Implementation of a Medication Reconciliation Assistive Technology: A Qualitative Analysis

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Abstract
Objective: To aid the implementation of a medication reconciliation process within a hybrid primary-specialty care setting by using qualitative techniques to describe the climate of implementation and provide guidance for future projects. Methods: Guided by McMullen et al’s Rapid Assessment Process1, we performed semi-structured interviews prior to and iteratively throughout the implementation. Interviews were coded and analyzed using grounded theory2 and cross-examined for validity. Results: We identified five barriers and five facilitators that impacted the implementation. Facilitators identified were process alignment with user values, and motivation and clinical champions fostered by the implementation team rather than the administration. Barriers included a perceived limited capacity for change, diverging priorities, and inconsistencies in process standards and role definitions. Discussion: A more complete, qualitative understanding of existing barriers and facilitators helps to guide critical decisions on the design and implementation of a successful medication reconciliation process.

Introduction
Medication errors are ubiquitous at interfaces in care delivery – including the ambulatory encounter3-4. An estimated one-quarter to one-half of errors are attributed to gaps in information or incomplete medication histories5-11. If undetected, these errors can result in adverse drug events (ADEs) and significant patient harm12, 14, 15. Medication reconciliation (MR) – the process of collecting a medication history, comparing available documentation, and resolving discrepancies – has been heralded as a crucial strategy to address information gaps5, 16-19. Unfortunately, durable solutions have been notoriously difficult to implement, owing to barriers associated with information technology, organizational culture, and patient health literacy4, 20-26.

A number of promising health information technology (HIT) solutions have been developed to support MR – many of which have extended the capabilities of the Veterans’ Affairs (VA) existing information systems20, 23, 24, 26-35. The Automated Patient History Intake Device (APHID) is one such HIT intervention20, 29, 36. Developed at VA Portland Healthcare System (VAPORHCS), APHID provides a standardized way for clinicians to collect and interpret medication information to identify and reconcile discrepancies. In addition to automatically assembling a list of prescriptions from across the enterprise, APHID displays the corresponding medication images in a questionnaire format for the patient and staff to review at the point-of-care. The developers used this approach with the intent to improve patient engagement and medication recall33, 34, 37-40.

It is important to note that APHID – like any decision support system – cannot be a standalone solution. Because it is subsumed under a larger, more complex activity system, implementation of software such as APHID requires a firm understanding of clinic environment, values, and workflow4, 26, 31, 32, 41, 42. The effect of an HIT intervention – particularly one aimed towards improving MR – is heavily dependent upon sociotechnical fit: local culture, business processes, and implementation strategies all mediating successful adoption. Accordingly, accounts of “real-world” implementations are needed to help informaticians and quality improvement specialists identify, label, and manage the significant sociotechnical determinants of change.

To address this gap, we conducted a qualitative study of a MR quality improvement project. Over the span of eight months in an outpatient clinic, an informatics team rolled out a new MR workflow that incorporated the APHID
software. Concurrent to the rollout, we conducted semi-structured interviews with key stakeholders to guide the implementation. By characterizing the sociotechnical context of the clinic and the implementation strategies used by the team, we sought to identify the barriers and enablers to MR software adoption.

Background

Facility leadership charged the informatics department with developing a comprehensive MR solution for ambulatory specialty clinics. This solution had to provide a standardized method for completing and documenting MR at each encounter. Furthermore, the solution needed to generate an updated medication list that could be furnished to the patient upon departure. In response, the informatics team developed and rolled out an “implementation bundle” that included 1) the APHID software, 2) structured note templates (based upon user-furnished requirements), 3) an “after-visit” summary report with medication list, 4) a redesigned workflow, 5) printed educational materials, and 6) at-the-elbow support provided by members of the informatics team.

The informatics team iteratively designed and usability tested software during a series of rapid design “sprints” with representative end-users. The team then introduced the implementation bundle in a phased roll-out, beginning with the nurses, proceeding with the physicians, and concluding with the medical support assistants. The nurses were instructed how to use the APHID software to collect and chart a medication history. Physicians were instructed how to use specially designed templates to review the history and document reconciliation efforts. They were also taught to generate an after-visit summary report. Medical support assistants were expected to print the after-visit summary along with follow-up appointment information at the time of patient checkout.

Despite initial implementation hurdles, the informatics team was able to successfully incorporate the tools and workflow into the clinic. At the time of manuscript preparation, the clinic had been using the MR bundle for four months following implementation. The full details of this implementation along with quantitative quality improvement statistics are described in a separate manuscript (in preparation).

Theoretical Framework

While an exhaustive review of implementation theory is beyond the scope of this manuscript, it is useful to briefly describe some of the contemporary theoretical frameworks that informed our approach to this study. Davis’ Technology Acceptance Model (TAM) is an extension of Ajzen and Fishbein’s Theory of Reasoned Action and has been widely used to describe users’ acceptance and adoption of technology in a wide array of disciplines, including healthcare. The model states that an individual’s predilection to use a technology has two determinants: perceived ease of use and perceived usefulness.

Although TAM has been studied extensively and has been said to predict 30-40% of variance in end-user behavior, it is limited in several important ways. First, TAM was developed outside the healthcare context and it may not suitably capture the complex-adaptive nature of healthcare systems. Second, TAM only addresses individual difference factors and neglects the social processes associated with implementation such as the voluntariness of HIT use, team-based care interactions, and healthcare governance. Finally, the model emphasizes the intent to use or frequency of use, as opposed to the quality or effectiveness of technology use.

To address these limitations, so-called “added variable” models have emerged to describe and explain the interaction between user and setting. Venkatesh developed the Unified Theory of Acceptance and Use of Technology (UTAUT) based on the TAM. The UTAUT is a widely cited model that adds facilitating conditions and has been shown to explain up to 70% of behavioral intention and 50% of actual use. Our research group developed the Effective Technology Use (ETU) model, which extends TAM and UTAUT in two important ways. First, ETU includes a parsimonious set of “belief-based” variables that are amenable to manipulation: 1) an internal locus of control (i.e., “Compatibility with Workplace Values”), 2) and two external contextual mediators (i.e., “Compatibility with Work Processes” and “Implementation Climate”). Second, ETU conceptualizes use of technology along a continuum ranging from avoidance to skillful and effective use. We used the ETU to develop semi-structured interview scripts described in the following Methods section. Our research team also used the framework throughout the analysis cycle to organize findings.
Methods

Setting
This study was conducted at a level 1a Veterans’ Affairs facility located in the Pacific Northwest United States from April to October 2016. Nearly 70,000 patients from Alaska, Washington, Idaho, and Oregon receive primary or specialty care from our center; more than 85% of the patients are 45 years of age or older and 91% are male. The informatics department selected the ID clinic as a “demonstration lab” for several reasons. First, the clinic is located in a single physical location, thereby avoiding the need to divide implementation personnel across multiple deployments. Second, ID staff provides primary care and specialty consultation to a medically complex patient population, allowing the implementation team to observe an array of reconciliation challenges. Finally, the ID clinic hosts a small number of physicians – typically, three ID physicians and 1-2 residents or fellows – hence, limiting the training burden shouldered by the implementation team.

Participants
Although we extended interview invitations to all staff members, several were unavailable to participate due to scheduling conflicts or clinical reassignment. Three physicians, two nurse, and five medical support assistants participated in a total of thirteen pre- and mid-implementation interviews.

Interviews
The research team used the ETU model to guide the development of semi-structured interviews scripts. We included questions and probes to address each construct in the model. For example, to gather information about user values we included the question, “how important is it to collect and reconcile a medication history in comparison to other tasks performed during a clinical encounter?” Similarly, to gather information about the climate for implementation we included the question, “how did leadership communicate to you about this implementation?” Questions were open-ended to encourage respondent-directed narratives and to capture emergent concepts.

Interviews were conducted in two discrete phases of the implementation: 1) pre-implementation interviews were completed before technology rollout and 2) mid-implementation interviews were conducted in a rolling fashion as end-users were oriented to the technology. Two research team members were present for each interview. One researcher conducted the majority of the scripted interview while the other acted as scribe, managed the recording equipment, and asked follow-up or clarifying questions.

Each interview guide was informed by the ETU model and began with broad open-ended questions, followed by a series of more specific probes. Specific scripts were developed for each clinical role (i.e., nurse, physician, or clerk). The pre-implementation interviews aimed to gather baseline information about the target users and workplace culture, while mid-implementation interviews focused on gathering information about tools, workflows, and support. The audio recordings were transcribed verbatim. Names were replaced with identification codes to protect individual identities.

Analysis
A team member uninvolved with the implementation completed the initial analysis of transcripts using open coding methods. Codes were applied by labeling each word, line, or passage. Initial codes were then pile-sorted into preliminary categories using a Grounded Theory technique to identify emergent themes. To establish validity, the data were presented to the implementation team for critique and feedback. The investigators then compared sample passages and codes to identify new codes and larger themes. This process was repeated until no new themes could be identified and consensus was reached among team members. Finally, themes were sorted into facilitators and barriers to successful technology use.

Results
After reviewing 132 pages of transcripts, the research team identified a total of five facilitating conditions and five barriers germane to the MR implantation. We outline herewith each facilitator or barrier along with exemplar quotes as well the ETU concept which most closely maps to each.
Facilitators

**Facilitator 1:** The innovation aligned with users’ clinical tasks, values, and priorities; prioritization varied as a function of professional role. *(ETU Theme: Compatibility with Workplace Values)*

While respondents in each professional role emphasized a different set of core patient care values, each respondent was able to spontaneously draw associations between a core value and one or more facets of the implementation. Medical support assistants emphasized the primacy of fostering patient-centered care:

“I think that the veteran has had a very positive experience, and they’re very happy to see it, and I think it’s great… I think that it gives them more information, and they have something in their hand” - (MSA1).

Nurses emphasized the importance of delivering accurate and useful information to providers:

“We want to make sure that we’re not only documenting properly but we’re also informing the provider so that they’re getting that information as soon as possible to address it in the, within the appointment.” - (LPN5)

Physicians emphasized the criticality of prescribing safety and patient communication:

“I think when we start doing better medication reconciliation the profile will be more accurate… My hope would be that that will make for better patient care.” - (MD4)

“One thing is that you know the patient has, each time, the right phone numbers and all of that stuff from our clinic, and so they constantly have the right information. I like that.” - (MD5)

**Facilitator 2:** Staff found the software interface easy to use; products were easily incorporated into existing workflows without reducing efficiency. *(ETU Theme: Perceived Ease of Use)*

Most users believed the software was easy to use and could be adapted to existing workflows:

“Really, it’s just one more little step than what we usually do. So I think that it’s just very easy. I mean you just click on it, print it out, and hand it to them along with their appointment list. It’s very smooth. No issues” - (MSA1).

Many seemed undeterred by the time required to complete MR:

[Is it worth the time?] – “Yeah, I think so, and honestly, I’m not sure that it takes more time. It took some time to learn the tools, and well, it still is, but I think in the end, I’m not sure that it takes too much more time from us” - (MD5).

**Facilitator 3:** Despite the absence of executive sponsorship, the implementation team successfully used a practice facilitation strategy to establish clinician champions and foster clinic staff engagement. *(ETU Theme: Implementation Climate)*

Typologies for overarching implementation strategies help broadly categorize and disambiguate between approaches. In general, the implementation team tended to use a “practice facilitation” approach – encouraging clinician uptake by providing intensive support and preparing local champions. This is in contrast to a primarily top-down approach where existing organizational structures such as executive boards or section leaders promote and enforce change directives.

“I thought the staff [Implementation team] was very helpful. They asked any questions I had or answered all of my questions, and they were very supportive. They asked me if there was anything that I needed or more additional information, and yeah, they were great. They were supportive” - (MSA1).

The implementation team encouraged clinical champions to adopt project ownership…

“But having the emphasis that medication reconciliation and medication adherence are very, very important for patient outcomes, that’s a very important thing, and then saying we’re providing you with tools to facilitate. You’re doing a good job with medication reconciliation. That’s the other important thing.” – (MD4)
“you have to go with, you have this great opportunity to help the patient, and we’re providing so many tools to make this so much easier for you and so much more of a streamlined process and as our head infection control nurse always used to say, the reason bad things happen in medicine is because the holes in Swiss cheese will line up sometimes, and having two people looking at things from medications from two different perspectives, that prevents these bad things from happening. So I have to go with the angle of rather than mandating things in a certain way of trying to have tools to help you help your patients. I think that that is the key” - (MD4).

…despite the absence of executive sponsorship.

“Thinking back to leadership support and stuff, I think it comes back to supporting staffing and supporting you guys to do it, and supporting the staff to be there to be able to implement it. We just don’t have that. So I find that very frustrating… Yeah, and I have no idea if, I mean I would assume that the Chief of Medicine would be supporting this. I don’t actually know because I just haven’t been involved in discussions past MD1” - (MD5).

Facilitator 4: At-the-elbow support was essential, and more valuable than printed educational materials. (ETU Theme: Implementation Climate)

Staff believed at-the-elbow support was a crucial training tool:

“I mean it would have been much more frustrating without having one of you guys there. I think that it was key to have at least one of you guys sitting in the clinic. Probably, I mean I’m not sure if we needed it for every individual provider, potentially to save some manpower, but one of you to be in clinic in real time is key” - (MD5).

Notably, users felt supporting staff did not necessarily need to have a clinical background:

[Was there much of a difference with us supporting you with a doctor versus someone else?] – “Not a huge difference; Yeah, not a huge difference… Yeah, but no, for the technical part of it, it maybe was slightly. I can say if all things being equal, potentially it would be nice to have a doctor there in kind of he understands that. I mean he really understands the physician part of the workflow that you’re dealing with, so that’s potentially slightly more helpful. But it’s almost as helpful to have non-[Physician] there” - (MD5).

Although customized paper educational materials were furnished to each professional role during training, they were rarely referenced in clinic:

[What educational materials did you use to learn the new tools and processes?] – “It was hands on. You guys just kind of came up and because I didn’t get to go to the initial walkthrough orientation. So I know that you for sure came out and kind of explained to me the process…” [Do you remember getting any educational materials from us?] – “I do not remember getting any educational material from you” – (MSA1).

Facilitator 5: Providers valued having flexible tools and processes available to accommodate the emergent properties of complex adaptive systems. (ETU Theme: Compatibility with Work Processes)

Providers emphasized that the clinical situations encountered – and practice strategies used – are heterogeneous and often improvised. Therefore, it is critical that tools can be adapted to the circumstances:

“The new note I haven't used at all because I do my own intake notes, and I have a way that I like them… Everybody is different… But these patients are so complex, and some of them we’ve followed for so long that I have my way that I like to have things in a specific place and follow them. So it helps me… Sometimes I’ll actually do that note and then cut and paste it into my other notes (laughter), some of the components of it. So I liked having it there. It’s more. All of these things to me are tools, but it’s nice to have different tools to be able to use in different circumstances for different patients. So overall, I think that it’s definitely been helpful” - (MD4).

Barriers

Barrier 1: With severely limited clinical time at baseline, users feared that using new technology would be time consuming and interfere with care delivery. (ETU Theme: Compatibility with Work Processes)

Clinicians and staff felt that they had insufficient time to complete even baseline clinical tasks:

“Because the doctors are just as busy if not sometimes more busy than nursing staff. They’re not going to always have time to get to everything they need to get to in an encounter. In all fairness they’re busy, too” - (LPN2).
“The way the clinic works, there is so much delay I will have them skip vitals and stuff, and have them put them in a
room. Or else you’ll inevitably get way behind” - (MD5).

Respondents representing each professional role expressed concerns over the time required to complete MR tasks:

“I think it’s going to be a learning curve a bit. I think it’s going to be time consuming at first. Other than that, I think if
all three of us work on it together, the MSA’s, I think it can be successful. My concern is that it’s time consuming” -
(MSA1).

**Barrier 2: There is no accepted standard for prioritizing clinical tasks; staff tends to prioritize according to their
dividually-held values. (ETU Theme: Compatibility with Workplace Values)**

Our VA facility is a matrix organization; control structures are siloed and clinical personnel tend to report to
different managers. As a result, leadership messaging can be unclear or even discordant. We found that in resource-
constrained settings, staff used personal and ad-hoc heuristics to organize and prioritize work:

[Regarding clinical tasks] “I don’t know that there really is a prioritization per se, unless they are saying things to
trigger the need to look at, ‘I’m depressed or I’m thinking to hurt myself’… at least if we get to a point where we can
get something set, where it relieves the guessing game, did we do it for this one, did we not do it for this one? That can
slow things down” - (LPN2).

**Barrier 3: Staff believed their capacity for change was limited by fixed resource constraints (staffing, environmental
space, patient social issues, and medical complexity). (ETU Theme: Implementation Climate)**

Staff identified fixed resource constraints such as physical configuration of the clinic (e.g., the number of exam
rooms, or distance between exam rooms and waiting area) or medical complexity of patients (e.g., multiple active
problems, high medication burden, co-management of patients) as important barriers to change:

“I think it is confusing for them [patients] as well, because they come through those double doors and they don’t know
whether to go left, right, straight… I’ve seen a lot of CDU patients come out of the double-doors, and say, ‘where are
the elevators, I need to check out.’ They don’t know where to check out” - (MSA3).

**Barrier 4: Gaps in codified process standards and unclear role definitions lead to disruptions in workflow. (ETU
Theme: Compatibility with Work Processes)**

Stakeholders role expectations – including those of the patients – are used to negotiate shared mental models, rules
of engagement, and production of deliverables. When these roles are not clear to everyone, workflows are disrupted:

“But the problem we realized at the time of that meeting was that everybody in our group does the process very
differently. Has very different goals, and very different… and I was like, ‘this is not going to be easy’”” - (MD4).

“I know with (sigh) the medication reconciliation part of it I feel that with patients cause they’re not used to the nurses
going through that part … because some of the patients aren’t, either are not comfortable, or it take, just takes a little bit
longer to do that, the medication reconciliation with patients that haven’t gone through it with the nurse cause they’re
used to doing it with the, a provider” - (LPN5).

**Barrier 5: Structured data forms were difficult to use and lacked sufficient expressivity for routine clinical
encounters. (ETU Theme: Perceived Ease of Use)**

The structured clinical notes requested by the ID staff and developed by the implementation team were found to be
over-engineered, not intuitive, and inflexible at the point-of-service:

“I kind of feel bad that we made this whole [clinic] template and created it, and that in practice we’ve found that it
really isn’t all that helpful. So I guess I’ve learned or I guess we’ve probably learned that there is some balance of over-
scripting and under-scripting these things… I guess the [clinic] template was a little bit surprising. I thought that it
would work great, but it didn’t seem to work in the end… I think that it’s over-customized. Yeah” - (MD5).
Discussion

Key Findings
This article is one of the first to use qualitative methods to describe and understand the sociotechnical determinants of MR adoption and, to our knowledge, only the second that explores ambulatory care culture. We identified several important facilitators and barriers to MR adoption that may inform the development and implementation of future MR processes.

Although articulated prioritization heuristics varied as a function of professional role, all users associated new tasks with a deeply held personal value. Medical support assistants typically orchestrated patient navigation activities (e.g., check-in, check-out, scheduling) and, therefore, more often extolled the virtues of our patient-centered documentation. Nurses and physicians, by contrast, valued the completeness of the medication adherence data. When asked why they used the tools, they cited the ability to improve prescribing safety and avoid medication misadventures. Interestingly, nurses also emphasized the significance of team-based care and quality information hand-offs. When end-users believed the innovation purpose aligned with their values, they were more likely to adjust workflows to accommodate the innovation. To summarize, it appears that when process improvement professionals select “practice facilitation” strategies, it is critical to understand the unique values associated with the different professional roles. This information can then be leveraged when recruiting clinical champions and developing information campaigns.

Our findings also suggest that lack of executive sponsorship – while undesirable – does not predict certain failure of an implementation. Although facility executives (i.e., the Chief of Staff Office) sponsored the project, there had been no direct communication with front-line staff regarding participation or expectations. In response, the implementation team adopted a set of “practice facilitation” techniques including 1) identifying and preparing champions, 2) ensuring ongoing training and facilitation, 3) providing audits and feedback, and 4) reminding clinicians of key tasks. In this regard, the implementation team acted as a liaison or proxy for the executives. Respondent reports suggest the implementation team effectively communicated project goals and expectations directly to key stakeholders. Stakeholders, in turn, were encouraged to reach out to the implementation team for questions or issues. Overall, this data supports the contention that an internal locus for change can be cultivated using a number of complementary and synergistic implementation strategies.

Finally, the data suggest that at-the-elbow support was an essential component of implementation success. Printed materials were quickly discarded and all but forgotten, whereas direct hands-on support helped reinforce tasks, navigate trouble spots, and build confidence in the process. This finding is unsurprising: staff training has long been recognized as a relatively weak intervention in process improvement campaigns. What may be more significant is that respondents valued the assistance of non-clinicians as well as clinicians, suggesting that the value of hands-on support is not necessarily limited to clinical colleagues. Future implementations may be able to use more non-clinician staff during training or to otherwise extend training beyond the capabilities of clinician “super-users”.

We identified many implementation barriers – some of which were at least partially addressed with targeted interventions. Fixed external constraints plagued the implementation and caused timeline slippage. Pre-implementation interviews suggested a climate of frustration with systematic barriers facing the clinic, such as clinician time, exam room space, and competing organizational expectations. Although optimism increased by mid-implementation, the research team identified a number of new barriers including unclear role definitions associated with the new workflow and poor note template usability. Fortunately, the structured approach to gathering feedback enabled the team to quickly identify problems and course correct. For example, a 15-minute schedule shift was enacted to provide more nurse-patient contact time. Staff roles were codified and reinforced with at-the-elbow support. Finally, the implementation team invested additional time role-modeling hand-offs to reinforce shared mental models and improve situational awareness.

In general, users indicated the software tools were easy to use, integrating well into existing workflows. The only notable exception appeared to be the initial structured note template. Providers found the input fields to be inefficient and difficult to navigate. Accordingly, the development team quickly abandoned this design for a more flexible MR input dialog that could be called by the user at any point in the workflow. What is exceptional about this finding is that the template was designed according to user-centered principles with requirements furnished and tested by the ID clinicians.
Human factors experts often find that end-users will describe – and build products – according to work-as-imagined rather than work-as-done\textsuperscript{69}. Fortunately, involvement of end-users and domain subject matter experts helped to build trust between implementation team and stakeholders. Furthermore, the collection of qualitative data at mid-implementation helped surface design challenges early and craft an agile response. This finding stands as a reminder that electronic health record documentation tools should balance the need to script workflow and collect computable data with the flexibility required to handle the emergent properties of the clinical environment.

Implications for Further Work

In the healthcare setting, technology is becoming nearly ubiquitous. However, advances in technology as well as biomedical knowledge\textsuperscript{10} will continually lead to the development of newer technologies and methods that will have an even greater potential to improve the way physicians care for patients. As such, it becomes ever more important to continue to evaluate and improve our understanding of technology implementation methods. There are many avenues for future research. As patients play a central role in the process, further exploration of the impact that patient values and expectations have on technology acceptance, even if the patient is not the primary user of the technology, would be of benefit for future MR implementations. More research is also needed regarding structured data elements in clinical documentation- How can structured documentation better be implemented without hindering the end user? Finally, in the near future as technologies with alternative input methods such as voice recognition using artificial intelligence as the primary interface mechanism become more available, research analyzing the intricacies of this novelty will be required.

Limitations

Limitations of our study include that it was conducted at a single site, limiting the generalizability of findings. Nurses and medical support assistants rotated through clinics at different time points during the implementation. Thus, it was not always possible to recruit the same participants from pre to mid-implementation. Finally, the total number of interviews is relatively low. Hence, this study should be considered exploratory in nature. Larger respondent samples from multiple clinics – or, preferably, multiple organizations – would help to enrich and validate the list of facilitators and barriers.

Conclusions

As we increasingly utilize new technologies to improve healthcare processes, more research is needed in how best to implement and integrate these technologies into clinical workflows. The findings in this qualitative analysis of an MR assistive technology implementation identify key sociotechnical aspects of technology adoption. While our findings generally agree with current literature on healthcare technology implementations, some aspects may be more specific to MR processes and these findings may be used to guide future efforts to implement MR processes.

References

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