

Aggregating Patient Safety and Status Information in the Electronic Health Record to Support Time-Sensitive Mobility Interventions in the ICU (ASSIST-ICU): Protocol for the Design and Testing of a Clinical Decision Support Tool

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Table of Contents

Original Manuscript..... 5

Supplementary Files..... 29

 Figures 30

 Figure 1..... 31

 Figure 2..... 32

 Multimedia Appendixes 33

 Multimedia Appendix 0..... 34

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Abstract

Background: Patients who require intensive care unit (ICU) level of care frequently develop hospital-acquired functional decline, a new or worsening loss of ability to perform self-care activities that is associated with prolonged periods in immobility. This morbidity may persist for months to years after hospitalization and is potentially preventable through initiating mobility interventions in the ICU using a multidisciplinary, evidence-based intervention to maintain functional status. While guidelines for ICU patients' physical activity exist, timely identification of patients suitable for activity interventions is an ongoing challenge due to the dynamic nature of critical illness and the number of locations in the electronic health record (EHR) that clinicians need to click in and out of to synthesize patient data. There is, therefore, a critical need to develop an effective knowledge-based clinical decision support system (CDSS) interface in the EHR for efficient identification of patients appropriate for physical activity interventions and coordination of patient-specific activity plans within the ICU team.

Objective: The objective of this two-phase project is to develop a CDSS interface for consistent translation of patient-specific data to inform evidence-based physical activity interventions delivered by registered nurses and physical therapists for ICU settings, and evaluate its usability, usefulness, cognitive workload, acceptability, feasibility, and effectiveness on decision-making outcomes.

Methods: In Phase 1, we will develop a useable, useful, and acceptable CDSS prototype by conducting clinician interviews using well-known methods in a novel sequence; we will use a user-centered design approach and identify clinical workflow considerations, potential barriers, and implementation strategies using an implementation science approach. In Phase 2, we will evaluate the CDSS usability, cognitive workload, acceptability, and effectiveness for activity guideline adoption in adequately powered trials, 1) virtually in a simulated EHR environment and, 2) in two ICU units in one tertiary care hospital.

Results: The CDSS development phase is expected to conclude by December 2025. Data collection and analysis of the CDSS evaluation are expected to conclude by December 2028.

Conclusions: We expect the results of this multi-method process for designing, testing efficacy and identifying barriers to real world use to have an important positive impact on others who seek to develop safe and effective CDSS that aligns with clinical workflow. Importantly, this work completes the necessary pilot study for a subsequent multi-site pragmatic clinical trial to scale

the concurrent use of patient data with guideline recommendations at the point of care to deliver evidence-based interventions to reduce hospital-acquired functional decline at its negative, costly outcomes.

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Aggregating Patient Safety and Status Information in the Electronic Health Record to Support Time-Sensitive Mobility Interventions in the ICU (ASSIST-ICU): Protocol for the Design and Testing of a Clinical Decision Support Tool

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Key words: Early mobility, Early ambulation, Critical care, Nursing, Nursing informatics, Decision support systems, Electronic Health Record

Introduction

Background

New functional impairment after hospitalization for critical illness is common and persistent. More than 5 million adults are admitted to intensive care units (ICUs) each year in the United States, and over 50% of ICU patients develop new physical health problems or hospital-acquired functional decline [1-4]. Functional decline is associated with negative outcomes during and after hospitalization, including ICU readmission, prolonged hospitalization, hospital readmission, nursing home admission, inability to return to work, and death [5-8]. These significant and long-term patient consequences demonstrate an urgent need to mitigate hospital-acquired functional decline.

The etiology of functional decline includes a combination of pre-existing health status, the acute illness, and the consequences of ICU care, (e.g. deep sedation and immobility) [9, 10]. Results of rigorous well-designed studies demonstrate that early and routine physical activity interventions are safe and effective in improving functional recovery by hospital discharge [11-13]. Multiple clinical practice guidelines recommend physical activity interventions as part of a bundle of standardized cares that are applicable for every ICU patient [14, 15]. The ABCDEF bundle (Figure 1) was developed to standardize processes for coordinating and delivering evidence-based interventions in the ICU [16, 17]. The early mobility “E” bundle element describes daily, progressive physical activity interventions for physiologically stable patients, beginning with exercises in bed, transferring to a chair, and advancing to walking. Results of ABCDEF bundle implementation studies demonstrate benefits of increased frequency and level of physical activity, decreased ICU and hospital lengths of stay, and decreased mortality [18-20]. However, reliable implementation of all elements remains challenging. A national, 68-hospital quality improvement collaborative study routinely measured ABCDEF bundle performance and found that mobility was the least frequently implemented bundle element, with only 29% of patients receiving physical activity interventions

greater than active range of motion [20]. To improve overall ABCDEF bundle implementation and patient outcomes, specific focus on innovative strategies to overcome barriers to physical activity are needed.

Numerous barriers to physical activity interventions have been identified and broadly classified as patient, clinician, unit, protocol, or ICU context-related [21]. Strategies to address these barriers have included use of structured quality improvement models to identify and target local barriers [22], nursing-initiated physical activity protocols to standardize patient assessment and goal setting [23], and focused interdisciplinary communication and collaboration [24, 25]. However, these resources and approaches have not spread widely. A limitation to physical activity protocols is the poor usability given the temporal and cognitive demands associated with registered nurse (RN) workflows. Our previous research identified that obstacles to existing RN-initiated physical activity protocols are significant – requiring time to synthesize multiple patient data elements either across different locations in the electronic health record (EHR) (e.g., blood pressure in vital signs documentation and vasopressor dose in medication administration record), or scrolling through data over several hours or shifts to determine patient stability or changes in condition (e.g., determining if current ventilator settings represent increased, decreased, or unchanged amount of respiratory support) [26].

Clinical decision support system (CDSS) interventions are particularly relevant in ICU settings to support decision-making and reduce cognitive load due to the large amounts of data from disparate areas of the EHR that clinicians must filter and process in making time-critical decisions [27, 28]. CDSS can provide data visualizations, alerts, reminders, dashboards, and/or decision support to augment clinicians in complex decision-making and support coordinated care delivery [29, 30]. CDSS can play an important role in the timeliness of physical activity decision-making which significantly impacts patient outcomes. Yet we are unable to find CDSS addressing physical activity decision-making practice.

Our team has successfully developed and validated an algorithm to synthesize patient data from multiple areas of the EHR with physical activity guideline recommendations (ASSIST-ICU) [31]. This two-phase project proposes to develop and implement a CDSS interface for the ASSIST-ICU algorithm and then evaluate multiple feasibility and effectiveness characteristics of ASSIST-ICU in a simulated EHR environment and a real-world pragmatic trial.

Study Objectives

The overarching aim is to evaluate the effectiveness of ASSIST-ICU CDSS for increasing use of evidence-based physical activity interventions in the ICU delivered by RNs and physical therapists (PTs). The primary objective is to determine the effectiveness of ASSIST-ICU CDSS for increased activity guideline adoption in a simulated EHR environment (objective 1a) and in a real-world pragmatic trial (objective 1b). The study's secondary objectives are to evaluate usability, usefulness, cognitive workload, acceptability, and implementation feasibility of the ASSIST-ICU CDSS.

Conceptual Framework

The theoretical basis for our study is grounded in an understanding of technology acceptance, cognitive load theory, and implementation science (Figure 2). The Technology Acceptance Model (TAM) is a widely used evidence-based model which focuses on perceived ease of use (or usability) and perceived usefulness. More than 30 years of research shows that TAM explains a substantial portion of health information technology acceptance and use [32, 33]. Although the TAM has been modified, we use the TAM1 for its parsimony, ease of use and usefulness in explaining acceptance [34]. Cognitive Load Theory, a theory in use for over 30 years, focuses on complex problem solving when excessive cognitive load decreases decision making performance [35, 36]. A suboptimal CDSS design would increase extraneous cognitive workload and decrease a user's ability to correctly interpret the evidence provided in the CDSS. Given the limited amount of information humans can

process in working memory before causing cognitive overload, our CDSS will aim to support cognitive load (NASA-Task Load Index (NASA-TLX)) [37]. Technology use is also influenced by organizational factors that are addressed by implementation science. The Consolidated Framework for Implementation Research (CFIR) organizes 39 constructs across 5 domains: innovation, outer setting, inner setting, individual characteristics, and the implementation process [38, 39]. This study will focus primarily on the CFIR's inner setting (organization and unit), individuals (clinicians), and implementation process domains.

Phase 1. ASSIST-ICU CDSS System Development and Implementation

The ASSIST-ICU CDSS system uses knowledge-based decision rules developed from existing evidence-based physical activity guidelines and discrete documentation in the EHR to indicate if a patient is classified as safe or unsafe for out-of-bed activity [40]. Retrospective testing of the decision support rules has been published [31]. The ASSIST-ICU CDSS will be delivered via an EHR tool. The tool will be updated in real-time and include the classification of all patients in the ICU, with the ability to hover by patient for additional details for why the patient did or did not meet the safety element(s).

Development: Iterative User-Centered Design Cycles to Design the ASSIST-ICU Design

We will design and iteratively revise the ASSIST-ICU CDSS prototype in a series of 4 user-centered design (UCD) cycles with practicing critical care clinicians per cycle (N= 24 RNs and PTs). We will conduct two types of sequential interviews: think-aloud [41] and cognitive interviews [42], as well as a survey to assess acceptability [32]. In the think-aloud interviews, participants will receive information about two patients with differing physical activity needs and will be instructed to open the prototype and navigate through the interface as they would if they were gathering clinical

information in the EHR for making a clinical physical activity decision. As they explore the interface, they are instructed to vocalize about the actions they are taking and the thought processes they are using to interact with the prototype. This is a well-accepted usability method in which the clinician is not interrupted during their exploration. The method elicits users' expectations, understanding and misunderstanding and identifies usability problems [43]. To capture interpretations and features that may have been missed during the think-aloud, a cognitive interview will be conducted to assess clinician understanding and interpretation of the prototype features. In this method we systematically review the prototype interface with the clinician, feature by feature to assess if the feature was interpreted as the designers intended as well as to solicit design ideas. In the third part to assess acceptability, the participant will complete the TAM survey (Cronbach alpha= .79-.93) to assess acceptability [44].

The design team will analyze the findings of the interviews by rating each feature as being positive, negative, or unclear using the following deductive coding categories: 1) ease of use, 2) usefulness, 3) interpretation and 4) satisfaction. Features with $\geq 25\%$ negative or unclear ratings will be redesigned [45]. Any re-design efforts will incorporate EHR feasibility into the methods to avoid solutions that will be unattainable. After redesign, clinician interviews will resume with a new group of participants.

Development: ASSIST-ICU CDSS EHR Integration

After completing the UCD process, we will collaborate with the clinical informatics team at our study site to build the final prototype of the ASSIST-ICU CDSS interface in their EHR training environment. To support simulated testing, we will create real-world simulated patients with simulated data to evaluate how the data will be displayed on the screen and how clinicians can interact with the data. Our CDSS design will aim to include primarily structured data fields that are already available in the EHR with an attempt to minimize creating custom documentation fields to

keep the design within a Fast Healthcare Interoperability Resources (FHIR) infrastructure that will allow for future interoperability between sites.

Development: ASSIST-ICU CDSS Implementation Plan

We will gather input from key stakeholders to identify clinical workflow considerations, potential barriers, and implementation strategies for the ASSIST-ICU CDSS using a descriptive, qualitative design, incorporating the CFIR to inform data collection and directed content analysis [38, 39]. We will interview stakeholders using a semi-structured interview guide. Interview questions will focus on 1) workflow considerations, 2) role needs, and 3) implementation strategies to prepare our team and participating site for the successful evaluation of the CDSS. Questions will be tailored to key stakeholders (e.g., ICU director of nursing, PT director, RN informaticist, chief medical information officer) as individuals have different influence in the organization. Interviews will be analyzed using directed content analysis [46]. We will review findings from the interviews to identify a follow-up plan for overcoming potential barriers and addressing workflow considerations prior to ASSIST-ICU CDSS clinical trial.

Methods

Phase 2. ASSIST-ICU Simulated Trial Design

We will conduct a simulated trial using our ASSIST-ICU CDSS interface and the “usual care” no ASSIST-ICU interface in a simulated EHR environment. We will operationalize evidence-based decision making through the creation of six expert validated clinical scenarios. Six simulations will be designed with only half meeting the out-of-bed safety definition. All six simulations will be completed by each participant in a random order determined by the Excel random number (RAND) function. The decisions (safe or unsafe for out-of-bed activity) will be recorded and the total correct decisions (0-6) for each participant will be our outcome measure of effectiveness (Table 1).

Table 1. Operationalization for scoring each clinical scenario

<i>ASSIST-ICU CDSS recommends patient out of bed</i>			
<i>out of bed to mobilize patient Clinician decision</i>		Yes	No
	Yes	1	0
	No	0	1

Study Participants for Simulated Trial

Inclusion criteria will be: 1) licensed RN or PT, 2) ≥ 6 months experience working in an ICU (to align with advanced beginner group the Dreyfus Model of Skill Acquisition) [47, 48], 3) access to a tablet or computer for the design session, and 4) fluent in English. Exclusion criteria will be: 1) No experience with EHR in a critical care setting and 2) unable to use a cloud-based video platform.

We will recruit a sample of 50 licensed RNs and PTs (N=25 control group, N= 25 intervention group) using publicly available lists from professional state boards of 7 geographically diverse states. We will randomly select clinicians to contact. Using a modified Dillman's Tailored Design Method [49], each of the randomly selected clinicians will be contacted with different modes of contact (letters, post cards and email) up to 5 times in a 21-day cycle via email and mail. For generalizability purposes we will use a quota sampling methodology to ensure the clinicians subjects represent the demographics of their profession [45]. In addition to the random sample, up to N=15

clinicians will be recruited using convenience sampling to assess the fidelity of ASSIST-ICU (e.g., agreement between clinical scenario sequence and variable display in the CDSS) in the simulated EHR.

Sample Power for Simulated Trial

The primary hypothesis to be tested in this study focuses on the efficacy of ASSIST-ICU on making evidence-based guideline physical activity decisions in a simulated EHR environment compared to no support. We hypothesize that participants assigned to the ASSIST-ICU intervention group will have a higher proportion of decisions that meet the out-of-bed safety definition. Assuming the true mean number of correct decisions out of six simulations is 4.5 (probability of correct decision = 75%) when using the decision tool and three (probability of correct decision = 50%) when not using it, two-sample binomial test simulations show that 25 clinicians per group will provide 99.2% power when testing for a between-group difference ($\alpha = 0.05$).

Study Procedures and Setting

Respondents that meet the eligibility criteria will participate in an informed consent process, complete a short demographic and clinical experience survey. At the time of the scheduled test session, participants will connect via the cloud-based video platform from their homes or quiet space of their choosing. The participant will connect with a member of the research team and share their screen as they interact with the prototype. This will allow the visualization of computer mouse movements to show which areas and features of the prototype they are focusing on. After receiving a standardized orientation to the simulated EHR environment, the research team member will begin recording and the clinicians will open the simulated EHR environment (with or without ASSIST-ICU CDSS) to begin the study. The fictional patients' scenarios will be presented in their preassigned random order. After exploring the EHR environment, participants will be asked to respond whether they 1) would or 2) would not decide to move each patient out-of-bed that day.

Data Collection and Analysis for Simulated Trial

Clinicians will receive a score from 0-6 based on the number of scenarios answered correctly. Participants will complete three brief surveys regarding the CDSS and decision-making process as a whole using a hyperlink in the cloud-based video platform's chat feature: the System Usability Scale (SUS) [50], NASA-TLX [37], and Acceptability of Intervention Measure (AIM) [51]. The SUS is a 10-item Likert type scale that is widely used to measure usability across a broad range of interfaces and performs well psychometrically (alphas=0.7-.92) [52, 53]. The NASA-TLX is a 6-item scale that measures subjective cognitive workload in performing a specific task and is a reliable measure of cognitive workload across industries, including ICU clinicians (coefficient alphas 0.83-0.92) [54]. The AIM is a 4-item Likert type scale that measures acceptability and performs well psychometrically (coefficient alphas 0.85-.91). Following completion of the surveys the clinician will receive a link to a \$100 gift card as an honorarium.

Summary statistics will be calculated for collected measures by group. Continuous measure distributions will be assessed for normality and reported as means and standard deviations or medians and inter-quartile ranges. Categorical measures will be reported as counts and percentages for each level. A two-sample binomial test will be used to test the null hypothesis that decision accuracy with the support tool is no different than without it. Further between-cohort assessments will be made for SUS, NASA-TLX, and AIM using two-sample t-tests or the Wilcoxon rank sum test. P-values will be reported, and conclusions about significance will be made at the $\alpha = 0.05$ level.

Phase 2. ASSIST-ICU Pragmatic Trial Design

The ASSIST-ICU pragmatic trial design is a prospective, non-randomized, two-unit pretest-posttest design. The specific components of the ASSIST-ICU CDSS and how the implementation will be operationalized, implemented, measured, and monitored for feasibility will be incorporated

into the research protocol at the end of Phase 1.

Study Setting for Pragmatic Trial

This study will take place at the University of Iowa Health Care (UIHC). Within UIHC, we will include 2 adult ICUs. Both units have implemented comprehensive patient physical activity programs that include protocol-based activity progression, routine PT consult upon ICU admission, and standardized activity assessment and intervention documentation for RNs and PTs in the EHR.

Study Participants for Pragmatic Trial

The ASSIST-ICU CDSS will include 2 participant groups: clinicians and patients. The clinicians will include all RNs and PTs working in the selected adult ICU units. RN-to-patient ratios in the ICUs are usually 1:2 and PTs usually manage 6-8 patients per day. Patients will include all adults admitted to a participating ICU for at least 24 hours. As a pragmatic trial focused on decision-making at the point-of-care, we will not place restrictions on age, comorbidities, severity of illness, or discharge outcome expectation.

Informed Consent

We will request an institutional review board waiver for informed consent for ICU patients and clinicians based on the premise that the trial meets the Office for Human Research Protections regulations regarding waivers of consent (45 CFR 46.116(f)(3)). Specifically, the research involves no more than minimal risk to the participants (patients and providers are the subjects of data collection procedures, which pose minimal risk) and the CDSS intervention is designed to increase the uptake of evidence-based care.

Intervention

As a prospective, non-randomized, two-unit pretest-posttest design, the ASSIST-ICU CDSS

will be implemented in each ICU for a period of 9 months using a staggered implementation with one ICU receiving the intervention at a time. A training period will be conducted with RN and PT end users prior to implementation to facilitate effective use of the ASSIST-ICU CDSS and integration into existing workflows. Training will occur in consideration of each clinician's schedule and last approximately 15 minutes. In addition, resource materials will be distributed to each unit before and throughout the trial.

Data Collection and Analysis for Pragmatic Trial

Feasibility and effectiveness data will be captured via the EHR. Study data will be extracted from the EHR using EHR reports that are built from the structured data fields used to create the ASSIST-ICU CDSS. Baseline data will be collected via the reports prior to the intervention implementation using silent data collection. Silent data collection functionality allows the CDSS logic to actively run in the system, but users do not yet have access to use the CDSS dashboard, allowing for baseline data collection.

We will evaluate key implementation and clinical outcomes using the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework as it considers both feasibility (reach, adoption, and implementation) and clinical effectiveness outcomes of the intervention (Table 2) [55].

Table 2. Study outcomes by RE-AIM element.

Element	Endpoints	Data Collection
Reach	80% of unit RNs and PTs participate in training 90% of unit RNs and PTs participate in trial 80% of unit RNs and PTs complete post-implementation surveys 100% of eligible patients receive CDSS recommendations in participating ICUs	Unit participation logs EHR report REDCap EHR report
Effectiveness	Ratio of safe alerts/total alerts Primary clinical endpoint: time to first out-of-bed activity Secondary clinical endpoints: highest level of activity in ICU, ICU and hospital length of stay, discharge disposition	EHR report

Adoption	Number of tool views	EHR audit log
Implementation	Primary feasibility outcome: physical activity decision-making Safety: fall to the floor, accidental tube dislodgement (endotracheal or line removal)	EHR report Safety reporting system
Maintenance	Continued physical activity practice after the clinical trial	EHR report

The primary feasibility outcome will be physical activity decision-making (number of patients with out-of-bed activity documented and CDSS = safe on a given ICU day). Secondary measures include acceptability and usability of the CDSS. Acceptability, defined as the belief an intervention is agreeable, palatable, or satisfactory [51], and usability, defined as being appropriate for a specific context of use [50], will be measured through online surveys. We will also evaluate potential safety events routinely reported in physical activity studies [56] and documented in the health system's patient safety reporting system, including if the following events occurred during out of bed activity: fall to the floor, unplanned extubation, or line removal requiring urgent replacement.

Upon trial completion, all ICU RNs and PTs who worked in a study ICU will be invited to participate in an online survey. Usability (SUS), cognitive workload (NASA-TLX), and acceptability (AIM) will be measured and calculated in the same manner as described for the simulated trial.

We will generate histograms and bar charts to evaluate the distributions of all variables of interest and report appropriate descriptive statistics. Continuous variables will be summarized by means and standard deviations or medians and inter-quartile ranges, as appropriate. Categorical variables will be summarized as counts and percentages. Pre-existing differences in the outcome variables at baseline will be assessed using two-sample t-, Wilcoxon rank sum, or Fisher's exact test. Frequencies and percentages will be calculated to determine the feasibility of participation measures. A two-sample binomial test will be used to test the null hypothesis that decision accuracy with the support tool is no different than without it. Unit-stratified means and standard deviations will be calculated for SUS, NASA-TLX, and AIM. P-values will be reported, and conclusions about significance will be made at the $\alpha = 0.05$ level.

Results

This two-phase CDSS development and evaluation study was funded in 2024 by AHRQ (1R21HS029959-01). The developmental phase (phase 1) began in April 2024 and the CDSS trial is planned to begin in 2026 with data collection and analysis to be completed in April 2028. Phase 1 of the study was approved by the University of Iowa Institutional Review Board (protocol # 202312543) with a waiver of informed consent and following the ethical standards of the institutional committee on human experimentation and with the Helsinki declaration of 1975. A separate IRB protocol will be submitted prior to beginning phase 2 of the study.

Discussion

Study Significance and Strengths

This study aims to develop and evaluate a CDSS that assists clinicians in coordinating and delivering evidence-based physical activity interventions at the point of care, with minimal extraneous cognitive workload, and demonstrated feasibility of real-world trial study procedures. This study rigorously addresses the most common potential pitfalls identified with CDSS, including usability, increased cognitive workload, usefulness, effectiveness, safety, fragmented workflows, and lack of spread by using a novel sequence of methods to design and test the CDSS interface [29]. First, a UCD approach, which is considered a “gold standard” by many, and involves iterative evaluations with future system users to enable user perspectives to be incorporated into the system design to improve the usefulness and usability [41, 57-59]. Second, we use the CFIR implementation science framework during the design phase understand barriers and facilitators to CDSS implementation [38, 39]. Next, we conduct a virtual trial to establish safety and effectiveness of the intervention in a simulated EHR environment before we test the feasibility of the CDSS in real-world settings. Although UCD is widely used in healthcare, randomized tests of efficacy and rigorous

testing of CDSS in a pragmatic trial within a single study is rare. In addition, few CDSS studies have implementation science theories informing CDSS development and testing, yet designing with an implementation science lens can identify additional modifiable barriers to address during CDSS design and implementation [60].

Despite multiple guidelines [14, 40] and paper-based algorithms [23, 61], there is a lack of multidisciplinary EHR-integrated CDSS, designed to enhance critical thinking, promote guideline adoption, and decrease cognitive burden of the complex ICU patient mobility decision-making process. Also, compared to medical CDSS, few CDSS have been designed and tested for ICU RNs and even less for PTs [62]. Given that physical activity interventions are delivered by multiple ICU team members, CDSS is needed to support multidisciplinary decision-making and physical activity care coordination across disciplines within the ICU team. Considering the low implementation of physical activity interventions during hospitalization, especially in ICU settings, it is imperative to identify methods to increase adoption of evidence-based physical activity interventions. ASSIST-ICU is expected to assist ICU clinicians in coordinating and delivering evidence-based physical activity interventions at the point of care, decrease the duration of bedrest, and ultimately reduce hospital-acquired functional decline.

Study Limitations

Although our study team has expertise recruiting a national internet-based clinical trial of nurses, we recognize that recruiting a multi-professional sample may be challenging. In our prior work, we successfully recruited a national sample using state board of nursing lists and a modified Dillman approach that includes repeated invitations with different methods (e.g. post card, mailed letter with small cash token) [49, 63]. In addition, we have assembled a team with representation from both nursing and physical therapy disciplines to help optimize our reach to both professions.

Barriers beyond the focus of the CDSS (efficient patient identification and physical activity

coordination) may impact patient physical activity practice. We envision this intervention may help to identify and prioritize addressing other barriers as the CDSS displays patient status at the unit-level, which can support unit leadership decision-making (e.g., staffing or equipment needs). Without identifying patient safety for physical activity, a fundamental step in planning physical activity activities, secondary barriers, such as staffing, are more difficult to plan for and address. We have selected ICUs with existing ICU activity protocols and will track unit-level barriers that may impact physical activity practice. For example, if nursing units are experiencing high levels of turnover and temporary staffing, we are prepared to modify CDSS training as needed to support unit needs.

Future Directions

Findings from this study will guide a future multi-site pragmatic clinical trial to assist ICU clinicians in coordinating and delivering evidence-based physical activity interventions at the point of care. The successful completion of this study will be significant because the CDSS is expected to ultimately be operable across different health systems (specified with FHIR standards), allowing for the CDSS to be scaled across organizations and evaluated for clinical impact in a multi-center study. Future work will compare institutions' current standard of care with the ASSIST-ICU visualization on patient outcomes, while exploring institution-specific implementation needs.

Conclusions

Our study aims to develop a CDSS interface for consistent patient-specific translation of evidence-based physical activity interventions for ICU settings, and evaluate its usability, usefulness, cognitive workload, acceptability, feasibility, and effectiveness on decision-making outcomes. We are developing a novel interdisciplinary CDSS that we hypothesize will increase the delivery of evidence-based recommendations for ICU physical activity. By using user-centered design cycles and implementation science methods during development, we aim to develop a CDSS that meets users' needs at the point of care and is feasible for health systems to implement into existing clinical

workflows. These methods may provide a framework for how to develop future interdisciplinary CDSS. The insights gained from this study are expected to provide strong justification for a subsequent multicenter study to deliver evidence-based interventions to reduce hospital-acquired functional decline at its negative, costly outcomes.

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Conflicts of Interest

None to declare.

Abbreviations

ICU: Intensive care unit

RN: Registered nurse

EHR: Electronic health record

CDSS: Clinical decision support system

PT: Physical therapist

TAM: Technology acceptance model

NASA-TLX: NASA-Task Load Index

CFIR: Consolidated framework for implementation research

USD: User-centered design

FHIR: Fast healthcare interoperability resources

SUS: System usability scale

AIM: Acceptability of intervention measure

RE-AIM: Reach, effectiveness, adoption, implementation, and maintenance framework

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Supplementary Files

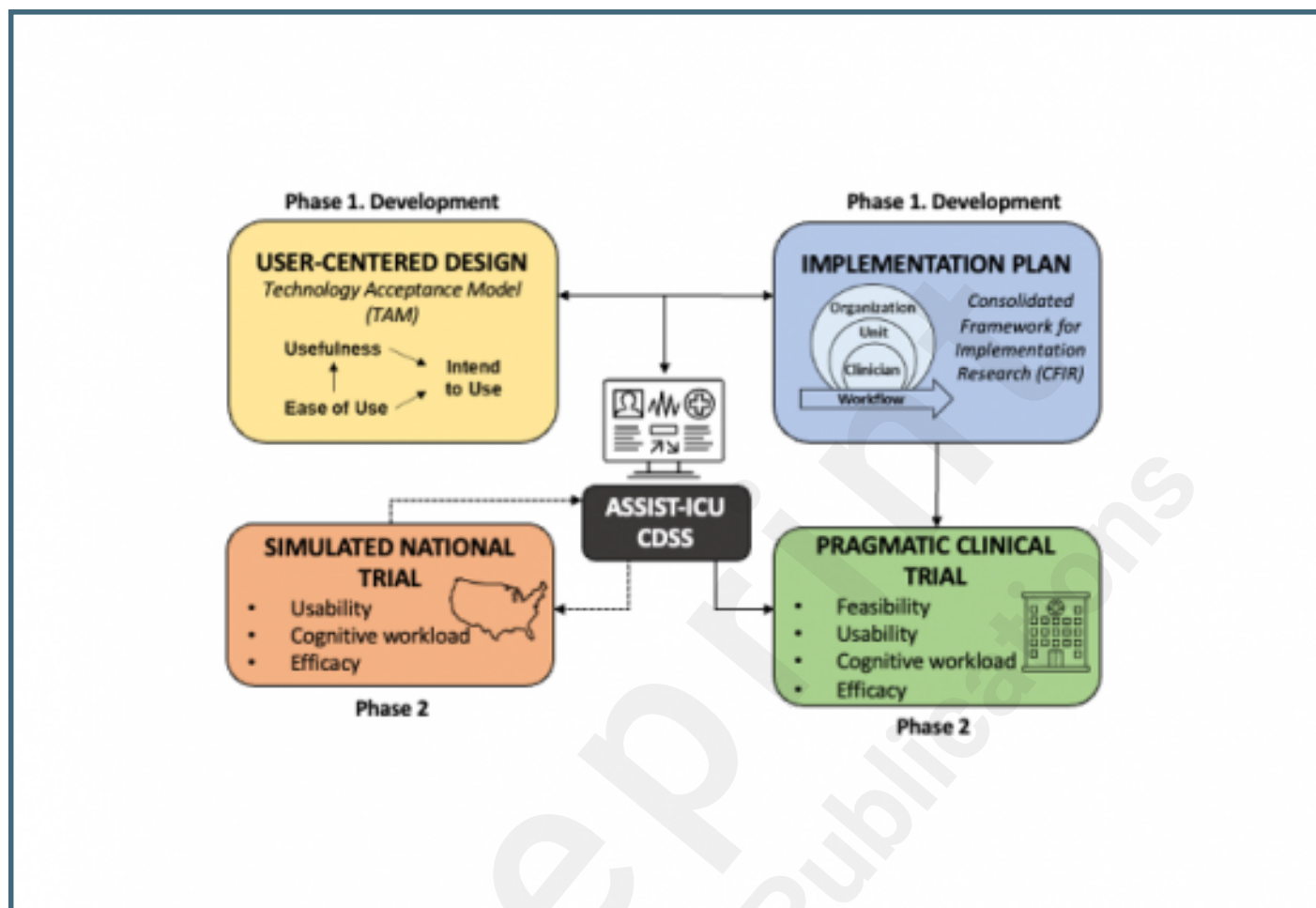
Figures

ABCDEF bundle elements.

- A** Assess, Prevent and Manage Pain
- B** Both SAT and SBT
- C** Choice of Analgesia and Sedation
- D** Delirium: Assess, Prevent, and Manage
- E** Early *Mobility and Exercise*
- F** Family Engagement and Empowerment

SAT = spontaneous awakening trial; SBT = spontaneous breathing trial

Research framework.



Multimedia Appendixes

AHRQ grant summary statement.

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