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Patient-Held Health IT Adoption Across the Primary-Secondary Care Interface: A Normalisation Process Theory Perspective

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ABSTRACT

Patient-held Health Information Technologies (HIT) can potentially reduce medical error by improving communication between patients and the healthcare team across settings. Despite the proposed benefits, the roll-out of patient-held HIT solutions remains nascent, leaving considerable gaps in our understanding of the adoption challenges inherent. This paper adopts Normalisation Process Theory to study the factors which support or impede the adoption and eventual 'normalisation' of patient-held HIT solutions, particularly across the primary-secondary care interface. The authors conducted an in-depth case study of a patient-held HIT adoption across four urban GP practices (approx. 8000 patients per practice), and the wards of a 350 bed urban hospital in Ireland. 35 semi-structured interviews were completed with patients, general practitioners, junior hospital doctors, and IT professionals. Findings point towards both user-specific and network-specific factors as significant challenges to normalisation across the primary-secondary care interface. This includes factors related to interactional workability, skill set workability, relational integration, and contextual integration. In addition, we discuss challenges specific to patient-held HIT adoption e.g. understanding the patient / clinician experience, supporting informal clinician networks, and spanning across IT boundaries.

KEYWORDS
Health information systems, electronic personal record, electronic medical record, implementation, diffusion, health information exchange, Normalisation Process Theory

1. Introduction

Patient-held Health Information Technology (HIT), such as electronic personal health records, has been proposed as a tool for improving standards of patient care at the transition between primary and secondary healthcare settings (Kruse & Beane, 2018; Zhang et al., 2019). This is achieved through efficient communication among patients and the healthcare team (Gates et al., 2019; Lahtiranta et al., 2015; Razmak & Bélanger, 2018; Walsh et al., 2018; Zhang et al., 2019). Patient-held HIT solutions are mainly preventative in nature and can help increase the quality of healthcare delivered by ensuring that stakeholders are provided with timely, accurate, and pertinent information regarding the patient's status (Jones et al., 2014; Zhang et al., 2019). For instance, patient-held HIT can increase adherence to guideline-based care, and enhance the surveillance and monitoring of a patient's medication treatment (Radley et al., 2013; Walsh, Kirby, et al., 2019; Walsh, Sahm, et al., 2019). HIT can in turn potentially help improve patient safety, performance, and patient experience across healthcare settings (Gates et al., 2019; Jones et al., 2014; Kruse & Beane, 2018).

Nevertheless, there are still numerous cases where HIT adoption has failed to deliver value; worst still, some studies have pointed to examples where the desired outcomes of HIT adoption were not realized and instead negative consequences were encountered such as increased medication error, procedural error, and reduced nurse-physician collaboration (Buntin et al., 2011; Gates et al., 2019). For instance, studies

have shown that HIT adoption can reduce patient safety due to factors such as alert fatigue and incongruent workflows (Jones et al., 2014). Inappropriate uses of HIT have also been widely documented in current literature, such as where users misreport or withhold data from the HIT (Bernardi et al., 2019).

Recent studies of HIT adoption such as Bernardi et al. (2019) have discussed the challenges of maintaining and changing embedded routines and practices in healthcare institutions. This raises interesting questions around how novel technologies, such as patient-held HIT, become embedded and routinized (i.e. 'normalised') in everyday practices. In particular, patient-held HIT solutions are typically implemented across the primary-secondary care interface where distinct yet interdependent practices meet (Carroll & Richardson, 2019). In order for the potential benefits of patient-held HIT to be realized, the challenges associated with HIT normalisation across these settings must therefore be understood (Kruse & Beane, 2018; Zhang et al., 2019).

However, investigations into how patient-held HIT adoption become routinely embedded and integrated across primary and secondary healthcare settings remains nascent (Karampela et al., 2019; Kruse & Beane, 2018). Despite the proliferation of patient-held solutions in recent years, our understanding of how these solutions become normalised across different user groups and settings is still only emerging. Consequently, this paper aims to investigate the following research question:
What factors support or impede the normalisation of patient-held HIT solutions across primary and secondary healthcare settings? In order to address this research question, we present empirical findings from the in-depth case study of PHARMS, a 7-month IT implementation involving General Practitioners (GPs), junior doctors, and patients, which sought to pilot a patient-held HIT solution across the primary-secondary care interface. A Normalisation Process Theory (May & Finch, 2009; Murray et al., 2011) perspective is adopted to analyse case study findings.

We make important contributions to existing literature which will be of interests to HIT scholars, clinicians, and IT practitioners. Firstly, we develop novel insights into the variegated factors that affect the normalisation of patient-held HIT solutions across healthcare settings, such as the primary and secondary care interface. Leveraging in-depth case study data from PHARMS, we theorise the challenges of normalising the new models of healthcare provision which patient-held HIT can enable. Literature suggests that patient-held HIT has the potential to create a new paradigm for value-based, patient-centric healthcare. However, there is consensus in literature that such solutions have not yet achieved their full potential (Gates et al., 2019). We contribute theoretical and practical insights why this might be so, thus adding to the body of knowledge on patient-held HIT adoption and normalisation. Secondly, we adapt Normalisation Process Theory (May & Finch, 2009; Murray et al., 2011) to the context of patient-held HIT adoption and suggest eight new types of context-specific challenges, including the need to understand patient / clinician experience, support for informal clinician networks, and spanning across IT boundaries. Normalisation Process Theory offers a novel and relevant framework for HIT adoption research. We demonstrate the usefulness of Normalisation Process Theory through in-depth case study findings and adapt the framework to tailor it to patient-held HIT.

2. Literature Review

There is a long tradition on technology adoption research in the information systems discipline, and more specifically in the HIT field. A significant body of literature has looked at the prediction of end users' IT adoption behaviour in the healthcare sector, using frameworks such as the Technology Acceptance Model to anticipate a system's perceived usefulness and ease of use, as well as inherent resistance (Venkatesh et al., 2007; Venkatesh et al., 2011). Adoption has also been identified as a key variable in gauging the success of an IT implementation which is shaped by user satisfaction levels and overall usage rates once the system goes live. For instance, DeLone and McLean's Information Systems success model (1992, 2003) sets out the

variables that will determine the benefits delivered from an IT implementation such as information quality, system quality, and service quality.

While the cumulative impact of individuals using HIT may lead to net benefits for an organisation, more recent literature suggests that this is predicated on positive system perceptions, attitudes and expectations among user groups (Kruse et al., 2016; Scantlebury et al., 2017; Zhang et al., 2019). This has important implications for HIT adoption research given that perceptions, attitudes, and expectations are emergent in nature, and are subject to change over time (Zhao et al., 2018). For instance, patient-held HIT solutions must align with the attitudes and expectations of users across settings in order to bridge the 'design-reality gap', where differences emerge between the assumptions built into a technology and the real-life healthcare practices of users e.g. self-management practices, information needs, and preferred styles of communication (McCrorie et al., 2019; Zhao et al., 2018). Adoption is therefore more than a matter of external direction from top-management; it is a complex socio-technical process in which HIT solutions interplay with human perceptions, attitudes, and expectations to become embedded and integrated (i.e. normalised), or not, in everyday practices (Farr et al., 2018; Greenhalgh et al., 2017; McCrorie et al., 2019; Scantlebury et al., 2017).

In addition, understanding the context-dependent nature of normalisation is essential for determining whether the directed activities of implementing a HIT solution leads to its eventual adoption or abandonment (Greenhalgh et al., 2017). Anticipating these contextual challenges requires that IT practitioners explore HIT adoption as a dynamic network involving numerous interdependent user groups and technological artefacts (Burton-Jones & Volkoff, 2017; Greenhalgh et al., 2017). Recent research suggests that the eventual adoption of HIT solutions rests on the emergence of informal network change across groups of interdependent actors in different organisations (Burton-Jones & Volkoff, 2017; Leonardi, 2013; Yaraghi et al., 2014). HIT adoption is more likely to occur when informal groups converge on a shared appropriation of features in the HIT solution (Leonardi, 2013; Zhang et al., 2019). Adoption across user groups such as paraprofessionals and administrative personnel may be positively affected when both groups incorporate shared affordances of the HIT solutions into their daily routines (Venkatesh et al., 2011).

Consequently, the adoption of self-services technologies such as patient-held HIT rests on both user-specific (i.e. perceptions, attitudes, expectations) and network-specific factors (i.e. informal groups and interactional processes) (Yaraghi et al., 2014). According to Kruse and Beane (2018), our ability to understand the factors which affect HIT adoptions will be crucial for ensuring successful HIT adoption going forward. However, existing research on HIT implementations and adoption to date has largely been atheoretical in nature which has raised questions around the richness and rigor of findings (Bautista et al., 2018; Heath et al., 2017). This has generated calls for more theory-driven investigations on how HIT adoptions become embedded and integrated into existing healthcare practices. Specifically, further empirical research is needed to understand the implementation and adoption of identical technologies in multiple contexts (Leonardi, 2013). Calls have also been made to focus on practice as a unit of analysis given that HIT adoption typically occurs at the practice level, potentially across multiple settings. Despite this, HIT research often focuses on an individual level (i.e. physicians) rather than the wider practice (Yaraghi et al., 2014).

3. Theoretical Background

In this paper, we adopted Normalisation Process Theory (May & Finch, 2009; Murray et al., 2011) as a theoretical framework to investigate the adoption and normalisation challenges associated with patient-held HIT solutions. Normalisation Process Theory is a multidimensional framework that describes elements which are pivotal to the successful adoption of new technologies and practices in healthcare, and how these technologies and practices become embedded and sustained (i.e. normalised) in routines over time

(Murray et al., 2011). In particular, Normalisation Process Theory provides insights into the questions of 'how?' and 'why' technologies or practices become, or indeed don't become, 'normalised' as routine and normal components of everyday practice (May & Finch, 2009). According to May and Finch (2009), new technologies become normalised through: (i) *implementing* the technology and adjusting the social organization of the work; (ii) *embedding* the technology to make them routine elements of everyday life; and (iii) *integrating* the technology in order to sustain and embedded them in their social contexts.

The rationale for choosing Normalisation Process Theory as a theoretical lens is that it provides an empirically validated framework for investigating the factors which impact the adoption of HIT solutions. Normalisation Process Theory can be applied to analyse how complex technologies and practices are made workable in context-dependent ways. It reasons that new technologies are more likely to 'normalise' where individuals and groups perceive that the technology fits well with user-specific and network-specific factors, including individual skill sets, stakeholder interactions (i.e. patients, clinicians), and existing practices in the social contexts (i.e. organisational goals) (May & Finch, 2009). In contrast, technologies are less likely to normalise when stakeholders perceive them to be a poor fit with the social context, or believe that they will impede their day-to-day work (McCrorie et al., 2019; Murray et al., 2011).

Building on the work of Murray et al. (2011), we adopt four components from Normalisation Process Theory which specifically look at the user and network-specific processes of enacting adoptions. This included: *Interactional Workability*, *Skill Set Workability*, *Relational Integration*, and *Contextual Integration* (see Table 1).

Table 1. Constructs of Collective Action Component in Normalisation Process Theory (Murray et al., 2011)

Workability	**Interactional Workability**	**Skill Set Workability**
	Investigates how new technologies relate to social interactions between actors within and across settings e.g. the patient-clinician interaction.	Investigates the degree to which new technologies relate to the existing skill sets of actors e.g. professional qualifications, IT literacy.
Integration	**Relational Integration**	**Contextual Integration**
	Investigates how new technologies fit with the relationships between different actors within and across healthcare settings e.g. the effect on routines and processes.	Investigates the degree to which technologies fit the organizational context e.g. organisational policies, infrastructure, resources.

As an example, Interactional Workability could centre on the patient-clinician interaction during hospital discharge and how HIT solutions for medication reporting are operationalized through a chain of interactions e.g. between doctors, nurses, pharmacists, and patients during discharge activities. Following this example, Relational Integration could focus on the actual adoption of new HIT solutions by GPs in a primary care context and how they are mediated and understood through relationships between the patient and GP during appointments. This relationship serves as the foundation for patients' trust relations

with the HIT solution with the GP informing about HIT solution usage and allaying potential concerns during adoption. Skill Set Workability could investigate how new HIT solutions impact the division of labour in the medical and surgical wards of a hospital, and the ways in which the skill sets of doctors, nurses, pharmacists, and allied healthcare professionals are redefined during the adoption process. Lastly, Contextual Integration could investigate how new HIT solutions impact existing organizational structures, procedures, and resources in the hospital and the impact HIT adoption has on IT operations, and healthcare management processes.

Normalisation Process Theory therefore provides a useful model for understanding how new technologies are implemented, embedded, and integrated into social contexts, particularly those characterised by complexity and emergence (May & Finch, 2009). The theoretical framework suggests that technologies which actors perceive to be a good fit with the social context, and are expected to have a positive impact on existing practices, are more likely to normalise i.e. support improved interactional chains (Interactional Workability), relationships between actors (Relational Integration), existing skill sets (Skill Set Workability), and the overall organisational context (Contextual Integration) (Murray et al., 2011).

4. Materials and Methods

An in-depth case study approach (Darke et al., 1998; Ritchie et al., 2013) was adopted to investigate the factors which affect the adoption and normalisation of a patient-held HIT solution across primary and secondary care settings. This was selected as the most appropriate research design as it allowed the authors to exploit their involvement in an IT implementation project and their investigation of the process. Case study research was also deemed appropriate given the exploratory nature of our research question and nascent research context (Ritchie et al., 2013). The in-depth case study focuses on the longitudinal 7-month timeframe and studies how individuals adopt and normalise the use of patient-held HIT solutions across multiple healthcare services and organisational contexts.

An opportunistic sampling approach (cf. Patton, 1990) was used to identify interviewees including those with a responsibility for identifying and solving technical issues associated with the proposed solution (e.g. IT staff), as well as end users of the solution (e.g. patients, general practitioners (GPs), and junior doctors). Patients were recruited across all five medical and surgical wards of the participating hospital, and the four participating GP practices. During recruitment, patients were provided with an information leaflet and were requested to provide written informed consent. Ability to provide informed consent was assessed by liaising with healthcare staff and family members on a case-by-case basis in order to exclude potentially vulnerable patients. Other stakeholders were then recruited in their local setting i.e. the participating hospital for doctors, nurses, and IT staff, and participating practices for GPs.

In total, 35 semi-structured interviews were conducted by the chief investigator (EW) with 12 patients, 8 general practitioners, 13 junior doctors, and the 2 IT professionals involved in the project. Interviews with each group took place in the participating hospital and GP practices, and lasted an average of 30-45 minutes in duration. Semi-structured interviews are useful for exploratory research as they allow the researcher to follow the interviewee's train of thought and open up new lines of enquiry during the interview (Myers & Newman, 2007) Appendix 1 describes the sample of participants in the qualitative interviews. The recorded interviews focused on the challenges encountered during the adoption of the patient-held HIT solution, and the benefits that were derived. In particular, qualitative interviews centred on the following key questions for different groups:

- Relative advantage of the PHARMS device over usual practice (*hospital staff, GPs, patients*).
- Usability of the device in terms of design and complexity (*hospital staff, GPs, patients*).

- Potential importance of the PHARMS device as perceived by wider secondary and primary care stakeholders (*hospital staff, GPs, patients*).
- Promotion of device usage from clinical and administrative directors/leaders within the participating hospital and general practices (*hospital staff, GPs, patients*).
- Readiness for change, communication quality and teamwork within participating hospital and GP practices (*hospital staff, GPs, IT staff*).
- Knowledge, beliefs and motivation of study participants (*hospital staff, patients, GPs*).
- Perceptions on a plan for evaluating a larger scale method to engage relevant individuals (*hospital staff, patients, GPs IT staff*).

In addition, the Chief Investigator (CI) carried out in-depth field observations during the adoption of the HIT solution and had prolonged access to the live healthcare settings during the conduct of the research study. The CI acted as both a researcher in the PHARMS project, and facilitator in enabling adoption of the intervention in the participating hospital and GP practices. The CI's role as researcher centred on her doctoral research project which examined medication error at the primary-secondary care interface, and pragmatic interventions to facilitate its reduction. PhD supervisors and external academic collaborators provided guidance to help the CI manage this research. The CI also assumed the role of facilitator in enabling HIT adoption. The CI worked alongside practicing clinicians, and academics from the IS domain to understand how best to enable adoption. This included the provision staff education and training to support the use of the technology. Informal feedback was also received from users during organised training sessions on how the HIT solution would be used in practice.

Data analysis was undertaken by two of the co-authors (acronyms withheld for review) using the qualitative technique of thematic analysis (cf. Patton, 2002). Data analysis was undertaken using NVivo software on encrypted computers. Interview data was first analysed using open coding to uncover themes related to the phenomenon of interest and their associated properties and dimensions. The co-authors then iteratively discussed their coding and merged additional codes identified from the data. In the final round of coding, the interview data was then analysed by the co-authors using the framework derived from Normalisation Process Theory (cf. Murray et al., 2011). The co-authors adapted the theoretical model to analyse their findings. Appendix 2 includes an example of the coding undertaken by the co-authors, as guided by information systems literature. Dual independent coding and thematic analysis was also conducted on published field notes (*reference withheld for review*), with a preliminary analysis run concurrently to guide data collection. Our analysis of field notes centred on the implementation process and the identification of barriers and facilitators to HIT adoption and normalisation. These field notes informed findings by providing anecdotal examples of interactions between study participants.

4.1. Case Description and Study Setting

The case study in question was carried out within the context of the PHARMS (Patient Held Active Record of Medication Status) study (*reference withheld for review*) which sought to pilot the introduction of an electronic patient-held medication record across primary and secondary healthcare settings. An electronic patient-held medication record was developed and implemented across the two settings of care. The study involved both patients and healthcare professionals (e.g. GPs, and junior doctors) in the management of medication data. The case study setting was four urban GP practices (8000 patients per practice) and the wards of a 350 bed urban hospital in Cork, Ireland.

The electronic patient-held medication record (hereafter referred to as the PHARMS solution) consisted of a physical device and a software application which in combination would store the medication records of participating patients across primary and secondary care settings. The physical device was a Universal Serial Bus (USB) key which would act as a patient-held medication record using the USB port of computers in the participating hospital and GP practices. A bespoke software application was developed in tandem, and installed on the computers of the four general practices and the computers of hospital wards to enable the integration of the patient-held medication record into existing systems.

Within the context of our study (the Irish healthcare system), the potential benefits of a patient-held medication record are considerable (Bates et al., 2010; Walsh, Kirby, et al., 2019; Walsh et al., 2015). Irish hospitals continue to remain largely reliant on paper-based systems for documenting patient medications, while the electronic systems used in primary care settings are largely disconnected from those in hospitals (Health Service Executive, 2019). Medication errors frequently occur at the point of discharge when patients move between the hospital and community setting and the control of patients' medication information becomes less clear (Alqenae et al., 2020). Poor communication between primary and secondary care healthcare professionals can therefore become a source of error in the prescribing process (Alqenae et al., 2020; Borgsteede et al., 2011; Hartel et al., 2011). Similar to many other developed nations where the transfer of medication information between primary and secondary care is paper based, discharge medication information is typically hand-written and generated by junior doctors (Hartel et al., 2011; Shamliyan et al., 2008).

Preventable medication errors caused by faults such as illegible handwriting can potentially be reduced through the use of electronic prescribing solutions which standardize the prescription writing process, and enhance the accuracy of submitted medication and patient record information. Considering the social and technological constraints, a patient-held HIT solution was developed using USB technology to potentially reduce medication errors across the Irish healthcare system. More advanced technologies than USBs are available, but do not necessarily integrate with the legacy systems in place across both primary and secondary care in Ireland. In contrast, USB technology currently offers a more established medium for sharing electronic data across hospitals and general practitioners (*reference withheld for review*).

During the feasibility study, the project team conducted a preliminary analysis of risks associated with USB technologies (e.g. security, accessibility) and more advanced technologies such as cloud-based applications (e.g. integration with legacy systems and current work processes, the IT skills of the eligible patients). Based on this preliminary analysis, it was decided that USB technology would better enable the timely delivery of a proof-of-concept showcasing the potential of HIT for reduced medication error going forward.

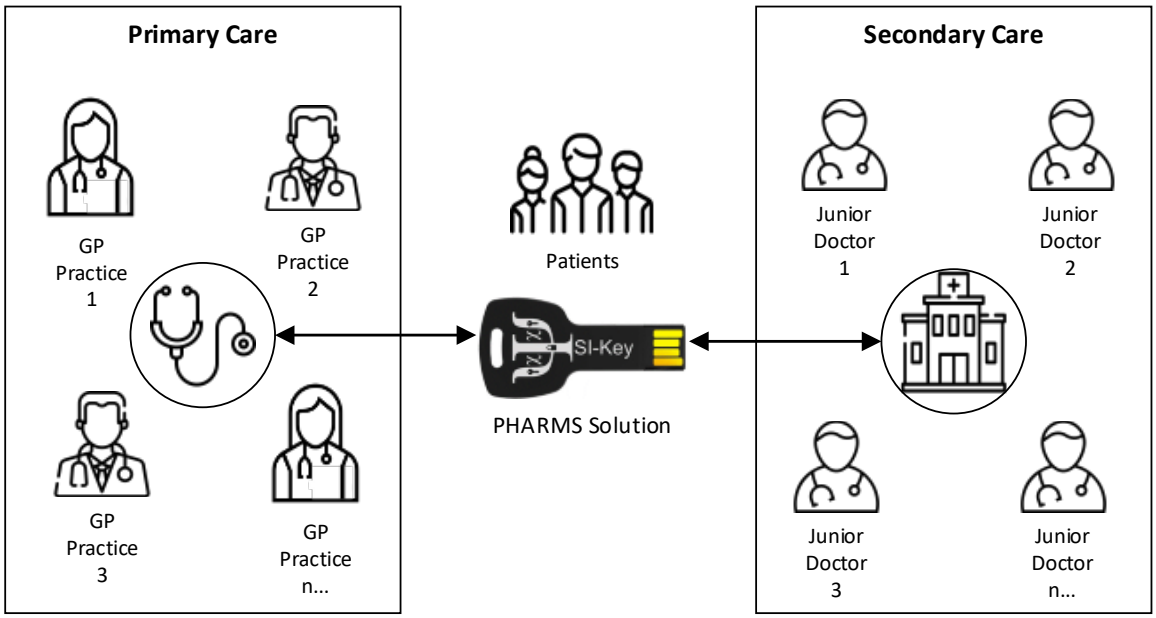
Security was outlined as a high priority during the development of the PHARMS solution, with the highest level of security standards adopted to limit any possible loss of confidential information during the study. Patient data was limited to medication information only and was password protected. In order to foster good security practices, the CI organised training sessions for doctors, nurses and allied healthcare professional staff on secure device use at the secondary care facility. Training session were also organised at each of the four participating GP practices.

Eligible patients were defined as community-dwelling patients over the age of 60 who were admitted to hospital with three or more active medication prescriptions. Purposive sampling ensured adequate representation of patients across gender and socioeconomic demographic groups. Any patients residing in long-term care facilities, receiving end of life care, or those unable to provide written informed consent were excluded. The study received ethical approval from the Cork Clinical Research Ethics Committee.

Following hospital admission, eligible patients were assigned a patient-held medication record and informed consent was obtained. The devices were activated by the CI and the GP medication list was linked from the electronic patient record in primary care. At time of discharge, junior doctors were asked to use

this device to access the patient's pre-admission medication list when generating the discharge prescription for the patient and to note any alterations made to medications during the inpatient stay. Following discharge, the patient's GP would then access this medication record and adjust the master medication list as necessary. Figure 1 provides an overview of the PHARMS solution and stakeholders and workflows involved in the study.

Figure 1. PHARMS Solution, Stakeholders, and Workflows



Workflows – Primary Care

- Activate PHARMS Device.
- Link GP Medication List to PHARMS.
- Adjust the master medication list as necessary (Post-discharge from hospital).

Workflows – Secondary Care

- View pre-admission medication list on PHARMS.
- Note any alterations made to medications during the inpatient stay (Post-discharge from hospital).

5. Results

This section presents findings from the PHARMS study (*reference withheld for review*), using a Normalisation Process Theory approach to analyse results. The case study findings relate to two related stages in PHARMS: the feasibility study and implementation stage. Stakeholders refer to patients, doctors, GPs, and IT staff unless otherwise noted.

5.1. *Interactional Workability*

At the beginning of the PHARMS study, the chief investigator conducted a feasibility study in the local hospital to empirically examine existing problems with the prescribing process, and potentially strengthen the evidence base for PHARMS. This evidence turned out to be crucial for fostering buy-in among key stakeholders (i.e. hospital doctors and general practitioners) early on by demonstrating how the PHARMS device would support clinical interactions across primary and secondary settings of care. In addition, the

evidence provided a 'wake-up call' for some hospital doctors and general practitioners, by highlighting the issues that may arise if the status quo is maintained and new technologies are not adopted.

As part of this feasibility study, general practitioners and junior doctors also shared their own experiences of the existing system, relaying stories of the sizable challenges faced in managing and communicating medication information during patient-clinician interactions. For instance, junior doctors noted the difficulties they faced in detecting medication error in an efficient and timely manner due to the absence of an integrated HIT solution, while general practitioners pointed to the difficult process of following up with the hospital on possible medication errors after a patient has been discharged. As stated by one general practitioner this process was "*incredibly time-consuming, frustrating and annoying… I can't [emphasize] strongly enough on what a waste of time it is"* [GP 1]. Meanwhile, patients complained about a lack of consistency when receiving information from clinicians around medication use. One patient described the frustration they experienced during one interaction with hospital staff: "*I remember like one day coming out and the nurse had to ring the doctor to query something because the inhaler they had given me shouldn't be given with the medications I was on"* [Patient 1].

Following the implementation of PHARMS, stakeholders felt that the HIT solution enhanced the management and communication of medication information across patient-clinician interactions by providing a trusted electronic record. The majority of general practitioners felt that the PHARMS solution provided a consistent solution for recording patients' medication information and allowed different stakeholders to see if there had been changes to the patient's prescribed medication during a hospital stay. One general practitioner noted: "*it was useful because it was instant and because I knew that's changed and it's changed for a reason*" [GP 1]. In addition, one junior doctor noted that the patient-held HIT solution also supported continuity of care in instances where a patient is readmitted to the hospital, a scenario which previously was very challenging to manage: *"one person I used (PHARMS) for was one who was in and out like a yo-yo, and in that instance… it was very valid and useful"* [Junior Doctor 4]. The PHARMS solution was relatively straightforward to interact with and had a low learning curve for clinicians which reduced IT staff's workload as *"clinicians knew how to use the app after they had used it twice"* [IT Staff 1]. Patients also pointed towards the convenience of possessing their medication record on a portable device, particularly when moving between different healthcare settings: "*your GP would have it [during appointments] and when you go to hospital all your information is on it. It's brilliant"* [Patient 3].

5.2. Skill Set Workability

While the PHARMS solution design garnered high levels of acceptability in terms of interactional workability among users, issues still arose around the fit between skill sets and the patient-held HIT solution design. Elderly patients who admitted that they "*wouldn't really be tech savvy*" [Patient 2] felt the HIT adoption created an extra layer of complexity for them during appointments. This group of patients admitted that they encountered difficulties when using all forms of new technology and felt that having their medication record on a smartphone would be equally problematic for them. As stated by one patient: *"[family members] tried to talk me into getting one of the touchphones but I'm sure I have toes for fingers because any time I tried to use it I couldn't"* [Patient 1]. One member of IT staff also raised the issue of usability by asserting that the design of the PHARMS solution could be problematic for some users: "*the function is to allow the patient to authenticate their medications, so the most important thing should be whether it is user friendly and appropriate… I'd question about the shape and design of key*" [IT Staff 1].

The ability of junior doctors to maintain information quality when using the patient-held HIT solution was also highlighted as a source of variability during adoption. General practitioners were dependent on junior doctors for inputting all medication information at the point of discharge and updating the record on the PHARMS solutions as necessary; however, one GP noted that the completeness of medication records

varied according to the different junior doctors involved, and there was a lack of consistency in the quality of information received: *"it very much depended on who had filled in the [information] from the hospital side. One [junior doctor] had made notes about what was stopped and what doses had increased which was really helpful. And the other [junior doctor] had just a prescription"* [GP 2].

The feasibility study had noted that variability of skill sets among user groups was of critical concern from the outset as the secondary care site of the PHARMS study employed approximately 1,000 clinical and non-clinical staff across a range of specialties. To deal with this, the chief investigator (herself a trained clinician) acted as a facilitator during the implementation and carried out informal staff education and training sessions to support adoption of the new solution. Prior to the rollout of PHARMS, oral presentations were targeted towards interns and other clinical and non-clinical staff with the aim of informing them on how to use the proposed solution correctly. Patients then trailed the PHARMS solution to determine its usability and appropriateness across clinical settings. However, challenges persisted around the ability of clinicians and patients to interact with the PHARMS solution effectively. Members of IT staff later stressed the need for matching user expectations with skill sets during the design and adoption of PHARMS.

5.3. Relational Integration

While the clinical need for a HIT solution was well established, there were several normalisation challenges faced in maintaining relationships within existing clinical practices and across healthcare settings. During the adoption of the PHARMS solution, the IT department realized that successful adoption of the PHARMS solution would require a significant change in the work practices of many staff. Change management initiatives were ongoing and new practices still needed to be solidified to ensure that medication data was captured digitally on the PHARMS software. As stated by a member of IT staff: "*people will have to carry out their tasks differently. [Workflow] must be very standardized for data to be effectively captured and interpreted across all sites*" [IT Staff 1]. Relational Integration of the PHARMS solution therefore proved difficult due to the limitations associated with existing clinical practices where medication orders in the secondary care study site were hand-written in paper charts by clinicians. These orders were then processed manually and interpreted by nursing staff and pharmacists.

Junior doctors felt that these existing processes created additional workload for them when using the patient-held HIT solution as it leads to "*duplication… filling out of the discharge summary, and then you're filling out a prescription and you're trying to find a computer"* [Junior Doctor 9]. This lowered the perceived acceptability of the PHARMS solution among junior doctors and impeded normalisation somewhat. Reflecting on this, one member of IT staff noted that while gathering clinical data in the paper-based chart and PHARMS solution concurrently *"is not the best"* [IT Staff 2], there were institutional pressures to maintain the status quo. However, the junior doctors felt that they had taken on the additional role of reconciling medication information during patient discharge and felt that the PHARMS solution "*would be much [more] helpful if you were doing an admission"* [Junior Doctor 5] only, as it didn't incur additional tasks. As a result, one Junior doctor conceded that during patient discharge*: "you didn't have time to verify with the consultant, with the GP, was this legit. So whatever they had… on here is what you sent them home with"* [Junior Doctor 9].

Another relational challenge was the issue of variable use of the PHARMS solution among junior doctors. Junior doctors noted that paper-based prescription pads were still the primary method for recording medication information and as a result "*you just forget about"* [Junior Doctor 11] the PHARMS solution when interacting with the patient. General practitioners felt that the lack of widespread adoption among junior doctors in turn impeded the full realization of benefits possible from the PHARMS solution. One GP pointed to the risk that the PHARMS solution would be perceived as "*just another system"* in the event that "*just a small portion of one hospital [group] use it"* [GP 7]. In addition, normalised usage of the PHARMS

solutions was highlighted as an issue by IT staff due to the high turnover of junior doctors in the hospital. As pointed out by one member of IT staff: "*Junior doctors are switching sites every 3 months so we have to manage user accounts of both starter and leavers which is a headache"* [IT Staff 1]. IT staff noted that despite being an operational issue associated hospital resource management, the high turnover of junior doctors became an issue that the IT department had to deal with, even though the source of the problem wasn't technological in nature. Consequently, informal clinician networks among junior doctors became essential for continuity of the PHARMS implementation during frequent changes to the clinical roster. Informal networks provided new entrants with advice for the handover of work and transferred practical knowledge on use of the patient-held HIT between users over time, without the need for continued formal training or education programs. Without these networks, the sustained use of the PHARMS solution would likely have diminished when junior doctors involved in earlier stages of the implementation left.

5.4. Contextual Integration

Uncertainty also arose due to technical issues around the operation of the PHARMS solution across different organisational contexts. The project team had failed to anticipate numerous technical challenges in the preliminary analysis undertaken during the feasibility study. Early in the project, the IT staff faced complications when configuring the PHARMS devices for use by junior doctors as the hospital's existing IT policies and resources meant that "*if you want to use a USB port we need to validate the key first*" [IT Staff 2]. One member of IT explained how the computers in the hospital had specialized software that limits what devices can be plugged into the USB ports of the computers and "*there [was] some confusion [with the vendor] as to getting the key to work with the USB extension cable"* [IT Staff 1]. Further issues were encountered when trying to provide the PHARMS software with access the internet, as the legacy firewall rules in place created difficulties for staff in opening access to the correct USB port. In addition, firewall differences between primary and secondary settings created issues during the installation of the system as the Transmission Control Protocol/Internet Protocol connections timed-out due to inconsistencies across servers.

As the hospital's USB port software was due to be updated during the PHARMS adoption, configuring devices became increasingly difficult and added further complications. In addition, the perceived lack of information sharing between product suppliers, software vendors, and IT staff in the hospital was viewed as a key leadership challenge during the adoption by IT staff. For instance, progress was slowed down initially as certain documents and files created by the vendor were not made available upfront, possibly due to concerns around intellectual property. IT staff were also concerned that some functional and non-functional requirements were overlooked, as IT staff's engagement with primary-secondary care users was constrained prior to the PHARMS solution's introduction. Prototyping and testing were identified as important tasks for ensuring that the PHARMS solution would meet user expectations; however, delays in the project timeline meant that the resources available for continuous prototyping and ongoing user engagement was limited. As pointed out by one IT staff member: "*When you're delivering a product into an environment you need to know what it is, what it will do, and the scope. This should be visible and measurable. It's a live environment so there are a lot of idiosyncrasies. Project members need to undertake a preliminary investigation*" [IT Staff 1].

System requirements were captured intermittently from users which created unforeseen challenges during systems testing. In turn, the PHARMS solution launch did not run as smoothly as expected due to considerable IT integration issues such as IT policy differences across primary and secondary healthcare settings, and compatibility issues between existing technology platforms. In hindsight, there was a realization among project team members that more attention should have been directed towards the use of agile development methods for requirements gathering early on, where rapid iterations of prototyping

would be undertaken with feedback from users. They felt that this may have reduced the likelihood of unforeseen challenges related to the integration of technological components.

6. Discussion

Patient-held HIT adoptions are often suboptimal due to a poor understanding of the context of use and the process through which HIT becomes normalised (Farr et al., 2018; Jones et al., 2014; McCrorie et al., 2019; Murray et al., 2011; Nguyen et al., 2014). Scholars have highlighted the need for further studies to investigate the socio-technical implications of HIT adoption, with a focus on how these HIT become normalised through user-specific and network-specific factors (Farr et al., 2018; McCrorie et al., 2019; Scantlebury et al., 2017). Motivated by the contemporary and important issue of patient-held HIT adoption across healthcare settings, our research contributes theoretical and practical insights into the interacting factors which affect the normalisation of patient-held HIT adoptions across healthcare settings (e.g. the primary and secondary care interface). In particular, we explicate patient-held HIT adoption and normalisation through the lens of four factors from Normalisation Process Theory: *Interactional Workability*, *Skill Set Workability*, *Relational Integration*, and *Contextual Integration*. In doing so, we answer the call of previous scholars and extend existing literature in several ways.

Consistent with existing literature on HIT adoption more generally, we find suggestive evidence that expectations of benefits from patient-held HIT for multiple user groups across different settings of care affects adoption and normalisation. Interactional Workability in PHARMS was supported by rigorously documented evidence across a number of studies on the potential the benefits of HIT for patient medication management (Gates et al., 2019; Jones et al., 2014; King et al., 2014; Kruse & Beane, 2018). For instance, a systematic review carried out by Gates et al. (2019) showed that HIT can potentially decrease the likelihood of dose errors in hospital wards, primarily at the ordering stage of the medication process and medication administration stage. Jones et al. (2014) seminal study on the effects of HIT on patient safety also found that about 78% cases had demonstrated some positive benefit. Based on this evidence, the PHARMS study was favourably assessed by clinicians early on which encouraged adoption during the initial pilot (*references withheld for review*). However, our findings also point towards the importance of studying patient and clinician experience to ensure that normalisation can occur. In particular, the significance of evaluating patients' and carers' experiences of efforts to introduce personal electronic health record in a healthcare system comes to the fore. We find that users' experiences of technology are often unique, and therefore patient-held HIT solutions cannot be completely standardised without adaptation; in addition, clinicians' experiences with the solution should be considered in terms of how it enables and constrains care, beyond the intended functions of the solution or the assumed benefits documented in literature (Greenhalgh et al., 2010).

Our findings suggest that Skill Set Workability represents another sizable barrier to the successful adoption and normalisation of patient-held HIT solutions. In particular, user skill traits created unforeseen challenges during PHARMS which slowed down adoption. The majority of challenges encountered during the early adoption of PHARMS concerned low levels of IT literacy among elderly patients, and inconsistent information recording practices among junior doctors. The reliance placed on paper-based medication documentation and reluctance to change over to the patient-held HIT solution also contributed to this. Indeed, prior research has previously pointed to instances where doctors have not embraced e-healthcare systems due to their preferred use of paper records (Scantlebury et al., 2017). However, we find that that ongoing facilitation efforts in an informal and relaxed setting were crucial to ensure that patient-held HIT solutions were fully integrated with existing practices and changes could be maintained. As elaborate training schemes are not always a luxury that clinicians can avail of (Venkatesh et al., 2011), a clear

strategic vision with ongoing facilitation in the form of seminar presentations and education are essential (Gleeson et al., 2019).

In terms of Relational Integration, we also find evidence that the closer patient-held HIT solutions align to existing organisational routines and structures, the greater the chance of adoption and normalisation. HIT solutions are unlikely to be adopted if they are perceived to negatively impact clinician workload and routines (Greenhalgh et al., 2010; Greenhalgh et al., 2017). Our findings point towards specific issues related to patient-held HIT solutions such as the need for changes in cross-organisational structures and new workflows to reduce the likelihood of disruption across entangled practices. Transitioning from paper-based records to new digital solutions also carries with it significant obstacles, something that has been well documented in existing literature (Scantlebury et al., 2017; Venkatesh et al., 2011). However, we find new evidence that this transition can be supported by ensuring that role conflict and duplicated processes are avoided during implementation. In addition, our findings suggest that informal clinician networks (cf. Leonardi, 2013) can have a sizable effect on the normalisation of patient-held HIT and should be considered integral to Relational Integration. Informal networks between junior doctors involved in PHARMS were essential during implementation activities for normalising user behaviours issues and addressing discontinuities caused by ongoing changes to the clinical staff roster. Informal networks provided new entrants with advice on how to use the patient-held HIT, and helped sustain engagement over time.

Lastly, in terms of Contextual Integration, our research points to the need for implementation activities to span across IT boundaries (i.e. IT resources and policies) in different settings. Interoperability and technical immaturity are of critical concern here (Greenhalgh et al., 2017); for instance, computers in the secondary care study site of PHARMS had specialized software that limited what devices could be plugged into the USB ports of the computers and impeded data transfer across sites. Consequently, the need to deliver frequent upgrades in response to user issues became apparent from our findings. The more sequential development process adopted in PHARMS, in which requirements gathering was followed by design, development and testing, created difficulties in proactively responding to changes during the development lifecycle. During a retrospective of PHARMS, project team members proposed the localised adoption of agile software development methods (such as Scrum or Extreme Programming) (Drury-Grogan et al., 2017) across different settings as a means to address these concerns going forward. Agile methods could address these challenges by facilitating continuous dialogue between patients, clinicians, and IT staff during rapid iterations of

Table 2. Recommendations from PHARMS

	Interactional Workability	**Skill Set Workability**
Workability	Investigates how new technologies relate to social interactions between actors within and across settings. <u>Recommendations</u> **Gather supportive evidence** • Conduct field study of 'pain points' at the primary-secondary care interface. • Disseminate systematic evidence from literature on the value of patient-held solutions. **Understand user experiences** • Gain feedback on patient/clinician experience during the patient-held HIT implementation.	Investigates the degree to which new technologies relate to the existing skill sets of actors. <u>Recommendations</u> **Identify skill set deficiencies across users** • Provide informal training sessions for different user groups, in relaxed settings. • Create slack in work processes to support use of patient-held HIT across settings. **Assign facilitators across settings** • Delegate an on-site leader with relevant expertise across each setting.

	Relational Integration	**Contextual Integration**
Integration	Investigates how new technologies fit with the relationships between different actors within and across healthcare settings. <u>Recommendations</u> **Mitigate role conflict** • Uncover potentially conflicting tasks across clinician groups. • Clarify each stakeholders' role in adoption. **Support informal clinician networks** • Ensure informal networks are supported during periods of change.	Investigates the degree to which technologies fit the organizational context. <u>Recommendations</u> **Span across IT boundaries** • Commit to initiatives that consolidate IT policies across settings. • Identify incompatible technologies / practices across settings. **Adopt agile development methods** • Carry out continuous prototyping across settings to evaluate the patient-held HIT solution with stakeholders.

prototyping (Huber et al., 2019; Wohlrab et al., 2019). We suggest that agility is a key enabler of patient-held HIT adoption and normalisation as it allows stakeholders to create, embrace, and learn from change.

Table 2 concludes by providing twelve recommendations on the adoption and normalisation of patient-held HIT solutions based on our case study findings. These recommendations are listed under the eight new sub-categories of Normalisation Process Theory which emerged from our case study research and enfolding findings in existing literature. Scholars have asserted the urgent need for empirically derived recommendations on how HIT adoption and normalisation challenges might be addressed (McCrorie et al., 2019; Scantlebury et al., 2017). Contributing these lessons learned can in turn provide scholars and practitioners with a better understanding of the critical success factors associated with the management of patient-held HIT adoption going forward.

7. Concluding Remarks

The successful adoption of novel HIT solutions rests on identifying and understanding the unique adoption challenges inherent in contextual settings (Kruse & Beane, 2018). Findings from PHARMS revealed a number of these unique challenges, both foreseen and unforeseen, that were encountered during the adoption of a patient-held HIT solution across the primary-secondary care interface. The sources of these challenges were investigated using Normalisation Process Theory as an organizing framework to understand the interplay between user-specific and network-specific factors.

In terms of theoretical implications, our research adapted Normalisation Process Theory as a theory of description and explanation for the adoption of patient-held HIT across primary and secondary healthcare settings. Specifically, we identified eight sub-categories of challenges, such as the need to understand

patient / clinician experience, support informal clinician network change, and span across IT boundaries. These sub-categories may be of value to researchers and practitioners going forward when studying the unique challenges that can arise during patient-held HIT normalisation. We direct focused attention towards the factors outlined in Normalisation Process Theory in order to gain insights into the challenges faced by different stakeholder groups during the adoption of PHARMS. The findings speak to the established framework of Normalisation Process Theory and draw out reflections on recommendations for future research on HIT adoption across healthcare settings.

The practical implications emanating from our research centre on how patient-held HIT solutions become normalised across the primary and secondary care interface over time, and the challenges and opportunities faced. In particular, recommendations are provided on how the normalisation of patient-held HIT solutions can be supported across each area of Normalisation Process Theory (e.g. Interactional Workability, Skill Set Workability, Relational Integration, and Contextual Integration). More specifically twelve recommendations are provided for each of the proposed sub-categories that we put forward in this paper, including: conducting a field study of 'pain points' at the primary-secondary care interface, providing informal training sessions for different user groups in relaxed settings, and uncovering potentially conflicting tasks across clinician groups. These insights will be useful for different stakeholder groups (i.e. IT staff, clinicians, and patients) involved in the implementation of patient-held HIT solutions, providing them with a map of the potential pitfalls that might be encountered.

Nevertheless, there are limitations to our study which future research can aim to address. Firstly, sampling in the PHARMS study was opportunistic in nature and relied on obtaining access to eligible patients through the participating hospital and GP practices. The PHARMS study was also limited to a single secondary care site based in the south of the country, and the HIT solution was not introduced in community pharmacies during this study. Future research can seek to undertake similar studies involving diverse patient cohorts, and multiple primary and secondary care settings. While the Irish healthcare system can provide a useful point of reference for healthcare systems in other developed nations, further studies are needed to examine the unique adoption challenges association with patient-held HIT solutions in other countries, particularly low middle-income countries (*reference withheld for review*). In addition, the existing infrastructure and IT policy constraints within Irish hospitals meant that USB technology was chosen as the medium for the PHARMS patient-held HIT solution. Future research can look at how alternative media, such as smartphone apps, be used to deliver patient-held HIT solutions for medication record management. Future research is also required to analyse other forms of adoption challenges associated with the normalisation of patient-held HIT solutions which were outside the scope of our study, such as political factors and power dynamics between user groups (Azad & Faraj, 2011).

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