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1. STRUCTURED ABSTRACT

Purpose: The purpose of this project was to create and evaluate a system of care that supports the safe journey of older adults after presentation to the ED.

Scope: Our transdisciplinary team of engineers, health services researchers, nurses, physicians, and pharmacists collaborated with a large health system with both academic and community EDs to create and evaluate a system of care that supports the safe journey of older adults after presentation to the Emergency Department (ED), the 'patient safety passport.'

Methods: We conducted a work system analysis and created a 'patient safety passport for vulnerable older patients during their care journey from the ED via two co-designed interventions. In implementing the AHRQ RFA 5-step methodology, we used multiple methods organized around two technical areas: (1) human factors and systems engineering work system analysis and participatory co-design and (2) electronic health record (EHR) data analysis and modeling.

Results: Our comprehensive work system analysis mapped the processes of older adults' journey after presentation to the ED and identified barriers and facilitators to those processes during care, disposition decision making, and care transitions. We developed a list of guidelines and design requirements for a patient safety passport that supports the safe journey of older adults after presentation to the ED. We also identified, designed, implemented, and evaluated three priority interventions for the initial patient safety. The guidelines and requirements identified in this project provide a roadmap for system design to transform care transitions from a point of risk to a point of opportunity to improve safety that can be used by other researchers and practitioners to develop patient safety passports within their unique healthcare systems.

Key Words: emergency department, discharge, care transitions, older adult patients, falls, antibiotic stewardship, sociotechnical systems, human factors and systems engineering.

2. PURPOSE

Our transdisciplinary team of engineers, health services researchers, nurses, physicians, and pharmacists collaborated with a large health system with both academic and community EDs to create and evaluate a system of care that supports the safe journey of older adults after presentation to the Emergency Department (ED): the 'patient safety passport.' We created a patient safety passport for vulnerable older patients during their care journey from the ED via two co-designed interventions. In implementing the AHRQ RFA five-step methodology, we used multiple methods organized around two technical areas: (1) human factors and systems engineering and (2) electronic health record (EHR) data analysis and modeling.

3. SCOPE

This project had two specific aims.

Aim 1: Using a systematic analysis, we will design, develop, implement, and evaluate a system of care (identified as the patient safety passport) that supports the safe journey of older adults after ED presentation. *Approach*: We will execute Aim 1 using a participatory, human-centered design process.

Aim 2: We will develop a transdisciplinary Patient Safety Learning Laboratory (PSLL) aimed at engineering safe care journeys for vulnerable patients, including older adults. *Approach*: Our PSLL will build on long-standing, strong research collaboration between engineering and the health sciences at the University of Wisconsin-Madison (represented by the two PIs), implemented through the Wisconsin Institute for Healthcare Systems Engineering (WIHSE).

3.1. Background and Context

The Census Bureau estimates that, from 2016-2050, the older adult (age>65) population will grow from 49 million to 84 million people.[1,2] The combination of the aging population with their increasingly complex care needs produces a major challenge for delivering healthcare,[1] in particular in the ED and the hospital.[3,4] Older patients comprise a large proportion of patients in the ED (20 million visits, 15% of all visits)[5] and hospital (13 million hospitalizations, 33% of discharges),[6] despite making up only 11% of the population.[7] Compared with others, older adults are more likely to present to the ED[4] and be hospitalized.[4] Unfortunately, many older adults experience poor outcomes after ED visits,[4,8] suggesting that these encounters represent missed opportunities to identify high-risk patients and intervene to improve both ED care and transitions to other providers. Frequent reasons for ED visits and subsequent hospitalizations for older adults include fall (18% of ED visits for older adults in our ED between 2013 and 2015[9]) and suspected UTI (25% of infectious disease-related ED visits in 2012[10]). Patients with these diagnoses represent particularly vulnerable groups; in both conditions, the risk of deterioration after discharge is balanced by the risk of harms from deconditioning or healthcare-associated harm in subsequent care settings. Our project focuses on vulnerable older patients over 65 who are diagnosed with fall or suspected UTI in the ED (AHRQ priority population).

Older patients are at high risk for patient safety issues and healthcare-associated harm, especially when receiving care in the ED and the hospital. Older ED patients are more likely to experience adverse outcomes after an ED visit compared with younger patients, including ED readmission, hospitalization and death.[4,8] Once admitted to the hospital, older adults experience higher incidence of patient safety issues than younger patients,[3,11-14] such as falls,[13,14] medication errors,[13] VTE,[15] and HAIs.[13,14] They are also more likely to suffer more serious consequences and greater harm, such as morbidity and mortality, longer hospital stay, functional decline, and hospital readmissions.[3,11,16]

ED patients diagnosed with fall or suspected UTI are particularly vulnerable and experience patient safety issues in the domains of fall, VTE, diagnostic and medication errors, and HAIs (Table 1). Older patients admitted because of a fall are often restricted in ambulation as a means to prevent a fall during admission.[17] However, restricting older adult patient mobility actually increases their risk for falls and injury due to loss of lower extremity muscle mass and strength, changes in blood volume, and restricted respiration.[18,19] Diagnostic and medication errors and HAIs frequently occur among ED patients diagnosed with suspected UTI.[20,21] In a study of women who were diagnosed with UTI in the ED, only 43% received a urine culture,[22] and, in women over 70, only 57% had confirmed UTI with a positive urine culture (representing overdiagnosis);[20] the rest were inappropriately treated (antibiotic medication error).[23] Unnecessary use of antibiotics can lead to HAIs, such as *C. difficile* infections.[24]

Table 1 – Specific Patient Safety Issues Experienced by ED Patients Diagnosed with Fall and Suspected UTI

ED Diagnosis	Specific Patient Safety Issues	Potential Elements of Patient Safety Passport
Fall	Repeated fall in hospital, SNF or home[18,19,25-27] VTE due restricted mobility for fear of another fall[17] Medication errors from drugs that increase fall risk[28,29]	Recommendation for home safety evaluation Recommendation for mobility Pharmacist review of medications[30]
UTI	Diagnostic error (overdiagnosis and missed test)[21,22] Medication error inc. inappropriate antibiotics[23,31] HAIs inc. *C. difficile* due to unnecessary antibiotics[23,24]	Reminder for urine culture; review to confirm/refute UTI diagnosis Review of antibiotics

Many patient safety issues experienced by ED and hospitalized older adults are inter-related.[3] For example, an ED patient diagnosed with a fall may experience another fall in the hospital and sustain an injury; as a result of immobilization, the patient may develop a VTE. An older patient who experiences a patient safety issue in the ED or the hospital is likely to come back to the ED or the hospital or stay in the hospital longer, which increases exposure to the hazardous hospital environment.

Most research focuses on single patient safety issues and ignores that they are closely related and do not occur in isolation.[3,32] In our project, we will use a systems approach for addressing inter-related patient safety issues experienced by older adults.[3] We will also look at what happens to older patients over time (i.e., during their care journey), not just one encounter or episode of care but for a longer period of time, starting with ED presentation with an acute problem (i.e., fall or suspected UTI).[33,34]

Older patients are at higher risk of harm during transitions; but transitions are also 'touch-points' in the patient journey where safety can be addressed. Older adults are vulnerable to transition-related risk,[35,36] with 20% of patients >65 years old returning to the ED within 30 days (29% ED revisit after 14 days for >75 years old).[37,38] They also experience more frequent transitions compared to others[35,36,39-41]; 22% have at least one hospital transition per year, 50% of whom experiencing multiple transitions annually.[41] Older adults' susceptibility to transition risks is related to system factors (e.g., more complex therapeutic regimens,[39] health care fragmentation[35,36]) and associated poor information flow. Interventions have focused on single transitions (e.g., hospital discharge). We propose a novel approach for looking at the sequence of transitions in the older patient's journey and the balance of safety and risk along the journey. During their journey initiated in the ED, older patients interact with multiple aspects of the healthcare system and are exposed to potential patient safety issues (Table 1). Care transitions during the patient journey may be high risk but may also provide an opportunity to re-evaluate the patient, his/her status, and treatment (error detection & recovery).

Older patients are increasingly transitioning directly to a Skilled Nursing Facility (SNF) without the traditional 3-day inpatient hospitalization, because Medicare has waived the SNF 3-day rule for Next-Generation Accountable Care Organizations. This waiver is based on evidence that many patients are safe for discharge without a 3-day inpatient stay.[42] The SNF 3-day waiver adds another type of transition after ED discharge for older patients. Research has focused on care transitions of older adults from SNF to ED[43] and from hospital to SNF or home,[44] including research by Werner (co-I) on transition from hospital to home health care[45]; however, we know little about the transition from ED to SNF.[46] In addition, research has examined handoffs from ED to hospital, but not specifically for older patients.[46] Some solutions have been tested for improving care management of older ED patients,[46-48] but studies have ignored the multifarious patient journeys and inter-related patient safety issues experienced by those patients. Our project will address these gaps through in-depth analysis of older adults' handoffs from the ED to hospital, SNF, and home.

4. METHODS

4.1. Study design

We conducted a participatory design approach to integrate the needs of multiple stakeholders (e.g., patients, care partners, clinicians) in the patient safety passport design process, including cognitive interviews, contextual inquiry, team-based analysis, EHR data analytics, and co-design sessions with the intervention implementation teams. Our approach is based on the Systems Engineering Initiative for Patient Safety (SEIPS) 3.0 model.[49] According to SEIPS 3.0,[49] the work system is composed of *individuals* (e.g., physician, nurse, patient, caregiver), performing *tasks* (e.g., discussing ED disposition alternatives), using various *tools and technologies* (e.g., EHR); these activities occur in a *physical environment* (e.g., ED patient room, transfer to hospital unit) and an *organizational context* (e.g., patient transfer, 3-day SNF waiver).[50] SEIPS 3.0 highlights the integration of the process and the work system and depicts the patient journey as crossing multiple, intersecting work systems over time.

4.2. Setting and Participants

We conducted this research within UW Health, which is an integrated health system that serves more than 600,000 patients each year in the Upper Midwest and beyond, with approximately 1,500 physicians and 16,500 staff at six hospitals and more than 80 outpatient sites, a 1,400-member physician group, and a 275,000-member HMO. UW Health EDs serve more than 80,000 patients each year and are staffed by 54 faculty members, a training program with 36 residents (12 per year), 17 advanced practice providers (APPs), 150 nurses, eight social workers and case managers, and 62 technicians.
We focused on older adults diagnosed with fall or suspected urinary tract infection (UTI) in the ED, as they are particularly vulnerable and experience patient safety issues in the domains of fall, venous thromboembolism (VTE), diagnostic and medication errors, and HAIs.

4.2.1. Inclusion of AHRQ Priority Populations. This research addressed one of AHRQ's priority populations: older adults.

4.3. Work system analysis

Conceptual framework. Our project was guided by the SEIPS (Systems Engineering Initiative for Patient Safety) model[49,50] as the conceptual framework for addressing multiple patient safety issues and healthcare-associated harm experienced by older adults during their care journey. According to the SEIPS 2.0 model,[49] which is based on the SEIPS model,[50-52] the work system is composed of *individuals* (e.g., physician, nurse, patient, caregiver), performing *tasks* (e.g., discussing ED disposition alternatives, sharing information about patient transfer), using various *tools and technologies* (e.g., EHR, blue envelope); these activities occur in a *physical environment* (e.g., ED patient room, hospital unit, home) and an *organizational context* (e.g., patient handoffs, 3-day SNF waiver). The entire work system needs to be designed to support care processes for ED patients, in particular the ability to detect, correct and anticipate errors and to support communication and coordination in the patient journey (Figure 1).[50]

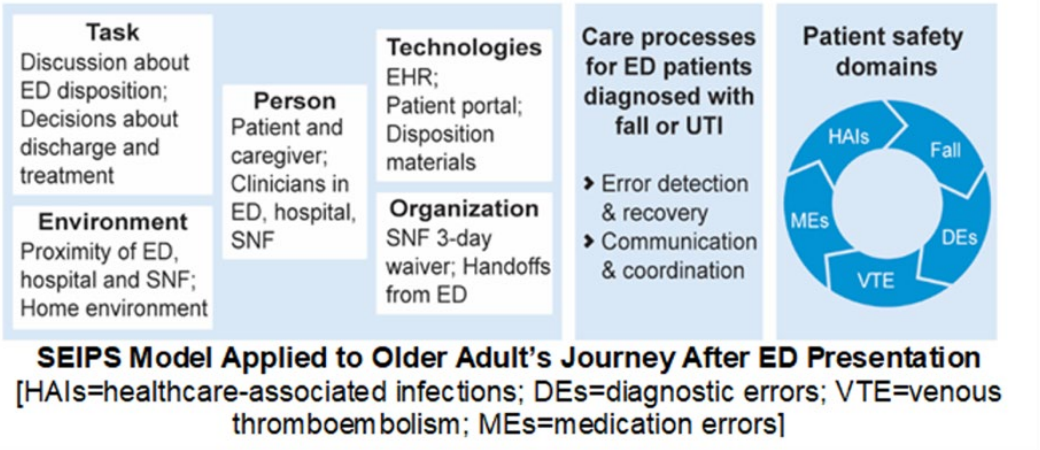

Figure 1. The Systems Engineering Initiative for Patient Safety (SEIPS) model applied to older adults' journey after ED presentation.

4.3.1. Data collection and analysis

4.3.1.1. Critical Incident Interviews. We conducted semi-structured interviews with stakeholders from the ED, hospital, and skilled nursing facilities who were recruited via email. The interview guides were developed by team members with qualitative training and expertise in HFE, Psychology, Emergency Medicine, and Nursing. The interview guide is based on a modified Critical Incident Technique (CIT), which provides a framework for collecting and analyzing information about human work activities and the significance of these activities to the people involved.[53] CIT lends itself to rich, contextualized data that reflect actual activities in context, making it an ideal method for developing a highly user-centered intervention.

Interview questions were designed to permit a full understanding of the work system and processes related to performing care transitions for older adults. Interview questions asked participants to describe specific instances of older adults' care transitions when the transition was safe and effective and when it was not combined with probes based on SEIPS 2.0. Interview guides were tailored for each setting to ensure the questions fit the language and expertise of interviewees. The interview guide is available at https:// cqpi.wisc.edu/wp-content/uploads/sites/599/2020/02/Interview-Guide-ED-disposition-and-transition.pdf. Interviews were a mean of 51 minutes (range=35 to 65 minutes) and took place in a location convenient for the interviewee. Interviews were audio recorded, transcribed verbatim, and uploaded to Dedoose 8.3.35.

4.3.1.2. Observations/Contextual Inquiry. We conducted 20 contextual inquiries of older adults' experiences in the ED. Contextual inquiry is a method used to observe people in their natural 'work environment' while they perform tasks as they normally do, coupled with interview probes unobtrusively inserted prior, during, and after observation.[54,55] Contextual inquiry was conducted with older adults who presented to the ED for a primary complaint of fall occurring within the previous 48 hours; were not categorized as a level 1 trauma; had their POA present at the time of ED visit, if they had an activated POA; and were aged 65 or older. Research assistants observed interactions between older adults, their care partners if present, and clinicians during the patient's entire ED stay and used a SEIPS 2.0-based observation guide to capture processes and related work system components. Research assistants also asked questions the patient and care partner(s), if present, clarifying questions throughout the observation. Observations ended once the older adult was transitioning to the next location of care. Observations lasted a mean of 4.5 hours (range=2-11.3), for a total of 103 hours. After the observation, research assistants conducted brief interviews with the ED clinician(s) who cared for the older adult during the observation.

We used multiple approaches to analyzing these data across multiple research questions related to the process mapping, work system barriers and facilitators, and collaborative work, as highlighted in the results. We used an Intervention Implementation Team (IIT),[56,57] in which multiple perspectives were presented, confronted, and combined throughout data analysis.[58] The data sets were merged and treated as one. First, the team conducted a general content analysis to identify individual process steps and their order relative to other steps to form a process map. Each transcript was dual coded by the research team, and codes were brought to the full research team in weekly meetings for consensus discussion. The codes were then translated into a visual depiction, which was refined through team meetings and stakeholder input. Next, a subset of the research team with HFE expertise conducted a general content analysis[59] guided by SEIPS 2.0 to analyze the interview transcripts and contextual inquiry observation and interview notes for work system barriers, facilitators, and solutions within the steps of the process. The goal of this analysis was to identify care transition process components, work system interactions, care transition barriers and facilitators, and potential solutions to work system barriers. Two members of the research team coded a subset of three transcripts to develop the initial codebook, which was subsequently discussed and refined by the full research. The codebook was then applied to all transcripts by one coder, with oversight by senior members of the research team (NW, PC, PH) through weekly team discussions. Next, we conducted a longitudinal and iterative affinity diagramming process that took place over the course of numerous research team meetings. The purpose of affinity diagramming was to categorize barriers and facilitators to the ED care transition process. We conducted multiple team-based data analysis sessions with the HFE team in which we performed team-based affinity diagramming sessions to inductively identify categories of barriers, facilitators, and solutions from the coded data related to our research objectives. As additional interviews were collected, coded, and summarized, the research team continually discussed and refined the categories. These analyses formed the foundation of the results described in section 5.1 below.

4.3.1.3. EHR data analytics. To further describe the ED work system and related transitions, we extracted and analyzed relevant EHR data (Table 2 provides an overview). In one study, we used EHR data to develop a transition flow model to study fall-related ED revisits for older patients with diabetes.[60] Approximately 18% of their ED visits are fall related, yet there are effective interventions to reduce falls in this population. We focused on identifying the most critical factors whose changes can lead to the largest reduction in ED revisits. Patients were categorized into five diabetes classes (Class 1: patients who have no diabetes-concordant conditions; Class 2: patients with risk factors for diabetes and its complications conditions only; Class 3: patients with non-cardiac vascular disease conditions, with or without risk factors, and without cardiac or advanced cardiac conditions; Class 4: patients with cardiac disease conditions but without advanced cardiac disease conditions, with or without risk factors or non-cardiac vascular disease; and Class 5: patients with advanced cardiac disease conditions, with or without any other diabetes-concordant conditions).

Patient transitions within these five classes were examined at discharge, within 7-day revisits, and between 8- and 30-day revisits. A transition flow model to evaluate patient revisiting risks was derived.
The largest potential for reduction in ED revisits was found in the transition from discharge to 7-day revisit for Class 3 patients (i.e., patients with diabetes and non-cardiac vascular disease conditions). Class 3 patients were 39.3% of the population. In addition, a reduction in the 7-day ED revisit rate from 5.22% to 4% would decrease the overall revisit rate within 30 days by 5.69% (7.91% to 7.46%).

In a second study, we developed a Markov chain model to analyze the dynamic behavior of the handoff process in hospital emergency departments (ED).[61] Due to overwhelming crowding in the ED, capacity constraints in other units, staff shortage, communication/coordination issues, etc., handoff delays are not uncommon, which may cause delayed treatment, increased mortality, poor patient outcomes, and other adverse events. The handoff process was categorized into four steps: Step 1: An ED physician will send a bed request to an inpatient unit. Step 2: An ED nurse coordinator will contact the inpatient unit Care Team Leader (CTL) to discuss about the patient and get a bed assignment. Step 3: After bed assignment, the inpatient unit nurse will review the ED SBAR (Situation Background Assessment Recommendation) within 15 minutes of receiving the text page. Step 4: ED starts transferring the patient to the receiving unit. Our model results in acceptable accuracy in performance evaluation, which provides a quantitative tool to study dynamic handoff processes. More transfer requests or possible unavailability will lead to longer waiting and handoff time, but faster service and quick resuming of availability can result in shorter time. We found changes in service rate could impact waiting time more significantly than unavailability. As communications can be strongly correlated to service rate, enabling effective coordination to reduce delays is of critical importance.

Table 2. Initial electronic health record domains and measures extracted in this study.

Domains of Patient Safety	Population (Fall, UTI)	Process or Outcome	Measures
Fall	Fall	Process	No fall risk assessment (Hendrich II) performed at index ED visit (uses our previously published definitions)[62]
Fall	Fall	Outcome	Repeat fall within 30 days of index ED visit (uses our previously published definitions)[62]
VTE	Both	Outcome	VTE within 30 days of index ED visit[63]
Diagnostic safety	UTI	Process	No urine culture performed at index ED visit[22]
Diagnostic safety	UTI	Process	Urine culture does not confirm infection within 3 days after index ED visit (uses CDC definition for confirmed UTI)[64]
Medication safety	Both	Process	Medication review not performed by pharmacist at index ED visit
Medication safety	Fall	Process	Newly prescribed fall-risk increasing drug or drug increasing risk of orthostatic hypotension at index ED visit[65]
HAIs	UTI	Outcome	*C. difficile* within 30 days after index ED visit (uses adapted CDC definition for *C. difficile*)[66]

ED or hospital readmission	Both	Outcome	Repeat ED visit or readmission within 30 days after discharge from the index ED visit (or hospital stay, if admitted) (will adapt CMS definition of unplanned readmissions)[67]

Finally, we also evaluated change in process and outcome measures from Year 1 to Year 5 of the grant period (Table 2b). For patients in the fall population, there was a significant decline in the rate of ED visit or hospital readmission at both 7 and 30 days after discharge from the index ED visit. There were no significant differences in fall-specific measures or in any measures for the suspected UTI population.

Table 2b. Change in Outcomes from Year 1 to Year 5	Fall Only			Suspected UTI Only		
Outcome	Year 1	Year 5	p-value	Year 1	Year 5	p-value
Patient Counts	620	1998	--	194	483	--
No fall risk assessment (Hendrich II) performed at index ED visit	23	24	0.43	--	--	--
Repeat fall presenting in ED within 30 days after the index ED visit	5.7	6.1	0.70	--	--	--
Repeat fall presenting in ED within 7 days after the index ED visit	3.4	3.3	0.87	--	--	--
VTE within 90 days after the index ED visit	2.1	2	0.87	2.1	3.4	0.37
VTE within 30 days after the index ED visit	1.6	1.3	0.48	1	2.3	0.27
VTE within 7 days after the index ED visit	0.48	0.5	0.96	0.52	1.2	0.40
No urine culture performed at index ED visit	--	--	--	39	35	0.28
Urine culture does not confirm infection within 3 days after index ED visit	--	--	--	22	23	0.82
Newly prescribed fall-risk increasing drug at index ED visit	3.20	3.2	0.98	--	--	--
Newly prescribed drug increasing risk of orthostatic hypotension at index ED visit	0.97	0.65	0.42	--	--	--
Newly prescribed fall-risk increasing drug or drug increasing risk of orthostatic hypotension at index ED visit	4	3.9	0.84	--	--	--
Positive CDiff Test and CDiff Abx Rx Within 6 Months of ED departure date	--	--	--	1.1	1.5	0.65
Positive CDiff Test and CDiff Diagnosis Within 6 Months of ED departure date	--	--	--	1.1	1.1	0.98
Repeat ED visit or readmission within 30 days after discharge from the index ED visit	21	17	0.02	36	30	0.11
Repeat ED visit or readmission within 7 days after discharge from the index ED visit	11	8.1	0.03	22	18	0.32

4.3.1.4. Patient and care partner survey. We conducted a survey of older adults and their care partners in the ED to explore care process outcomes from the patient and care partner perspective. This survey, which was delivered in three parts (see Table 3), included questions related to perceptions of caring and discharge teaching (ED)[68,69]; information provided (4-8 days after ED/hospital discharge)[70]; overall quality of care transition (4-8 days after ED/hospital discharge)[71,72]; and patient participation (4-8 days after ED/hospital discharge).[73,74] We conducted two rounds of data collection, pre- and post-implementation. Survey data collection was suspended in March 2020 due to COVID-19 restrictions. We enrolled 255 older adult patients and 54 care partners into the survey. We are still completing analyses, as these data were complicated by the suspension of data collection during the COVID-19 pandemic. However, results of pre-implementation data indicate that most patients were satisfied with the information that they received from the ED (90.1% of all patients satisfied with discharge instructions). However, about 10-15% of patients were dissatisfied. In addition, 49% of patients who were discharged from the ED think that their PCP was notified about their ED visit. However, many patients (ED: 40%) did not know whether their PCP was informed or not.

Table 3. Patient survey topics and timepoints

Survey #	Survey topic	# of questions	Survey administration (When?)
Survey #1	Patient characteristics	21	At recruitment
Survey #2	Patient experiences in ED	19	Right before discharge
Survey #3	Patient experiences with transition	25	4-8 days after ED discharge

4.4. Co-Design

To identify the foundational design requirements for the patient safety passport, we conducted a five-stage participatory design process with the intervention implementation team following the 'funnel' model of participatory design, in which we started with broad solutions based on an understanding of the problem based on the interview and contextual inquiry data and then converged across sessions to the final patient safety passport components.[75] The first design stage focused on orienting the team to the problem. We held a design session in which we reviewed the categories of barriers, facilitators, and solutions and generated some initial broad concepts related to the patient safety passport. The second stage focused on solution generation. We held a second design session in which the design team used the results of the first session to generate specific potential patient safety passport components. The next two stages focused on convergence. We held a third design session in which the design team rated components based on their feasibility and the likelihood that the component would influence measurable care-transition related quality and patient safety outcomes).

We then had a final design session with the Human Factors Engineering team. During that session, the team further discussed, refined, and converged upon the prototype components of the patient safety passport. The fifth and final stage of the design process focused on initial evaluation. We surveyed the full design team and other stakeholders, asking them to rate each of the converged upon patient safety passport components on feasibility of implementation (on a scale of 1 to 7) and on impact on three outcomes: the patient satisfaction with the quality of the transition, clinician satisfaction with the transition, and the patient safety outcomes (on a scale of 1 to 5). We held one final design team meeting to discuss the results of the survey and converge on the final patient safety passport components.

5. RESULTS

5.1. Work system analysis

The work system analysis resulted in a comprehensive process map of older adults' journey from the ED to the next setting of care, with barriers and facilitators at each stage of the process. We identified seven distinct process map sections: 1) tasks that occur during the transition from a patient's home to the ED or that occur at home prior to the ED transition; 2) tasks that occur during the transition from a skilled nursing facility to the ED or that occur at the skilled nursing facility prior to ED transition; 3) tasks that occur in the ED before the patient's transition into the ED, during the patient's ED stay, and after the patient has transitioned to their subsequent location (e.g., follow up); 4) tasks that happen before the ED to skilled nursing facility transition at the skilled nursing facility (e.g., preparing a bed), during the ED to skilled nursing facility transition, or after the ED to skilled nursing facility transition at the skilled nursing facility; 5) tasks that happen before the ED to home transition at the home or in the community, during the ED to home transition, or after the ED to home transition at the home or in the community; 6) tasks that happen before the ED to hospital transition at the hospital, during the ED to hospital transition, or after the ED to hospital transition; and 7) tasks that happen before the ED to observation unit transition at the observation unit, during the observation unit to hospital transition, or after the ED to observation unit transition.

5.1.1. Overall work system analysis

A synthesis of these findings is presented in Figure 2 below. We conducted interviews with N=31 participants. Twelve ED and transitional care clinicians (mean years in role = 8.2 (1-20)) and 12 SNF healthcare professionals (mean years in role = 9 (1-20)) consented to participate.

We conducted 20 contextual inquiries followed by 20 interviews with ED attending physicians, ED resident physicians, ED APPs, and ED nurses who cared for the patient over the course of the observation. In analyzing the number and types of roles involved in the process, we identified 16 different ED roles involved in older adult care transitions from the ED. In addition to patients and caregivers, the other roles represent a range of professional backgrounds, including medicine (e.g., ED attending physician, trauma surgeon), nursing, case management (i.e., ED case manager, utilization case manager), social work, and pharmacy. The analysis of the 20 patient-centered observations revealed that older adults encountered an average of six different roles involved in care transitions during their ED visit, ranging from four to nine roles. Older adults frequently encountered multiple people with the same role (e.g., average of two ED physicians and three ED nurses) throughout their stay, with an average of 10 and at most 20 different people involved in transitions interacting with older adults in the ED.

5.1.2. Disposition decision making

Furthermore, we conducted an in-depth work system analysis focused on the disposition decision-making stage using an additional content analysis approach.[76,77] Disposition decision making represents a unique opportunity to promote patient safety older adults who receive care in the emergency department (ED). Given the influence of variable demands in the ED, critical to understanding how to improve disposition decision making is a robust understanding of the ED work system and how it may change under conditions of high and low demands. We identified 40 work system elements that influence the disposition decision-making process generally (i.e., under conditions of both low and high demand) and identified specific elements that influence the disposition decision process differently under conditions of high and low demands, which reflect the dynamic nature of the ED. This analysis led to the successful dissertation defense of graduate research assistant Rachel Rutkowski.

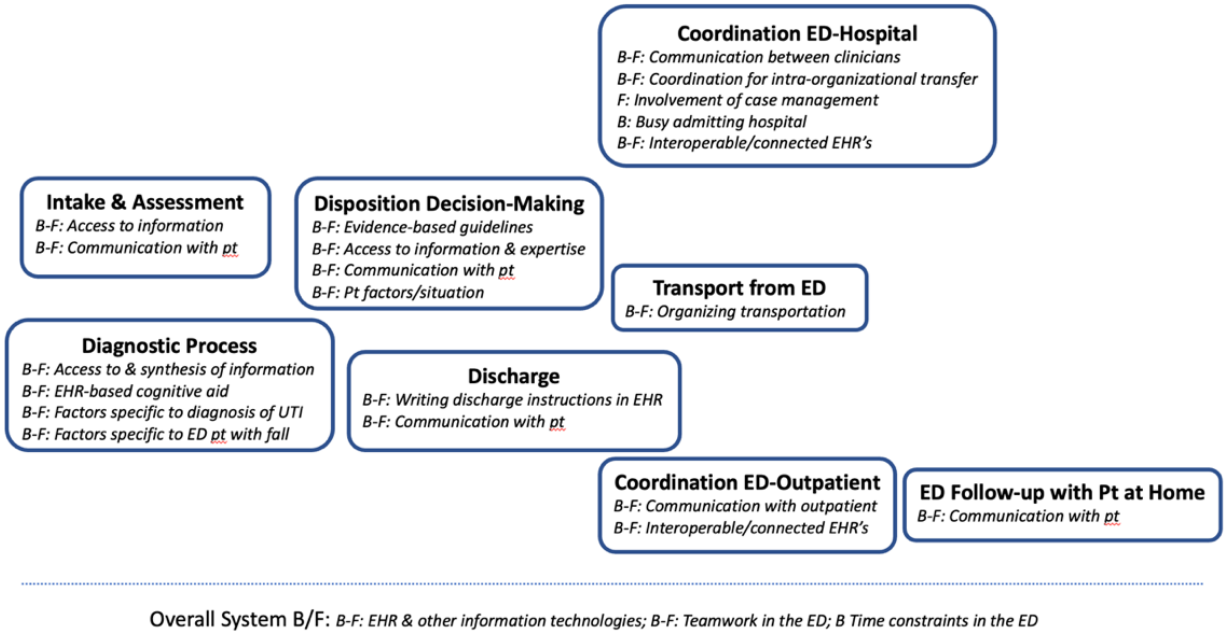

Figure 2. Simplified process map with associated barriers and facilitators at each process stage.

5.1.3. ED to skilled nursing facility transition

We also conducted a thematic analysis of the initial work system analysis to examine the mental models of healthcare professionals during older adults' care transitions between the ED and skilled nursing facility (SNF) and determined to what extent mental models related to older adults' SNF-ED-SNF transitions are shared between the ED and SNF.[78]

We conducted a thematic analysis of interviews with ED and SNF healthcare professionals and identified three themes (Table 4): 1) ED and SNF healthcare professionals had misaligned mental models regarding communication processes and tools used during care transitions, 2) ED and SNF healthcare professionals had misaligned mental models regarding healthcare system capability, and 3) misalignments led to individual and organizational consequences. Overall, we found that SNF and ED healthcare professionals are part of the same process but have different perceptions of the process.[78]

Table 4. Disparate mental models of transitions steps between the Skilled Nursing Facility (SNF) and Emergency Department (ED) during older adults' ED-SNF transitions

Transition step	SNF Mental Model	ED Mental Model
Older adult needs to go to the ED	SNF does everything possible before sending older adults to the ED	SNF could do more to avoid needing to send older adults to the ED
SNF calls ED for verbal handoff	ED relies on information from an older adult who may be confused, EMS, and family	ED does not receive adequate information about why the patient is there
Older adult receives needed care in the ED	ED care frequently inconsistent with reason older adult was sent to ED	ED addresses acute problem presented with limited information from SNF
ED calls SNF for verbal handoff	Verbal handoff often received after older adult is in transit	Verbal handoff is made to SNF ~ 1 hour prior to ED discharge
ED provides SNF documentation	EHR is not integrated into SNF workflow; limited access	SNF can access older adult's ED visit info using the EHR
ED=Emergency Department; EHR=Electronic Health Record; EMS=Emergency Medical Services; SNF=Skilled Nursing Facility		

5.1.4. Patient and clinician collaboration analysis

We also conducted a secondary deductive content analysis of the contextual inquiry data to explore the collaboration between patients, families, and clinicians in the ED with an emphasis on identifying the knowledge brokering roles.[79] This analysis led to the successful dissertation defense of graduate research assistant Kathryn Wust. We found that patients and care partners act as knowledge brokers by providing information about diagnostic testing, medications, the patient's health history, and care accommodations at the disposition location. Patients and care partners filled the role of knowledge broker proactively (i.e., offer information) and reactively (i.e., are asked to provide information by clinicians or staff), within ED work systems and across work systems (e.g., between the ED and hospital) and in anticipation of future knowledge brokering. Our results demonstrate that, in 87% of observations, patients and care partners assumed the role of knowledge broker at least once, and that, on average, patients and care partners assumed this role 2.6 times during their ED visit (range: 0-7). We found that care partners assumed the role of knowledge broker for older adults in the ED for a fall in 52% of cases. Furthermore, patients and caregivers act as knowledge brokers within the ED system and across systems (e.g., between emergency medical services (EMS) and the ED).

5.2. Co-design

Through the design process described above in section 4.4, we also identified broad guidelines and design requirements for a patient safety passport, as detailed below. These results are currently in preparation for publication.

5.2.1. Patient safety passport (PSP) guidelines

*Guideline 1: PSP should be an intervention process***.** The PSP is not conceptualized as a single intervention or single entity. Rather, the PSP is an intervention process, which might involve multiple interventions and process changes delivered by different modes at different time points.

Guideline 2: PSP should be both patient and clinician facing. The PSP should include components that engage patients and clinicians with relevant aspects tailored toward the intended user.
Guideline 3: PSP should account for healthcare as a patient journey. The PSP should acknowledge that rather than starting upon discharge, care transitions are an extended process that begins during and even prior to current care encounter.

Guideline 4: PSP should be a continuous feedback loop. The PSP should account for the longitudinal nature of the patient journey, measuring safety and risk and adapting to changes over time. Thus, the PSP should be linked to measurable outcomes.

Guideline 5: PSP should be a participatory human-centered design process. The PSP should be a continuous work-in-progress with emergent properties that guide improvements iteratively over time through continuous design that engages PSP users in the design process.

5.2.2. Patient safety passport (PSP) design requirements

Requirement 1: What the patient and care partner should expect. The PSP should provide clear communication to patients and care partners about what to expect during that episode of care. This component of the PSP is patient facing and might include a paper handout, brochure, video, mobile application, etc. The purpose is to support patients and care partners in feeling prepared and confident in the process of receiving care during the care transition.

Requirement 2: Patient safety risk assessment. The PSP should also include a mechanism for patient safety risk assessments, such as patient safety risk thresholds, that serve as triggers for other pre-identified interventions. This component is clinician facing first and integrated into the electronic health record (EHR). For example, a patient safety risk assessment that is triggered within the EHR would prompt a clinician with the corresponding action to initiate an intervention.

Requirement 3: Actions and resources to address patient safety risk. Following on from requirement 2, the PSP should include interventions that provide guidance to the clinician about what to do when the patient safety risk assessment indicates a risk. These interventions could include specific actions such as referrals to clinical or community resources, notifications sent to the primary care physician regarding the risk and recommended actions, and resources to support risk communication and associated mitigating steps with patients and care partners. This component is clinician facing first and includes patient- and care partner-facing materials.

Requirement 4: Pathway forward and accountability. The PSP should provide communication and guidance regarding care and self-management after discharge. This requires an after-visit summary that clearly states what the patient should do next to ensure they receive the care they need and reduce their risk of a patient safety event (i.e., what happens next when they leave the ED, what is the specific care plan, and who is responsible for what aspects of the care plan). These documents should be designed with universal accessibility in mind. This also requires a clinician-facing component that communicates a patient safety order set. The clinician-facing component of this design requirement should support communication between the ED and next settings of care. The after-visit communication should include both short-term plans (e.g., when is the patient returning, immediate safety risks) and long-term plans (e.g., what happened, care plan modifications, long-term safety risks). The PSP must also indicate who is the person responsible during the immediate transition period and who is responsible for what specific aspects of the patient safety order set and care plan moving forward from the transition period. The PSP should include a process for indicating responsibility and for accepting responsibility**.**

PSP design requirement 5: Feedback loop. Finally, the PSP should include feedback loops, such that the patient safety risks and associated interventions can adapt to changes over time. This requires the ability to update risk assessments within the patient safety passport and communicate those to all care team members, including the patient and care partner.

6. DESIGN AND EVALUATION OF PATIENT SAFETY PASSPORT INTERVENTIONS

From these foundational work system analyses and the co-design process, we identified three initial targets for the patient safety passport intervention. The design and evaluation processes for three patient safety passport interventions are described below: the **ED discharge intervention**, which targets the journey from the ED to the home; the **ED to Skilled Nursing Facility antibiotic stewardship intervention**; and the **patient journey map**, which is designed for patients and care partners during the ED visit. All interventions are currently implemented in a healthcare system.

6.1. ED Discharge Intervention

6.1.1. Intervention overview

The goal of this intervention was to redesign the ED discharge process, including the template for discharge instructions given to patients/caregivers and the process used to communicate discharge instructions to patients/caregivers. We convened an Intervention Implementation team of our Human Factors Engineering team as well as ED physicians, ED nurses, ED leadership, ED operations, IT, patient experience leadership, graphic designers, and patient care partners. This aspect of the patient safety passport intervention contains four components, each of which targets a different step in the ED discharge process. Many of the intervention components are based on the Coleman et al. (2006) pillars of care transitions: (1) medication self-management, (2) patient care plan, (3) follow-up, and (4) red flags. The four components of the intervention are depicted within the ED discharge process in Figure 3 and detailed in Table 5 below.

6.1.2. Evaluation

The components of the intervention were evaluated using multiple qualitative and quantitative methods (e.g., patient interviews and survey, ED nurse interviews, ED physician survey, EHR data). Table 5 outlines the four components of the interventions and provides a detailed description of each component and how they were evaluated. Figure 3 outlines how intervention components were integrated into the ED discharge process.

Table 5. ED discharge intervention component explanation and methods of evaluation.

No.	Intervention component	Description	Methods for evaluation
1	EHR template for physician instructions	Dot phrase template in EHR for ED physicians to enter discharge instructions into AVS. Integrates Coleman et al. [80] four pillars of care transitions: medication self-management, patient care plan, follow-up, and red flags.	EHR data on use of template Survey of ED physicians
2	Redesigned after-visit summary (AVS)	Redesigned AVS through staged heuristic evaluation,[81] feedback from design meetings, meeting with community members, and patient and care partner focus groups	Older adult interviews and survey ED nurse interviews
3	Teach back	Integration of teach back method during patient and ED nurse conversation during discharge process. Teach back education distributed to ED nurses.	Older adult interviews and survey ED nurse interviews
4	Redesigned follow-up call	EHR-based guide for ED RN to following when conducting post-discharge follow-up call with patient. Integrates the Coleman et al. (2006) four pillars of care transitions: medication self-management, patient care plan, follow-up, and red flags.	Older adult interviews and survey ED nurse interviews

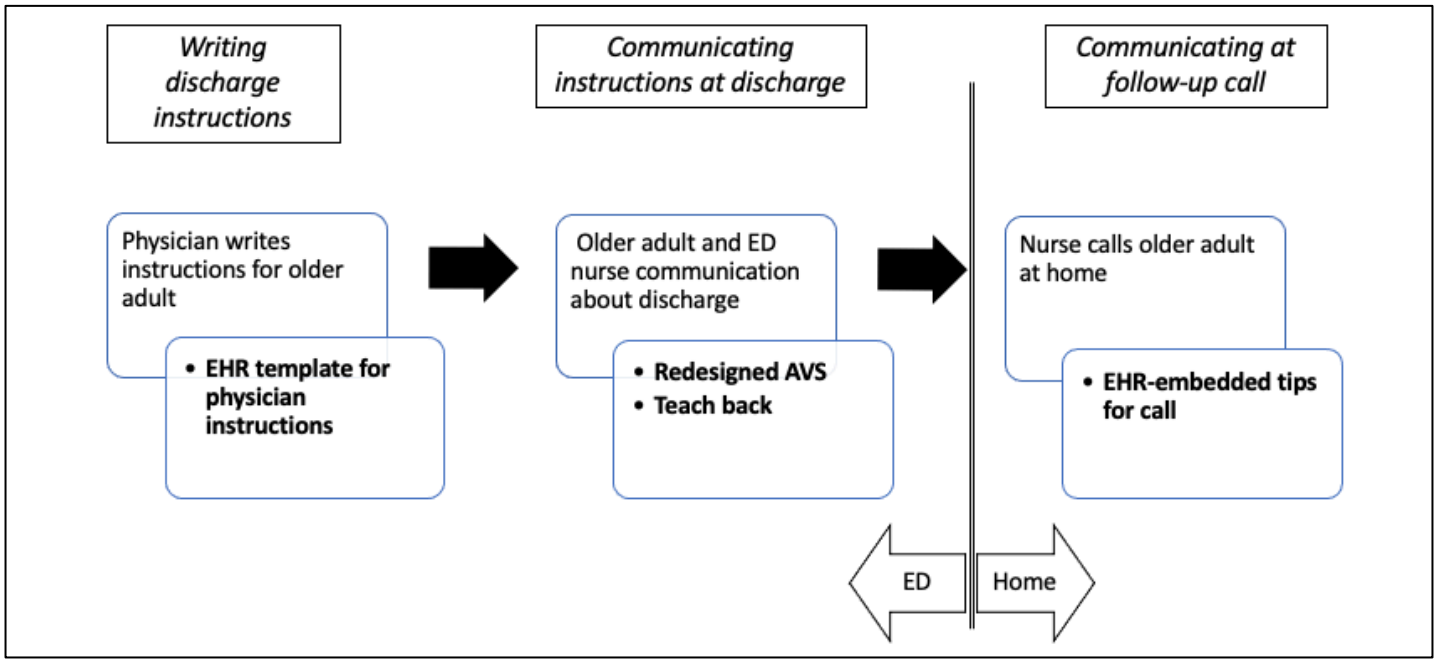

Figure 3. ED discharge intervention components within the ED discharge process.

6.1.2.a. Survey of ED physicians. We conducted a five-item survey to assess implementation (reported use); a total of 42 ED physicians and APPs participated in the survey: 23 were attending physicians, 12 were residents, and seven were APPs. We achieved a response rate of 44%. The majority of survey respondents (79%) used the template for most or all of their patients (69%) or for some or few of their patients (10%). Twenty-one percent rarely or never used it. Most of the physicians and APPs who used the template were satisfied with the template (75%). Table 6 provides information on the work system barriers and facilitators reported by the 33 ED physicians and APPs who used the new EHR-based template. They highlighted the well-designed and efficient template that provided clear and structured instructions to patient. They wished for more pre-populated patient-related information, such as the diagnosis. Table 6 provides additional details of the perspective of physicians and APPS on the intervention.

Table 6 – Perspective of Physicians and APPs on Intervention – Sub-process: Writing Discharge Instructions [N=33].

		Facilitators (F)	Barriers (B)	Illustrative quotes
Work system elements	Person – residents, APPs	• Template supports specifically work of residents and APPs.	• Residents unsure about what to write for: "what we found."	"Ensures residents and APPs are providing thoughtful and useful return precautions" [F]
	Person – patient	• Patients receive clear, useful and easy-to-understand D/C instructions.		"The 'what to do at home' and 'reasons to return to the ED' sections … provide clear concise instruction to patients" [F]
	Task	• Writing of structured, consistent and complete D/C instructions. • Speeds up process of writing D/C instructions.	• Need more pre-populated information. • Some sections may not apply.	"It's standardized and gives the opportunity to answer most relevant questions" [F] "It would be great if we could auto fill prescriptions and what pharmacy we sent them to" [B]

	Technology	• Well-designed template: e.g. large font size, bold text, clear bullet points.	• Suggestions for redesign: for example, reducing font size, adding drop-down menu.	"Cleanly sorts into different areas, gives good bullet points" [F] "Font size is huge on the monitor, almost unusable on my screen and doesn't fit on one screen when trying to type D/C instructions" [B]
	Organization		• Need to include PCP follow-up. • Need information on the pharmacy where patient can pick up their medications.	"I know at faculty meeting we decided to take the follow-up with PCP out of the dotphrase... I kind of wish it was back in there as I add it every time." [B]

Note: facilitators or barriers in the physical environment work system element were not mentioned. D/C=discharge.

6.1.2.b. ED nurse and patient interviews. We conducted post-implementation semi-structured interviews with the 10 ED nurses to ask the nurses for their perspective on the different components of the intervention, including the redesigned after-visit summary (AVS), teach back method, and follow-up call. ED nurses were asked to reflect on how these intervention components fit into their work processes and how it affected their interactions with older adults and their care partners. Nurses are satisfied with the redesigned AVS. In particular, they mentioned improvements related to the discharge instructions (bullet points, layman's language), format (bold text, large font), and the front page, which contains the main information with specific and personalized information. They also talk about how the redesigned AVS fits with their workflow (e.g., highlighting the bold text). Nurses indicated a few issues remaining with the AVS and provided ideas for future redesigns. Nurses described challenges with teach back, including time pressure for both themselves and patients who want to leave the ED. A few nurses described how the redesigned AVS can be helpful to support teach back, as the main information is on the first page and provides structure for the conversation.

We also conducted post-implementation semi-structured interviews with older adults (≥ 65 years) about their discharge experience and the intervention. The sample consisted of 15 older adults who had been discharged home from the ED. See Table 7 for the categories of work system barriers and facilitators identified with illustrative quotations from the data.

Table 7 – Perspective of Nurses and Patients on Intervention – Sub-process: Communicating at Discharge [N=10 nurses and 15 patients].

		Perspective of Nurses		Perspective of Patients		Illustrative Quotes
		Facilitators (F)	Barriers (B)	Facilitators (F)	Barriers (B)	
Work system elements	Person – ED nurse	• Nurse knowledge of pt	• Nurse lack of knowledge of pt	• Nurse knowledge of pt • Nurse helpful, nice, good conversationalist		"They're likely my patient, so I … knew what was probably going to be in the paperwork" [Nurse-F] Nurse was "a very good conversationalist and helpful" [Pt-F]

		Perspective of Nurses		Perspective of Patients		Illustrative Quotes
		Facilitators (F)	Barriers (B)	Facilitators (F)	Barriers (B)	
	Person – patient (pt)	• Pt technical knowledge (e.g., finding AVS in pt portal)	• Pt lack of understanding instructions (e.g., language barriers) • Pt physical or cognitive limitations (e.g., hearing, medicated, in pain)	• Pt health literacy • Pt familiarity with AVS • Pt advocating for self	• Pt limited knowledge of medical terminology • Pt physical or cognitive limitations (e.g. hearing, in pain, fatigued, overwhelmed)	"… the biggest problem is they're not focusing when we're talking because there's so much going on" [Nurse-B] "I've got [family] in healthcare, and I'm not reluctant to ask them what they say" [Pt-F] "… it's a lot, … a lot of stuff is going on, kind of nervous, and might not catch everything" [Pt-B]
	Task	• Nurse preparation before talking to pt (e.g., editing AVS in EHR, highlighting parts of AVS, reviewing AVS) • ED nurse can quickly read AVS • Pt reading AVS later on (e.g., reading follow-up information and attached info sheets)	• Difficult for ED nurse to point out important info to pt on AVS • Not enough time for communicating D/C instructions and teach-back • ED nurse needs to clarify AVS to pt as some info may not apply to pt	• Pt reading and reviewing AVS later on (e.g., available in pt portal, paper AVS)	• Pt not looking through AVS • ED nurse not providing sufficient info or explanation (e.g., pain management, finding test results in pt portal, impact of injury)	"… we'll highlight the name… and those bolded areas that are really important… that you really want patients to pay attention to" [Nurse-F] "if it was on the first page, … it would be easier for the patients to pinpoint everything they need to know on the first page" [Nurse-B] "I didn't have to look for anything. I just had that document and just grabbed my phone… and made the call" [Pt-F] "I don't remember them telling me to do… the normal things that you would think they would do." [Pt-B]

		Perspective of Nurses		Perspective of Patients		Illustrative Quotes
		Facilitators (F)	Barriers (B)	Facilitators (F)	Barriers (B)	
	Technology	• Helpful use of EHR template (e.g., nice, tells physician/APP what to enter) • Well-designed AVS (e.g., well-organized, easy to read, bold text, larger font, clear, concise, diagnosis at top of AVS) • Good layout of AVS (e.g., most important info at front) • Useful info in AVS (e.g., inclusion of last dose info for meds and labs/ tests done, info on f/up plan, meds, pharmacy, upcoming appointment, red flags, nice summary that pt can read at home)	• Inconsistent use of template by physician/APP • Poor design of AVS (e.g., small font for info on ED phone number) • Poor layout of AVS (e.g., new meds should be on front page, info on how to take meds should be on front page) • Not useful info in AVS (e.g., some info not necessary (e.g. seat belts), too long, overwhelming)	• Well-designed AVS: larger font, descriptive, info on AVS easy to find, bolding, info organized logically, important info on front page • Useful info in AVS (e.g., info on home care (wound care), list of medications (in particular, new meds prescribed in ED), ED contact info for pt questions, upcoming appointments, what was done in the ED, right amount of info, enough info, thorough) • Both paper and electronic AVS	• Poor design of AVS: e.g. printed on white paper, therefore hard to find • Not useful info in AVS (e.g., info that does not apply or is not specific to pt (e.g., info sheets), list of medications not necessary – not related to ED visit; too much info, info hard to understand, medical terminology) • Lack of info in AVS (e.g., no info on how long pt should take OTC pain meds, unclear that specialty clinic will call pt for f/ up appointment)	"I love how you… put the last dose of medication, … the times that they were given and all of the lab tests… that were done" [Nurse-F] "… some of these are … five pages long or more, and some of the information is not… really necessary" [Nurse-B] "… the format was great. The highlighted in boldface items drew my attention to things that I needed to read" [Pt-F] "… it was seven pages, and some of the pages are… just probably things that have to be included that aren't so important" [Pt-B]

		Perspective of Nurses		Perspective of Patients		Illustrative Quotes
		Facilitators (F)	Barriers (B)	Facilitators (F)	Barriers (B)	
	Organization	• Presence of care partner during D/C • ED physician/ APP talking with pt about D/C before ED nurse	• Time pressure in busy ED and ED nurse time constraints • Pt ready to leave ED • Limited number of care partners allowed in ED • Challenging to D/C other nurses' pts	• Involvement of care partner in D/C • Timely and smooth D/C (e.g., sufficient time with ED nurse)	• Busy ED and busy nurses (e.g., insufficient time to talk with ED nurse, short conversation) • Pt ready to leave ED • Different nurse doing D/C than nurse caring for pt during ED visit	"I'll talk to both of them [pt and care partner] … at the same time, to make sure to include both of them" [Nurse-F] ".. if there's any hindrance to … spending time doing quality teach back, it's just time, timing in the ER" [Nurse-B] "by the time they were releasing me… the new ones [ED nurses] were really not up on what was going on. [Pt-B]
	Environment		• Difficult for nurse to provide D/C instructions to pt in hallway			"I'm going to start talking to [pt] as we're walking out because I have another patient coming into your room as we speak. So it's hard." [Nurse-B]

6.1.2.c. ED clinician and staff workload and satisfaction. We also evaluated the impact of implementation on experienced workload and satisfaction of clinicians and staff in in the ED. We hypothesized that implementation of the tool would not increase workload or decrease satisfaction of clinicians and staff in the ED. All clinicians (physicians, nurses, and pharmacists) and ED technicians in the ED were sent a link to an electronic survey (Qualtrics©) about the burden of caring for older patients. The overall response rate was 46.5%. Fifty respondents in the pre- and post-implementation samples were paired.

We created a workload scale consisting of six items (e.g., I feel that my older adult patients are overly demanding to care for) on a scale from 1 (strongly disagree) to 5 (strongly agree). Schumacher reported a Cronbach's alpha of 0.86. Results of our own analysis show the alpha to be 0.89 (pre-intervention sample, n=125). See Table 8 for more information on the workload scale. We created the workload scale by calculating the average score on the six burden items on a scale between 0 (lowest workload) and 100 (highest workload).

We created a Relational Challenge Scale by calculating the average score of the three relational challenge items (e.g., "Communication difficulties with patient") on a scale from 0 (no issues that prevent you from doing as much as you would like for your older adult ED patients) to 100 (many issues). Schumacher et al. report a reliability of 0.71 for the scale. Results of our analysis show a reliability of 0.79 in the pre-intervention sample (N=125).

Results indicated that clinicians and staff estimate that, on average, more than 50% of their caseload consists of older patients. Results of the Looney and Jones corrected Z-test show that there are no statistically significant differences in experienced workload pre- and post-implementation (mean difference = -0.47, Z (corr) = -0.2266, p=0.589). Table 8 provides detailed scores related to workload.

Table 8. Burden of care (pre-implementation, n=125).

Question	Mean (SD) Pre-imple-mentation (n=124)	Mean (SD) Post-imple-mentation (n=103)	Sign
1. I feel that my older patients are overly demanding to care for.	2.50 (0.85)	2.47 (0.93)	Ns
2. I feel that as a result of caring for my older patients, I do not have enough time for my other patients.	2.57 (0.95)	2.63 (1.09)	Ns
3. I feel that caring for my older patients disrupts my routine practice in the ED.	2.30 (0.87)	2.33 (0.89)	Ns
4. I feel that caring for older patients in the ED is too expensive.	2.26 (1.00)	2.25 (1.08)	Ns
5. Caring for older patients in the ED makes me depressed.	1.98 (0.88)	1.93 (0.87)	Ns
6. It is difficult to treat older patients because it takes so much time.	2.42 (0.96)	2.52 (1.06)	Ns
Scale Workload (0-100)	33.44 (18.05)	33.92 (18.89)	Ns

There were also no statistically significant differences in patient satisfaction, pre- and post-implementation (Table 9).

Table 9: Overall satisfaction with care for older patients, pre- and post-implementation.

In general, I am satisfied with the quality of care that I provide to older patients	Strongly disagree	Disagree	Neither	Agree	Strongly agree	sign
Pre-implementation	1 (0.8%)	5 (4.1%)	10 (8.3%)	74 (61.2%)	31 (25.6%)	Ns
Post-implementation	3 (2.9%)	9 (8.7%)	7 (6.8%)	64 (62.1%)	20 (19.4%	Ns

6.1.2.d. After-visit summary evaluation. We conducted a three-staged heuristic evaluation of the original after-visit summary using heuristics developed for use evaluating patient-facing documentation. In stage 1, HFE experts reviewed the document to identify usability issues. In stage 2, six experts of varying expertise (e.g., ED clinicians, geriatrician, transitional care nurse, patient/care partner) rated each previously identified usability issue on its potential impact on patient comprehension and patient safety. Finally, an IT expert reviewed each usability issue to identify the likelihood of successfully addressing the issue. In stage 1, we identified 60 usability issues that violated a total of 108 heuristics. In stage 2, experts identified 18 additional usability issues that violated 27 heuristics. Impact ratings ranged from all experts rating the issue as "no impact" to five of six experts rating the issue as having a "large negative impact." On average, the patient/care partner representative rated usability issues as being more significant more of the time. In stage 3, 31 usability issues were rated by an IT professional as "impossible to address"; 21, as "maybe"; and 24, as "can be addressed."

6.1.2.e. Community evaluation of the redesigned after-visit summary. We also partnered with an established community-based research advisory group (Community Advisors on Research Design and Strategies, CARDS) to conduct a focus group to evaluate the usability of the redesigned emergency department (ED) discharge instructions. The CARDS group consisted of 10 older adult members recruited from the community who represent diverse racial, socioeconomic, and educational backgrounds. We used a convergent mixed methods design to collect both quantitative and qualitative data on the usability of the ED discharge instructions.[82] We collected quantitative data on the usability of the ED discharge instructions using a modified System Usability Scale (SUS).[83,84] The meeting was audio recorded and transcribed. We analyzed the qualitative data to identify opportunities for redesigning the discharge instructions. The CARDS group overwhelmingly agreed that the discharge instructions had "too much information" and provided specific feedback on what they thought could be removed.

Input from the CARDS group was integrated with feedback from the entire research team throughout the data analysis into the redesigned discharge instructions. The average usability score of three of the 10 items on the SUS improved after the focus group discussion.

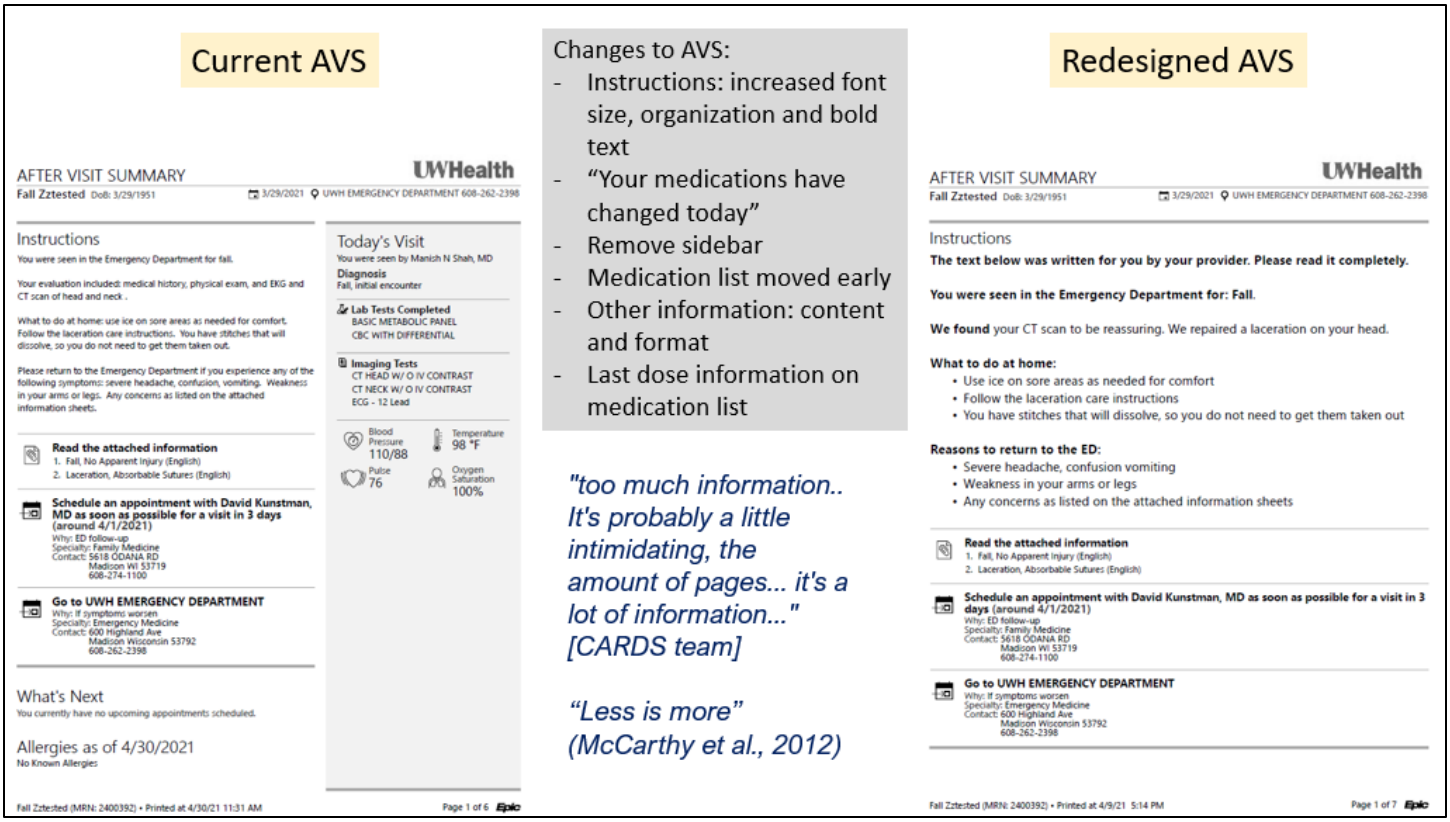

Figure 4. Comparison of the first page of the original and redesigned After-Visit Summary (AVS) provided to older adult patients upon ED discharge.

The SUS data and opportunities for redesign. Out of the 10 CARDS participants, nine completed and returned the SUS survey, and one did not receive the survey in the mail prior to the focus group meeting. The results of the SUS survey before and after the focus group meeting are presented in Table 10. On average, for six of the 10 items on the SUS, participants found the discharge instructions to be slightly less usable after the focus group discussion than prior to the discussion. The average usability score of three of the 10 items on the SUS improved after the focus group discussion, and one item did not change (Table 10).

Table 10. Results of the SUS survey. DI = Discharge instructions.

Modified SUS Question	Pre-focus group average (min, max)	Post-focus group average (min, max)	Usability pre/post
1. I think I would refer to the DI frequently	3.2 (1, 5)	2.8 (1, 5)	Less
2. I find the DI unnecessarily complex.	4 (2, 5)	3.5 (2, 4)	More
3. I think that the DI is easy to read and understand.	2.3 (1, 4)	2.4 (1, 5)	More
4. I think that I would need the support of a nurse of physician to be able to understand the DI.	3.6 (2, 5)	3.1 (1, 5)	More
5. I find the elements of the DI well organized.	2.8 (1, 5)	2.3 (1, 5)	Less
6. I think that there is too much inconsistency in the DI.	3 (1, 5)	3.5 (2, 5)	Less
7. I would imagine that most people would understand the DI very quickly.	2.2 (1, 4)	2.2 (1, 4)	No change

8. I find the flow of the DI very awkward.	3.6 (2, 5)	4 (3, 5)	Less
9. I feel very confident understanding the DI.	3 (1, 5)	2.6 (1, 4)	Less
10. I need to learn a lot of things before I can read and understand the DI.	2.7 (2, 5)	3.4 (2, 5)	Less

6.2. ED to Skilled Nursing Facility Antibiotic Stewardship intervention

6.2.1. Intervention overview

We convened a second Intervention Implementation Team, consisting of our Human Factors Engineering team, ED physicians, ED nurse supervisor, ED case manager, the skilled nursing facility advanced practice provider group supervisor, a nursing researcher, and an emergency medicine clinical nurse specialist. Over the course of the intervention design, we also consulted with a variety of key stakeholders to ensure the feasibility of our intervention. The final intervention was integrated into the electronic health record as described in Table 11. The intervention aimed to automatically identify older adult patients who present to the ED and who were residing in a skilled nursing facility to trigger a series of actions aimed at increasing communication between the ED and skilled nursing facility to improve antibiotic stewardship for older adults with a suspected urinary tract infection. The automated identification would trigger alert to the skilled nursing facility Nurse Practitioner who cares for the older adult that their patient was being seen in the ED that included antibiotic and culture-specific information in the after-visit summary sent directly via the EHR to the Nurse Practitioner. Finally, the intervention includes feedback loops with direct communication to the Nurse Practitioner regarding culture results and a mechanism for the Nurse Practitioner to follow up with the health system regarding the outcome of the antibiotic prescribed.

6.2.2. Development and evaluation

We evaluated the intervention with the main user group – SNF Nurse Practitioners – using a pre and post survey as well as a mid-implementation group meeting to receive feedback on intervention implementation. The survey asked the SNF Nurse Practitioners to consider their experiences managing older adults following a visit to the Emergency Department (ED) regarding the following concepts: perception of communication and coordination with the ED; frequency of communication with the ED; effectiveness of communication with the ED; and timeliness of communication with the ED. Survey responses indicated that, before implementation, they often did not know when one of their patients was being seen in the ED, they often did not receive discharge communication, and they often did not receive essential information from the ED about antibiotic prescribing (e.g., infection type, indication) within 24 hours of when one of their patients is seen in the ED. The post-implementation survey results indicated that SNF Nurse Practitioners were more frequently receiving discharge communication with information about antibiotic prescribing. The implementation feedback meeting further confirmed this and also highlighted continued areas of challenge related to who is overseeing a patient's case as they transition in and out of the SNF that will inform future design improvements.

Table 11. ED to Skilled Nursing Facility Antibiotic Stewardship intervention.

Intervention description	Who	What	When	Where
1a. Identify and document residence at SNF and PCP status (indicates SNF NP is following)	Patient access representatives (PARs)	Added multiple-choice question to the PAR workflow (i.e., Where does the patient reside?) with specific and discrete options	ED registration	PAR EHR
1b. Automatic link of presence of a PCP and residence at a SNF in the EHR triggers #2 & #3	PAR, ED physician, ED RN	Silent BPA - Inbasket message that will be sent to the LTC APP inbasket pool while a patient is in the ED and they are a patient who resides in a SNF	See "What" description	EHR

2. Communication at time of discharge with SNF NP about antibiotic and urine culture orders	N/A	Added antibiotic and urine culture orders to facility AVS Added a bolded note on facility AVS requesting that the SNF contact SNF NP to discuss antibiotics Send SNF Pool notification that the patient is in the ED with a copy of the facility AVS When a urine culture is pending, send a message to the SNF NP Pool and the Culture RN pool indicating pending culture for the patient		
2b. Communication to SNF	ED RNs	Send facility AVS to SNF	Discharge paperwork	Discharge paperwork
3. Notification to SNF NP of urine culture results – Culture RNs send results to SNF NP through EHR inbox (includes guidance for discontinuation when appropriate	ED rad culture RNs and SNF NPs	Included a column in culture RN workflow that indicates patient's residence (i.e., the information added under the "where does the patient reside?" question – intervention 1a)	Once the information is entered and saved from 1a	EHR
4. SNF NP following up with rad culture RN	SNF NP	SNF NPs will follow up with culture RNs regarding the outcome of the antibiotic prescribed	When the urine culture comes	Inbasket communication
APP – Advanced practice provider, AVS – After-visit summary, CBRF – Community-based residential facility, ED – Emergency department, EHR – Electronic health record, LTC – Long-term care, N/A – Not applicable, PAR – Patient access representative (registration staff), PCP – Primary care physician, NH – Nursing home, NP – Nurse practitioner, RN – Registered nurse, SNF – Skilled nursing facility, UTI – Urinary tract infection				

6.3. Patient journey map

6.3.1. Overview of the patient journey map

The patient journey map is divided into three segments that represent different stages in the patient's ED experience: intake and triage; assessment, diagnosis, and next steps; and discharge. Throughout the patient journey map, we use emergency room (ER) instead of emergency department (ED), because we found during our patient focus groups that ER was easier to interpret than ED for patients. The first segment, on the left-hand side, represents the intake and triage process. It shows how patients arrive to the ED, what will happen to them once they arrive, and what to expect while waiting. The bracketed text explains the organizational context of the ED, such as the waiting and triage process, which are unique to the ED and may be confusing to patients and their care partners who are not familiar with the ED. The middle segment, with the patient represented in the middle circle, represents the assessment, diagnosis, and next steps processes. These tasks are visually represented around the patient, rather than sequentially, because they may not occur in the same order for every patient or patients may experience some tasks more than once (e.g., receiving diagnostic tests). The bracketed text explains the organizational context of the ED, including the different ED clinicians and staff the patient may see, the different locations within the ED the patient may receive care, and how care processes operate within the ED. The last segment, on the right-hand side, is discharge and final disposition and represents tasks that the patient may experience in transition between the ED and their disposition location and once at their disposition location. As patients experience different care journeys, both hospital admission and discharge to a disposition location outside of the ED (e.g., home, skilled nursing facility) are represented.

6.3.2. Development and evaluation

We developed a patient journey map of the ED patient experience, using 20 patient-centered observations of older adults (≥ 65 years old) presenting in the ED, as described in detail above; 10 multidisciplinary meetings; and two 1-hour patient and care partner focus groups. We took detailed notes during the meetings, and the focus groups were audio recorded and transcribed. Two researchers reviewed the notes and transcripts and inductively identified parts of the patient journey map at which clinicians, patients, and care partner representatives had either similar or conflicting perspectives regarding collaborative work. Throughout the design and development process, we created eight versions of the patient journey map. The initial version of the patient journey map was developed using the patient-centered observation data. These data were analyzed by our team, who abstracted the major reoccurring tasks of an ED visit experienced by patients and their care partners. We visually represented these tasks in the first iteration of the patient journey map. The next six versions of the patient journey map were iteratively updated and redesigned based on the clinician and stakeholder feedback. The current version of the patient journey map, as seen in Figure 5, is the result of feedback from the patient and care partner focus groups. Two Human Factors Engineers reviewed the audio recordings of the focus groups and edited the map based on direct suggestions for revision and indirect feedback (e.g., aspects of the map that were misinterpreted or unclear to the patients and care partners).

Figure 5. Patient Journey Map.

7. DISCUSSION

7.1. Conclusions and implications

Our patient safety learning laboratory applied a participatory systems engineering approach with a transdisciplinary team of engineers, health services researchers, nurses, physicians, and pharmacists that collaborated with a large health system with both academic and community EDs to create and evaluate a system of care that supports the safe journey of older adults after presentation to the Emergency Department (ED): the 'patient safety passport.'

Our comprehensive work system analysis mapped the processes of older adults' journey after presentation to the ED and identified barriers and facilitators to those processes during care, disposition decision making, and care transitions. Through a rigorous co-design process, we developed an overarching list of guidelines and design requirements for a patient safety passport that supports the safe journey of older adults after presentation to the ED. The patient safety passport seeks to address some of the key challenges associated with care transitions across healthcare settings, including role ambiguity, accountability, and lack of feedback across transitions of care. The guidelines and requirements identified in this project provide a roadmap for system design to transform care transitions from a point of risk to a point of opportunity to improve safety that can be used by other researchers and practitioners to develop patient safety passports within their unique healthcare systems. We also identified, designed, implemented, and evaluated three priority interventions for the initial patient safety passport focused on improving the quality and safety of experienced by older adults and their care partners in the ED and in the transition from the ED to home or a skilled nursing facility. For patients with falls, there was a reduction over time in repeat ED visits or readmissions, although no differences were seen for patients with suspected UTI. We did not see differences in in repeat falls, VTE, newly prescribed fall risk-increasing drugs, or positive *C. difficile* tests/diagnoses.

Patient safety experts Vincent and Amalberti[33] have argued that, to better address patient safety, we need to look at the complex sequence of transitions and interfaces along what has been termed the *patient journe*y. As suggested by Carayon and Wood,[34] the patient journey should be a system-based representation of what happens to the patient, in particular across transitions. The concept of patient journey for patient safety emphasizes the need for a systems approach to care transitions that recognizes the hazardous nature of transitions as well as their potential for error detection and recovery.[85,86] The patient safety passport can facilitate such an approach by proactively and continuously assessing risk at the point of transition, intervening as needed, and communicating risk to the next setting of care. Like a passport to travel between countries, the patient safety passport will be 'checked' at each transition point and will facilitate the recognition and anticipation of specific safety needs of the older adult. The patient will travel with their patient safety passport to each subsequent healthcare setting, which in turn will review the passport and implement the recommended precautions for safe care. As a patient safety learning lab, findings from this work have provided the foundation to inform future work to further innovation on patient safety during the patient journey, including as the foundation for multiple doctoral student dissertations, conference panels and presentations, and additional projects from collaborations among patient safety learning laboratory team members (e.g., AHRQ 1R01HS028669-01).

7.2. Limitations

This study had several limitations. First, the study took place in only one healthcare system, which limits the generalizability of the results. However, we conducted contextual inquiry, interviews, surveys, focus groups, EHR analyses, and co-design and included multiple ED settings across the healthcare system. This extensive data collection was complemented with input and feedback from multiple experts, which increases the trustworthiness of our results and conclusions. This work was conducted starting in 2018, which means that the COVID-19 pandemic occurred in the middle of the project, inherently affecting our data collection and resultant interventions and complicating our ability to interpret comparisons with data collected prior to the onset of the pandemic. However, the ability to continue this project following the height of the pandemic social distancing measures meant that we were able to account for system changes in our patient safety passport interventions.

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