ready for discharge, but also to make them aware of the patient's activity. For example, OT3 mentioned: *"Sometimes families would, you know when we report patients getting out of bed* (in the hospital)*, they'd say well that's new – they don't do that at home. So this way you can see if they were doing that at home or they weren't"*. DC continued: *"If some families don't want them* (the patient) *to go home, its an argument – well they never got out of bed before and now they're at risk, can you guarantee that they're not going to fall?"* Man2 also raised this benefit of having data to show family members. The fact that data collected is from the patient's *"natural environment"* was seen as particularly useful. OT3 and CNM noted how at home, patients *"come into their own"*, or do better.

Another theme related to patient self-management, and how this could support preventative rather than reactive healthcare. OT1 said: *"You're focusing on prevention. I think the problem with all the health services is that we are more reactive instead of proactive. So this (the data) is forcing it to be a bit more proactive"*. OT1 provided the example of patients self-reporting that they are falling. If picked up, the patient can be referred to a falls prevention class early (as was the case with P1 during the study), rather than at a later stage after they've fallen and potentially broken a hip.

4.3.3 Benefits for Patients and Family
From the HCPs' perspectives, the main benefit for patients and their families related to potential empowerment: *"I would say that patients start to take a bit of ownership over their own health. I don't think they do that very often"* (OT1). DC noted: *"It's giving them (the patient) governance for their self-care and that would be very important"*.

Phy2 felt that the data could by used by patients to *"guide their own recovery"*. She noted, *"It's down to what the person does themselves, it's not all about what the therapist is doing for them"*. DC noted: *"What they're (patients) interested in and what their family is interested in, is that they're improving, that they can see that they're improving"*. Despite the potential benefits for patients, some HCPs also spoke of potential drawbacks. Man1 questioned the benefit of some of the data for patients: *"You're talking about sleep patterns. So how is this helping the patient who is going home to live on their own?"* Phy1, Phy2 and OT1 worried whether anxious patients should have access to their data, with OT1 wondering whether it could turn patients into *"hypochondriacs"*. Man2 raised the point that sometimes "ignorance is bliss".

5. DISCUSSION

This study highlights a potential new paradigm for remote monitoring technology – its ability to play a role in monitoring and supporting rehabilitation, functioning and patient empowerment not only when transitioning from hospital to home, but across pathways and services. This section discusses the implications of our findings.

5.1 Key Roles for Technology to Support Transitional Care
From synthesizing study findings, a number of key roles have emerged for technology to support transitional care. These include (1) Enhanced, personalised and integrated care plans; (2) Risk mitigation (associated with discharge and re-hospitalisation) and (3) Patient Empowerment.

5.1.1 Enhanced Patient-Centred and Integrated Care Plans
HCPs in our study highlighted the potential for such data to aid in more detailed, personalised care plans, from monitoring patient progress, treatment planning and goal setting to understanding a person's baseline while at home. HCPs highlighted how this technology would not only support the transition from hospital to home, but would also support community and service referrals, as well as hospital readmission, providing baseline information on how a person behaves in their own environment. Thus, such data would be of benefit to all current and future HCPs caring for a particular patient, as well as to patients and carers, and the data could act as a centralized care plan, supporting collaboration amongst different stakeholders, centred around the needs of the patient. In line with this, supporting the generation of a two-page, printable summary of patient data would ease its integration into the current work practice of many HCPs and increase the likelihood that such data would be used as part of patient care.

Integrated care refers to services that span the care continuum, are integrated within and among the different levels and sites of care within the health and long-term care systems (including the home) and are offered according to peoples' needs throughout the life course. While our study was limited to one country, it is well documented that lack of integrated care is a critical issue in health systems globally, affecting various patient cohorts and diseases/illnesses (Rijken et al., 2013), (WHO, 2015). The effects of this may include reduced efficiency as many HCPs do not have access to patient histories, previous test results and treatments, potential lack of safety, for example

when multiple medications might be prescribed and increased burden for patients, who may need to recall history and treatment plans for new HCPs. Evidence suggest that integrated care for older adults can be achieved by bringing relevant services together in a person-centred approach, placing emphasis on case management and supporting self-management and ageing in place (Goodwin et al., 2014), (WHO, 2015).

5.1.2 Risk Mitigation
It was generally felt that such technology could mitigate the risk involved in discharging patients home, particularly if it is deployed as part of a staged transition phase, to determine if patients are ready to be discharged. This could address issues of delayed discharge as outlined in (Age UK, 2014) and (O'Regan, 2015). HCPs felt the technology would increase confidence, not only for HCPs but also for family members, who are often concerned that patients are being discharged before they are ready. While technology might not prevent re-hospitalisation for new medical issues, it could potentially prevent readmission for issues related to mobility and function. If data is actively monitored, timely interventions can be made.

5.2 Barriers to Integration

As expected, HCPs felt that barriers to integration included issues surrounding cost (of introducing technology) and time of HCPs to review data. Such barriers are also noted in (Chiauzzi, Rodarte & DasMahapatra, 2015). Lack of digitisation in the health service also represents a significant barrier. Further issues, which didn't arise in the interviews but which nevertheless would impact on integration into practice include additional cost and resource challenges around rolling the service out nationally and continuing provision. National infrastructure, particularly access to broadband, could prohibit the roll out in some geographic areas.

However, the main perceived barrier, from a HCP perspective, to the integration of such technology into practice is the current gap in service required to govern the data, including issues around responsibility of acting on data. Despite this, Man2 felt that this wouldn't be an issue that would affect integration. She felt it was more important for the technology to be *"working and making a difference"*.

Figure 4(a) shows current/ traditional pathways for patients transitioning, while 4(b) illustrates where we believe health systems need to move. The dotted green circle represents a new, central hub where care coordination needs to occur. Which service this new role 'fits' within (i.e. clinical, social etc.) is something that health systems need to consider. Man2 suggested it might be a clinical nurse specialist, preforming a 'triage' type role. The
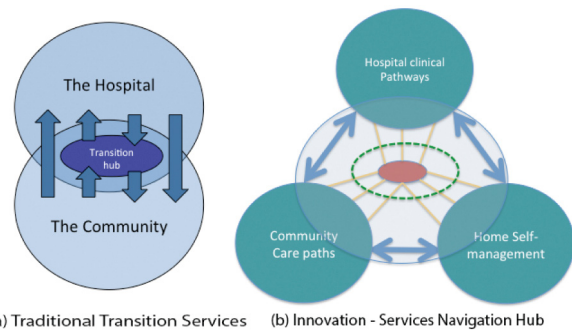

Figure 4: Traditional vs. Possible Pathways

idea of a case manager or coordinator is not new and it is recognised this role can translate to a single point of entry for patients, help with assessments and improve patient flow, sharing of information and service coordination across multiple healthcare settings (Goodwin et al., 2014). The introduction of technology-based patient data to support this role is novel and can potentially result in provision of better intelligence to support better decision making across settings, increased patient and family home-based capacity to self-manage, provision of continuous visibility of patient status and extension of the reach of clinical excellence through community to the home. We envisage this role as crucial to integration of such technology into practice.

5.3 Facilitators to Integration

HCP acceptance and acknowledgement of the benefits of the data will likely be one of the main facilitators to technology integration. HCPs saw the benefits of each data type for assisting the transition process and supporting further rehabilitation post-discharge. The data was also deemed beneficial to HCPs across various healthcare settings, as well as to patients, family members, carers and other services that might also be involved in older adult care. Man2 said that linking in with hospital and community geriatricians would help to get traction, and highlighted the need to find one or two champions within the health system who could help to drive this towards becoming a service.

An important finding was the perceived benefit of the self-report data. While it was noted that self-report might not always be accurate, having an indication of how the patient is coping post-discharge is considered very important. Participant reporting of falls through the Patient Application also enabled the referral of the patient into a falls prevention programme, highlighting its potential benefit in practice.

An interesting finding, which is potentially vital for integration into practice, relates to HCPs trusting the data, and moreover, trusting it enough to use it. One of the reasons provided for this was the

longitudinal nature of the data. Despite this, it is important to note that such technology is not always reliable and robust. Completeness of data and potentially the quality of data can be compromised by inaccurate usage of devices, internet outages, unplugging sensor devices etc. A concern is that the HCP's job becomes more difficult when presented with potentially uncertain data and this leads to further issues around where responsibility and liability sits. This topic will be explored further throughout the course of the study.

Another finding related to discussions with Man2, who outlined that success criteria for such a project would include the ability to show relevant decision makers case studies of participant data, highlighting benefits for both patients and HCPs, and particularly including feedback on how HCPs would use this in their work practice. Traditionally, health systems have required RCT-type evaluations as evidence of robustness and effectiveness of technology interventions. However, it is possible that health systems are now recognizing that more pragmatic study designs, as are required in such studies, can also provide convincing 'evidence'. We will further investigate this issue through interviews with key clinical and health service management staff throughout our study.

6. CONCLUSION

This paper has explored issues surrounding the integration of technology into healthcare practice, to support older adult patients transitioning from hospital to home. One of the main goals of our research study is to understand how this might be integrated as a service into healthcare systems, to ensure such research moves beyond pilot studies. As such, our study represents a proof of concept, for which to explore these issues. Through our evaluations with HCPs, based on real data from patients who have transitioned from hospital to home, we have learned that such technology and data can support more personalised and integrated care, can provide confidence in readiness for discharge and ability to cope post-discharge, as well as potentially empowering patients to take more control of their recovery and wellbeing. We also learned that key facilitators to successful integration involve a potential new role within health systems to govern and respond to data, as well as case studies that demonstrate benefits to various stakeholders.

The main contribution of this paper is an exploration of *how* and *why* the data generated from remote monitoring technology could be used by HCPs in practice, specifically to support older adults transitioning from hospital to home. An understanding of these issues is critical for HCI

researchers to ensure such systems are accepted and adopted. The strengths of this paper lie in the nature of the data presented to HCPs. Data was from patients known to them, which provided rich context to the interviews. Furthermore, the main case study presented to HCPs consisted of 12 weeks of patient data spanning both transition hospital and home environments. The paper is not without limitations, however. Our goal was to interview HCPs who treated our study participants. Our findings indicate that this data is potentially of benefit to a much wider range of HCPs than we originally thought, and as such we will interview additional HCPs across different care settings, including GPs and consultants. This will allow us to further explore the potential of such data to support care across pathways other than transitioning from transition hospitals to home.

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