TITLE: Interactive Patient-Centered Discharge Toolkit

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STRUCTURED ABSTRACT

Purpose: We implemented and evaluated a suite of electronic health record (EHR)-integrated tools, including a discharge checklist and video, safety dashboard, and secure patient-clinician messaging, to engage patients, caregivers, and clinicians in the discharge process.

Scope: Approximately 19-23% of hospitalized patients experience preventable adverse events post-discharge. Despite the 35 million patient discharges each year, attempts at standardizing the process through checklists have not focused on patients. Lack of patient engagement may contribute to preventable adverse events and readmissions.

Methods: We used RE-AIM to identiy research questions to assess real-world feasibility of implementing our intervention. We used an iterative and participatory process to refine key intervention components. We conducted pre-post study in which we enrolled adult patients admitted to general medicine units. We measured patient activation (PAM-13, Insignia Health, Inc.) at discharge and at 30-days, and utilization of healthcare resources after discharge. We used mixed methods to evaluate our implementation experience.

Results: Of 678 patients approached, 484 (71.4%) were enrolled. The intervention components were used moderately to highly by patients, but only modestly by clinicians. We observed a non-significant increase in the proportion of activated patients (PAM Level 3, 4) at discharge (56.7 % to 59.8%, OR 1.13 [0.79, 1.64], p=0.49); and a significant increase in mean PAM scores at discharge (63.3 to 66.4, unadjusted OR 3.12 [0.05, 6.19], p=0.05). There was no significant change for post-discharge healthcare resource utilization. In sub-group analyses the primary outcome was favored among post-intervention participants with high socioeconomic and low HOSPITAL readmission scores. Lessons learned should help other institutions considering how to implement EHR-integrated digital health tools to engage patients in discharge preparation.

Key Words: digital health, discharge preparation, checklists, patient engagement, care transitions of care

PURPOSE

The purpose of this research project was to conduct a pilot and feasibility study in which we implement and evaluate a suite of electronic health record (EHR)-integrated digital health tools, an interactive patient-centered discharge toolkit (PDTK) that engages patients and caregivers in preparing for discharge during hospitalization. We used the RE-AIM (reach, effectiveness, adoption, implementation, and maintenance) framework to inform the research questions and methods that guide our implementation and evaluation. Our objectives were to:

- Refine and implement the PDTK on general medicine units for patient and caregivers to prepare for discharge and communicate with key clinicians during the transition home.
- Conduct a pilot study to evaluate the effect of the PDTK on patient activation at discharge (primary outcome) and 30-days, and post-discharge healthcare resource utilization at 30-days post-discharge.
- Identify barriers and facilitators of implementation, adoption, and use of the PDTK by patients, caregivers, and clinicians using qualitative and quantitative methods.

SCOPE

The transition from the acute to ambulatory care setting is a vulnerable time for patients and stressful for caregivers–new treatments have been initiated, conditions require monitoring, and the plan is in flux. Approximately 19-23% of hospitalized patients experience preventable adverse events post-discharge. During hospitalization, discharge planning is often initiated late, and input from patients regarding their preparedness is frequently lacking, which may lead to delays and dissatisfaction. After discharge, patients report issues related to follow-up, medications, and self-care and may have unanswered questions that could have been easily addressed before leaving the hospital. Lack of patient engagement during the process of discharge preparation may contribute to preventable adverse events and costly readmissions.

Despite the 35 million patient discharges from U.S. hospitals each year, most reported attempts at standardizing the discharge process through routine use of checklists have focused on clinicians. Few efforts have reported use of structured instruments to assess patients' perspective of discharge readiness: interventions directed at patients may provide an opportunity to improve patient understanding, self-management, and post-discharge outcomes. National agencies (e.g., AHRQ, CMS) are attempting to engage patients and caregivers more

broadly by offering access to discharge preparation materials, but few institutions have determined how best to incorporate these tools into routine clinical practice.

Mobile and web-based technologies that are integrated with the EHR have potential to engage patients and caregivers in improving their knowledge, skills, and confidence during and after hospitalization. However, use of these tools for hospital-based care delivery is nascent at best. Leveraging digital health technology to engage patients and caregivers in self-management during the transition from hospital back home is one compelling approach to improve discharge safety and mitigate readmission risk. Currently available patient-facing digital health tools, such as patient portals, have gaps in functionality with regard to assessing discharge readiness, are not well integrated with the EHR, and present challenges when used during hospitalization.

METHODS

We conducted this study in parallel with our AHRQ-funded Patient Safety Learning Laboratory (PSLL; P30-HS023535, PI Bates). As part of the PSLL, a *bedside display* for patients and clinicians, a *patient portal* for patients and caregivers, and a *safety dashboard* for clinicians were integrated into our EHR environment (Epic Systems, Inc.). These applications used enterprise data services to obtain clinical data from the EHR in real-time. The PSLL infrastructure served as a platform on which to incorporate and test specific enhancements for the PDTK project based on user requirements and alignment with organizational priorities. Specifically, the goal of the PDTK was to design, develop, and implement enhancements to the PSLL infrastructure with the purpose of minimizing threats to safety during the transition from hospital to home by enhancing discharge safety.

To achieve this, we used the RE-AIM framework to identify research questions to better understand the real-world feasibility of implementing the proposed EHR-integrated digital health tools to engage patients in discharge preparation. First, we conducted informal workflow observations on study units and interviews with our stakeholders to identify requirements for engaging patients and clinicians in discharge preparation while aligning with key organizational priorities: engaging patients to improve patient satisfaction, improving expected discharge date (EDD) entry in the EHR, increasing discharges before noon, and reducing 30-day hospital readmission.

We used user-centered design principles and an iterative, participatory process to refine key intervention components. For the discharge checklist, our goal was to improve structure and organization, validate content, and clarify wording and utility. Key refinements were identified through multiple iterations of the original discharge checklist within our research team, our hospital's Patient and Family Advisory Council (PFAC), and a short pilot in which we administered a paper-based prototype to a convenience sample of hospitalized patients. Based on feedback from unit nurses and patient advisors, we identified the need to create a video to help hospitalized patients understand the purpose of completing the checklist in preparation for discharge. We determined that patients would need to watch the video and complete the checklist via several workflows: a patient portal on hospital-issued mobile device, their own mobile device, or a web-based submission process (REDCap) facilitated by research staff.

We made discharge process-based enhancements to the PSLL technical infrastructure to ensure that patient-reported information from the checklist would be communicated to clinicians as the EDD approached. Based on feedback from patients, patient advisors, and clinical unit leadership, we confirmed that patients wanted their care team members to have access to the checklist responses sufficiently before actual discharge to allow time for the care team to review and address any issues. Using REDCap, we developed a real-time checklist submission and review process to ensure checklist responses submitted by patients would be visible for clinicians to review in the EHR in real-time.

The final intervention (**Table 1**) was comprised of a discharge checklist and video for patients, safety dashboard for clinicians, and secure patient-clinician post-discharge messaging for up to seven days post-discharge.

Table 1. Components of the Interactive Patient-Centered Discharge Toolkit

Component	Functionality
Discharge Checklist & Video	• Patients completed pre-discharge checklist from electronically via patient portal or REDCap • Patients entered their mobile phone number to request post-discharge messaging
Safety Dashboard	• Providers could view the current status of each component of the patients' discharge self-assessment on the dashboard and then address any unsatisfied item as appropriate (e.g., unable to pay for medication, patient unaware of follow-up)
Post-Discharge Patient-Physician Messaging	• Physicians could choose to initiate a post-discharge messaging thread with patients who requested post-discharge texting by clicking a link in dashboard

We conducted a pre-post study on three general medicine units at Brigham and Women's Hospital (BWH). All adult patients (>18 years) admitted to these general medicine units for at least 24 hours during the pre-intervention (1/2017 to 10/2017) and post-intervention (1/2018 to 7/2018) periods were eligible to participate. Patients who demonstrated capacity (determined by a nurse or physician member of the care team) or had a legally designated healthcare proxy (who spoke English and was available to participate on their behalf) were eligible to participate, and included those who enrolled in the acute care patient portal as part of the concurrent PSLL study. All patients provided informed consent to participate in data collection activities up to 30-days after discharge.

For the main trial, we estimated a sample size of 416 patients (208 pre and 208 post) based on 695 patients admitted to the general medicine units during a 12-month study period and a 60% participation rate. Our effective sample size was reduced to 358 patients (179 pre and 179 post) after accounting for clustering. Assuming that 72% of our patients would be classified as PAM Level 3 or 4 (based on the literature), we anticipated having 80% power to detect a 12% absolute increase in the primary outcome (proportion of patients classified as PAM Level 3 or 4) from 72% to 84% with an alpha of 0.05.

A trained research assistant (RA) identified eligible patients admitted to study units with a plan to be discharged within the next 24-48 hours based on their EDD as currently entered into the EHR. During the intervention period, patients were coached to watch a discharge preparation video, complete a discharge checklist via the patient portal or REDCap, and request post-discharge text messaging capability with a physician 24-48 hours prior to their expected discharge date. Clinicians were able to view concerns reported by patients based on their checklist responses in real-time on the EHR-integrated safety dashboard and choose to open a secure messaging thread with the patient for up to 7-days after discharge.

Patients (or caregivers) were asked to complete the patient or caregiver activation measure (PAM-13 or CAM-13, Insignia Health, Inc.) survey at discharge. The patient or designated caregiver were then contacted approximately 30-days after discharge. On this call, patients (or caregivers) were asked to complete the PAM-13 (or CAM-13); and a post-discharge healthcare utilization survey, which asked about total utilization of healthcare services (e.g., ambulatory visits to PCPs, emergency department visits, hospital readmissions). We used administrative databases to obtain demographic information and utilization of healthcare resources within the Partners Healthcare network during the 30-day period after discharge.

We tracked all intervention usage events, including watching the video, completing the checklist, requesting post-discharge messaging, as well as the number and type of patient-reported concerns. We captured the number of times that clinicians accessed the discharge column on the safety dashboard to view patient-reported concerns, acknowledged yellow and red flags, and clicked on the link to initiate post-discharge messaging. Finally, we conducted structured interviews with a purposeful sample of patients and focus groups with clinicians regarding their respective intervention components.

We analyzed and compared the proportion of patients with PAM scores greater than 55 (Level 3, 4) from pre to post using Chi-squared test; and mean PAM scores from pre to post using a difference in means analysis. We analyzed and compared patient activation at 30 days similarly to the primary outcome. We used descriptive statistics to report patient demographic and administrative data, quantify patient-reported concerns, calculate frequency of tool use by patients and clinicians, and report survey data. Finally, we used grounded theory and inductive analysis to extract codes and identify key themes from transcribed interviews and focus groups.

Our final study design had several limitations. First, as a pre-post study, it was non-randomized and subject to confounding. Second, sample size estimates were based on our ability to demonstrate significant improvement in PAM scores at the patient-level at the time of discharge; however, we had not previously used the PAM-13 instrument in our population to assess baseline PAM levels. Third, we assumed that PAM scores would be influenced over short periods of time based on interaction with the intervention and coaching by research staff; however, emerging data has called into question whether PAM scores can change over short periods of time.

RESULTS

Of 678 patients approached, 484 (71.4%) were enrolled; of these, 479 (98.9%) were included in the main analysis (245 pre-intervention, 234 intervention). Of these 479, 215 (44.9%) were available for 30-day phone call (99 pre-intervention, 116 intervention). There were notable demographic differences: post-intervention participants were more often non-Hispanic and English-speaking, and had higher DRG weights, longer lengths of stay, and higher HOSPIT

During the intervention period, approximately 67.8% of patient participants completed the checklist, and most also watched the video. On average, 4.24 concerns were reported per checklist submission, most commonly about medications (30.7%) and follow-up (30.3%). A

member of the care team accessed the safety dashboard to view patient-reported concerns for 41.2% of checklists submitted. Patients requested secure messaging with the physician for 33.4% of checklists submitted; however, when secure messaging was requested, a physician initiated the secure messaging thread in 2.1%.

We identified two key themes about the checklist and video from structured interviews of 12 patients and three key themes about the safety dashboard from focus groups with 22 clinicians. Patient interview participants endorsed gaps in communication with their care team and thought that the video and checklist would be useful closer towards discharge. Clinicians participating in focus groups perceived value for patients but suggested that low awareness and variable workflow regarding the intervention, lack of technical optimization, and inconsistent leadership limited use of clinician-facing components.

Main outcomes are summarized as follows:

- The proportion of activated patients (PAM Level 3, 4) at discharge increased from pre to post, but this was non-significant in both unadjusted and adjusted analyses.
- There was a significant increase in mean PAM scores at discharge from pre to post (63.3 to 66.4, unadjusted OR 3.12 [0.05, 6.19], p=0.05); however, this effect was non-significant in adjusted analysis (62.2 to 67.7, adjusted OR 5.46 [-4.19, 15.11], p=0.27).
- The proportion of activated patients (PAM Level 3, 4) at 30-days significantly decreased from pre to post (59.6% to 45.7%, unadjusted OR 0.57 [0.33, 0.98], p=0.04); this effect was non-significant in adjusted analysis (59.6% to 45.5%, OR 0.56 [0.10, 3.19], p=0.51).
- There was a non-significant decrease in mean PAM scores at 30-days post-discharge from pre to post in both unadjusted and adjusted analyses.
- There was no significant change from pre to post for post-discharge healthcare resource utilization, readmissions, or hospital operational metrics in unadjusted or adjusted analyses.

In sub-group analyses, the primary outcome was favored among post-intervention participants with high socioeconomic status (OR [95% CI] 1.3 [1.01, 1.66], p=0.04) and low HOSPITAL readmission scores (OR [95% CI] 1.40 [1.15, 1.72], p<0.01).

In summary, we observed moderate to high participation by patients for watching the discharge video and completing the checklist, but modest usage of the safety dashboard by clinicians. A few clinicians initiated secure messaging despite a modest percentage of requests by patients. With regard to main outcomes, we observed a trend towards improvement in patient activation as measured by mean PAM scores, but not the overall proportion of patients classified as PAM Levels 3 or 4. We observed no effect on post-discharge healthcare utilization,

including 30-day readmissions. Sub-group analyses demonstrated that intervention participants with high patient activation levels at discharge were significantly more likely to have high socioeconomic status and low HOSPITAL readmission risk scores.

We attribute the high rate of patient participation to facilitation and coaching by research staff, and flexible web-based workflows. Uptake of clinician-facing intervention components was sub-optimal; we attribute this to low awareness of the intervention, inconsistent understanding of its purpose and how to use it, and lack of specificity of patient-reported concerns viewable on the safety dashboard. With regard to our main outcomes, it is possible that the intervention as a whole was transiently activating but that patients who enrolled during the intervention period were less activated at baseline as reflected by PAM scores at 30-day follow-up. Specifically, our main outcomes analyses may have been confounded by a sicker and more medically complex intervention cohort compared to the pre-intervention cohort. Notably, intervention participants had longer lengths of stay, higher DRG weights, and higher HOSPITAL readmission risk scores during their index hospitalization. Alternatively, the intervention may not have been sufficiently activating for hospitalized patients, the majority of whom where coached to submit the checklist. Finally, patient activation as measured by PAM-13 might be more difficult to modify in certain patient populations, particularly the elderly, minorities, as well as those with poor health literacy and debilitating chronic illness who often have lower patient activation levels. Thus, we may have been underpowered to detect a statistically significant improvement in patient activation associated with our technological intervention in a patient population that included many elderly patients with multiple comorbidities.

In conclusion, we evaluated the impact of EHR-integrated digital health tools to engage patients, caregivers, and clinicians in discharge preparation, but did not demonstrate statistically significant improvement in patient activation. Our evaluation of our implementation experience (**Table 2**) suggests several barriers as well as strategies to promote more robust adoption, use, and maintenance of the intervention components. In short, the lessons learned from our experience should have practical implications for other institutions considering how to more proactively engage patients in discharge preparation using EHR-integrated structured instruments such as we describe, while simultaneously addressing clinician workflow challenges.

Table 2. Implementation Barriers and Strategies to Promote Adoption

Implementation Barriers	Strategies to Promote Adoption
Discharge Video	
Timing and access of video after admission to unit	• Make videos available via patient portal, bedside display, television • Engage nurses to have patients watch videos as EDD approaches
Too generic and impersonal	• Have clinical unit leaders create unit-specific videos • Create videos for each attending, play video for patient's current attending by linking to the treatment team in the EHR • Translate videos into common languages (e.g., Spanish) using medical interpreters
Discharge Checklist	
Timing and administration	• Determine optimal timing of checklist administration for specific patient categories (e.g., admissions for acute on chronic disease exacerbations; awaiting procedures; undifferentiated diagnoses) • Demonstrate impact on key hospital priorities and process metrics (EDD accuracy, early hospital discharges)
Patients' belief that clinicians will address all items	• Encourage patients to review checklist early during hospitalization • Allow patients to update checklist responses as EDD approaches or changes
Checklist responses out-of-date due to discharge delays	• Identify workflow to update checklist after initial submission (e.g., notification via patient portal, email, or mobile app)
Dashboard Discharge Column	
Variable EHR data entry of key data elements (EDD, medical, non-medical barriers)	• Demonstrate how EDD can be viewed by patients (patient portal, bedside display) and clinicians (bedside display, dashboard) • Add a confidence indicator that estimates the likelihood that EDD will equal ADD to manage patient and clinician expectations • Demonstrate value of structured EHR data entry for driving dashboard logic (flagging red when EDD not entered) • Encourage checklist completion for patients at high risk for readmission by incorporating patient-specific readmission risk scores from EHR into logic • Display barriers to discharge on dashboard
Competing quality improvement (QI) interventions	• Understand current institutional priorities and emerging workflows for identifying and escalating discharge barriers • Propose enhancements based on lessons learned from concurrent QI efforts
Poor specificity of patient-reported concerns viewed in dashboard	• Provide a link to discharge checklist questions and patient's responses • Link patient-reported concerns to specific clinical actions (e.g., if poor understanding of main diagnosis, update After Visit Summary with condition-specific educational materials)
Secure Post-Discharge Messaging	
Physician resistance	• Frame the initiation of secure messaging thread as an opt-in process • Align with value-based incentives for clinical services (readmissions) • Communicate success stories from early adopters to assuage fears
Managing patient expectations about whether physicians will initiate secure messaging	• Educate patients about the opt-in process for attendings • Encourage patients to request attendings to use this feature for clearly defined reasons (e.g., concern about obtaining a key medication)

EDD=Expected Discharge Date; ADD=Actual Discharge Date; EHR=Electronic Health Record; QI=Quality Improvement

As an early attempt at rigorously evaluating a discharge checklist that was designed, developed, and implemented for patients and caregivers, and whose responses were accessible to clinicians in real-time via the EHR, our project has clear significance. First, our findings add to the nascent but growing literature regarding potential impact of digital health tools that promote patient engagement during acute care. Few studies have evaluated

interventions designed to structure the discharge preparation process for patients and caregivers as we describe. Our qualitative analysis suggests much potential from both the patient and clinician perspective for incorporating these tools more broadly into routine clinical practice once key barriers are addressed. Second, our experience with post-discharge messaging between patients and hospital-based clinicians underscores the need to better align incentives for novel interventions during the immediate post-discharge period: many patients clearly requested this feature, but hospital-based clinicians were reluctant to initiate the request in nearly all cases. Third, our experience underscores the complexity in using patient activation alone as an outcomes measure. Though we did not detect improvement in patient activation, there were several methodological reasons that we identified that may explain this. Few studies evaluating use of digital health tools, including patient portals and mobile tablets, have demonstrated statistically significant improvements in patient activation at discharge as measured by PAM-13.

Our main trial findings have several implications. Incorporating discharge checklists and videos into clinical practice with the intention of engaging patients, caregivers, and clinicians though feasible, may not immediately result in measurable improvement of key outcomes. Ensuring institutional commitment is a crucial step for maximizing adoption, use, and maintenance of these tools into routine practice: only then could these tools have potential to favorably impact outcomes. Our analysis also suggests that PAM scores may be better utilized to stratify hospitalized patients who may preferentially benefit from technology interventions. It is possible that patients with high PAM score may benefit from technological intervention, whereas those with low PAM scores may benefit from more coaching and caregiver support during recovery. Future studies should be designed to address these types of questions, which may become increasingly important as institutions adopt, scale, and spread digital health tools to engage patients in discharge preparation.

PUBLICATIONS & PRODUCTS

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5. Design, Development, and Implementation of Interactive Patient-centered tools to Engage Patients and Caregivers in Discharge Preparation, 2018 AMIA Annual Meeting, San Francisco, CA
6. Interactive Patient-Centered Discharge Toolkit to Promote Self-Management During Transitions, 2019 National Web Conference on the Role of Health IT to Improve Care Transitions, AHRQ
7. Condition-Specific Discharge Videos: A Novel Approach to Patient Education and Activation (Manuscript Under Review)
8. Interactive Digital Health Tools to Engage Patients and Caregivers in Discharge Preparation: An Implementation Study (Manuscript Under Review)
9. Interactive Digital Health Tools to Engage Patients and Caregivers in Discharge Preparation: Impact on Outcomes (Manuscript Under Review)