Technical Brief
Number 40

Interventions To Decrease Hospital Length of Stay

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Key Messages

Purpose

The goals of this Technical Brief are to 1) categorize and evaluate current knowledge regarding strategies to reduce length of stay (LOS) for medically complex, high-risk, or vulnerable patients at increased risk of extended LOS; 2) examine contextual factors (e.g., resources, costs, staffing, technology) that affect implementation of LOS-focused interventions; 3) identify emerging concepts or initiatives that may merit future research; and 4) develop a series of evidence maps to inform health systems' strategic efforts for LOS reduction in these populations.

Key Messages

- Few studies have evaluated system-level interventions focused on medically complex, high-risk, or vulnerable patient populations, including frail elderly patients and those with complex chronic illness. Strategies assessed in multiple systematic reviews include geriatric consultation services and early specialized discharge planning.
- Substantial research gaps need to be addressed, including interventions for socially or economically vulnerable populations and patients with psychiatric or substance use disorders, contextual factors affecting feasibility of implementation, and the resources and potential savings associated with interventions to reduce LOS.
- Hospital administrative leaders, researchers, and policymakers can work to reduce LOS by improving research practice, developing targeted health system interventions, and collaboratively addressing the social care needs of medically complex and vulnerable patient populations.
- Two interventions (clinical pathways and case management) improved key outcomes for patients with heart failure. Clinical pathways reduced LOS, readmission, and mortality (low to moderate quality evidence from a single systematic review). Similarly, case management decreased LOS and readmissions (moderate quality evidence from a single systematic review). More research is needed to confirm these findings (Figure i).
- For other interventions, evidence for LOS reduction was inconsistent. Only limited evidence was available for other post-discharge adverse outcomes (hospital readmission, mortality).
- The evidence base examining strategies for reducing LOS is large but focuses primarily on average-risk patients undergoing elective surgery or specialized procedures, who were not the focus of this Technical Brief.

Figure i. Evidence map for length of stay, readmissions, and mortality outcomes

Interventions		Key Outcomes			Patient Population
		Length of Stay	Readmissions	Mortality	Population
Discharge Planning	***Mabire 2017, 2016***	↑ L	↓ M		Older
	Mabire 2017, 2016 *(transitional care)*		↔ L		Older
	Goncalves-Bradley 2016	↓ M	↓ M		Older
	Goncalves-Bradley 2016	↔ L			Older surgical patients
	Bryant-Lukosius 2015	↔ L		↔ L	Older
	Bryant-Lukosius 2015	↓ M			High-risk pregnant women
	Bryant-Lukosius 2015		↔ L	↔ L	Heart failure
	Bryant-Lukosius 2015		↔ L		Infants
	Zhu 2015	↔ M	↓ M	↓ H	Chronic conditions
	Zhu 2015		↓ M		Younger (< 65 years)
Geriatric Assessment	***Eagles 2020***	↓ M		↓ M	Older
	Ellis 2017			↔ H	Older
	Van Craen 2010	↔ H	↔ M	↔ H	Older
Medication Management	***Gillaizeau 2013***	↔ L			Chronic conditions
Clinical Pathways	***Kul 2012***	↓ L	↓ M	↓ M	Heart failure
Interdisciplinary Care	***Pannick 2015*** *(altering team composition)*	↔ M	↑ L	↔ M	Chronic conditions
	Pannick 2015 *(altering team practice)*	↔ M	↔ L	↓ M	Not reported
Case Management	***Huntley 2016***	↓ M	↓ M		Heart failure
Telehealth	***Baratloo 2018***	↓ M		↔ M	Other

Direction of Effect: (arrow direction)
- ↑ Increase
- ↓ Decrease
- ↔ Inconclusive

Strength of Evidence: (superscript letter)
- H High
- M Moderate
- L Low/Very low

This report is based on research conducted by the ECRI–Penn Medicine Evidence-based Practice Center contract to the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD (Contract No. 75Q80120D00002). The findings and conclusions in this document are those of the authors, who are responsible for its contents; the findings and conclusions do not necessarily represent the views of AHRQ. Therefore, no statement in this report should be construed as an official position of AHRQ or of the U.S. Department of Health and Human Services.

None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of healthcare in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new healthcare technologies and strategies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

This EPC evidence report is a Technical Brief. A Technical Brief is a rapid report, typically on an emerging medical technology, strategy, or intervention. It provides an overview of key issues related to the intervention—for example, current indications, relevant patient populations and subgroups of interest, outcomes measured, and contextual factors that may affect decisions regarding the intervention. Although Technical Briefs generally focus on interventions for which there are limited published data and too few completed protocol-driven studies to support definitive conclusions, the decision to request a Technical Brief is not based solely on the availability of clinical studies. The goals of the Technical Brief are to provide an early objective description of the state of the science, a potential framework for assessing the applications and implications of the intervention, a summary of ongoing research, and information on future research needs. In particular, through the Technical Brief, AHRQ hopes to gain insight on the appropriate conceptual framework and critical issues that will inform future research.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the healthcare system as a whole by providing important information to help improve healthcare quality.

If you have comments on this Technical Brief, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

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Key Informants

In designing the study questions, the EPC consulted a panel of Key Informants who represent subject experts and end-users of research. Key Informant input can inform key issues related to the topic of the Technical Brief. Key Informants are not involved in the analysis of the evidence or the writing of the report. Therefore, in the end, study questions, design, methodological approaches, and/or conclusions do not necessarily represent the views of individual Key Informants.

Key Informants must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their role as end-users, individuals with potential conflicts may be retained. The Task Order Officer and the EPC work to balance, manage, or mitigate any conflicts of interest.

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Prior to publication of the final evidence report, the EPC sought input from independent Peer Reviewers without financial conflicts of interest. However, the conclusions and synthesis of the scientific literature presented in this report do not necessarily represent the views of individual reviewers.

Peer Reviewers must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential nonfinancial conflicts may be retained. The Task Order Officer and the EPC work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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Interventions To Decrease Hospital Length of Stay

Structured Abstract

Background. Timely discharge of hospitalized patients can prevent patient harm, improve patient satisfaction and quality of life, and reduce costs. Numerous strategies have been tested to improve the efficiency and safety of patient recovery and discharge, but hospitals continue to face challenges.

Purpose. This Technical Brief aimed to identify and synthesize current knowledge and emerging concepts regarding systematic strategies that hospitals and health systems can implement to reduce length of stay (LOS), with emphasis on medically complex or vulnerable patients at high risk for prolonged LOS due to clinical, social, or economic barriers to timely discharge.

Methods. We conducted a structured search for published and unpublished studies and conducted interviews with Key Informants representing vulnerable patients, hospitals, health systems, and clinicians. The interviews provided guidance on our research protocol, search strategy, and analysis. Due to the large and diverse evidence base, we limited our evaluation to systematic reviews of interventions to decrease hospital LOS for patients at potentially higher risk for delayed discharge; primary research studies were not included, and searches were restricted to reviews published since 2010. We cataloged the characteristics of relevant interventions and assessed evidence of their effectiveness.

Findings. Our searches yielded 4,364 potential studies. After screening, we included 19 systematic reviews reported in 20 articles. The reviews described eight strategies for reducing LOS: discharge planning; geriatric assessment or consultation; medication management; clinical pathways; inter- or multidisciplinary care; case management; hospitalist services; and telehealth. All reviews included adult patients, and two reviews also included children. Interventions were frequently designed for older (often frail) patients or patients with chronic illness. One review included pregnant women at high risk for premature delivery. No reviews focused on factors linking patient vulnerability with social determinants of health.

The reviews reported few details about hospital setting, context, or resources associated with the interventions studied. Evidence for effectiveness of interventions was generally not robust and often inconsistent—for example, we identified six reviews of discharge planning; three found no effect on LOS, two found LOS decreased, and one reported an increase. Many reviews also reported patient readmission rates and mortality but with similarly inconsistent results.

Conclusions. A broad range of strategies have been employed to reduce LOS, but rigorous systematic reviews have not consistently demonstrated effectiveness within medically complex, high-risk, and vulnerable populations. Health system leaders, researchers, and policymakers must collaborate to address these needs.

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Introduction

Background

In 2018, there were 36.4 million inpatient hospital stays in the United States.[1] The average length of stay (LOS) for a hospitalization is 5½ days.[2] Unnecessary days in hospital may lead to increased hospital-acquired patient complications (e.g., healthcare-associated infections, falls) and increased costs for patients and healthcare systems. In addition, prolonged LOS may negatively affect both patient and staff experience.[3] Delays in hospital discharge may be related to unnecessary waiting, poor organization of care, delays in decision-making, or difficulties related to discharge planning.[3,4]

A broad array of interventions have been developed to reduce hospital LOS, and they differ in design, intent, and focal point. While some interventions primarily aim at improving clinical care (enhanced recovery programs,[5-7] clinical pathways,[8] and early patient mobility programs[9]), other approaches address logistical factors (care coordination, transition and discharge planning,[10-12] case management,[13] medication management,[14] or specialized units for high-risk populations[15,16]). Other interventions target the workforce, such as multidisciplinary care teams[17] or redesigned staffing models.[18]

Interventions have the potential to create trade-offs between outcomes. Reducing LOS might increase concerns for readmission risk or shifting costs of care to the outpatient setting.[3] Conversely, interventions might be ineffective in reducing LOS but yield significant improvements in other patient-centered outcomes, such as patient satisfaction. Further, interventions to reduce LOS may differ for those needing treatment for exacerbation of a complex chronic condition and those needing treatment for an acute illness or undergoing an elective surgical procedure.

Particular patient populations, such as patients who are socioeconomically vulnerable, affected by healthcare disparities, or with medically complex needs, may be at increased risk for unnecessary delays in discharge.[19-21] These patients are typically at greater risk for adverse events during and after hospitalization.[22] Interventions that address the distinctive challenges of LOS reduction in these populations might increase efficiency of patient throughput, reduce health inequities, and improve the delivery of safe and effective care.

Successful hospital-based interventions may significantly depend on environmental factors, including the unique resources, personnel, leadership, and infrastructure specific to each setting. A hospital or health system-based approach could therefore address the multiple factors (e.g., admission process, discharge disposition) contributing to unnecessary delays in hospital discharge.[3] We categorized and evaluated current knowledge regarding the many strategies to reduce LOS; examined contextual factors (e.g., resources, costs, staffing, technology) that may affect implementation of LOS-focused interventions; identified emerging concepts or initiatives that merit future research; and developed a series of evidence maps to inform health systems' strategic efforts.

Guiding Questions

Guiding Question (GQ) 1: What are the characteristics of interventions to decrease length of hospital stay, and how do they vary?

GQ 2: What are the contextual factors (e.g., resources, staffing, technology) that impact implementation of interventions to decrease hospital length of stay?

GQ 3: What is the current evidence addressing interventions to decrease hospital length of stay?

GQ 4: What future research is needed to close evidence gaps regarding interventions to decrease length of hospital stay?

Methods

AHRQ's Learning Health System panel nominated this topic to inform current and future patient safety efforts and access to care initiatives. We generated a protocol that included preliminary Guiding Questions (GQs) and inclusion/exclusion criteria in the form of PICOTS (populations, interventions, comparators, outcomes, timing, and settings). We interviewed Key Informants (KIs) representing a broad range of stakeholders (described below) and incorporated their feedback into a final protocol that was posted on the Effective Healthcare website (https://effectivehealthcare.ahrq.gov). The protocol was also submitted to the PROSPERO database but was not prioritized for immediate inclusion due to the COVID-19 pandemic.

Data Collection

Discussions With Key Informants

The intent of KI interviews is to provide context and guidance on areas most important to consider for this Technical Brief. Seven KIs provided input on this review, representing diverse leadership experiences, including hospital administration, patient safety organizations, community-based healthcare initiatives, policy analysis, and patient advocacy. KI expertise included care model transformation (e.g., co-design, coaching), healthcare delivery processes, managed care and risk management, and hospital quality and safety. Additionally, KIs had first-hand experience of working with medically complex, high-risk, and vulnerable populations at their institutions. We sought KI feedback on the review's scope, including the proposed PICOTS. We asked about vulnerable populations at risk for unnecessary increases in length of stay (LOS), such as those with specific clinical conditions and demographic risk factors. We similarly requested KI input on key components to capture organizational interventions focused on LOS reduction. Most of the KI discussions were real-time interviews. However, due to scheduling challenges during the COVID-19 pandemic, two KIs provided responses by email instead.

The KIs provided key insights on defining patient populations at high-risk for prolonged hospitalization. First, we presented to the KIs two potential conditions of interest: acute exacerbations of chronic obstructive pulmonary disease and decompensated congestive heart failure. KI input led to the inclusion of high-volume chronic diseases with a significant risk of exacerbation or complications, including the addition of chronic kidney disease and diabetes mellitus. Second, KIs helped identify additional characteristics of medically complex patients. Several KIs highlighted that patients with multiple medical and psychiatric diagnoses are at much higher risk than those with a single clinical diagnosis. Therefore, we included comorbid psychiatric or behavioral health conditions, comorbid substance use disorder, frailty, and multimorbidity in our patient population. Third, KI input allowed further definition of vulnerable populations, including those with high levels of socioeconomic risk. Specifically, socioeconomic risk factors were expanded to include patients with housing instability, social isolation and vulnerability, limited social mobility, lack of social network or support, limited access to healthcare or social services, and living in rural settings. These factors were added to other proposed factors, such as underinsured or uninsured patients and those with limited English proficiency. Finally, the KIs highlighted the importance of distinguishing conditions that require acute care as opposed to hospitalizations planned for elective procedures. Based on KI input, we

narrowed our population to exclude those specifically hospitalized for nonemergent elective procedures or surgeries because KIs felt that they were at lower risk for prolonged LOS.

The KIs agreed with our proposal to focus on interventions that are initiated within the hospital and designed to evaluate LOS as our primary outcome. A few KIs highlighted the importance of including initiatives with both an inpatient and outpatient component, given that multidisciplinary transitional partnership can be powerful and effective. Therefore, our final protocol included multicomponent interventions initiated within an inpatient hospital setting to directly affect LOS, even if several other facets occurred as an outpatient. However, studies with interventions solely occurring in an outpatient setting (e.g., isolated community-based interventions) were excluded; KIs agreed that in those cases, the primary goal was to reduce readmissions, as opposed to LOS reduction.

Regarding outcomes, the KIs agreed that LOS metrics that provide a standardized comparison among hospitals are important; therefore, we included LOS index as a primary outcome. Additionally, secondary and surrogate outcomes were expanded based on KI input, such as patient experience, functional return, and inclusion of discharge disposition.

KI input informed GQs 1, 2, and 4. In addition, input was also used to refine the systematic literature search, identify grey literature resources, provide information about ongoing research, confirm evidence limitations, recommend approaches to help fill these gaps, and provide input on the potential design, focus, and audience for the evidence maps featured in this Technical Brief. Table 1 presents the questions for the KIs.

Table 1. Questions for Key Informants

Number	Question
1.	What clinical conditions are top priorities for you when thinking about efforts to reduce length of stay (LOS)? How do you decide on prioritization for these efforts?
2.	Based on national admissions and LOS data, some of the chronic conditions for specific focus include: acute exacerbations of chronic obstructive pulmonary disease (COPD), acute exacerbations of chronic congestive heart failure. a. Are there other chronic conditions with frequent decompensations often requiring inpatient admission missing from this list that are of particular interest?
3.	Can you describe characteristics of medically complex patients for which interventions to reduce LOS would be particularly helpful?
4.	How would you describe vulnerable populations within a hospital setting as it relates to LOS? a. Are there interventions of interest that would be specific and/or different to LOS in these at-risk populations?
5.	How would you define a hospital or health system-based organizational intervention to reduce LOS? What are the most important elements of such interventions?
6.	What characteristics of interventions are important for you to know or understand so that you can judge feasibility of implementation? (e.g., staffing requirements, infrastructure, resource utilization) a. How do emerging or existing payment models affect approaches to operationalizing or prioritizing LOS interventions?
7.	The information about interventions we glean from studies will be presented in evidence maps. For example, https://www.ncbi.nlm.nih.gov/books/NBK379312/figure/findings.f7/?report=objectonly a. What are your thoughts about 2 or 3 key variables that would be most helpful for you to see graphically presented? b. What types of categories of interventions or conditions would be useful to highlight or group together?
8.	What outcomes other than LOS, including potential positive or negative effects to a system or care team are of particular interest for interventions to decrease LOS? What outcomes are important to patients?
9.	Where do you think are the most important gaps in current knowledge, and can you recommend approaches to help fill and/or identify these gaps?
10.	In addition to published literature, what unpublished resources could help inform our analysis?

Grey Literature Search

Multiple grey literature sources were searched, including websites of relevant stakeholder organizations (e.g., American Hospital Association, Institute for Healthcare Improvement, The Joint Commission), healthcare consulting firms (e.g., Premier, Vizient, Socially Determined), and government agencies (e.g., ClinicalTrials.gov, Agency for Healthcare Research and Quality (AHRQ), Centers for Medicare & Medicaid Services). The information from this search helped to orient the team to work being conducted to reduce hospital LOS.

Published Literature Search

Evidence from the published literature helped inform GQ 3. Medical librarians searched bibliographic databases, including MEDLINE®, PubMed® (unprocessed records only), Embase®, CINAHL®, and the Cochrane Library using controlled vocabulary and text words. Searches covered the literature published from January 1, 2010, through September 30, 2020. A complete list of the resources searched, as well as search concepts and strategies, are available in Appendix A. Reference lists from systematic reviews were reviewed and compared against our retrieved articles. If a systematic review contained references that appeared to meet our inclusion criteria, but had not been captured by our initial search results, we reviewed the search strategy to determine whether we needed to refine the search strategy to include these articles. We also requested additional studies through AHRQ's Supplemental Evidence and Data process.

Literature screening was performed using the database Distiller SR (Evidence Partners, Ottawa, Canada). Literature search results were initially screened for relevancy based on predetermined eligibility criteria (see Table 2). Full text of relevant abstracts were then requested and screened. We structured literature screening to ensure that both a clinician and a methodologist reviewed every abstract and full-text report. All disagreements were resolved by consensus discussion among the two original screeners.

Inclusion of Published Literature

Published systematic reviews (SRs) of both randomized and nonrandomized primary studies were included if they met the inclusion criteria in Table 2 and certain methodologic standards, such as providing search criteria, explicit inclusion/exclusion criteria, and risk-of-bias assessment. SRs were excluded if they focused solely on patients undergoing nonemergent elective procedures or exclusively set in intensive care units, emergency departments, or managed or implemented by entities external to the hospital setting, such as community organizations. Interventions not intended or expected to reduce LOS were not evaluated. Systematic reviews were also excluded if they did not include LOS data. Finally, we excluded SRs of primary studies that were either conducted solely outside the United States or if 50 percent or more of the studies reporting hospital LOS were conducted outside the United States. Appendix B lists excluded studies, organized by reason for exclusion.

Table 2. PICOTS and inclusion criteria

Category	Criteria
Population	**Include** hospitalized children and adults (including pregnant women) with one or more of the following risk factors for prolonged length of stay (LOS), harms, or adverse outcomes: Vulnerable populations: • high levels of socioeconomic risk (e.g., housing instability, social isolation, social vulnerability, social mobility, lack of social network, lack of social support, limited access to healthcare services or social services, rural settings) • medically uninsured, underinsured • hospitalization at safety-net, tertiary, or quaternary care institution • limited English proficiency Medically complex patients: • comorbid psychiatric or behavioral health conditions • comorbid substance use disorder • frailty • multimorbidity (≥2 chronic health conditions) • high volume chronic disease conditions with significant risk of exacerbation or complications, including chronic kidney disease, diabetes, congestive heart failure, and chronic obstructive pulmonary disease **Exclude** patients undergoing non-emergent or elective procedures
Interventions	**Include** interventions that are: • initiated within the hospital; and • designed (at least in part) to evaluate LOS *Examples* include but are not limited to: clinical pathways, enhanced recovery programs, discharge planning, case management, multidisciplinary teams **Exclude** interventions that are: • initiated, managed, or implemented by entities wholly external to the hospital setting; or • are not intended or expected to reduce LOS *Examples* include but are not limited to ambulatory clinic follow-up visits, community-based support resources, regulatory policies, third-party reimbursement programs
Comparators	**Include:** Usual care; any comparison; other active intervention
Outcomes	**Include** Primary: • Length of stay, length of stay index Secondary: • Readmission • Patient harms, such as hospital-acquired conditions and medical errors • Patient experience/satisfaction • Patient functional return • Clinician/staff satisfaction • Resource use including patient flow and discharge disposition **Exclude** studies that only describe cost-related outcomes without reporting LOS, exclude cost related outcomes that do not quantify valuations of both comparisons or alternative interventions (including usual or standard of care) and both of their associated outcomes
Timing	**Include:** All
Setting	**Include** • acute care hospitalizations in general or pediatric hospitals • reviews of studies conducted in the United States **Exclude** • reviews focused solely on intensive care unit stays, emergency departments, or observation units • specialty hospitals (e.g., psychiatric, ophthalmologic, orthopedic, cancer, rehabilitation, long-term acute care) • reviews of studies conducted solely outside the U.S.

Data Organization and Presentation

Information Management

We abstracted and tabled descriptive characteristics from published SRs. Factors abstracted from published studies included PICOTS categories (population, intervention, comparator, outcomes, timing, setting). We highlighted outcome measures used in these studies and the applicability of results to various populations. KI interviews helped refine data points for abstraction and how they might be organized. A designated project team member documented KI interviews during each call.

- Patient population (age; sex; primary language; primary diagnosis and comorbidities; medical insurance or lack of coverage; housing type; other measures of social isolation and/or vulnerability as reported by systematic reviews)
- Hospital characteristics (adult/pediatric; bed size; location [urban, rural, etc.]; type of hospital [academic medical center, community hospital]; health system affiliation or standalone hospital)
- Intervention characteristics (description of intervention; resources needed; implementation factors including durability, if described)
- Comparators (description of comparison group, including models of care for controlled trials or cohort studies, or preexisting hospital care factors for pre-post studies)
- Outcomes (LOS or LOS index; sustainment of LOS changes; readmission rates; measures of hospital-related harms as reported in SRs; patient functional status and time to functional return; patient satisfaction/experience; clinician/staff experience; resource use; patient throughput)

Data Presentation

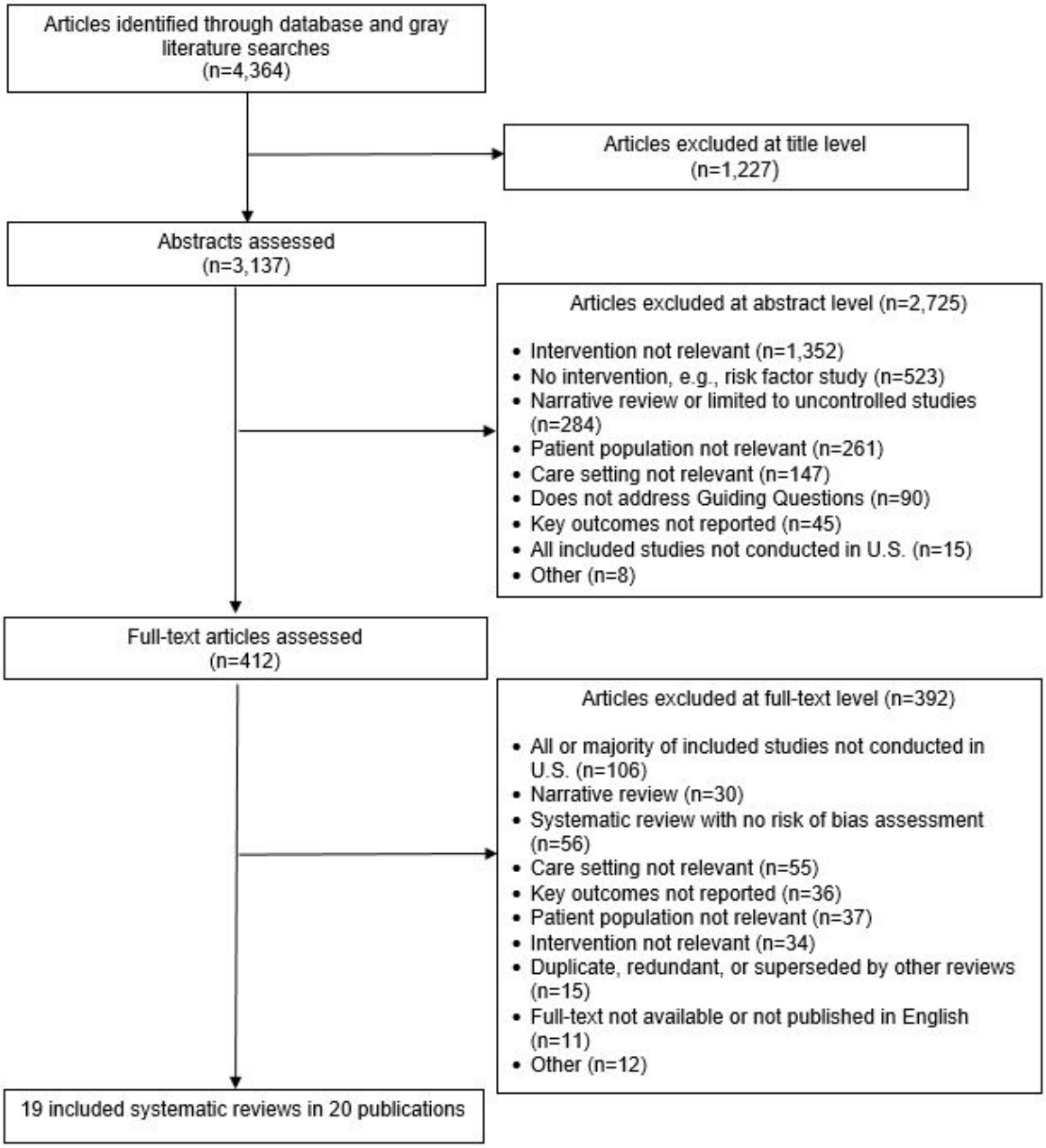
We designed a series of evidence maps that summarize the volume and quality of existing research for each intervention category and describe their effects on LOS, readmissions, mortality, and other outcomes as reported. Characteristics of published systematic reviews of randomized and nonrandomized primary studies are presented in searchable evidence tables. Where available, we included strength of evidence (SOE) ratings provided by SRs; if not provided, we used AHRQ Evidence-based Practice Center guidance by Berkman et al. 2013[23] to appraise SOE (see Appendix C). We also highlighted the current state of knowledge regarding implementation of interventions and important evidence gaps that require further study and assessment using visualization approaches as appropriate. Finally, we narratively summarized significant perspectives and insights gathered from KIs.

Findings

Our search of the published literature identified 4,364 potentially relevant studies, of which we excluded 1,227 at the title level (not relevant). We excluded 2,725 studies during abstract screening for one of the following reasons: intervention, population, or care setting was not relevant, the study design did not meet our inclusion criteria (e.g., narrative review), the abstract did not address one of the Guiding Questions (GQs), key outcomes were not reported, or studies in the systematic review were either conducted solely outside the United States or 50 percent or more of the studies reporting hospital length of stay (LOS) were conducted outside the United States. The most common reason a described intervention was considered "not relevant" was because it was not a hospital or health system-led intervention. This resulted in full-text screening of 412 articles. We excluded 392 studies at the full-text level. Reasons for exclusion at this level were similar to reasons listed for the abstract level (see Appendix B). We also received three studies through the Agency for Healthcare Research and Quality (AHRQ's) Supplemental Evidence and Data submission process. We excluded all three studies because they were not systematic reviews.

We included 19 systematic reviews in 20 publications, 1 of which was identified in our grey literature search.[12,15,24-41] Figure 1 presents a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram of our study screening.

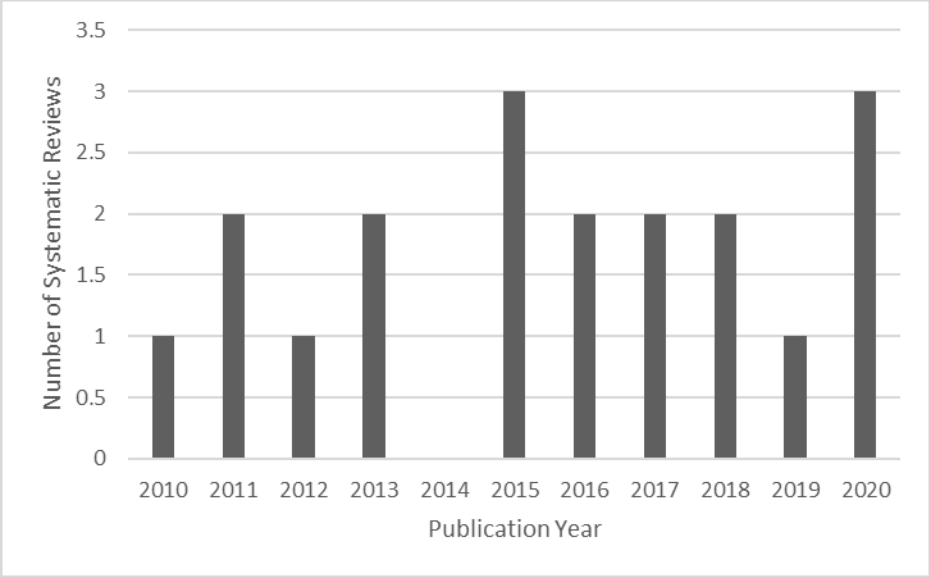
Figure 1. Study attrition diagram



Ten systematic reviews included a mix of study designs (e.g., randomized controlled trials [RCTs], observational cohort studies),[15,24-33] eight included RCTs,[12,34-40] and one included retrospective cohort studies.[41]

Our searches were limited to articles published since 2010, and Figure 2 summarizes the distribution of systematic reviews by year of publication. Comprehensive evidence tables summarizing each systematic review are in Appendix C, and summary tables of key outcomes are included below under GQ 3.

Figure 2. Publication year of included systematic reviews



A search of ClinicalTrials.gov and a Patient-Centered Outcomes Research Institute (PCORI) database identified 11 trials of interventions to decrease LOS that are currently underway in the United States. Four trials are evaluating system-level interventions and include high-risk patient populations. These trials are listed in Appendix C.

Characteristics of Interventions (GQ 1)

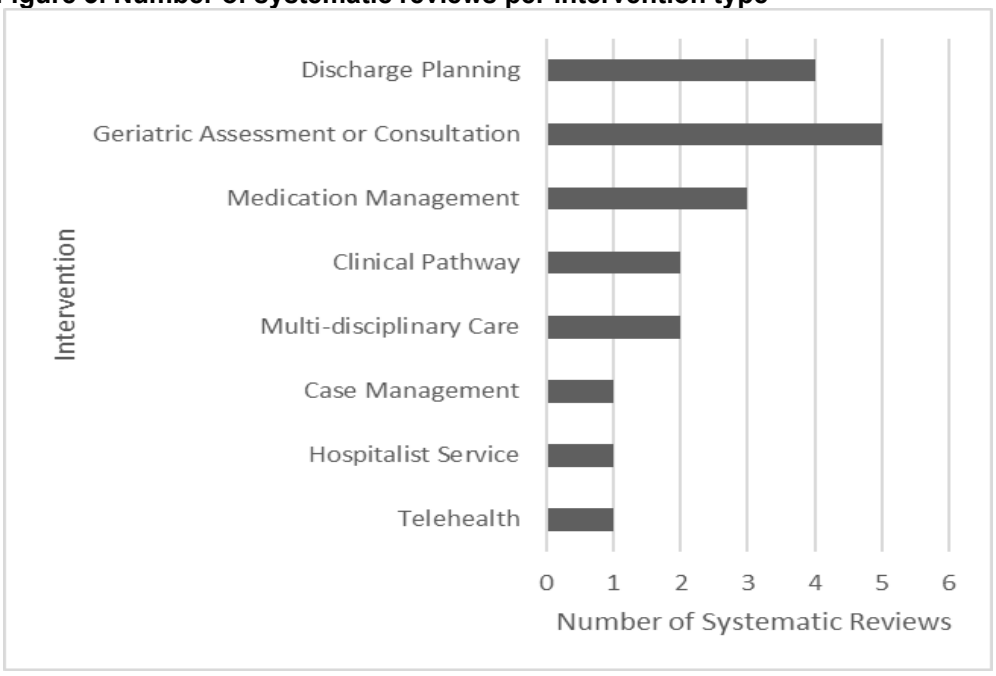
Type of Interventions

The interventions reported in the systematic reviews were organizational interventions within hospitals or health systems and included:

- Discharge planning[12,15,30,35,38]
- Geriatric assessment or consultation[26,31,36,39,41]
- Medication management[24,27,37]
- Clinical pathways[29,34]
- Inter- or multidisciplinary care[32,40]
- Case management[28]
- Hospitalist services[33]
- Telehealth[25]

Figure 3 summarizes the number of systematic reviews examining the various types of interventions included in the evidence base. Evidence tables summarizing each systematic review and describing the interventions are in Appendix C. Interventions identified in excluded reviews are summarized under GQ 4.

Figure 3. Number of systematic reviews per intervention type



Discharge Planning

Four systematic reviews in five publications examined discharge planning.[12,15,30,35,38] In general, discharge planning was delivered by a nurse (e.g., master's level prepared, specialist, advanced practice) or another healthcare professional (e.g., case manager, volunteer supported by a social worker) and included an assessment (e.g., suitability for early discharge), planning, implementation (e.g., in-hospital visits, patient education), and/or postdischarge followup. Followup care involved a phone call within 24 hours of discharge, scheduling outpatient visits, home visits, and/or on-call services.

Geriatric Assessment or Consultation

Five systematic reviews assessed geriatric assessment or consultation.[26,31,36,39,41] This type of intervention often included a geriatrician or a multidisciplinary healthcare professional team (e.g., geriatrician, advanced nurse, physicians, pharmacist, social workers) consulting on patient management or participating in various stages of care (e.g., initial assessment, developing treatment plans, goal setting, postdischarge plan). Patel et al. 2020[31] assessed a co-managed orthopedic-led and geriatric-led intervention that included prompt admission and surgical optimization (e.g., fast-tracking hip fracture), evaluating patients' social and dynamic needs from the first day of admission, and coordinating postoperative followup for patients with comorbidities.

Medication Management

Two systematic reviews examined systemic support of anticoagulant prescribing compared with routine care, such as a physician-led anticoagulation service. Austin et al. 2020[24] included studies assessing computerized provider order entry (CPOE), clinical decision support systems (CDSS), dashboard utilization, and electronic medical record implementation. In studies assessing CPOE interventions, providers used computer assistance to enter orders from a computer or mobile device and some specifically assessed discharge reconciliation processes, medication errors and preventable adverse events, or CPOE's appropriateness on pathology information.[24] In studies examining CDSS, CDSS alerts were the most frequently assessed methods. Frazer et al. 2019[37] examined pharmacist-led anticoagulation consultation services, various decision supported warfarin dosing algorithms (e.g., computer-dosing, genotype and clinical information dosing), heparin monitoring systems (e.g., point-of-care), other CDSSs (e.g., alert system requiring active response, hard-stop alert), and systematic education and feedback programs (e.g., multifaceted safety program, enhanced feedback intervention).

One systematic review by Gillaizeau et al. 2013[27] evaluated CDSS compared with usual care. Included studies used real-time computer support to guide drug-dosing (e.g., theophylline, aminoglycoside).

Clinical Pathways

In the two systematic reviews examining clinical pathways, Agarwal et al. 2018[34] included studies on multicomponent interventions, such as quality-improvement initiatives, including inpatient critical pathway for heart failure management, standardized admission orders, education for staff and patients, or telephone surveillance postdischarge. A description of the interventions in studies included in the systematic review by Kul et al. 2012[29] was not provided. The authors reported that pathways had to meet the definition of a pathway according to the European Pathway Association[29]

Inter- or Multidisciplinary Care

Pannick et al. 2015[32] and Zhang et al. 2013[40] examined inter- or multidisciplinary interventions to decrease LOS compared with usual care. The interventions assessed in the systematic review by Pannick et al. included an altered team composition that required additional specialists (e.g., psychiatry, stroke) or professionals to provide advice or embedding specialists in rounding teams. The authors also assessed an interdisciplinary intervention addressing team practice, such as the logistics of working together (e.g., location of team members, communication program). In Zhang et al. 2013,[40] the intervention included consultation service and implementation of targeted recommendations, staff education, and/or individual care planning.

Case Management

The systematic review by Huntley et al. 2016[28] assessed case management compared with usual care. The intervention was directed by nurse case managers and included various strategies, such as medication review, family conferencing, education, home environment assessment, or referral to other services.

Hospitalist Services

White et al. 2011[33] assessed hospitalist physician structures that have significantly redesigned delivery of inpatient care over the past 25 years. Comparators included staffing by community-based physicians and traditional academic attending physicians. The hospitalist staffing intervention was evaluated based on assessments of physician performance on quality of care provided.

Telehealth

Baratloo et al. 2018[25] examined telestroke systems that support hospital-based care of patients with stroke by linking healthcare providers at the point of care to clinical expertise outside of a hospital setting. This might be accomplished by telephone, videoconferencing, or teleradiology. These interventions differ from the increasingly widespread telehealth initiatives that support outpatient care.

Setting

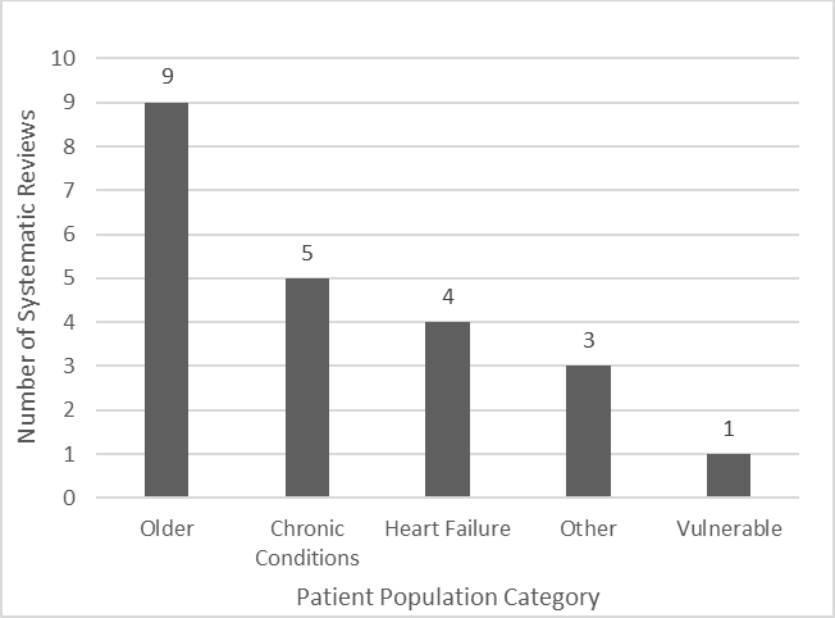
Systematic reviews reported limited information regarding the setting of included studies. Thirteen reviews all described interventions conducted in multiple types of hospitals, including academic medical centers, community hospitals, and less frequently, Veterans Affairs hospitals. One systematic review focused on trauma centers, and six reviews did not report hospital type. Only five reviews reported whether all included studies were conducted in urban, suburban, or rural settings: three included urban and rural hospitals, one was limited to urban settings, and one included only rural hospitals. Few reviews reported hospital bed size or affiliation with a health system. Of the five systematic reviews that indicated a health system affiliation of included studies, only Bryant-Lukosius et al. 2015[35] specified the states in which the health systems operated, which included Pennsylvania and Vermont.

Population

This report's population of interest included medically complex, high-risk, and vulnerable hospitalized children and adults. Only two systematic reviews included pediatric populations, while most included studies with patients at least 60 years of age or older. We organized patient populations into five categories for analysis: older patients (e.g., >60 years), patients with multimorbidity, patients with heart failure, vulnerable patients (e.g., low socioeconomic status), and patients with other conditions (e.g., stroke).

Nine systematic reviews in 10 publications included older patients,[15,26,30,31,35,36,38-41] and four of these focused on frail elderly patients. Five reviews included patients with at least one chronic illness (e.g., diabetes, chronic obstructive pulmonary disease, renal disease, congestive heart failure, psychiatric illness),[12,27,32,33,37] while four other reviews included studies focused exclusively on patients with congestive heart failure.[28,29,34,35] One systematic review included studies with a vulnerable population of high-risk pregnant women.[35] Other populations addressed by the reviews included low-birthweight infants,[35] patients with acute ischemic stroke,[25] and patients prescribed anticoagulants.[24] Figure 4 summarizes the number of systematic reviews examining each patient population category; note that the total number exceeds 19 because 1 review included populations from multiple categories.[35] Evidence tables describing the populations in each systematic review are in Appendix C.

Figure 4. Number of systematic reviews examining each patient population category



Very few reviews addressed nonclinical factors that might be associated with prolonged LOS. Only two systematic reviews provided details about the medical insurance status of included patients.[12,35] Coverage included Medicare, Medicaid, or public health insurance. However, this information was not reported for all included studies in these reviews. Bryant-Lukosius et al. 2015[35] indicated that most patients in the studies they reviewed had an annual income level of less than $20,000, while no other reviews reported patients' socioeconomic status. Gonçalves-Bradley et al. 2016[38] and Huntley et al. 2016[28] included studies with patients whose first language was not English. No reviews addressed populations struggling with homelessness or housing instability, isolation, poverty, or other social determinants of health.

Implementation of Interventions (GQ 2)

Of the 19 systematic reviews identified in our literature search, four reviews examining geriatric assessment or discharge planning provided some level of detail about the implementation process (e.g., location, personnel involved). In the review by Ellis et al. 2017,[36] studies implemented comprehensive geriatric assessment in a dedicated geriatric ward or through the use of a mobile team on a general ward. Van Craen et al. 2010[39] reported that studies admitted patients directly to the geriatric evaluation unit from home, the emergency department, or other hospitals. In addition, patient management teams met at various time points (e.g., daily, weekly). Gonçalves-Bradley et al. 2016[38] indicated that discharge planning interventions were implemented from admission to three days before discharge, and Zhu et al. 2015[12] reported that, at times, hospital staff, family members, caregivers, or volunteers supported by social workers provided support to nurse-led discharge planning. The resources used to support implementation were often not reported. However, several systematic reviews reported the position of the individual(s) either implementing or participating in the intervention's delivery (e.g., physician, nurse, multidisciplinary team).

Effectiveness of Interventions (GQ 3)

Outcomes

All included systematic reviews met our requirement to report LOS. Most reviews also reported readmissions, although the definition varied across reviews (e.g., 30-day readmissions, unscheduled readmissions)[12,15,24,26,28-39] and patient harms, specifically mortality.[12,24-26,29,31-39,41] Similarly, reviews defined mortality measurements inconsistently (e.g., early mortality, mortality at discharge). Ten systematic reviews reported resource use,[12,26-29,33,35-38] six reported patient/family experience,[12,15,30,33-35,38] three reported patient functional return,[26,34,39] and two reported clinician/staff satisfaction.[24,38]

Not all the systematic reviews quantitatively synthesized their results; instead, some presented either a narrative synthesis or data from individual studies. Table 3 summarizes reported outcomes for included systematic reviews according to type of synthesis performed. Interventions are organized alphabetically, and letters indicate the type of synthesis performed for each reported outcome, as follows:

- Q indicates a quantitative synthesis.
- QN indicates the authors conducted a quantitative synthesis and either narratively synthesized some findings or reported individual study data.
- N indicates only a narrative synthesis or reporting of individual study data.
- NR indicates the authors did not report this outcome.

Table 3. Outcomes reported in the systematic reviews

Type of Intervention	Author Year	Population Category	LOS	Patient Functional Return	Readmissions	Patient Harms	Patient/ Family Experience	Clinician/ Staff Satisfaction	Resource Use
Discharge planning	Mabire et al 2017[30] Mabire et al. 2016[15]	Older	Q	NR	Q	NR	NR	NR	NR
Discharge planning	Gonçalves-Bradley et al. 2016[38]	Older	Q	NR	Q	NR	N	N	N
Discharge planning	Bryant-Lukosius et al. 2015[35]	Older, heart failure, vulnerable (high-risk pregnant women), other (infants)	QN	NR	QN	Q	Q	NR	N
Discharge planning	Zhu et al. 2015[12]	Chronic conditions	Q	NR	Q	Q	N	NR	N
Geriatric assessment or consultation	Bakker et al. 2011[26]	Older	N	N	N	N	NR	NR	N
Geriatric assessment or consultation	Eagles et al. 2020[41]	Older	Q	NR	NR	QN	NR	NR	NR
Geriatric assessment or consultation	Ellis et al. 2017[36]	Older	N	NR	NR	Q	NR	NR	NR
Geriatric assessment or consultation	Patel et al. 2020[31]	Older	N	NR	N	N	NR	NR	NR
Geriatric assessment or consultation	Van Craen et al. 2010[39]	Older	Q	Q	Q	Q	NR	NR	NR
Medication management	Austin et al. 2020[24]	Other (prescribed anticoagulants)	N	NR	N	N	NR	N	NR
Medication management	Frazer et al. 2019[37]	Chronic conditions	N	NR	N	N	NR	NR	N
Medication management	Gillaizeau et al. 2013[27]	Chronic conditions	Q	NR	NR	NR	NR	NR	N
Clinical pathways	Agarwal et al. 2018[34]	Heart failure	N	N	N	N	N	NR	NR
Clinical pathways	Kul et al. 2012[29]	Heart failure	Q	NR	Q	Q	NR	NR	N
Inter- or multi-disciplinary care	Pannick et al. 2015[32]	Chronic conditions	Q	NR	Q	Q	NR	NR	NR

Type of Intervention	Author Year	Population Category	LOS	Patient Functional Return	Readmissions	Patient Harms	Patient/ Family Experience	Clinician/ Staff Satisfaction	Resource Use
Inter- or multi-disciplinary care	Zhang et al. 2013[40]	Older	**N**	**NR**	**NR**	**NR**	**NR**	**NR**	**NR**
Case management	Huntley et al. 2016[28]	Heart failure	**Q**	**NR**	**Q**	**NR**	**NR**	**NR**	**N**
Hospitalist service	White et al. 2011[33]	Chronic conditions	**N**	**NR**	**N**	**N**	**N**	**NR**	**N**
Telehealth	Baratloo et al. 2018[25]	Other (stroke)	**Q**	**NR**	**NR**	**Q**	**NR**	**NR**	**NR**

LOS = length of stay; Q = quantitative synthesis; QN = quantitative synthesis and narrative synthesis or results from and individual trial for other outcomes; N = narrative synthesis or results from an individual trial; NR = not reported.

Below, we present effectiveness from SRs providing quantitative synthesis of outcomes of interest (e.g., LOS, readmissions), organized by intervention type. Figure 5 displays a distribution of the number and type of study designs included in the systematic reviews conducting meta-analyses for LOS. The distribution is organized by intervention type.

The main quantitative findings for LOS, readmissions, mortality, and other outcomes are displayed in Figure 6. This evidence map provides an overview of direction of effect, strength of evidence (SOE) for key outcomes, and patient population addressed for each intervention. In the left panel, direction of effect on the outcome of interest is represented by an arrow pointing up (an increase), down (a decrease), or a horizontal arrow (inconclusive). The SOE is represented by letters H, M, and L, specifically: High SOE (H); Moderate SOE (M); Low/Very Low SOE (L). The right panel denotes each SR's patient population.

Further details from findings presented in the evidence map can be found in the Summary of Findings tables (Tables 4 through 7). Subgroup analyses not captured in the evidence map are also listed in the tables. We include tables for LOS (Table 4), readmissions (Table 5), patient harms (Table 6), and other outcomes (Table 7).

Figure 5. Number of randomized controlled trials (RCTs) and non-RCTs in systematic reviews with a quantitative synthesis for length of stay

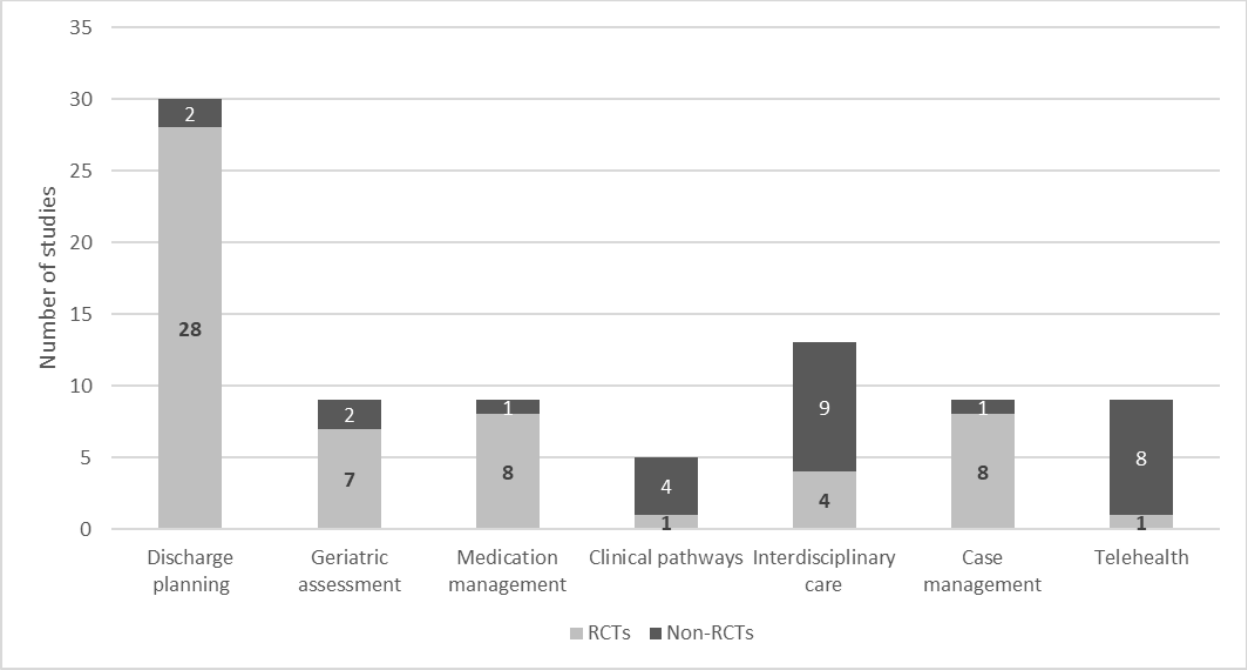


Figure 6. Evidence map for length of stay, readmissions, mortality, and other adverse events

Interventions		Key Outcomes				Patient Population							
		Length of Stay	Readmissions	Mortality	Other AEs	Older	Older (Surgical Patients)	Younger (< 65 Years)	Heart Failure	High-Risk Pregnant Women	Infants	Chronic Conditions	Other
Discharge Planning	***Mabire 2017, 2016***	↑L	↓M			√							
	Mabire 2017, 2016 *(transitional care)*		↔L			√							
	Goncalves-Bradley 2016	↓M	↓M			√							
	Goncalves-Bradley 2016	↔L					√						
	Bryant-Lukosius 2015	↔L		↔L		√							
	Bryant-Lukosius 2015	↓M								√			
	Bryant-Lukosius 2015		↔L	↔L					√				
	Bryant-Lukosius 2015		↔L								√		√
	Zhu 2015	↔M	↓M	↓H								√	
	Zhu 2015		↓M					√					
Geriatric Assessment	***Eagles 2020***	↓M		↓M		√							
	Ellis 2017			↔H		√							
	Van Craen 2010	↔H	↔M	↔H		√							
Medication Management	***Gillaizeau 2013***	↔L										√	
Clinical Pathways	***Kul 2012***	↓L	↓M	↓M					√				
Interdisciplinary Care	***Pannick 2015*** *(altering team composition)*	↔M	↑L	↔M								√	
	Pannick 2015 *(altering team practice)*	↔M	↔L	↓M									NR
Case Management	***Huntley 2016***	↓M	↓M						√				
Telehealth	***Baratloo 2018***	↓M		↔M	↔M								√

AE = adverse events; NR = not reported

Direction of Effect: (arrow direction)
- ↑ Increase
- ↓ Decrease
- ↔ Inconclusive

Strength of Evidence: (superscript letter)
- H High
- M Moderate
- L Low/Very low

Table 4. Summary of findings for length of stay meta-analyses

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Discharge planning	Mabire et al. 2017[15,30]	Nursing discharge planning interventions vs. usual care	Older patients with or without comorbidities	4 RCTs, 1 pre-post, and 1 cohort (3 of 6 US) (n=2,370)	WMD: 0.29 days, 95% CI: 0.24 to 0.35, I^2=0%, intervention increases LOS	Low
Discharge planning	Goncalves-Bradley et al. 2016[38]	Discharge planning vs. usual care	Older patients with a medical condition	12 RCTs (6 of 12 US) (n=2,193)	MD: -0.73 days, 95% CI: -1.33 to -0.12, I^2=9.44%, favors intervention	Moderate
Discharge planning	Goncalves-Bradley et al. 2016[38]	Discharge planning vs. usual care	Older surgical patients	2 RCTs (1 of 2 US) (n=184)	MD: -0.06, 95% CI: -1.23 to 1.11, I^2=0%, no difference	Very Low
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	Elderly hospitalized patients	3 US RCTs (n=396)	MD: -0.69 days, 95% CI: -1.95 to 0.56, p=0.28, no difference	Low
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	High-risk pregnant women	2 US RCTs (n=215)	MD: -1.19 days, 95% CI: -1.55 to -0.83, p <0.00001, favors intervention (reduces maternal postpartum LOS)	Moderate
Discharge planning	Zhu et al. 2015[12]	Nurse-led early discharge planning vs. usual care	Mix includes older patients, decompensated heart failure, hip fracture, rehab, congestive heart disease, hospitalized psychiatric patients	5 RCTs (4 of 5 US) (n=1,912)	SMD: 0.03, 95% CI: -0.06 to 0.12, p=0.540, I^2=0%, no difference in LOS	Moderate
Geriatric assessment	Eagles et al. 2020[41]	Geriatric trauma consultation vs. usual trauma care	Older adults admitted to trauma center	2 US retrospective cohort studies (n=5,414)	MD: -1.11 days, 95% CI: -1.43 to -0.79, I^2=0%, favors intervention	Moderate
Geriatric assessment	Van Craen et al. 2010[39]	Geriatric evaluation unit vs. usual care	Frail elderly	7 RCTs (n=4,759)	Mean reduction measured by Hedges g 0.07 days, 95% CI: -0.11 to 0.26, no difference	High*
Medication management	Gillaizeau et al. 2013[27]	Computerized decision support vs. usual care	Mix includes diabetes, COPD, renal disease, etc.	8 RCTs and 1 observational study (n=18,507)	SMD: -0.15, 95% CI: -0.33 to 0.02, I^2=57%, no difference in reduction of LOS, but leans toward favoring intervention	Very Low*

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Clinical pathways	Kul et al. 2012[29]	Clinical pathways vs. usual care	Congestive heart failure	1 RCT and 4 observational studies (n=2,095)	Mean reduction: 1.89 days, 95% CI: 1.33 to 2.44, I^2=42%, favors intervention	Low*
Interdisciplinary care	Pannick et al. 2015[32]	Altering interdisciplinary team composition vs. usual care	Mixed patient population – geriatric, liver transplant, psychiatric, delirium, infectious diseases	2 RCTs, 2 non-RCT cluster studies, 2 before/after studies (4 of 6 US) (n=NR)	WMD: 0.087 days, 95% CI: −0.083 to 0.257, no difference	Low*
Interdisciplinary care	Pannick et al. 2015[32]	Altering interdisciplinary team practice vs. usual care	Most studies did not specify patient population, 1 study include geriatric patients and 1 study's setting VA hospital	2 cluster RCTs, 3 non RCT cluster studies, 2 interrupted time series (6 of 7 US) (n=NR)	WMD: 0.001 days, 95% CI: −0.035 to 0.037, no difference	Low*
Case management	Huntley et al. 2016[28]	Case management vs. usual care	Congestive heart failure	8 RCTs and 1 observational study (n=1,765)	Mean reduction: 1.28 days, 95% CI: 0.52 to 2.04, I^2=63%, favors intervention Subgroup analysis, excluding studies at high risk of bias: Mean reduction: 1.76 days, 95% CI: 1.23 to 2.29, I^2=14%, favors intervention	Moderate*
Telehealth	Baratloo et al. 2018[25]	Telestroke-based systems vs. bedside (face-to-face)	Tissue plasminogen activator treated patients with acute ischemic stroke	6 retrospective controlled studies, 2 prospective controlled studies, 1 RCT (6 of 9 US) (n=2,850)	MD: -0.55 days, 95% CI: -1.02 to -0.07, p=0.02, I^2=38%, favors intervention	Low*

LOS = length of stay; CI = confidence interval; COPD = chronic obstructive pulmonary disease; MD = mean difference; NR = not reported; OR = odds ratio; RCT = randomized controlled trial; RR = risk ratio; US = United States; VA = Veteran Affairs; WMD = weighted mean difference

*Authors of systematic reviews did not assess the strength of evidence for this outcome. Strength of evidence rating is based on guidance from Berkman et al. 2013.[23]

Table 5. Summary of findings for readmissions meta-analyses

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Discharge planning	Mabire et al. 2017[15,30]	Nursing discharge planning interventions vs. usual care	Older patients with or without comorbidities	3 US RCTs/pre-post studies (n=465)	OR: 0.57, 95% CI: 0.40 to 0.81, p=0.01, I^2=0%, favors intervention	Moderate*
Discharge planning	Mabire et al. 2017[15,30]	Nursing discharge planning intervention (transitional care) vs. usual care	Older patients with or without comorbidities	4 RCTs (3 of 4 US) (n=1,030)	OR: 0.70, 95% CI: 0.38 to 1.27, I^2=69.2%, no difference	Low*
Discharge planning	Gonçalves-Bradley et al. 2016[38]	Discharge planning vs. standard care	Older patients with a medical condition	15 RCTs (9 of 15 US) (n=4,743)	Unscheduled readmission within 3 months: RR: 0.87, 95% CI: 0.79 to 0.97, I^2=28.26%, favors intervention	Moderate
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	Patients with heart failure	2 US RCTs (n=495)	Re-hospitalization more than once for any reason at 90 days and 52 weeks: RR: 0.81, 95% CI: 0.57 to 1.13, p=0.21, no difference	Low
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	Infants	2 US RCTs (n=202)	Rehospitalizations at 2- and 8-weeks postdischarge: RR: 0.56, 95% CI: 0.21 to 1.44, p=0.23, no difference	Low
Discharge planning	Zhu et al. 2015[12]	Nurse-led early discharge planning vs. usual care	Mix includes older patients, decompensated heart failure, hip fracture, rehab, congestive heart disease, hospitalized psychiatric patients	10 RCTs (5 of 10 US) (n=3,376)	RR: 0.72, 95% CI: 0.58 to 0.89, p=0.002, I^2=66%, favors intervention	Moderate
Discharge planning	Zhu et al. 2015[12]	Nurse-led early discharge planning vs. usual care	Non-older adults (<65 years)	2 US RCTs (n=768)	RR: 0.69, 95% CI: 0.51 to 0.92, p=0.010, I^2=0%, favors intervention	Moderate
Discharge planning	Zhu et al. 2015[12]	Nurse-led early discharge planning vs. usual care	Mix includes older patients, decompensated heart failure, hip fracture, rehab, congestive heart disease, hospitalized psychiatric patients	3 RCTs (2 of 3 US) (n=2,013)	Readmissions at 1 month: RR: 0.73, 95% CI: 0.46 to 1.15, p=0.170, I^2=75%, no difference	Moderate

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Discharge planning	Zhu et al. 2015[12]	Nurse-led early discharge planning vs. usual care	Mix includes older patients, decompensated heart failure, hip fracture, rehab, congestive heart disease, hospitalized psychiatric patients	2 US RCTs (n=393)	Readmissions at 6 months: RR: 0.48, 95% CI: 0.37 to 0.63, p<0.001, I^2=0%, favors intervention	Moderate
Geriatric assessment	Van Craen et al. 2010[39]	Geriatric evaluation unit vs. usual care	Frail elderly	2 RCTs (n=668)	RR: 0.85, 95% CI: 0.65 to 1.11, no difference	Moderate*
Clinical pathways	Kul et al. 2012[29]	Clinical pathways vs. usual care	Congestive heart failure	2 RCTs and 3 observational studies (n=3,006)	RR: 0.81, 95% CI: 0.66 to 0.99, I^2=16%, favors intervention	Moderate*
Interdisciplinary care	Pannick et al. 2015[32]	Altering interdisciplinary team composition vs. usual care	Mixed patient population – infectious diseases, pneumonia, or not specified	2 cluster RCTs, 1 non-RCT (all US) (n=NR)	Early readmissions: RR: 1.341, 95% CI: 1.120 to 1.607, intervention tended to increase early readmissions (authors noted there were important confounding factors, factors not specified)	Low*
Interdisciplinary care	Pannick et al. 2015[32]	Altering interdisciplinary team practice vs. usual care	Mixed patient population – geriatric, VA hospital, or not specified	2 non-RCT cluster studies, 2 interrupted time series, 1 before/ after study (all US) (n=NR)	Early readmissions: RR: 0.995, 95% CI: 0.912 to 1.085, no difference	Low*
Case management	Huntley et al. 2016[28]	Case management vs. usual care	Congestive heart failure	12 RCTs and 1 observation study (n=3,346)	RR: 0.74, 95% CI: 0.60 to 0.92, I^2=69%, favors intervention Subgroup analysis, excluding studies at high risk of bias RR: 0.77, 95% CI: 0.61 to 0.96, I^2=68%, favors intervention	Moderate*

CI = confidence interval; MD = mean difference; NR = not reported; OR = odds ratio; RCT = randomized controlled trial; RR = risk ratio; US = United States; VA = Veteran Affairs; WMD = weighted mean difference

*Authors of systematic reviews did not assess the strength of evidence for this outcome. Strength of evidence rating is based on guidance from Berkman et al. 2013[23]

Table 6. Summary of findings for patient harms meta-analyses

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	Patients with heart failure	2 RCTs (1 of 2 US) (n=345)	Mortality at 6 months and 52 weeks of followup RR: 0.76, 95% CI: 0.41 to 1.42, p=0.40, no difference	Low
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	Elderly hospitalized patients	2 US RCTs (n=443)	Mortality during index hospitalization and 6- and 8-weeks postdischarge RR: 1.05, 95% CI: 0.48 to 2.28, p=0.90, no difference	Low
Discharge planning	Zhu et al. 2015[12]	Nurse-led early discharge planning vs. usual care	Mix includes older patients, decompensated heart failure, hip fracture, rehab, congestive heart disease, hospitalized psychiatric patients	5 RCTs (3 of 5 US) (n=2,729)	All-cause mortality (index admission to within 30 days) RR: 0.70, 95% CI: 0.52 to 0.95, p=0.020, I^2=0%, favors intervention	High
Geriatric assessment	Eagles et al. 2020[41]	Geriatric trauma consultation (GTC) vs. standard trauma care	Older adults admitted to trauma center	6 retrospective cohort studies (5 of 6 US) (n=7,408)	In-hospital mortality after vs. before implementation of GTC service Unadjusted OR: 0.91, 95% CI: 0.70 to 1.18, I^2=18%, no difference	Moderate
Geriatric assessment	Eagles et al. 2020[41]	GTC vs. standard trauma care	Older adults admitted to trauma center	2 US retrospective cohort studies (n=482)	In-hospital mortality with GTC vs. without GTC Unadjusted OR: 0.24, 95% CI: 0.12 to 0.52, I^2=0%, favors intervention	Moderate
Geriatric assessment	Ellis et al. 2017[36]	Comprehensive geriatric assessment vs. usual care	Frail or at-risk/older patients	11 RCTs (7 of 11 US) (n=4346)	Mortality at discharge RR: 1.04, 95% CI: 0.82 to 1.32, I^2=16%, no difference	High
Geriatric assessment	Ellis et al. 2017[36]	Comprehensive geriatric assessment vs. usual care	Frail or at-risk/older patients	21 RCTs (12 of 21 US) (n=10,023)	Mortality at 3- to 12-month followup RR: 1.00, 95% CI: 0.93 to 1.07, I^2=0%, no difference	High
Geriatric assessment	Van Craen et al. 2010[39]	Geriatric evaluation unit vs. usual care	Frail elderly	6 RCTs (n=4,108)	Mortality at 12 months RR: 0.97, 95% CI: 0.88 to 1.08, no difference	High*

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Clinical pathways	Kul et al. 2012[29]	Clinical pathways vs. usual care	Congestive heart failure	3 RCTs and 2 observational studies (n=2,343)	Hospital mortality RR: 0.45, 95% CI: 0.21 to 0.94, I^2=73%, favors intervention	Low*
Interdisciplinary care	Pannick et al. 2015[32]	Altering interdisciplinary team composition vs. usual care	Mixed patient population – delirium, infectious diseases	4 cluster RCTs, 2 non-RCTs, 1 RCT (4 of 7 US) (n=NR)	Early mortality RR: 0.925, 95% CI: 0.816 to 1.049, no difference	Low*
Interdisciplinary care	Pannick et al. 2015[32]	Altering interdisciplinary team practice vs. usual care	Population not specified	2 non-RCT cluster studies (1 of 2 US) (n=NR)	Early mortality RR: 0.665, 95% CI: 0.449 to 0.986, intervention tended to reduce early mortality	Low*
Telehealth	Baratloo et al. 2018[25]	Telestroke-based systems vs. bedside (face-to-face)	Tissue plasminogen activator-treated patients with acute ischemic stroke	15 retrospective controlled: studies, 2 prospective controlled studies, 1 RCT (10 of 18 US) (n=4,907)	In-hospital mortality OR: 1.21, 95% CI: 0.98 to 1.49, p=0.08, I^2=0%, no difference	Low*
Telehealth	Baratloo et al. 2018[25]	Telestroke-based systems vs. bedside (face-to-face)	Tissue plasminogen activator-treated patients with acute ischemic stroke	14 retrospective controlled studies, 6 prospective controlled studies, 1 RCT (10 of 21 US) (n=4,022)	Symptomatic intracranial Hemorrhage OR: 1.10, 95% CI: 0.79 to 1.53, p=0.58, I^2=0%, no difference	Low*

CI = confidence interval; NR = not reported; OR = odds ratio; RCT = randomized controlled trial; RR = risk ratio; US = United States

*Authors of systematic reviews did not assess the strength of evidence for this outcome. Strength of evidence rating is based on guidance from Berkman et al. 2013.[23]

Table 7. Summary of findings for patient functional return and patient/family experience meta-analyses

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	Patients with heart failure	2 US RCTs (n=403)	Patient satisfaction with care at 4 and 6 weeks MD: 6.09, 95 % CI: 3.55 to 8.63, p <0.00001, favors intervention	Moderate
Discharge planning	Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care vs. usual care	High-risk pregnant women	2 US RCTs (n=218)	Maternal satisfaction with care at discharge and 8-weeks postpartum MD: 18.15, 95% CI: 11.9 to 24.4, p <0.00001, favors intervention (authors noted considerable heterogeneity for this outcome)	Low
Geriatric assessment	Van Craen et al. 2010[39]	Geriatric evaluation unit vs. usual care	Frail elderly	2 RCTs (n=2,182)	Functional decline at discharge RR: 0.87, 95% CI: 0.77 to 0.99, favors intervention	High*
Geriatric assessment	Van Craen et al. 2010[39]	Geriatric evaluation unit vs. usual care	Frail elderly	2 RCTs (n=1,654)	Functional decline at 12 months RR: 0.84, 95% CI: 0.69 to 1.03, no difference	Moderate

CI = confidence interval; MD = mean difference; OR = odds ratio; RCT = randomized controlled trial; RR = risk ratio; US = United States

*Authors of systematic reviews did not assess the strength of evidence for this outcome. Strength of evidence rating is based on guidance from Berkman et al. 2013.[23]

Below, we describe reported outcomes for each intervention (e.g., discharge planning). Systematic review authors may have decided against conducting meta-analysis for various reasons, such as limited data reported by the primary studies or heterogeneity across studies, such as differences in patient populations or components of the intervention. If an intervention category held findings that the authors summarized narratively or reported individual trial data (e.g., hospitalist services), we included this information in the summary below. Furthermore, some authors did not assess the SOE for the quantitative findings of a given outcome. Therefore, we used AHRQ Evidence-based Practice Center guidance[23] to assess the SOE for these outcomes.

Discharge Planning

Four systematic reviews in five publications assessed discharge planning. All the reviews included older adults; one review also included high-risk pregnant woman and low-birthweight infants, while another review also included patients with chronic illnesses and psychiatric comorbidities. Results for older patients were inconsistent. One review found a reduction in LOS for older patients with comorbidity, based on 12 RCTs (SOE: Moderate), but no difference for older patients undergoing surgery based on 2 RCTs (SOE: Very Low).[38] Another review found no difference in LOS for older patients based on three RCTs (SOE: Low),[35] while an additional review reported that LOS increased for older patients, based on four RCTs and two observational studies (SOE: Low).[15,30] A review that combined results for older adults, patients with chronic disease, and patients with psychiatric illness found no difference in LOS based on five RCTs (SOE: Moderate).[12] Finally, one review found a reduction in LOS in high-risk pregnant women based on two RCTs (SOE: Moderate) and in very-low-birthweight infants based on one RCT (SOE: Low).[35]

These four systematic reviews also examined readmissions but measured the outcome differently, such as unscheduled readmissions within 3 months or rehospitalization more than once for any reason at a given time point. Three systematic reviews in four publications found that discharge planning decreased readmissions in older adults and patients with a mixture of conditions (SOE: Moderate).[12,15,30,38] However, there was substantial heterogeneity within reviews, and some of the findings from subgroup analyses suggested no difference in readmission. A fourth review[35] indicated no difference in readmissions in patients with heart failure based on two RCTs (SOE: Low) or infants (2 RCTs, SOE: Low). In addition, the authors reported no difference between discharge planning and usual care for high-risk pregnant women, although this was based on one small RCT (SOE: Low).

Two systematic reviews reported on mortality. One review reported a lower risk of all-cause mortality within 30 days of admission in a combination of older adults and patients with chronic disease or psychiatric illness, based on 5 RCTs in the discharge planning intervention groups (SOE: High).[12] Conversely, Bryant-Lukosius et al. 2015[35] found no difference in mortality at 6 months or 1 year for patients with heart failure based on two RCTs (SOE: Low), and no difference at 6- and 8-weeks postdischarge in older patients, based on two RCTs (SOE: Low).

Two reviews examined patient satisfaction. One review found that patients with heart failure had better satisfaction with care at 4 and 6 weeks in the intervention group, based on two RCTs (SOE: Moderate).[35] Furthermore, the findings suggest that high-risk pregnant women in the discharge planning group were more satisfied with care at discharge and 8-weeks postpartum, based on two RCTs (SOE: Low). Gonçalves-Bradley et al. 2016[38] reported that discharge planning "may lead to increased satisfaction for patients and healthcare professionals. However,

satisfaction was measured in different ways and findings were inconsistent across six studies (SOE: Low)."

Lastly, two reviews addressed resource use. One reported that none of the studies included in their review assessed costs and outcomes jointly, but "there was no instance when resource use or costs were higher with the clinical nurse specialists care but there were instances when the intervention reduced resource use and costs, despite the [fact that the intervention] was an add-on cost."[35] In the other review,[38] the authors indicated that lower direct hospital costs or charges costs may be associated with a reduction in readmissions, based on five studies (SOE: Very Low).

Geriatric Assessment

Four systematic reviews that examined geriatric assessment reported LOS. Two of the reviews performed meta-analyses, while the other two synthesized their findings qualitatively, and results were mixed across the systematic reviews. Eagles et al. 2020[41] found a reduction in LOS in older adults based on two observational studies (SOE: Moderate).[41] In comparison, Van Craen et al. 2010[39] suggested no difference in LOS in a frail elderly population based on seven RCTs (SOE: High). Of note, the interventions assessed by Van Craen et al. appeared to be more comprehensive and often included several components, such as assessment of medical, functional, nutritional, cognitive and psychiatric status, social situation, and quality of life. Bakker et al.[26] evaluated six studies of older patients and found that three studies reported no difference in LOS, while three studies did not provide a statistical analysis of results. Finally, Patel et al. 2020[31] described 10 studies showing a reduction in LOS in older patients but also found two studies that reported no difference and one study that found an increase in LOS.

Three systematic reviews evaluated readmissions, but only one performed meta-analyses. Van Craen et al. 2010[39] found no difference in readmission risk in a frail and elderly population based on two RCTs (SOE: Moderate). Bakker et al. 2011[26] assessed two studies of older patients and reported that one study found a reduction in readmissions while the other did not provide a statistical analysis of the results.[26] Patel et al. 2020[31] reported that three studies showed no difference in readmission rates, one study found a decrease in readmission rates, and one study found an increase in readmission rates.

Five systematic reviews reported on mortality. Eagles et al. 2020[41] found patients admitted to a trauma center that received a geriatric consultation had a decreased risk of in-hospital mortality compared with those receiving standard trauma care, based on two observational studies (SOE: Moderate). Conversely, this review also analyzed six other observational studies in trauma center patients and found no difference in mortality (SOE: Moderate). The findings from Ellis et al. 2017[36] suggested no difference between comprehensive geriatric assessment and usual care in the risk of mortality at discharge (11 RCTs, SOE: High) or at 3 to 12 months after discharge (21 RCTs, SOE: High). Van Craen et al. 2010[39] suggested there is no difference in mortality risk at 12 months, based on 6 RCTs (SOE: High).

Two systematic reviews did not conduct a meta-analysis.[26,31] Bakker et al. 2011[26] identified 1 study with 197 patients that found no difference in mortality between specialized geriatric teams or units and usual care. Patel et al. 2020[31] reported that 5 studies showed a decrease in postoperative mortality rates, while 11 studies showed no difference in surgical patients receiving geriatric assessment.

Two systematic reviews examined patient functional return. One review[39] suggested a lower risk of functional decline at discharge in frail elderly patients based on two RCTs (SOE: High).

However, at 12 months, the effect was no longer observed (SOE: Moderate). Another review[26] assessed patient functional return using multiple measures in four studies. Most functional measures found no difference in older patients, but one study favored the intervention using the Self Rating Depression Scale, and one study favored the intervention using the Mini-Mental State Examination.[42]

Finally, only one study within one review addressed resource use.[26] The study found no difference in cost between geriatric specialty teams and usual care.

Medication Management

Two systematic reviews examined strategies for managing anticoagulant prescribing compared with usual care.[24,37] One review assessed CPOE systems and CDSS and found no difference in LOS or 30-day readmission, based mainly on observational studies.[24] Another review found that anticoagulation consultation services had no effect on LOS but were associated with reduced readmissions, while decision-supported dosing was associated with reduced LOS in one RCT.[37]

Anticoagulant medication management was associated with reduced 90-day mortality in 1 large observational study but no difference in 3 smaller studies in the same review.[24] The other review also found no effect on mortality.[37] One review viewed medication management as having a positive effect on patient safety.[24]

A systematic review of eight RCTs and one observational study examined computerized decision support for drug dosing in patients with chronic illnesses, such as diabetes, chronic kidney disease, and chronic obstructive pulmonary disease (COPD)[27] The authors found no difference in LOS reduction, although the findings leaned toward favoring the intervention (SOE: Very Low).

Clinical Pathways

Two systematic reviews examined clinical pathways for patients with congestive heart failure. One review[29] found that pathways reduced LOS, based on one RCT and four observational studies (SOE: Low) and reduced readmissions, based on two RCTs and three observational studies (SOE: Moderate). Mortality was also reduced in the clinical pathways group, based on three RCTs and two observational studies (SOE: Low). This review found no difference in costs between groups.

Another systematic review[34] found a decrease in LOS when implementing a clinical pathway along with other quality-improvement initiatives, based on a single but large RCT with 2,906 patients. Readmissions within 90 days of discharge decreased in 2 of 3 studies included in this review, while the remaining study found no difference. No difference was observed in mortality in three studies reporting this outcome. Finally, one RCT reported improved quality of life, while two RCTs found no difference.

Interdisciplinary Care

Two systematic reviews evaluated models of interdisciplinary care. One review[32] included studies that assessed either the composition of care teams or the processes they used to provide care; high-risk populations were included, such as patients with psychiatric illness and geriatric patients. No difference in LOS was reported (SOE: Low). The authors found that altering the composition of interdisciplinary teams tended to increase the readmission risk (SOE: Low) but had no effect on mortality (SOE: Low), while changes to team processes were not associated

with changes in readmissions (SOE: Low) but may be associated with reduction in mortality (SOE: Low).

Another systematic review[40] examined multicomponent interventions that included team-based approaches as well as staff education, individual care planning, and other strategies. Meta-analysis was not performed, and results were not consistent across studies.

Case Management

Case management in patients with congestive heart failure was examined in a systematic review of eight RCTs and one observational study.[28] Case management reduced LOS (SOE: Moderate) and suggested a lower readmission risk (SOE: Moderate). The authors also described direct hospital costs and cost-effectiveness reported in the primary studies but did not perform a meta-analysis of these data. One study found that direct hospital costs were reduced; however, limited details were provided. Another study found that case management saved a hospital $225 in direct costs associated with caring for each Medicare patient. A third study reported that the overall net savings after 18 months of implementing the intervention across 3 hospitals totaled $1.6 million, primarily due to reduced hospital days. Six studies found no difference in direct hospital costs, charges, or cost-effectiveness measures between case management and usual care.

Hospitalist Services

One systematic review[33] examined hospitalist services compared with traditional attending physician structures in patients with chronic conditions, such as heart failure, COPD, psychiatric illness, and substance use disorder. The authors reported that the intervention was associated with LOS reduction in 40 studies, while 13 studies found no difference and 5 studies found that LOS increased in the hospitalist groups. Six studies found that hospitalists were associated with a reduction in readmissions, but 34 studies found no difference and 3 studies found that readmissions increased. Eight studies found a reduction in mortality associated with hospitalists, while 29 studies found no difference. Two studies reported a reduction in complications, while 5 found no difference, and 1 study reported that complications increased. Patient satisfaction improved in one study but yielded no difference in seven studies. Finally, 30 studies found that hospitalist services reduced costs or charges, while 10 studies found no difference, and 3 studies reported higher costs or charges.

Telehealth

One systematic review compared telestroke-based systems with bedside (face-to-face) care.[25] The authors found reduced LOS in patients with acute ischemic stroke treated with tissue plasminogen activator, based on one RCT and eight observational studies (SOE: Low). No difference in mortality risk was reported, based on 1 RCT and 17 observational studies (SOE: Low), and evidence from 1 RCT and 20 observational studies indicated there was no difference in symptomatic intracranial hemorrhage (SOE: Low).

Evidence Gaps and Challenges (GQ 4)

This Technical Brief was designed to focus on structural interventions that health systems can implement broadly across departments or entities, rather than strategies that solely reflect point-of-care clinical decision-making. Moreover, we narrowed our scope to include only patients who require both acute and immediate medical care and populations that may present

substantial challenges to timely discharge. These patients may have complex and comorbid medical conditions and might face significant social or economic barriers to achieving safe and effective recovery. We also limited our search to systematic reviews that meet a minimal quality standard and include primary studies of which at least a majority were conducted in the United States. These limits on our scope resulted in 19 systematic reviews that addressed our GQs out of over 4,000 studies screened by our searches. Many of the excluded reviews met at least one, but not all, of our inclusion criteria.

To understand the most important gaps in the evidence base, it is useful to examine why such a large body of research – most of which evaluates interventions to reduce hospital LOS – did not satisfy all of our criteria for inclusion. The next five sections discuss the pertinent reasons.

Research Gaps: Interventions

The most common reason we excluded systematic reviews was failure to assess structural interventions that could be implemented at a system level. Many hundreds of reviews focused on one type of medication's effectiveness compared with that of another, such as various anesthesia regimens or analgesic drugs to improve patient recovery times and thus reduce LOS. While these studies are important, they address issues that are fundamentally clinical rather than structural and are generally managed by hospital formulary committees, clinical departments, and individual physicians.

We also excluded 268 reviews of laparoscopic and/or robot-assisted surgical techniques. These reviews often focused on the potential for minimally invasive or robotic surgery to accelerate time to hospital discharge, and such interventions may contribute substantially to reduced LOS. However, they were beyond this Technical Brief's scope.

Another common strategy designed largely to reduce LOS is a bundle of surgical processes often referred to as enhanced recovery programs (ERP) or enhanced recovery after surgery (ERAS®). Our searches identified 123 articles that examined ERP protocols; however, we found this literature base consisted mainly of elective abdominal or orthopedic surgical procedures, or surgical treatment for cancer, and did not include our populations of interest. Additionally, numerous articles were narrative reviews or brief summaries of ERPs rather than systematic reviews. We did not identify any systematic reviews of ERPs applied to medically complex, high-risk, or otherwise vulnerable patients.

In contrast to the large body of work published on ERPs, we also sought to assess the smaller but evolving evidence base on patient mobility programs. These strategies aim to encourage patient ambulation early during a hospitalization to prevent loss of muscle tone and reduce risk of pressure ulcers, blood clots, and other adverse events. We identified five reviews of mobility programs, but they were mainly limited to studies of patients without chronic or complex illness. None of the reviews met all of our inclusion criteria.

We also excluded more than 100 reviews that examined interventions similar or identical to those included in the evidence maps, tables, and figures under GQ 1, 2, and 3. For example, we excluded 30 reviews of discharge planning, 24 reviews of clinical pathways, and 18 reviews of interdisciplinary teams. We also excluded 13 reviews of geriatric assessment programs, 10 reviews of case management, 8 reviews of decision support tools, and 6 reviews of medication management. We excluded these reviews because they did not involve a relevant patient population, did not report LOS, were conducted in an excluded setting such as the emergency department, or did not consist mainly of studies based in the United States.

Research Gaps: Patient Populations

We found two primary challenges in evaluating the evidence base for reducing LOS in the patient populations of interest. First, many reviews that focused on our included populations were nevertheless excluded due to the intervention type, setting, or research design. We identified 101 reviews of patients with congestive heart failure, 83 reviews of patients over age 60, 71 reviews of patients with diabetes, 67 reviews of patients with COPD, and 19 reviews of patients with chronic kidney disease. We did not include these reviews because they focused on nonstructural interventions, were conducted in outpatient or specialized inpatient settings (such as intensive care units), or lacked sufficient methodologic rigor.

The second main challenge presented by the current state of evidence is the almost complete lack of research focused on patients who face severe social or economic barriers to achieving and maintaining wellness before, during, and after hospitalization. Our searches identified no reviews– regardless of whether they were included or excluded from our analysis – that explicitly limited the population to patients enduring housing instability or food insecurity, discrimination or isolation, language or cultural barriers, or other challenges that increase vulnerability and risk.

We did, however, find many reviews relied wholly or in large part on studies conducted outside the United States. We excluded 119 reviews because at least half their primary studies were not based in the United States. This highlights the need for additional funding of both primary research and evidence synthesis that is applicable to the unique characteristics of U.S. healthcare delivery.

Finally, we note that only two reviews addressed pediatric populations. While children are much less likely to fit into the complex or chronic illness categories we have highlighted, they are unfortunately susceptible to many sources of social and economic vulnerability. Little is known about how health systems can address those unique challenges.

Research Gaps: Hospital Settings

This review was limited to interventions in general hospital settings. We excluded studies focused on emergency departments, intensive care units, specialty hospitals (e.g., psychiatric, rehabilitation), and outpatient, community, and home-based care. This resulted in exclusion of 200 systematic reviews. Of these, 123 interventions were based in intensive care settings, while 51 were in the emergency department and did not report on hospital LOS. This suggests strong interest in designing interventions to improve patient flow through the bottleneck of the emergency department and resource-intense critical care units, but further research is needed on interventions that affect the entire hospitalization and subsequent LOS rather than solely emergency department LOS or intensive care unit LOS.

Additionally, an inherent limitation of using systematic reviews in this Technical Brief is our limited ability to describe in detail the local hospital settings where initiatives to reduce LOS have been implemented. Reviews rarely reported demographic data on patient volume, bed size, or payer mix. We did not examine the primary studies to determine whether they occurred in urban, suburban, or rural regions or whether hospitals were part of a large integrated care network or were a standalone safety-net facility. Inclusion of these factors in future systematic reviews would provide valuable context for learning health systems seeking to adopt new interventions.

Research Gaps: Implementation Context

The lack of detail regarding hospital settings is mirrored by the dearth of information about how interventions were implemented. We sought to describe key contextual factors specific to the interventions, such as resource allocation, staffing needs, role of leadership, organizational culture, sustainability, and assessment of progress. However, the systematic reviews generally lacked a description of these factors, aside from several reviews that identified the core personnel responsible for implementation (e.g., nurses, case managers). It is unclear whether these types of details were absent from the primary studies or if they were reported initially but later excluded from the systematic reviews. Future research on hospital-based interventions should aim to provide sufficient operational context to enable other hospitals to reach informed conclusions about implementation.

Research Gaps: Study Design

This Technical Brief was limited at the outset to identifying and evaluating systematic reviews rather than primary studies, but we found that many potential articles were not rigorous systematic reviews. We excluded 372 articles that were narrative reviews, reported only on uncontrolled trials, or did not assess the quality or risk of bias of included primary studies. Future efforts to synthesize this evidence base with well-designed systematic reviews would serve an important need for health system leaders.

We also found that surprisingly many primary studies informing systematic reviews were conducted outside the United States. We excluded 114 reviews because at least half of the studies they assessed were not based in the United States. Moreover, most of the reviews we included featured studies from both U.S.- and non-U.S.-based hospitals. Therefore, despite the overall breadth of the published literature, a need remains for additional primary research on interventions to reduce hospital LOS specific to the United States.

Summary and Implications

In this report, we summarize evidence from systematic reviews (SRs) assessing structural interventions that health systems can implement broadly for medically complex, high-risk, or vulnerable patients requiring acute medical care. We identified 19 systematic reviews in 20 articles that assessed 8 interventions: discharge planning, geriatric assessment or consultation, medication management, clinical pathways, inter- or multidisciplinary care, case management, hospitalist services, and telehealth.[12,15,24-41] Interventions primarily assessed older patients (i.e., > 60 years of age) or patients with chronic conditions. Limited evidence was identified for vulnerable populations, and no SRs addressed key vulnerable populations, such as underinsured, uninsured, patients experiencing homelessness, those with low socioeconomic status, or those with psychiatric comorbidities.

Frequently Studied Interventions

Identifying a broad system-level intervention or approach to reduce length of stay (LOS) is of interest to most hospitals and health systems. Geriatric assessment and discharge planning were the most frequently reported interventions in our evidence base. Five systematic reviews examined geriatric assessment, and this intervention often included a patient management consultation by a geriatrician or multidisciplinary healthcare team to assess needs, develop or review treatment plans, set goals, and/or develop postdischarge plans. Four systematic reviews assessed discharge planning, and this intervention was often nurse-led and included an initial assessment and plan for in-hospital care, patient education, and a plan for postdischarge care and followup (e.g., phone calls, home visits, outpatient appointments).

Challenging Patient Populations

All hospitals face the perennial challenge of providing high-quality care for medically complex and vulnerable populations, ideally without incurring significant costs or penalties due to unnecessarily prolonged LOS. These patients are typically at greater risk for adverse events during and after hospitalization.[22] This report identified only limited information on systematic interventions that address these challenging populations. Most reviews focused on nonsystematic interventions. Only two systematic reviews included pediatric populations,[33,35] while most included studies with patients at least 60 years of age or older. Our searches identified a large volume of reviews conducting research in medically complex patient populations (e.g., chronic obstructive pulmonary disease [COPD], diabetes). We identified very few reviews that addressed nonclinical factors, such as socioeconomic status, that might be associated with prolonged LOS. Only two systematic reviews provided details about the medical insurance status of included patients.[12,35] No reviews addressed populations struggling with homelessness or housing instability, isolation, poverty, or other social determinants of health.

Inconsistent Evidence on Effectiveness of Interventions

The evidence base highlights inconsistencies on the effectiveness of interventions to reduce LOS; no intervention demonstrated a clear direction of effect. For example, three systematic reviews evaluating discharge planning compared with usual care in either older adults or patients with chronic conditions found no difference between groups for LOS,[12,35,38] while two found that discharge planning decreased LOS,[35,38] and one found that discharge planning increased

LOS[15,30]. Similarly, findings varied for readmissions and mortality. Reviews examining geriatric assessment, decision support, interdisciplinary care, and telehealth also reported heterogeneous and sometimes inconsistent findings for quantitative syntheses.

However, one SR examining case management[28] and one SR assessing clinical pathways[29] in patients with heart failure found a reduction in LOS, a lower risk of readmissions, and a lower risk or odds of mortality compared with usual care. The findings suggest that case management or clinical pathways may have a consistent direction of effect for these outcomes in patients with heart failure, but more research is needed.

Challenges for Local Implementation

To gauge to what extent these interventions might be successfully implemented for reducing LOS and improving other outcomes in a local setting, hospital administrators benefit from details about the local context and implementation factors (e.g., process and resources required). However, SRs provided only limited information. Thirteen reviews (in 14 articles) all described interventions conducted in multiple types of hospitals, including academic medical centers, community hospitals, and less frequently, Veterans Affairs hospitals.[15,26-28,30,32-39,41] Only five reviews reported whether all included studies were conducted in urban, suburban, or rural settings,[25,34-36,38] and few reviews reported hospital bed size or affiliation with a health system.

In addition, the process and resources used to support implementation were often not reported. Not all primary studies informing the systematic reviews provided details about the expertise of staff leading and implementing interventions. For instance, for discharge planning interventions, only one review specified that included study interventions were led by a nurse practitioner. Otherwise, systematic reviews simply indicated a provider (e.g., nurse, clinician) or multidisciplinary team led or participated in implementing the intervention. Availability of current resources, such as staff with particular expertise, will undoubtedly affect the feasibility of successfully implementing many interventions. For example, several systematic reviews evaluated geriatric assessment, which often involved specialized assessment by a geriatrician. However, hospitals or health systems may not necessarily have a geriatrician to lead this intervention and may instead engage staff members for training to deliver this intervention, which may affect ultimate success.

Ultimately, we did not find evidence that most interventions have been widely replicated or scaled with sufficient detail or context to adequately inform local implementation.

Trade-Offs and Implications

System-level interventions have the potential to create trade-offs between outcomes, such as LOS and postdischarge adverse outcomes (e.g., hospital readmission, mortality). All systematic reviews in our evidence base reported LOS, and most reported readmissions and mortality. However, the manner in which outcomes were measured varied. Not only is it important for studies to evaluate these outcomes collectively, but also to standardize the way outcomes are reported.

Our findings suggest that, at present, no existing intervention or approach can be implemented to decrease LOS for broad populations of medically complex, high-risk, or otherwise vulnerable patient populations. Attempting to implement an unfocused broad-based intervention across varied populations may have unintended consequences and lead to worse outcomes. Hospitals and health systems may need to carefully consider their own local contexts and populations when assessing whether particular interventions would be a good fit. Input from

our Key Informants emphasized the importance of considering factors associated with social care needs and ways to address these needs when seeking to reduce LOS with a system-level intervention. Building relationships and establishing partnerships with community organizations may help hospitals and health systems leverage resources to support and manage needs of medically complex, high-risk, and vulnerable patients postdischarge.

Finally, interpretation of these findings should also consider several key additional factors. Systematic review design lags behind primary research. Thus, our evidence base may not reflect the most recent findings or evolving interventions yet to be synthesized in published reviews. Moreover, the evidence we reviewed was generated before the COVID-19 pandemic. It is likely that the pandemic has led hospitals to innovate in myriad ways that may affect hospital care, LOS, and other critical outcomes that we cannot yet assess. Additionally, we focused on medically complex, high-risk, and vulnerable patient populations, including those at high socioeconomic risk of poor medical outcomes, but found little direct evidence on socioeconomically disadvantaged patients. Emerging efforts to address longstanding social, economic, and health inequities may yield new insights on how to best design care to benefit these patients.

Overall, understanding the unique challenges and needs of a hospital or health system and its surrounding community may help inform the development of a strategic plan to implement a system-level intervention to reduce hospital LOS and provide high-quality care for the patient populations served.

Next Steps

Hospital Administrative Leaders Can Do the Following:

- Understand different populations with varying risk levels within hospitals attempting to reduce LOS.
- Explore specific interventions matched to medically complex, high-risk, and vulnerable populations with higher LOS.
- Maximize expertise of current staff when identifying and implementing system-level intervention (e.g., clinical pathways, geriatric assessment).
- Understand tradeoffs between reducing LOS in medically complex, high-risk, and vulnerable populations and other patient-centered outcomes (e.g., functional decline, patient experience, mortality, readmissions) and patient safety and quality metrics.
- Evaluate opportunities to support research and implementation of system-level interventions targeting medically complex, high-risk, or vulnerable populations.
- Work with policymakers to identify best approaches to reducing hospital LOS in U.S. healthcare delivery systems.

Researchers Can Do the Following:

- Conduct research focused on general medical and surgical ward inpatients.
- Provide sufficient operational context about how interventions were implemented in primary studies and evidence syntheses.
- Report details about local hospital settings where initiatives to reduce LOS have been implemented (e.g., patient volume, bed size, payer mix) in primary studies and evidence syntheses.

- Assess health information technology's role in supporting interventions to reduce LOS and identify opportunities to develop or adapt technology to support new initiatives.
- Include and subgroup patients facing severe social and economic barriers to achieving and maintaining wellness before, during, and after hospitalization in primary studies evaluating system-level interventions to decrease LOS.
- Evaluate how health systems can address the unique challenges pediatric populations' face, specifically those that are susceptible to many sources of social and economic vulnerability.
- Examine enhanced recovery programs and patient mobility programs in medically complex or otherwise vulnerable patient populations.
- Conduct well-designed systematic reviews, such as those assessing both the risk of bias of primary studies and providing the strategy for the literature search.

Policymakers Can Do the Following:

- Support new research and development with additional funding of both primary research and evidence synthesis applicable to the unique characteristics of the U.S. healthcare delivery system.
- Address the role of LOS – as both a metric and a concept – in value-based reimbursement systems.

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Appendix A. Methods

Resources Searched

ECRI Institute information specialists searched the following bibliographic databases and websites for relevant information. Detailed search strategies for each bibliographic database appear below.

Table A-1. Bibliographic databases

Name	Date Limits	Platform/Provider
Cochrane Database of Systematic Reviews (Cochrane Reviews)	January 1, 2010 through May 12, 2020	Wiley
Cumulative Index of Nursing and Allied Health Literature (CINAHL)	January 1, 2010 through September 30, 2020	EBSCOhost
EMBASE.com (Excerpta Medica)	January 1, 2010 through September 30, 2020	Embase.com
MEDLINE (via Embase.com)	January 1, 2010 through September 30, 2020	Embase.com
PubMed (publisher supplied/in process citations)	January 1, 2010 through September 30, 2020	NLM

Table A-2. Grey literature resources

Name	Date Limits	Platform/Provider
Agency for Healthcare Research and Quality (AHRQ)	January 1, 2010 through May 15, 2020	Department of Health and Human Services - Web
American Hospital Association	January 1, 2010 through May 18, 2020	Web
The Camden Coalition	January 1, 2020 through May 15, 2020	Web
Clinicaltrials.gov	January 1, 2010 through May 18, 2020	National Library of Medicine - Web
Centers for Medicare and Medicaid	January 1, 2010 through May 18, 2020	Web
Institute for Healthcare Improvement	January 1, 2020 through May 18, 2020	Web
The Joint Commission	January 1, 2020 through May 18, 2020	Web
Root Cause Coalition	January 1, 2020 through May 15, 2020	Web
Social Interventions Research and Evaluation Network (SIGN)	January 1, 2020 through May 15, 2020	Web
Socially Determined	January 1, 2020 through May 15, 2020	Web

Grey Literature

Websites from professional organizations and government agencies were also screened for relevant grey literature. (Grey literature consists of reports, educational materials, promotional documents, and articles produced by government agencies, professional associations and educational facilities. These documents do not appear in the peer-reviewed journal literature.)

Search Strategies

Table A-3. Embase/MEDLINE (searched via Embase.com)

Set Number	Concept	Search Statement
#1	Length of stay - highly specific search (controlled terms searched as major concepts and keywords searched in the title only)	'length of stay'/exp/mj OR ('hospital discharge'/exp/mj AND 'time factor'/exp/mj) OR 'los':ti OR (((length OR duration) NEXT/3 stay):ti) OR 'bed days':ti OR (((length OR duration OR days) NEAR/3 hospital*):ti) OR (((inpatient OR patient OR short) NEAR/1 (stay* OR throughput OR flow* OR days)):ti) OR (((discharge* OR stay) NEAR/4 (delay* OR timely OR timeliness OR fast OR faster OR sooner OR quick* OR haste* OR rapid* OR early OR earlier OR reduc* OR decrease OR lessen OR speed*)):ti) OR ((fast NEXT/1 track):ti)
#2	Length of stay – less specific search (controlled terms searches as both major and minor concepts and keywords searched in title and abstract)	'length of stay'/exp OR ('hospital discharge'/exp AND 'time factor'/exp) OR ('los':ti,ab OR (((length OR duration) NEXT/3 stay):ti,ab) OR 'bed days':ti,ab OR (((length OR duration OR days) NEAR/3 hospital*):ti,ab) OR (((inpatient OR patient OR short) NEAR/1 (stay* OR throughput OR flow* OR days)):ti,ab) OR (((discharge* OR stay) NEAR/4 (delay* OR timely OR timeliness OR fast OR faster OR sooner OR quick* OR haste* OR rapid* OR early OR earlier OR reduc* OR decrease OR lessen OR speed*)):ti,ab) OR ((fast NEXT/1 track):ti,ab))
#3	Socially vulnerable populations – controlled terms	'vulnerable population'/exp OR 'frail elderly'/exp OR 'homelessness'/exp OR 'homeless person'/exp OR 'poverty'/exp OR 'sexual and gender minority'/exp OR 'minority group'/exp OR 'household economic status'/exp OR 'lowest income group'/exp OR 'social status'/exp OR 'health disparity'/exp OR 'health equity'/exp OR 'income group'/exp OR 'safety net hospital'/exp OR 'medically uninsured'/exp OR 'health literacy'/exp OR 'educational status'/exp OR 'literacy'/exp OR 'employment'/exp OR 'employment status'/exp OR 'veteran'/exp OR 'veterans health'/exp OR 'migrant'/exp OR 'English as a second language'/exp OR 'limited English proficiency'/exp OR 'language ability'/exp OR 'prisoner'/exp OR 'social environment'/exp OR 'health care access'/exp OR 'socioeconomics'/de OR 'social isolation'/exp
#4	Socially vulnerable populations - keywords	(((vulnerable OR marginalized) NEAR/2 (population* OR patient* OR person*)):ti,ab) OR homeless*:ti,ab OR poverty*:ti,ab OR impoverished:ti,ab OR indigent:ti,ab OR ((poor NEAR/3 (people OR persons)):ti,ab) OR 'low income':ti,ab OR (((sexual OR gender OR ethnic OR racial) NEAR/3 minorit*):ti,ab) OR socioeconomic*:ti,ab OR ((social NEAR/2 (class* OR health* OR status OR support OR mobility OR isolation)):ti,ab) OR ((health* NEAR/4 (disparit* OR equit* OR inequalit* OR literacy OR illiteracy OR literate OR illiterate* OR inequit* OR access*)):ti,ab) OR ((('safety net' OR 'safety-net' OR tertiary OR quaternary) NEAR/3 (provider* OR hospital*)):ti,ab) OR uninsured:ti,ab OR 'un insured':ti,ab OR 'under insured':ti,ab OR 'under-insured':ti,ab OR underinsured:ti,ab OR ((without NEXT/3 insurance):ti,ab) OR unemploy*:ti,ab OR underemploy*:ti,ab OR 'working poor':ti,ab OR veteran*:ti,ab OR immigrant*:ti,ab OR migrant*:ti,ab OR refugee*:ti,ab OR ((english NEAR/3 (proficien* OR second)):ti,ab) OR (non NEXT/1 english):ti,ab OR (((language OR communication) NEAR/3 barrier*):ti,ab) OR prison*:ti,ab OR incarcerat*:ti,ab OR jail*:ti,ab
#5	Medically vulnerable populations – controlled terms	'disabled person'/exp OR 'disability'/exp OR 'developmental disorder'/exp OR 'mental disease'/exp OR 'communication barrier'/exp OR 'drug dependence'/exp OR 'multiple chronic conditions'/exp OR 'rare disease'/exp OR 'chronic disease'/exp OR 'substance use'/de OR 'alcohol consumption'/exp OR 'cannabis use'/exp OR 'addiction'/de OR 'chronic obstructive lung disease'/exp OR 'heart failure'/exp OR 'dementia'/exp OR 'diabetes mellitus'/exp OR 'chronic kidney failure'/exp OR comorbidity/exp/mj

Set Number	Concept	Search Statement
#6	Medically vulnerable populations - keywords	frail:ti,ab OR frailty:ti,ab OR disabilities:ti,ab OR disabled:ti,ab OR multimorbid*:ti,ab OR ((multi* NEXT/1 morbid*):ti,ab) OR alcoholic*:ti,ab OR (((alcohol OR substance* OR drug OR drugs OR opiate* OR opioid* OR narcotic*) NEAR/3 (abuse OR misuse OR addict* OR disorder* OR users OR dependen*)):ti,ab) OR (((rare OR chronic) NEAR/2 (disease* OR disorder* OR condition*)):ti,ab) OR ((chronic* NEAR/2 (multisymptom OR 'multi symptom')):ti,ab) OR ((multiple NEAR/3 (comorbid* OR morbid*)):ti,ab) OR (((mental OR developmental OR behavioral OR psychiatric) NEAR/3 (illness* OR disorder* OR delay* OR comorbid*)):ti,ab) OR ((chronic NEXT/1 obstruct* NEXT/2 (lung* OR pulmonary* OR respirat*)):ti,ab) OR copd*:ti,ab OR (((heart OR cardio* OR cardiac OR cardiogen* OR coronary) NEAR/2 (failure OR shock OR death OR infarct* OR arrest*)):ti,ab) OR dementia*:ti,ab OR alzheimer*:ti,ab OR diabetes:ti,ab OR diabetic:ti,ab OR chronic:ti,ab OR ('end stage' NEAR/3 (kidney OR renal)):ti,ab OR esrd:ti,ab OR ckd:ti,ab OR (complex* NEAR/2 patient*)
#7	Combine sets –	#1 OR (#2 AND (#3 OR #4 OR #5 OR #6))

Table A-3a. Add-on search for organizational interventions to decrease length of stay

Set Number	Concept	Search Statement
#8	Length of Stay -	'length of stay'/exp/mj OR 'los':ti,ab OR ((length OR duration) NEXT/3 stay):ti,ab OR 'bed days':ti,ab OR ((length OR duration OR days) NEAR/3 hospital*):ti,ab
#9	Organizational interventions	'health program'/exp/mj OR 'care coordination'/exp/mj OR 'case management'/exp/mj OR 'interdisciplinary communication'/exp/mj OR 'hospital policy'/exp/mj OR 'clinical decision making'/exp/mj OR 'hospital readmission reduction program'/exp/mj OR 'clinical pathway'/exp/mj OR 'personnel management'/exp/mj OR 'hospital personnel'/exp/mj OR 'care bundle'/exp/mj OR 'health care quality'/exp/mj OR 'multidisciplinary team'/exp/mj OR 'patient care'/exp/mj OR (((case NEXT/1 manag*):ti,ab) OR (((interdisciplin* OR multdisciplin*) NEAR/3 (rounds OR rounding OR communicat*)):ti,ab) OR (((organizat* OR organisat* OR hospital*) NEAR/5 (policy OR policies OR program* OR intervention*)):ti,ab) OR staff:ti,ab OR staffing:ti,ab OR bundl*:ti,ab OR model*:ti,ab OR pathway*:ti,ab OR personnel:ti,ab OR 'system level':ti,ab OR 'hospital wide':ti,ab OR ('lean process' OR 'eras' OR ((enhanced NEXT/1 recovery):ti,ab) OR 'hospital elder life program' OR 'goal-directed achievement through geographic location' OR gagl OR 'older people assessment liason' OR opal OR 'early supported discharge' OR 'early home supported discharge'):ti,ab OR (six NEXT/1 sigma):ti,ab OR (OASIS NEXT/4 framework*):ti,ab)
#10	Combine sets – organizational interventions	#8 AND #9
#11	Combine sets	#7 OR #10
#12	Remove unwanted publication types	#11 NOT (abstract:nc OR annual:nc OR book/de OR 'case report'/de OR 'case study'/de OR conference:nc OR 'conference abstract':it OR 'conference paper'/de OR 'conference paper':it OR 'conference proceeding':pt OR 'conference review':it OR congress:nc OR editorial/de OR editorial:it OR erratum/de OR letter:it OR note/de OR note:it OR meeting:nc OR sessions:nc OR 'short survey'/de OR symposium:nc)
#13	Limit to systematic reviews and meta-analyses	#12 AND ('systematic review'/de OR 'meta analysis'/de OR (systematic* NEAR/2 review*) OR metaanalysis OR metaanalyses OR (meta NEXT/1 (analysis OR analyses)) OR Cochrane)
#14	Limit to English, Human studies	Limit #13 to English, Human, py:01/01/2010-09/30/2020

EMBASE.com Syntax:

* = truncation character (wildcard)
/exp = denotes a subject heading that has been searched to include narrower terms/concepts
/mj = denotes a term that has been searched as a major subject heading
/py = limit to publication year(s)
:ti = limit to title
:ti,ab = limit to title and abstract

Table A-4. CINAHL

Set Number	Concept	Search Statement
#1	Length of stay – highly specific search (controlled terms searched as major concepts and keywords searched in the title only)	((MM "Length of Stay") OR (MM "Patient Discharge+") AND (MM "Time Factors")) OR (TI ((length OR duration OR days) W3 (stay OR hospital*))) OR (TI “bed days”) OR (TI ((inpatient OR patient OR short) N1 (stay* OR throughput OR flow* OR days))) OR (TI ((Discharge* OR stay) N3 (delay* OR timely OR timeliness OR fast OR faster OR sooner OR quick* OR haste* OR rapid* OR early OR earlier OR reduc* OR decrease OR lessen))) OR (TI (fast N1 track))
#2	Length of stay – less specific (controlled terms searches as both major and minor concepts and keywords searched in title)	(MH "Length of Stay") OR (TI ((length OR duration OR days) W3 (stay OR hospital*))) OR (TI “bed days”) OR (TI ((inpatient OR patient OR short) N1 (stay* OR throughput OR flow* OR days))) OR (TI ((Discharge* OR stay) N3 (delay* OR timely OR timeliness OR fast OR faster OR sooner OR quick* OR haste* OR rapid* OR early OR earlier OR reduc* OR decrease OR lessen))) OR (TI (fast N1 track))
#3	Socially vulnerable populations – controlled terms	(MH "Special Populations") OR (MH "Sex Factors") OR (MH "Race Factors") OR (MH "Homeless Persons") OR (MH "Homelessness") OR (MH "Frail Elderly") OR (MH "Poverty") OR (MH "Poverty Areas") OR (MH "Health Services for the Indigent") OR (MH "Indigent Persons") OR (MH "Minority Groups") OR (MH "Social Isolation") OR (MH "Social Environment") OR (MH "Socioeconomic Factors") OR (MH "Illiteracy") OR (MH "Substance Abusers") OR (MH "Veterans") OR (MH "Health Status Disparities") OR (MH "Safety-Net Providers") OR (MH "Medically Uninsured") OR (MH "Health Literacy") OR (MH "Educational Status") OR (MH "Transients and Migrants") OR (MH "Immigrants+") OR (MH "English as a Second Language") OR (MH "Articulation Disorders") OR (MH "Prisoners") OR (MH "Healthcare Disparities") OR (MH "Tertiary Health Care")
#4	Socially vulnerable populations – keywords	(TI ((vulnerable OR marginalized) N2 (population* OR patient* OR person*))) OR (TI (homeless* OR poverty*)) OR (TI (poor N3 (people OR persons))) OR (TI “low income”) OR (TI ((sexual OR gender OR ethnic OR racial) N3 minorit*))) OR (TI socioeconomic*) OR (TI (social N2 (class* OR health* OR status OR support OR mobility OR isolation))) OR (TI (health* N4 (disparit* OR equit* OR inequalit* OR literacy OR illiteracy OR literate OR illiterate* OR inequit* OR access*))) OR (TI (('safety net' OR 'safety-net' OR tertiary OR quaternary) N4 (provider* OR hospital*))) OR (TI (uninsured OR 'un insured' OR 'under insured' OR 'under-insured' OR underinsured)) OR (TI (without N3 insurance)) OR unemploy* OR (TI underemploy* OR “working poor” OR veteran* OR immigrant* OR migrant* OR refugee*) OR (TI (english N3 (proficien* OR second))) OR (TI (non W1 english)) OR (TI ((language OR communication) N3 barrier*)) OR (TI (prison* OR incarcerat* OR jail* OR indigent* OR impoverished))

Set Number	Concept	Search Statement
#5	Medically vulnerable populations – controlled terms	(MH "Mentally Disabled Persons") OR (MH "Intellectual Disability+") OR (MH "Developmental Disabilities") OR (MH "Mental Disorders") OR (MH "Behavioral and Mental Disorders+") OR (MH "Communication Barriers") OR (MH "Communicative Disorders") OR (MH "Substance Use Disorders+") OR (MH "Rare Diseases") OR (MH "Chronic Disease+") OR (MH "Substance Dependence+") OR (MH "Pulmonary Disease, Chronic Obstructive+") OR (MH "Heart Failure+") OR (MH "Dementia+") OR (MH "Diabetes Mellitus+") OR (MH "Kidney Failure, Chronic+") OR (MH "Comorbidity")
#6	Medically vulnerable populations – keywords	(TI (frail OR frailty OR disabilities OR disabled OR multimorbid*)) OR (TI (multi* W1 morbid*)) OR (TI alcoholic*) OR (TI ((alcohol OR substance* OR drug OR drugs OR opiate* OR opioid* OR narcotic*) N3 (abuse OR misuse OR addict* OR disorder* OR users OR dependen*))) OR (TI ((rare OR chronic) N2 (disease* OR disorder* OR condition*))) OR (TI (chronic* N2 (multisymptom OR 'multi symptom'))) OR (TI (multiple N3 (comorbid* OR morbid*))) OR (TI ((mental OR developmental OR behavioral OR psychiatric) N3 (illness* OR disorder* OR delay* OR comorbid*))) OR (TI (chronic W1 obstruct* W2 (lung* OR pulmonary* OR respiratory))) OR (TI copd*) OR (TI ((heart OR cardio* OR cardiac OR cardiogen* OR coronary) N2 (failure OR shock OR death OR infarct* OR arrest*))) OR (TI dementia* OR alzheimer* OR diabetes OR diabetic)) OR (TI ('end stage' N3 (kidney OR renal))) OR (TI (esrd OR ckd)) OR (TI (complex* N2 patient*)) OR (TI “chf”)
#7	Combine sets	#1 OR (#2 AND (#3 OR #4 OR #5 OR #6))

Table A-4a. Add-on search for organizational interventions to decrease length of stay

Set Number	Concept	Search Statement
#8	Length of Stay	(MM "Length of Stay") OR (TI ((length OR duration) W3 stay)) OR (TI 'bed days') OR (TI (length OR days) N3 hospital*))
#9	Organizational interventions	(MM "Case Management") OR (MM "Case Managers") OR (MM "Multidisciplinary Care Team+") OR (MM "Patient Centered Care") OR (MM "Hospital Policies+") OR (MM "Organizational Policies+") OR (MM "Decision Making, Clinical") OR (MM "Decision Making, Shared") OR (MM "Personnel Management+") OR (MM "Personnel Staffing and Scheduling+") OR (MM "Nursing Care Plans+") OR (MM "Quality of Health Care+") OR (MM "Patient Care Plans+") OR (MM "Patient Care+") OR (TI (case W1 manag*)) OR (TI ((interdisciplin* OR multdisciplin*) N3 (rounds OR rounding OR communicat*))) OR (TI ((organization* OR hospital*) N3 (policy OR policies OR program* OR intervention*))) OR (TI (staff OR staffing OR bundl* OR model* OR pathway* OR personnel)) OR (TI (“system level” OR “hospital wide”)) OR (TI ('lean process' OR 'eras')) OR (TI (enhanced W1 recovery)) OR (TI 'hospital elder life program') OR (TI ('goal-directed achievement through geographic location' OR gagl OR 'older people assessment liason' OR opal OR 'early supported discharge' OR 'early home supported discharge')) OR (TI (six W1 sigma)) OR (TI (OASIS N4 framework*))
#10	Combine sets – organizational interventions	#8 AND #9
#11	Combine sets	#7 OR #10
#12	Limit to systematic reviews and meta-analyses	#11 AND ((MH "Systematic Review") OR (MH "Cochrane Library") OR (systematic* N2 review*) OR metaanalysis OR 'meta analysis' OR Cochrane) OR (MH "Meta Analysis")

Set Number	Concept	Search Statement
#13	Exclude MEDLINE records; limit to academic journals and publication date 2010-2020	Exclude MEDLINE records; Published Date: 20100101-20201231; Limit to: Academic journals

CINAHL Syntax:

* = truncation character (wildcard)
\+ = denotes a denotes a subject heading that has been searched to include narrower terms/concepts
MH = denotes a term that has been searched as a subject heading
MM = denotes a term that has been searched as a major subject heading
TI = limit to title
:ti,ab = limit to title and abstract* = truncation character (wildcard)

Table A-5. PubMed publisher-supplied/in-process citations

Set Number	Concept	Search Statement
#1	Length of stay – highly specific search	((length[ti] OR duration[ti]) AND stay[ti]) OR “LOS”[ti]
#2	Length of stay – less specific search	“length of stay”[tiab] OR “length of hospital stay”[tiab] OR “LOS”[tiab] OR “duration of stay”[tiab] OR “duration of hospital stay”[tiab] OR "hospital days"[tiab] OR "hospitalization days"[tiab] OR "days of hospitalization"[tiab] OR "days in the hospital"[tiab]
#3	Socially vulnerable populations	((vulnerable[tiab] OR marginalized[tiab]) AND (population*[tiab] OR patient*[tiab] OR person*[tiab])) OR homeless*[tiab] OR poverty*[tiab] OR impoverished[tiab] OR “poor person”[tiab] OR “poor people”[tiab] OR “low income”[tiab] OR ((sexual[tiab] OR gender[tiab] OR ethnic[tiab] OR racial[tiab]) AND minorit*[tiab]) OR socioeconomic*[tiab] OR “social class”[tiab] OR “social support”[tiab] OR “social mobility”[tiab] OR “social isolation”[tiab] OR ((health[tiab] OR healthcare[tiab]) AND (disparit*[tiab] OR equit*[tiab] OR inequalit*[tiab] OR literacy[tiab]OR illiteracy[tiab] OR literate[tiab] OR illiterate*[tiab] OR inequit*[tiab] OR access*[tiab])) OR (('safety net'[tiab] OR 'safety-net'[tiab] OR tertiary[tiab] OR quaternary[tiab]) AND (provider*[tiab] OR hospital*[tiab])) OR uninsured[tiab] OR 'un insured'[tiab] OR 'under insured'[tiab] OR underinsured[tiab] OR unemploy*[tiab] OR underemploy*[tiab] OR 'working poor'[tiab] OR veteran*[tiab] OR immigrant*[tiab] OR migrant*[tiab] OR refugee*[tiab] OR “language barrier”[tiab] OR “language barriers”[tiab] OR “communication barrier”[tiab] OR “communication barriers”[tiab] OR Non-English[tiab] OR (English[tiab] AND language[tiab] AND (proficien* OR speak*[tiab] OR second[tiab])) OR prison* [tiab] OR incarcerat*[tiab] OR jail*[tiab]

Set Number	Concept	Search Statement
#4	Medically vulnerable populations	Frail[tiab] OR frailty[tiab] OR disabilities[tiab] OR disabled[tiab] OR multimorbid*[tiab] OR “multi morbidity”[tiab] OR “multi morbidities”[tiab] OR alcoholic*[tiab] OR ((alcohol[tiab] OR substance*[tiab] OR drug[tiab] OR drugs[tiab] OR opiate*[tiab] OR opioid* OR narcotic*[tiab]) AND (abuse[tiab] OR misuse[tiab] OR addict*[tiab] OR disorder*[tiab] OR users[tiab] OR dependen*[tiab])) OR “rare disease”[tiab] OR “rare disorder”[tiab] OR “chronic multisymptom”[tiab] OR “chronic multi symptom”[tiab] OR “chronic condition”[tiab] OR “chronic conditions”[tiab] OR “chronic disease”[tiab] OR “chronic diseases”[tiab] OR “chronic disorder”[tiab] OR “chronic disorders”[tiab] OR comorbidities[tiab] OR “mental illness”[tiab] OR “mental disorder”[tiab] OR “developmental disorder”[tiab] OR “mental illness”[tiab] OR ((psychiatric[tiab] OR behavioral[tiab]) AND (illness*[tiab] OR disorder*[tiab] OR comorbid*[tiab])) OR “chronic obstructive pulmonary disease”[tiab] OR copd[tiab] OR “heart failure”[tiab] OR “cardiogenic shock”[tiab] OR “heart arrest”[tiab] OR “cardiac arrest”[tiab] OR dementia*[tiab] OR alzheimer*[tiab] OR diabetes[tiab] OR diabetic[tiab] OR “chronic kidney disease”[tiab] OR “end stage renal disease”[tiab] OR “end stage kidney disease”[tiab] OR esrd[tiab] OR ckd[tiab] OR chf[tiab] OR “complex patient”[tiab] OR “complex patients”[tiab]
#5	Organizational interventions	“health program”[tiab] OR “care coordination”[tiab] OR “case management”[tiab] OR “'interdisciplinary communication”[tiab] OR “hospital policy”[tiab] OR “clinical decision making”[tiab] OR “hospital readmission reduction program”[tiab] OR “clinical pathway”[tiab] OR “personnel management”[tiab] OR “hospital personnel”[tiab] OR “care bundle”[tiab] OR “health care quality”[tiab] OR “multidisciplinary team”[tiab] OR “patient care”[tiab] OR (case[tiab] AND manag*[tiab]) OR ((interdisciplin*[tiab] OR multdisciplin*[tiab]) AND (rounds[tiab] OR rounding OR communicat*[tiab])) OR ((organizat*[tiab] OR organisat*[tiab] OR hospital*[tiab]) AND (policy[tiab] OR policies[tiab] OR program*[tiab] OR intervention*[tiab])) OR staff[tiab] OR staffing[tiab] OR bundl*[tiab] OR model*[tiab] OR pathway*[tiab] OR personnel[tiab] OR “system level”[tiab] OR “hospital wide”[tiab] OR “lean process”[tiab] OR “eras”[tiab] OR “enhanced recovery”[tiab] OR “hospital elder life program”[tiab] OR “goal-directed achievement through geographic location”[tiab] OR gagl[tiab] OR “older people assessment liason”[tiab] OR opal[tiab] OR “early supported discharge”[tiab] OR “early home supported discharge”[tiab] OR “six sigma”[tiab] OR “OASIS framework”[tiab]
#6	Combine sets	#1 OR (#2 AND (#3 OR #4 OR #5))
#7	Remove unwanted publication types	#6 NOT (case reports[pt] OR comment[pt] OR editorial[pt] OR letter[pt] OR news[pt] OR Textbooks[pt] OR "Book Reviews"[pt] OR "Book Illustrations"[pt] OR book OR books OR textbook* OR meeting* OR conference* OR symposia OR symposium*)
#8	Limit to systematic reviews and meta-analyses	#7 AND (meta-analysis OR meta-analysis[pt] OR meta-analyses OR metaanalysis OR metaanalyses OR "Systematic Review"[pt] OR (systematic*[tiab] AND review*[tiab]))
#9	Limit to in-process citations	#8 AND ("inprocess"[sb] OR publisher[sb] OR pubmednotmedline[sb])

PubMed Syntax:

* = truncation character (wildcard)
[edat] = entrez date (date added to database)
[sb] = subset
[ti] = limit to title field
[tiab] = limit to title and abstract fields

Appendix B. List of Excluded Studies

Not U.S.-Based

1. Abdelaal E, Rao SV, Gilchrist IC, Bernat I, Shroff A, Caputo R, Costerousse O, Pancholy SB, Bertrand OF. Same-day discharge compared with overnight hospitalization after uncomplicated percutaneous coronary intervention: a systematic review and meta-analysis. Jacc. Cardiovascular Interventions. Feb 2013. 6:99-112. Also available: https://doi.org/10.1016/j.suronc.2019.11.004. PMID: 23352820.
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11. Bruns ERJ, van den Heuvel B, Buskens CJ, van Duijvendijk P, Festen S, Wassenaar EB, van der Zaag ES, Bemelman WA, van Munster BC. The effects of physical prehabilitation in elderly patients undergoing colorectal surgery: a systematic review. Colorectal Disease. 1 Aug 2016. 18. Also available: https://doi.org/10.1111/codi.13429. PMID: 27332897.

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Appendix C. Evidence Tables

Table C-1. Characteristics of systematic reviews on reducing length of hospital stay

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Austin et al. 2020[24]	Examine which electronic medical record interventions have improved safety and quality of therapeutic anticoagulation in an inpatient hospital setting	27 total studies: 3 RCTs, 4 cohort studies, 20 pre/post observational studies (N=not reported)	Inception to September 2018	Included: Studies published in English with pediatric and adult inpatients; EMR compared to routine care; reporting at least one outcome of interest	Yes, EPOC for RCTs and cohort studies	No	Yes	No
Agarwal et al. 2018[34]	Examine the effect and quality of evidence for hospital-based HF quality improvement interventions on process of care measures and clinical outcomes among patients with acute HF	14 RCTs (N=96,913) *(N=75,664 for 6 US RCTs) reporting outcomes of interest	Inception to February 6, 2017	Included: RCTs or quasi-randomized trials of HF quality improvement interventions testing effect of individual or combined interventions (e.g., audit and feedback reporting systems, admission and discharge checklists, chart case management, patient educational or behavioral change materials, healthcare quality training that was directed at the hospital system, doctors, nurses or allied health professionals or information management systems	Yes, Cochrane ROB	No (due to substantial unexplained heterogeneity, differences in presentation of intervention effects)	Yes	Yes, GRADE (For the most part, outcomes from specific RCTs of interest for this report were not graded separately)

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Baratloo et al. 2018[25]	Examine effects of telemedicine on treatment times and clinical outcomes of acute stroke care	26 total studies: 2 RCTs, 8 prospective observational studies, 16 retrospective observational studies (N=6,605)	May 2017	Included: Original prospective and retrospective studies, individuals with AIS, telestroke-based systems, bedside (face to face) care as a comparator, studies investigating outcomes of interest Excluded: Single-arm studies, studies reporting irrelevant outcomes, conference abstracts	Yes, Cochrane (RCTs), Newcastle-Ottawa scale (observational studies)	Yes	No	No
Bryant-Lukosius et al. 2015[35]	Examine the clinical effectiveness and cost-effectiveness of clinical nurse specialists transitional care	13 RCTS (N=2,463)	1980 to July 31, 2013	Included: Published and unpublished RCTs comparing CNS-led transitional care to usual care. Intervention was delivered by a master's prepared CNS Excluded: Studies of outcomes that could not be solely attributed to the CNS; the control group was exposed to a CNS; or did not include a measure of health system utilization	Yes, Cochrane ROB	Yes	Yes	Yes, GRADE

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Bakker et al. 2011[26]	Examine effectiveness of geriatric care teams and units	17 total studies; 6 reported LOS: 4 RCTs, 2 observational	1980 – May 2009	Included: RCTs and observational studies; patients at least 65 years old; multicomponent interventions Excluded: Non-English studies; single-disease or single-component interventions	EPOC tool	No	Yes	No
Eagles et al. 2020[41]	Examine impact of a geriatric assessment on mortality, hospital length of stay, discharge destination, and delirium incidence in patients 65 years and older admitted to a trauma center	8 retrospective cohort studies (N=122 to 4,534)	April 26, 2019	Included: Peer-reviewed studies describing impact of geriatric trauma consultation (GTC) in adults 65 years and older admitted to a trauma center compared with standard trauma care alone Excluded: Case reports, SRs, and commentaries	Yes, Newcastle-Ottawa Quality Assessment Scale	Yes	Yes	No formal analysis. Authors reported strength of findings are limited by study design, confounding, meta-analysis results based on few studies.
Ellis et al. 2017[36]	Examine effectiveness and resource use of comprehensive geriatric assessment (CGA) for older adults admitted to hospital, and to use these data to estimate its cost-effectiveness	29 RCTs (N=13,766)	Inception to October 5, 2016	Included: RCTs comparing inpatient CGA versus usual care on a general medical ward or on a ward for older people, usually admitted to hospital for acute care or for inpatient rehabilitation after an acute admission	Yes, using guidance for EPOC reviews	Yes	Yes	Yes, GRADE

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Frazer et al. 2019[37]	Examine interventions intended to improve safety or quality anticoagulant prescribing	19 RCTs (N=12,742)	Inception to March 24, 2018	Included: RCTs, non-RCTs, controlled before-after, interrupted time-series in economically developed countries assessing system-level interventions for any indication in adult inpatients aged 18 years or older Excluded: Interventions targeting prophylactic (low-dose) anticoagulant use, evaluating intra-operative anticoagulation, delivered in the outpatient setting or at transition to outpatient care, or compared with interventions not in current practice. Cross-sectional, uncontrolled cohort, review articles, unpublished, opinion pieces, conference abstracts/proceedings	Yes, Cochrane EPOC criteria	Yes	Yes	No
Gonçalves-Bradley et al. 2016[38]	Examine effectiveness of planning the discharge of individual patients moving from hospital	30 RCTs (N=11,964)	1946 to October 2015	Included: RCTs; participants were hospital inpatients Excluded: Studies of discharge planning part of a broader package of inpatient care, did not describe study design or report control group results	Yes, Cochrane ROB	Yes	Yes	GRADE (Moderate to very low)

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Gillaizeau et al. 2013[27]	Examine effectiveness of computerized advice on drug dosing	42 total studies; 9 reported LOS: 8 RCTs, 1 observational	Through January 2012	Included: RCTs and observational studies; interventions using computerized advice to guide drug dosing tailored to individual patient Excluded: Studies of equations or algorithms not supported by a computerized device; popups or dosing advice that was not patient-specific	EPOC tool	Yes	Yes	Very low
Huntley et al. 2016[28]	Examine effectiveness and cost of case management for patients with heart failure	22 total studies; 9 reported LOS: 8 RCTs, 1 observational; 13 reported readmissions: 12 RCTs, 1 observational	1985 – November 2015	Included: RCTs and observational studies; adult studies only; all languages	Cochrane risk of bias tool for RCTs; EPOC tool for observational studies	Yes	Yes	No
Kul et al. 2012[29]	Examine effectiveness of clinical pathways for patients with heart failure	7 total studies: 3 RCTs, 1 cohort, 3 pre-post	1985 – 2011	Included: RCTs and observational studies; all languages	Jadad tool for RCTs; Newcastle-Ottawa Scale for observational studies	Yes	No	No

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Mabire et al. 2017[15,30]	Examine effectiveness of nursing discharge planning interventions on health-related outcomes for older inpatients discharged home	13 total studies: 11 RCTs, 1 pilot cohort, 1 pre-post study (N=3,964)	2000 to 2015	Included: Studies published in English of older patients (≥65 years) discharged home from an acute care or post-acute care rehabilitation setting, i.e., skilled nursing facility. Interventions had to be provided by at least one nurse and involve a multi-disciplinary and/or interdisciplinary model of care	Yes, JBI-MAStARI assessment of methodological quality	Yes	Yes	Yes, GRADE
Patel et al. 2020[31]	Examine treatment of geriatric hip fractures by a multidisciplinary hip fracture service and what impact this has on patient outcomes	17 total studies: 9 retrospective studies, 6 prospective studies, 1 RCT, 1 non-RCT (N=146 to 23,973)	January 1, 2012 to November 12, 2017	Included: Indexed in the databases searched, full-text comparative studies published in English that studied at least one of the four main outcome measures of interest	Yes, Oxford quality-scoring system (Jadad) for RCTs and Newcastle Ottawa grading system for non-RCTs	No	Yes	Tool used not reported 16 of 17 studies receive an evidence grade of good, 1 of 17 received an evidence grade of fair

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Pannick et al. 2015[32]	Examine the range of objective patient outcomes used in studies of general medical ward interdisciplinary team care, and to evaluate the performance of interdisciplinary interventions against them	30 total studies: 8 RCTs, 9 cluster-RCTs, 8 non-RCT cluster, 4 before-after, 1 interrupted time series (N=66,548)	January 1, 1998 January 29, 2014	Included: Primary reports of inter-disciplinary team care interventions in adult general medical wards using an objective patient outcome measure Excluded: Patients <18 years in intensive care unit, operating rooms, stroke units, coronary care, pharmacotherapy; interventions relying solely on a staff member taking dedicated coordinating or facilitating role (e.g., case management); interventions targeting continuation of care by a similar group during the following shift (e.g., handoff processes)	Yes, Cochrane ROB	Yes	Yes	No
Van Craen et al. 2010[39]	Examine effectiveness of geriatric evaluation units	7 RCTs	Through October 2007	Included: RCTs and cohort studies; patients at least 65 years old; published in English, French, or Dutch Excluded: Studies of single-disease management programs and geriatric consultation services	Delphi list for RCTs	Yes	No	No

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
White et al. 2011[33]	Examine the effectiveness of hospitalists on the quality of inpatient care	65 total studies; 1 RCT, 8 non-randomized controlled trials, 1 interrupted time series, 37 cohort, 18 pre-post	1996 – December 2010	Included: All study designs, ages, languages	Modified Downs and Black checklist, 32 items	No	Yes	No
Zhu et al. 2015[12]	Examine effectiveness of nurse-led early discharge planning program (DPP) to standard care for in-patients with chronic disease or rehabilitation needs	10 RCTs (N=3,438)	1946 to March 29, 2014	Included: RCTs; general hospital setting; include at least one primary or secondary outcome Excluded: Non-English studies, assessing patients with acute, critical illness, or social admissions; programs was directed by non-nursing staff; assessing post-discharge care of patients transferred to nursing home or long-term care facility; intervention initiated at discharge; post-discharge care	Yes, Cochrane ROB	Yes	Yes	No

Author Year	Objective	Primary Studies: N, Design	Search Timeframe	Inclusion/Exclusion Criteria	Risk of Bias Assessment	Meta-Analysis	Qualitative or Narrative Synthesis	GRADE or Similar Analysis
Zhang et al. 2013[40]	Examine effectiveness of interventions to prevent postoperative delirium in elderly patients	38 total RCTs; 10 studies reported LOS, only 2 used a systemic intervention (others were pharmacologic)	Through July 2012	Included: RCTs only; adult patients Excluded: Non-English studies; patients with delirium prior to surgery; non-surgical patients; patients with alcohol withdrawal syndrome; studies of homogenous populations of patients with central nervous diseases or mental disorders	Modified Jadad tool	Not for the 2 studies of systemic interventions reporting LOS; meta-analysis performed for all studies reporting LOS	Yes	No

AIS = acute ischemic stroke; CGA = comprehensive geriatric assessment; CNS = clinical nurse specialists; EMR = electronic medical record; EPOC = effective practice and organization of care; GRADE = Grading of Recommendations Assessment, Development and Evaluation; GTC = geriatric trauma consultation; HF = heart failure; JBI-MAStARI = Joanna Briggs Institute Meta-analysis Statistics Assessment and Review Instrument; LOS = length of stay; RCT = randomized controlled trial; ROB = risk of bias; US = United States

Table C-2. Hospital and patient characteristics of systematic reviews on reducing length of hospital stay

Author Year	Patient Age Cohort	Location, No. of Studies	Bed Size, No. of Studies	Type of Hospital, No. of Studies	Health System Affiliation, No. of Studies	Age, No. of Studies	Primary Dx & Comorbidity, No. of Studies	Medical Insurance, No. of Studies	Vulnerability/ Social Isolation Measures, No. of Studies
Austin et al. 2020[24]	Adults	Not reported	Not reported	Not reported	Not reported	>18 years	Types of anticoagulants assessed: Unfractionated heparin: 9 Vitamin K antagonists: 8 Combination of anticoagulants: 8 studies Low molecular weight heparins: 2	Not reported	Not reported
Agarwal et al. 2018[34]	Adults	Urban, rural	Not reported	Academic centers: 2 Community hospital: 2	Not reported	67.5 to 79.3 years	Heart failure	Not reported	Not reported
Baratloo et al. 2018[25]	Adult	Rural and remote areas	Not reported	Not reported	Not reported	Mean range: 60.1 to 80 years	Tissue plasminogen activator treated patients with acute ischemic stroke	Not reported	Not reported

Author Year	Patient Age Cohort	Location, No. of Studies	Bed Size, No. of Studies	Type of Hospital, No. of Studies	Health System Affiliation, No. of Studies	Age, No. of Studies	Primary Dx & Comorbidity, No. of Studies	Medical Insurance, No. of Studies	Vulnerability/ Social Isolation Measures, No. of Studies
Bryant-Lukosius et al. 2015[35]	Adults and infants	Urban and rural	Few studies reported bed size 500 to 550 beds: 2	Academic medical centers, community hospitals, non-profit acute care teaching hospital	Systems in Pennsylvania and Vermont	Patients with heart failure: mean range: 70.7 to 76 years Elderly hospitalized patients: mean range: 74.4 to 80.3 years High-risk pregnant women and infants: mean range: 23.5 to 28.5	Patients with heart failure: 3 Elderly hospitalized patients: 5 High-risk pregnant women and infants: 3	Patients with heart failure: authors reported no baseline group differences in health resource use or costs Elderly hospitalized patients: 97.5% received Medicare and 7.5% received Medicaid (1 RCT) High-risk pregnant women and infants: 65% Medicaid (1 RCT), 36.5% Medicaid (1 RCT), 65% public health insurance (1 RCT)	Patients with heart failure: 1 RCT: 43.2% <$15,000 annual income; 41.8% $15–50,000; 7.7% >$50,000 1 RCT: 33.1% <$10,000 annual income; 26.8% $10,000 to $19,999; 15.9% ≥$20,000 Elderly hospitalized patients: 1 RCT: 35% <$10,000 annual income 1 RCT: 64% (intervention) and 46% (control) <$20,000 annual income; 36% (intervention) and 46% (control) >$20,000 annual income 1 RCT: 72% <$19,000 annual income; 28% ≥$20,000

Author Year	Patient Age Cohort	Location, No. of Studies	Bed Size, No. of Studies	Type of Hospital, No. of Studies	Health System Affiliation, No. of Studies	Age, No. of Studies	Primary Dx & Comorbidity, No. of Studies	Medical Insurance, No. of Studies	Vulnerability/ Social Isolation Measures, No. of Studies
									High-risk pregnant women and infants: 1 RCT: 68% <$9999; 21% $10,000 to $49,000, 11% >$50,000 1 RCT: 31% <$9999 annual income; 25.5% $10,000 to $24,999; 43.5% ≥$25,000 1 RCT: 62% below poverty-level income
Bakker et al. 2011[26]	Adult	Not reported	Not reported	AMC: 2 Community: 2 VA: 1 Not reported: 1	Not reported	65+ years	Frail elderly	Not reported	Not reported
Eagles et al. 2020[41]	Adults	Not reported	Not reported	Level 2 trauma center: 2 (US) Level 1 trauma center: 5 (US), 1 (Canada)	Not reported	Range: 60 to 70 years	Older adults admitted to trauma center	Not reported	Not reported
Ellis et al. 2017[36]	Adults	Mostly urban	Few studies reported bed size. 60 beds: 1 1500 beds: 1	University/ teaching; VA; Community; Multi-center	Yes	Mean range: 74 to 85 years	Frail or at-risk participants: 11 Older participants: 11	Not reported	Not reported

Author Year	Patient Age Cohort	Location, No. of Studies	Bed Size, No. of Studies	Type of Hospital, No. of Studies	Health System Affiliation, No. of Studies	Age, No. of Studies	Primary Dx & Comorbidity, No. of Studies	Medical Insurance, No. of Studies	Vulnerability/ Social Isolation Measures, No. of Studies
Frazer et al. 2019[37]	Adults	Not reported	Not reported	Single hospital: 10 Multiple centers: 9	Not reported	Mean range: 46 to 77 years	History of AF, ACS, VTE, stroke/TIA, valve replacement, severe heart failure, PVD, ARDS, bridge to lung transplant, valve disease, systemic arterial embolism, left ventricular thrombus, cardiac prophylaxis	Not reported	Not reported
Gonçalves-Bradley et al. 2016[38]	Adult	Urban, rural	Few studies reported bed size Minimum bed size reported: 100 beds	US studies: Academic/ teaching: 9 VA: 2 Safety-net: 2	Most reported health system affiliation	75 years: 10 70 to 75 years: 7 <70 years: 13	Older participant: 21 Mix of medical and surgical conditions including heart failure: 5 Psychiatric hospital or general ward: 2 Admitted following fall: 2 Note: some trials included multiple population types	Not reported	Language and health literacy: 4 *Mixed evidence for non-English speakers, and evidence does not seem to support an increased or decreased effect of discharge planning for patients with low health literacy.
Gillaizeau et al. 2013[27]	Adult	4 urban, 6 not reported	4 studies reported: range 288 to 1400	AMC: 4 VA: 2 Community: 3	Not reported	Not reported	Mix includes diabetes, COPD, renal disease, etc.	Not reported	Not reported

Author Year	Patient Age Cohort	Location, No. of Studies	Bed Size, No. of Studies	Type of Hospital, No. of Studies	Health System Affiliation, No. of Studies	Age, No. of Studies	Primary Dx & Comorbidity, No. of Studies	Medical Insurance, No. of Studies	Vulnerability/ Social Isolation Measures, No. of Studies
Huntley et al. 2016[28]	Adult	For LOS: Urban: 5 Not reported: 4	Not reported	For LOS: AMC:2 Community: 5 Not reported: 2	For LOS: Yes: 2 Not reported: 7	65+ years	Congestive heart failure	Not reported	3 studies have >20% of patients with first language other than English; in 2 studies, >50% of patients are Black, other non-white, or Hispanic
Kul et al. 2012[29]	Adult	1 urban, 1 suburban, 1 rural, 4 not reported	Not reported	Not reported	Not reported	Mean: >65 years	Congestive heart failure	Not reported	Not reported
Mabire et al 2017[15,30]	Adults	Not reported	Not reported	University hospitals: 11 City hospitals: 2	Not reported	Median: 77 years	Older patients: With severe comorbidities: 1 With moderate comorbidities: 5 With low morbidities: 5	Not reported	Not reported
Patel et al. 2020[31]	Adults	Not reported	Not reported	Not reported	Not reported	>60 years	Older patients with hip fracture	Not reported	Not reported
Pannick et al. 2015[32]	Adults	Not reported	Not reported	Safety-net hospitals, large academic facilities	Yes	Mean: 63 years	Variety of primary diagnoses: delirium, community-acquired pneumonia, acute stroke, advanced liver disease, patients taking anticoagulant medication	Not reported	Not reported

Author Year	Patient Age Cohort	Location, No. of Studies	Bed Size, No. of Studies	Type of Hospital, No. of Studies	Health System Affiliation, No. of Studies	Age, No. of Studies	Primary Dx & Comorbidity, No. of Studies	Medical Insurance, No. of Studies	Vulnerability/ Social Isolation Measures, No. of Studies
Van Craen et al. 2010[39]	Adult	Not reported	Not reported	AMC: 2 Community: 1 VA: 2 Not reported: 2	Not reported	65+ years	Frail elderly	Not reported	Not reported
White et al. 2011[33]	Adult only: 25 studies Pediatric only: 10 studies All ages: 30 studies	Not reported	Not reported	AMC: 54 Community: 11	Not reported	All ages	Mix includes heart failure, COPD, psychiatric illness, substance use disorder, etc.	Not reported	Not reported
Zhu et al. 2015[12]	Adults	Not reported	Not reported	Not reported	Not reported	Mean range: 36.4 to 94 years	Older hospitalized adults: 5 Decompensated HF: 1 Hip fracture patients: 1 Rehab patients: 1 CHD: 1 Hospitalized psychiatric patients: 1	Medicare: 1	Not reported
Zhang et al. 2013[40]	Adult	Not reported	Not reported	Not reported	Not reported	Mean age: 80+ years	Frail elderly undergoing orthopedic surgery	Not reported	Not reported

ACS = acute coronary syndrome; AF = atrial fibrillation; AMC = academic medical center; ARDS = acute respiratory distress syndrome; CHD = congenital heart disease; COPD = chronic obstructive pulmonary disease; PVD = peripheral vascular disease; RCT = randomized controlled trial; TIA = transient ischemic attack; VA = Veteran Affairs; VTE = venous thromboembolism

Table C-3. Interventions to reduce length of hospital stay

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Austin et al. 2020[24]	Computerized physician order entry (CPOE): 4 Clinical decision support system (CDSS): 21 Dashboard utilization: 1 EMR implementation in general: 1	CPOE: Providers used computer assistance to directly enter medication orders from a computer or mobile device. 2 studies focused on discharge reconciliation process (warfarin prescribing), 1 study assessed impact of CPOE on medication errors and preventable adverse events, and 1 study assessed appropriateness of CPOE on pathology information. CDSS: Majority of methods assessed impact of CDSS alerts (14 studies). Additional strategies or functionality of the EMR utilized were classified according to type of CDSS.	Routine care	Providers	Not reported
Agarwal et al. 2018[34]	Clinical pathway: Multi-component interventions (5 RCTs) Education at discharge (1 RCT)	5 RCTs assessed a variety of multi-component interventions: In 2 trials these were quality improvement initiatives including inpatient critical pathway for HF management, standardized admissions orders, staff and patient HF education, home care pathway for after hospital discharge, and tailored performance reports; 3 other trials assessed multi-component interventions including components such as use of case manager, HF education, medication review, and telephone surveillance post-discharge; 1 RCT assessed 1 hour educational session at discharge.	Usual care	1 intervention included experienced consulting form assisted in implementation of the pathways and other pathway components	Not reported

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Baratloo et al. 2018[25]	Telestroke-based systems	Telephone, videoconferencing, or tele radiology used to deliver intervention.	Bedside (face to face) acute stroke care at comprehensive stroke center with 24 hour access to thrombolysis and specialized stroke expertise	Not reported	Not reported
Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists (CNS) transitional care	Early discharge interventions: 3 studies of patients with heart failure, CNSs visited patients while in hospital, had regular post-discharge contact via telephone, home visits, or home and heart failure clinic. Early discharge interventions: 3 studies of high-risk pregnant women and infants, CNSs provided direct care to hospitalized women and infants, assessed their suitability for early discharge and provided post-discharge care via home visits, telephone calls, and on-call services over several weeks. Post-discharge intervention: 5 studies of elderly hospitalized patients, CNSs and/or nurse practitioners visited patients in hospital to prepare individualized discharge plans and provide regular post-discharge follow-up home visits or telephone calls. Patients had telephone access to CNS as needed.	Usual care	Master's prepared CNS, nurse practitioner	Not reported
Bakker et al. 2011[26]	Geriatric specialty teams or units	3 studies used multidisciplinary geriatrics team to consult on patient management; 3 studies had separate geriatric unit.	Usual care	Not reported	Not reported

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Eagles et al. 2020[41]	Geriatric trauma consultation	Mandatory element in all studies was an assessment by a geriatrician. Some studies reported participation in multidisciplinary rounds (3 studies) or compliance of trauma team to geriatric recommendations (2 studies).	Standard trauma care	Geriatrician, advanced practice nurse (2 studies), resident/fellows (2 studies)	Not reported
Ellis et al. 2017[36]	Comprehensive geriatric assessment	Most common components included tailored treatment plans to the individual. 12 studies held multi-disciplinary team meetings; 11 studies included clinical leadership; 11 studies included specialty knowledge, experience, and competence; and 10 studies involved participants and carers in goal setting.	Usual care	Consultant geriatricians, healthcare assistants, junior doctors, nurses, occupational therapists, pharmacists, physiotherapists, psychiatric nurses, social workers, therapy assistants	Delivered in a dedicated geriatric ward (20 studies); mobile team on a general medical ward (8 studies)

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Frazer et al. 2019[37]	Anticoagulation consultation services Decision supported warfarin dosing Heparin monitoring systems Other CDSS Systematic education and feedback programs	Anticoagulation consultation services: Pharmacist-led anticoagulation service Decision supported warfarin dosing: Computer dosing-algorithm, linear regression dosing algorithm, genotype and clinical information dosing algorithm, mathematical formula dosing algorithm Heparin monitoring systems: Point of care coagulation monitoring, thromboelastography, heparin assay Other CDSS: Computerized electronic alert system requiring active response or with hard-stop alert, computer based decision support system Systematic education and feedback programs: Multifaceted safety program, enhanced feedback intervention	Physician-led anticoagulation service, usual physician care, standard physician-led dose adjustment, clinical information dosing algorithm, standard activated partial thromboplastin time monitoring, computerized alert system, written feedback intervention	Pharmacist, physician	Not reported
Gonçalves-Bradley et al. 2016[38]	Discharge planning	Studies included assessment, planning, implementation and monitoring (e.g., telephone, PCP appointments) phases. 7 studies evaluated a pharmacy discharge plan implemented by a hospital pharmacy. 12 studies provided post-discharge phone call, four a visit, two a phone call and visit. Most studies included a patient education component and 7 studies reported place of discharge (e.g., home residential care).	Standard care with no individualized discharge plan	Healthcare professional coordinated plan	Implemented from admission to three days prior to discharge

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Gillaizeau et al. 2013[27]	Computerized decision support	All studies used real-time computer support to guide drug dosing; drugs included: theophylline (3 studies), aminoglycoside (2 studies), oral anticoagulants (2 studies), insulin (1 study), cyclosporine (1 study); 3 studies supported computerized physician order entry.	Usual care	Not reported	Not reported
Huntley et al. 2016[28]	Case management	Studies included various strategies, usually directed by a nurse case manager, including: medication review, family conferencing, education, home environment assessment, referral to other services or medical specialties.	Usual care	Case managers	Not reported
Kul et al. 2012[29]	Clinical pathways	Descriptions of each study not given. All studies had to include pathways that met the definition of a pathway according to the European Pathway Association.	Usual care	Not reported	Not reported
Mabire et al 2017[15,30]	Nursing discharge planning interventions	All interventions comprised nurse assessment and follow-up. Some interventions continued post-discharge in the home setting (i.e. telephone contact, visits, combination); number of contacts varied widely (2 to 10+) and timing varied. Follow-up contacts were within 24 hours post discharge, others persisted up to 9 months. 5 studies included geriatric assessment; 6 studies considered discharge preparation interventions as either effective communication/ information regarding the discharge care plan; 1 study examined patient participation.	Usual care	Registered nurses and cardiac nurses (4 studies); Case managers (3 studies); Advance practice nurses (2 studies); Community nurse (1 study)	Not reported

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Patel et al. 2020[31]	Orthopedic-led care (13 studies) Geriatrics-led care (4 studies)	Interventions included co-management between orthopedic service and geriatrics/medicine service. Example of components include prompt admission with surgical optimization, fast-tracking hip fractures from ED to inpatient unit, surgeon availability, case management evaluation of patient's social dynamics/needs and anticipate discharge needs starting day of admission, brief meeting/discussion between management team, continued medical optimization (i.e. coordinating postoperative follow-up for comorbidities).	Coordinated ortho-geriatrics care model (13 studies) or orthopedic-led care model (4 studies)	Not reported	Not reported

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
Pannick et al. 2015[32]	Interdisciplinary team care 8 studies involved low-intensity interventions and remainder were of medium or high intensity	Interdisciplinary team care with altered composition: 15 studies required additional specialists or professionals to provide advice. Consultants specialized in geriatrics, infectious diseases, intravenous therapy, stroke, pharmacotherapy, or psychiatry. 4 studies assessed effect of embedding additional health care professionals in rounding teams, incorporating pharmacists, medical librarians, supervising medical subspecialists. Interdisciplinary team care addressing team practice: 10 studies addressed the logistics of when, where, and how team members would work together. 2 studies assessed team localization, with medical and nursing staff co-positioned in same geographic area in hospital. 1 study described teamwork and communication program.	Usual, routine, or standard care	Interdisciplinary teams including specialists and subspecialists, physicians, nurses, pharmacists, medical librarians	Not reported
Van Craen et al. 2010[39]	Geriatric evaluation unit	Geriatric units included many or most of the following: Assessment of medical, functional, nutritional cognitive, and psychiatric status, social situation, and quality of life Development of individual care plans Initiation of early discharge planning Ensuring rehabilitation services were available Arranging post-discharge follow-up plan	Usual care	Interdisciplinary teams including physicians, nurses, and/or social workers, dieticians, psychologists, physical/ occupational therapists	5 studies admitted patients directly to geriatric unit from home or emergency department; 2 studies admitted patients from other hospitals 4 studies specifically targeted frail patients, while 3 studies included all elderly patients Patient management teams met daily (2 studies), twice weekly (2 studies), or weekly (3 studies)

Author Year	Type of Intervention	Description of Intervention	Comparator	Resources	Implementation Features
White et al. 2011[33]	Hospitalist service	All studies used hospitalist physician structures.	Traditional attending physician structures	Not reported	Not reported
Zhu et al. 2015[12]	Nurse-led early discharge planning	Interventions included telephone-based programs, biopsychosocial assessment and individualized plans to address transitional care needs, comprehensive program for a specific condition of interest (i.e. decompensated heart failure) providing easy availability for consults and close follow-up at clinic. Nurse advocates work with patients during stay to arrange follow-up appointments, confirm medication reconciliation; discharge planning needs assessment, individualized nursing instruction, monitoring services, coordinated resources, arranging referrals and home or nursing visits (e.g., within first 48 hours of admission).	Usual care	Nurse, nurse case manager, volunteers supported by social workers	Nurse-led with or without additional support from hospital staff, family member or caregiver, or volunteers supported by social workers
Zhang et al. 2013[40]	Multicomponent interventions	1 study used geriatrics consultation service, and implementation of targeted recommendations; 1 study used staff education, team-based approach, individual care planning.	Usual care	Not reported	Not reported

CDSS = clinical decision support system; CPOE = computerized physician order entry; EMR = electronic medical record; HF = heart failure; RCT = randomized controlled trial

Table C-4. Outcomes of interventions to reduce length of hospital stay

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Austin et al. 2020[24]	CDSS (heparin-induced thrombocytopenia alerts) (1 US RCT, n=2086) Median LOS: 49.7% vs. 50.3%, p=0.94, no difference CDSS (order sets) (1 US retrospective study, n=5,879) Median LOS (hours): 68.3 hours vs. 68.9 hours, p=0.2615, no difference CDSS (general acute myocardial infarction order set) (1 US retrospective study, n=5,879) No significant difference in reduction of LOS Multiple CDSS/CPOE interventions (1 US pre-post study, n=190) No significant improvement in LOS (study reported LOS days differently for intervention and comparator, i.e., mean vs. median)	Not reported	All-cause hospitalization after 30 days (1 US retrospective study, n=5,879) 16.3% vs. 17.1%, p=0.4398, no difference	**Adverse drug events (ADEs)** CPOE (1 US pre-post study, N=NR) Significant reduction in adverse drug events (ADEs) per 1000 patient-days post CPOE implementation, 0.18 vs. 0, p=0.01, favors intervention **90-day mortality** CDSS (heparin-induced thrombocytopenia alerts) (1 US RCT, n=2,086) 29.% vs. 34.2%, OR: 1.0; 95% CI: 0.8 to 1.2, p=0.98, no difference CDSS Other alerts (effectiveness on antithrombotic medication ordering with severe CKD and ACS) (1 US prospective study, n=80) 15% vs. 12%, p=0.5, no difference **In-hospital bleeding** CDSS Other alerts (effectiveness on antithrombotic	Not reported	User satisfaction scale of 1 to 5 (how user friendly & accessible is new warfarin order) (1 study, n=28) 1=4%; 2=7%; 3=29%; 4=54%; 5=7% User acceptance/ satisfaction survey (1 study, 87 of 207 responded) 58% viewed safe transitions anticoagulation report (STAR), of these, 67% found it helpful, 58% improved workflow, 77% improved patient safety Pharmacist survey (1 study, 56 of 96 responded) 80% reported it improved documentation of Heparin-induced thrombocyte-penia	Not reported

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
				medication ordering with severe CKD and ACS) (1 US prospective study, n=80) 21% vs. 9%, p=0.12, no difference **Reduction in inpatient mortality** CDSS (general acute myocardial infarction order set) (1 US retrospective study, n=5,879) 6.5% vs. 3.5%, p<0.0001, favors intervention Multiple CDSS/CPOE interventions 1 US pre-post study (n=190) found no significant improvement in mortality (study reported data differently for intervention and comparator groups, i.e. mean vs. median) **EMR (patients with NSTEMI)** Mortality (1 US retrospective study, n=NR) OR: 0.82; 95% CI: 0.69 to 0.97, favors intervention Major bleeding (1 US retrospective		Overall satisfaction (1 study, 7-point Likert scale, n=NR) Development phase: Median: 2 (Agree), IQR: 2 to 4 Validation phase: Median: 3 (Somewhat agree), IQR: 2 to 4 (p=0.29), inconclusive	

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
				study): OR: 0.78; 95% CI: 0.67 to 0.91, favors intervention if admitted to a fully implemented EMR site A slightly lower risk of bleeding in partially implemented sites (OR: 0.81; 95% CI: 0.70 to 0.94), favors intervention Authors report no significant difference in adjusted risk of mortality or major bleeding for patients admitted with STEMI in 1 US retrospective study			

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Agarwal et al. 2018[34] *Note: Laramee 2003 and Rich 1995 are also reported in Goncalves-Bradley et al. 2016[38] and Bryant-Lukosius et al. 2015[35]	1 RCT (n=2906), compared to usual care, intervention was associated with a -1.1 days; 95% CI: -2.9 to 0.7 change in LOS, favors intervention	1 RCT found that compared to usual care, the intervention was not associated with a statistically significant change in NYHA class: 0; 95% CI: -0.4 to 0.3, p=0.88, no difference	Hospital readmission (up to 90 days after discharge) (3 RCTs [2 of 3 US], n=706 2 studies (419 combined patients) reported intervention was associated with decreased hospital readmissions up to 90 days after discharge 37% (intervention) vs. 67% (comparator), p=-0.02, favors intervention 7% (intervention) vs. 19% (comparator), absolute risk reduction: 12%, p=0.04, favors intervention 1 study (n=287), found no difference 37% (intervention) vs. 37% (comparator), p>0.99	In-hospital mortality 2 RCTs (n=74,735) reported in-hospital mortality; neither study found a statistically significant change in in-hospital mortality All-cause mortality (30 days) 1 RCT (Sales 2013) found no statistically significant change in mortality: Absolute risk reduction 0.4% (p=1.00)	3 RCTs reported on QOL (n=3,411) 1 RCT found intervention improved QOL, while 2 RCTs found no statistically significant change Ladder of Life: -0.3; 95% CI: -1.6 to 1.0 higher scores reflect better quality of life Minnesota Living with Heart Failure Questionnaire: p=0.049 Chronic Heart Failure Questionnaire (CFHQ): Mean: 22.1 (intervention) vs. 11.3 (comparator), p=0.001	Not reported	Not reported

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Baratloo et al. 2018[25]	9 trials (6 of 9 US), n=2,850 MD: -0.55 days; 95% CI: -1.02 to -0.07, p=0.02, I^2=38%, favors intervention	Not reported	Not reported	In-hospital mortality (18 trials [10 of 18 US], n=4,907) OR: 1.21; 95% CI: 0.98 to 1.49, p=0.08, I^2=0%, no difference Symptomatic Intracranial Hemorrhage (21 trials [10 of 21 US], n=4,022) OR: 1.10; 95% CI: 0.79 to 1.53, p=0.58, I^2=0%, no difference	Not reported	Not reported	Not reported
Bryant-Lukosius et al. 2015[35] *Some studies in this SR overlap with Goncalves-Bradley et al. 2016[38], Zhu et al. 2015[12], and Mabire et al. 2017[30] data reported here is not reported by the other SRs.	Elderly hospitalized patients (3 US RCTs, n=396) MD: -0.69 days; 95% CI: -1.95 to 0.56, p=0.28, no difference (SOE: Low) Very-low birth weight infants (1 US RCT, n=79) MD: -11.2 days; 95% CI: -17.8 to -4.6, p <0.05, favors intervention (SOE: Low) Infants (1 US RCT, n=93) MD: -2.7 days; 95% CI: -6.67 to 1.27, p=0.45, no difference (SOE: Low) Maternal post-partum (high-risk pregnant	Not reported	Re-hospitalization more than once for any reason at 90 days and 52 weeks patients with heart failure (2 US RCTs, n=495) RR: 0.81; 95% CI: 0.57 to 1.13, p=0.21, no difference (SOE: Low) Maternal re-hospitalizations high-risk pregnant women (1 US RCT, n=122) RR: 0.14; 95% CI: 0.01 to 2.71, p=0.19, no difference (SOE: Low) Maternal re-hospitalizations	Mortality at 6 months and 52 weeks of follow-up patients with heart failure (2 RCTs [1 of 2 US], n=345) RR: 0.76; 95% CI: 0.41 to 1.42, p=0.40, no difference (SOE: Low) Mortality during index hospitalization and 6 and 8 weeks post-discharge elderly hospitalized patients (2 US RCTs, n=443) RR: 1.05; 95% CI: 0.48 to 2.28, p=0.90, no difference (SOE: Low)	Patient satisfaction with care at 4 and 6 weeks (5-point scales converted to 100-point scales) patients with heart failure (2 US RCTs, n=403) MD: 6.09; 95% CI: 3.55 to 8.63, p<0.00001, favors intervention (SOE: Moderate) Maternal satisfaction with care at discharge and 8 weeks post-partum high-risk pregnancy (2 US RCTs, n=218) MD: 18.15; 95% CI: 11.9 to	Not reported	Authors reported that none of the studies assessed costs and outcomes jointly. There was no instance when resource use or costs were higher with CNS care but often instances when the CNS reduced resource use and costs, despite the fact that the CNS was an 'add-on' cost.

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
	women) (2 US RCTs, n=215) MD: -1.19 days; 95% CI: -1.55 to -0.83, p <0.00001, favors intervention (reduces maternal post-partum LOS) (SOE: Moderate)		before delivery high-risk pregnant women (1 US RCT, n=55) RR: 0.7; 95% CI: 0.33 to 1.47, p=0.34, no difference (SOE: Low) Infant re-hospitalizations at 2 and 8 weeks post-discharge (2 US RCTs, n=202) RR: 0.56; 95% CI: 0.21 to 1.44, p=0.23, no difference (SOE: Low)		24.4, p <0.00001, favors intervention (SOE: Low) Authors noted considerable heterogeneity for this outcome.		
Bakker et al. 2011[26]	6 studies, n=1660 patients 3 studies found no difference; 3 studies did not provide statistical analysis of results	Multiple function measures (4 studies, n=833) Most measures found no difference; 1 study favors intervention for Self Rating Depression Scale; 1 study favors intervention for Mini-Mental State Examination	2 studies, n=252 patients 1 study favors intervention; 1 study did not provide statistical analysis of results	Mortality 1 study (N=197) found no difference Complications (type not specified): 1 study (N=695) found no difference	Not reported	Not reported	1 study found reduced costs

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Eagles et al. 2020[41]	2 US retrospective cohort studies, n=5,414 MD: -1.11 days; 95% CI: -1.43 to -0.79, I^2=0%, favors intervention (post implementation)	Not reported	Not reported	<u>In-hospital mortality after vs. before implementation of GTC service</u> (6 retrospective cohort studies [5 of 6 US], n=7,408) Unadjusted OR: 0.91; 95% CI: 0.70 to 1.18, I^2=18%, no difference Intervention: 276 events Usual care: 200 events <u>In-hospital mortality with GTC vs. without GTC service</u> (2 US retrospective cohort studies, n=482) Unadjusted OR: 0.24; 95% CI: 0.12 to 0.52, $I^{2=}$0%, favors intervention Intervention: 9 events Usual care: 44 events <u>Delirium occurrence</u> (1 US retrospective cohort study, n=59) Unadjusted OR: 6.30; 95% CI: 1.80 to 21.99, favors pre-intervention (pre GTC implementation) Post-intervention: 34 events	Not reported	Not reported	Not reported

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
				Pre-intervention: 6 events			
Ellis et al. 2017[36]	17 trials reported LOS (n=5303) Geriatric assessment group: Mean LOS ranged from 1.63 to 40.7 days Control group: Mean LOS ranged from 1.8 to 42.8 days Authors did not retain meta-analysis due to high levels of heterogeneity. Trials showed inconsistency.	Not reported	Note: <50% of studies reporting readmissions were US based, therefore data is not reported	Mortality at discharge (11 RCTs [7 of 11 US], n=4346) RR: 1.04; 95% CI: 0.82 to 1.32, I^2=16%, no difference (SOE: high-certainty evidence) Intervention: 130 events Usual care: 138 events Mortality at 3 to 12 months' follow-up (21 RCTs [12 of 21 US, n=10,023) RR: 1.00; 95% CI: 0.93 to 1.07, I^2=0%, no difference (SOE: high-certainty evidence) Intervention: 1195 events Usual care: 1089 events	Not reported	Not reported	Note: Summary of costs reported in non-US currency. Therefore, cost data not reported here.

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Frazer et al. 2019[37]	Anticoagulation consultation service (physician-led) (1 US RCT, n=101) Mean (days): 12.9 vs. 13.4, p ≥0.2, no difference Decision supported warfarin dosing (1 RCT, n=75) Mean (days): 13 vs. 20, p=0.01, favors intervention	Not reported	% Unplanned readmission (1 US RCT, n=101) 19% vs. 29%	Anticoagulation consultation service (physician-led) In-hospital bleeding rates (1 US RCT, n=101): 58% lower in physician-led group; 95% CI: 2% to 82%, p=0.03, favors intervention Number of in-hospital deaths (%; 1 US RCT, n=101): 9% vs. 5%, p≥0.2, no difference Intervention: 4 events Usual care: 3 events Decision supported warfarin dosing vs. control (1 US RCT, n=1,015) Number of deaths: 0.4% vs. 0.2%, p=0.55, no difference Intervention: 2 events Usual care: 1 event	Not reported	Not reported	Costs of protocol (per patient per day) 1 US study (n=268): $31.46 vs. $27.10
Gonçalves-Bradley et al. 2016[38]	Older patients with medical condition (12 trials [6 of 12 US], n=2,193) MD: -0.73 days; 95% CI: -1.33 to -0.12, I^2=9.44%, favors intervention	Not reported	Unscheduled readmission within 3 months for patients with medical condition (15 trials [9 of 15 US], n=4,743) RR: 0.87; 95% CI: 0.79 to 0.97, I^2=28.26%, favors	Note: <50% of studies reporting harms were US based, therefore data is not reported	May lead to increased satisfaction for patients and healthcare professionals. Satisfaction was measured in different ways and findings were	May lead to increased satisfaction for patients and healthcare professionals (low certainty evidence, six trials but not specified, n=NR)	A lower readmission rate for those receiving discharge planning may be associated with lower health service costs in the

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
	(SOE: moderate certainty of evidence) Older surgical patients (2 trials [1 of 2 US], n=184) MD: -0.06; 95% CI: -1.23 to 1.11, I^2=0%, no difference		intervention (SOE: moderate certainty of evidence) Intervention: 525 events Usual care: 605 events *Lin 2009 and Jack 2009 (US) also included in Zhu SR meta-analysis for readmissions		inconsistent across studies (low certainty evidence, six trials but not specified, n=NR).		short term. Differences in use of primary care varied. (SOE: very low certainty evidence, five trials but not specified, n=NR). Findings were inconsistent. Healthcare resources that were assessed varied among studies, e.g., primary care visits, readmission, length of stay, laboratory services, medication, diagnostic imaging. The charges used to cost the healthcare resources also varied.
Gillaizeau et al. 2013[27]	9 studies, n=18507 patients SMD: -0.15 days; 95% CI: -0.33 to 0.02, I^2=57%, no difference, but leans towards favoring intervention	Not reported	Not reported	Not reported	Not reported	Not reported	1 study found reduced costs of $7,103 per patient vs. $13,759; 1 study found no difference

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Huntley et al. 2016[28]	9 studies, n=1765 patients Mean reduction: 1.28 days; 95% CI: 0.52 to 2.04, I^2=63%, favors intervention Subgroup analysis, excluding studies at high risk of bias: Mean reduction: 1.76 days; 95% CI: 1.23 to 2.29, I^2=14%, favors intervention	Not reported	13 studies, n=3346 patients RR: 0.74; 95% CI: 0.60 to 0.92, I^2=69%, favors intervention Subgroup analysis, excluding studies at high risk of bias RR: 0.77; 95% CI: 0.61 to 0.96, I^2=68%, favors intervention	Not reported	Not reported	Not reported	1 study found reduced costs but details not reported; 1 study found hospital saved $227 per Medicare patient; 1 study found overall savings after 18 months of $1.6 million; 6 studies found no difference in costs
Kul et al. 2012[29]	5 studies, n=2095 patients Mean reduction: 1.89 days; 95% CI: 1.33 to 2.44, I^2=42%, favors intervention	Not reported	5 studies, N=3006 patients RR: 0.81; 95% CI: 0.66 to 0.99, I^2=16%, favors intervention	Hospital Mortality (5 studies, N=2343 patients) RR: 0.45; 0.21 to 0.94, I^2=73%, favors intervention	Not reported	Not reported	3 studies found no difference in costs

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Mabire et al 2017[15,30]	Initial (index) hospitalization (6 studies, [3 of 6 US] n=2,370) WMD: 0.29 days; 95% CI: 0.24 to 0.35, I^2=0%, intervention increases LOS (SOE: Low)	Not reported	Readmission rates (3 US RCTs/pre-post studies, n=465) OR: 0.57; 95% CI: 0.40 to 0.81, p=0.01, I^2=0%, favors intervention Intervention: 84 events Usual care: 131 events Readmission rates (transitional care intervention) (4 RCTs [3 of 4 US], n=1,030) OR: 0.70; 95% CI: 0.38 to 1.27, I^2=69.2%, no difference Intervention: 117 events Usual care: 157 events	Not reported	Note: <50% of studies reporting QoL were US based, therefore data is not reported	Not reported	Not reported

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Patel et al. 2020[31]	10 studies showed a notable decrease in hospital length of stay when patients were admitted to either an ortho-geriatrics unit or a geriatrics unit compared with being admitted to an orthopedic unit. 2 studies found no notable difference or improvement with no statistical significance. 1 study found a notable increase.	Not reported	3 studies showed no notable difference in readmission rates when hip fracture patients were admitted to an ortho-geriatrics unit or geriatrics unit versus being admitted to an orthopedic unit. 1 study showed a notable increase in readmission rates when patients were admitted to an orthopedic unit; 1 study showed a notable decrease in readmission rates when patients were admitted to a geriatrics unit.	Post-operative mortality (in-hospital mortality and 1 year mortality rates) Five studies showed a notable decrease in postoperative mortality rates when hip fracture patients were admitted to an orthogeriatrics unit or a geriatrics unit. 11 studies showed no notable difference in mortality rates.	Not reported	Not reported	Not reported

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Pannick et al. 2015[32]	Interventions altering interdisciplinary team composition (ITC-C) (6 studies [4 of 6 US], n=NR, mixed patient population – geriatric, liver transplant, psychiatric, delirium, infectious diseases) WMD: 0.087 days; 95% CI: -0.083 to 0.257, no difference Interventions altering interdisciplinary team practice (ITC-P) (7 studies [6 of 7 US], n=NR, most studies did not specify patient population, 1 study include geriatric patients and 1 study's setting VA hospital) WMD: 0.001 days; 95% CI: -0.035 to 0.037, no difference	Not reported	**Early readmissions** ITC-C (3 US studies, n=NR, mixed patient population – infectious diseases, pneumonia, or not specified) RR: 1.341; 95% CI: 1.120 to 1.607, ITC-C tended to increase early readmissions (authors noted there were important confounding factors, factors not specified) ITC-P (5 US studies, n=NR, mixed patient population – geriatric, VA hospital, or not specified) RR: 0.995; 95% CI: 0.912 to 1.085, no difference (ITC-P did not significantly reduce early readmissions)	**Early mortality** ITC-C (7 studies [4 of 7 US], n=NR, mixed patient population – delirium, infectious diseases) RR: 0.925; 95% CI: 0.816 to 1.049, no difference ITC-P (2 studies [1 of 2 US], n=NR, population not specified) RR: 0.665; 95% CI: 0.449 to 0.986, ITC-P tended to reduce early mortality	Not reported	Not reported	Not reported

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Van Craen et al. 2010[39]	7 studies, n=4759 patients Mean reduction measured by Hedges g 0.07 days; 95% CI: -0.11 to 0.26, no difference	Functional decline at discharge (2 studies, n=2182) RR: 0.87; 95% CI: 0.77 to 0.99, favors intervention Functional decline at 12 months (2 studies, n=1654) RR: 0.84; 95% CI: 0.69 to 1.03, no difference	2 studies, n=668 patients RR: 0.85; 95% CI: 0.65 to 1.11, no difference	Hospital Mortality at 12 months (6 studies, n=4108) RR: 0.97; 95% CI: 0.88 to 1.08, no difference	Not reported	Not reported	Not reported
White et al. 2011[33]	40 studies favor intervention with reduction in LOS; 13 studies found no difference; 5 studies found longer LOS	Not reported	6 studies favor intervention with reduction in readmissions; 34 studies found no difference; 3 studies found readmissions increased	Mortality 8 studies favor intervention with reduction in mortality; 29 studies found no difference Complications (type not specified) 2 studies favor intervention with reduction in complications; 5 studies found no difference; 1 study found complications increased	Patient satisfaction 1 study favors intervention with improved satisfaction; 7 studies found no difference	Not reported	30 studies found reduced costs or charges; 10 studies found no difference; 3 studies found higher costs or charges

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
Zhu et al. 2015[12]	5 trials (4 of 5 US), n=1,912 SMD: 0.03 days; 95% CI: -0.06 to 0.12, p=0.540, I^2=0%, no difference	Not reported	10 trials (5 of 10 US), n=3,376 RR: 0.72; 95% CI: 0.58 to 0.89, p=0.002, I^2=66%, favors intervention Intervention: 368 events Standard care: 533 events *2 studies (Lin 2009 and Jack 2009) also included in Goncalves SR meta-analysis for readmissions <u>Non-older adults (< 65 years)</u> (2 US trials, n=768) RR: 0.69; 95% CI: 0.51 to 0.92, p=0.010, I^2=0%, favors intervention Intervention: 60 events Standard care: 86 events <u>Readmissions at 1 month</u> (3 trials [2 of 3 US], n=2,013) RR: 0.73; 95% CI: 0.46 to 1.15, p=0.170, I^2=75%, no difference Intervention: 136 events	<u>All-cause mortality (index admission to within 30 days)</u> (5 trials [3 of 5 US], n=2,729) RR: 0.70; 95% CI: 0.52 to 0.95, p=0.020, I^2=0%, favors intervention Intervention: 59 events Standard care: 87 events	1 US RCT (n=363): used mean scores and found little change over time and good rates of satisfaction with care in both nurse-led early DPP and control groups	Not reported	<u>Total cost</u> 1 US RCT measured total Medicare reimburse-ments for health services at 24 weeks Intervention $0.6 million vs. standard care $1.2 million, p<0.001, favors intervention

Author Year	Length of Stay	Patient Functional Return	Readmissions	Patient Harms	Patient/Family Experience	Clinician/Staff Satisfaction	Resource Use
			Standard care: 171 events <u>Readmissions at 6 months</u> (2 US trials, n=393) RR: 0.48; 95% CI: 0.37 to 0.63, p<0.001, I^2=0%, favors intervention Intervention: 50 events Standard care: 109 events				
Zhang et al. 2013[40]	2 studies, n=325 patients Study of geriatrics consultation service found no difference: Mean LOS 5 days in both groups Study of staff education, team approach, care planning favors intervention: Mean LOS 28 vs. 38 days	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported

ACS = acute coronary syndrome; CDSS = clinical decision support system; CI = confidence interval; CKD = chronic kidney disease; CNS = clinical nurse specialists; CPOE = computerized physician order entry; EMR = electronic medical record; GTC = geriatric trauma consultation; HF = heart failure; IQR = interquartile range; LOS = length of stay; MD = mean difference; NR = not reported; NSTEMI = non-ST-elevation myocardial infarction; NYHA = New York Heart Association; OR = odds ratio; QoL = quality of life; RCT = randomized controlled trial; RR = risk ratio; SMD = standardized mean difference; SOE = strength of evidence; STEMI = ST-elevation myocardial infarction; US = United States; WMD = weighted mean difference

Table C-5. Risk of bias assessment reported in systematic reviews

Author Year	Intervention	Comparator	Primary Studies: N, Design	Risk of Bias Assessment Tool	Detailed Risk of Bias Data
Austin et al. 2020[24]	Anticoagulant prescribing	Routine care	27 total studies: 3 RCTs, 4 cohort studies, 20 pre/post observational studies (n=not reported)	EPOC for RCTs and cohort studies	RCTs: Low ROB due to allocation sequence and concealment, baseline comparability of characteristics, and selective outcome reporting. Either unclear or high ROB for potential of inadequately addressing incomplete outcome data or protecting against contamination. Cohort studies: Mostly at high or unclear ROB for adequate allocation sequence or concealment, potential of not adequately addressing incomplete outcome data, protecting against contamination or knowledge of the allocated intervention. Low ROB for selective outcome reporting.
Agarwal et al. 2018[34]	Quality improvement (multi-component interventions)	Usual care	14 RCTs (n=96,913) *(N=75,664 for 6 US RCTs) reporting outcomes of interest	Cochrane ROB	Randomization: Low ROB (all 6 US RCTs) Adequate allocation concealment: Low ROB (3 US RCTs) Adequate blinding of outcome assessors: Low ROB (2 US RCTs) Attrition bias: Low ROB (4 US RCTs) Selective outcome reporting: High ROB (1 US RCT)
Baratloo et al. 2018[25]	Telestroke-based systems	Bedside (face-to-face)	26 total studies: 2 RCTs, 8 prospective observational studies, 16 retrospective observational studies (N=6,605)	Cochrane (RCTs), Newcastle-Ottawa scale (observational studies)	RCTs: Low ROB for random sequence generation, incomplete outcome data, selective reporting. High ROB due to lack of blinding participants and personnel, 1 RCT reported blinding outcome evaluators. Observational studies: Low ROB (mean of 8 out of 9 points on Newcastle-Ottawa scale)

Author Year	Intervention	Comparator	Primary Studies: N, Design	Risk of Bias Assessment Tool	Detailed Risk of Bias Data
Bryant-Lukosius et al. 2015[35]	Clinical nurse specialists transitional care	Usual care	13 RCTS (n=2,463)	Cochrane ROB	Low ROB (3 RCTs), moderate ROB (n=8) and high ROB (n=2) 16-item Quality of Health Economic Studies for economic analyses
Bakker et al. 2011[26]	Geriatric specialty teams or units	Usual care	17 total studies; 6 reported LOS: 4 RCTs, 2 observational	EPOC tool	Most studies high risk of bias
Eagles et al. 2020[41]	Geriatric trauma consultation	Standard trauma care	8 retrospective cohort studies (n=122 to 4,534)	Newcastle-Ottawa Quality Assessment Scale	Main threat to study quality was a lack of controlling for study variables. 3 studies controlled for at least two factors in their analyses. Moderate to high ROB due to selection, comparability, and outcomes.
Ellis et al. 2017[36]	Comprehensive geriatric assessment	Usual care	29 RCTs (n=13,766)	Used guidance for EPOC reviews	Random sequence generation: Low or unclear ROB (26 RCTs) Allocation concealment: High ROB (1 RCT) Blinding of participant or researchers: High ROB (all RCTs) Blinding of outcome assessors: Low ROB (most RCTs) Attrition bias: High ROB (3 RCTs), low ROB (6 RCTs), unclear ROB (18 RCTs) Selective reporting due to not publishing a protocol: Unclear ROB (25 RCTs) Other potential sources of bias: Unclear ROB (21 RCTs) Uncertainty about whether the study adequately protected against contamination (i.e. received the intervention): High ROB (6 RCTs)

Author Year	Intervention	Comparator	Primary Studies: N, Design	Risk of Bias Assessment Tool	Detailed Risk of Bias Data
Frazer et al. 2019[37]	Anticoagulant prescribing	Physician-led usual care	19 RCTs (n=12,742)	Cochrane EPOC criteria	High ROB due to randomization not clearly defined (8 RCTs) or suboptimal (10 RCTs), lack of clarity surrounding allocation concealment (7 RCTs). 3 RCTs blinded outcome assessors; 4 RCTs describe independent review of subjective results, verification of data collection. 1 RCT funded by manufacturing company.
Gonçalves-Bradley et al. 2016[38]	Discharge planning	Standard care with no individualized discharge plan	30 RCTs (n=11,964)	Cochrane ROB	Most trials low risk of Bias: 18 RCTs reported adequate allocation concealment, 28 RCTs collected data at baseline, 21 RCTs measured primary outcomes (LOS, readmissions)
Gillaizeau et al. 2013[27]	Computerized decision support	Usual care	42 total studies; 9 reported LOS: 8 RCTs, 1 observational	EPOC tool	Studies varied in quality but GRADE was not lowered due to risk of bias
Huntley et al. 2016[28]	Case management	Usual care	22 total studies; 9 reported LOS: 8 RCTs, 1 observational; 13 reported readmissions: 12 RCTs, 1 observational	Cochrane risk of bias tool for RCTs; EPOC tool for observational studies	Most RCTs low risk of bias; most observational studies high risk of bias
Kul et al. 2012[29]	Clinical pathways	Usual care	7 total studies: 3 RCTs, 1 cohort, 3 pre-post	Jadad tool for RCTs; Newcastle-Ottawa Scale for observational studies	Sensitivity analyses performed for each outcome after removing respective study with highest risk of bias

Author Year	Intervention	Comparator	Primary Studies: N, Design	Risk of Bias Assessment Tool	Detailed Risk of Bias Data
Mabire et al 2017[15,30]	Nursing discharge planning interventions	Usual care	13 total studies: 11 RCTs, 1 pilot cohort, 1 pre-post study (n=3,964)	Yes, JBI-MAStARI assessment of methodological quality	12 studies considered truly random; 7 studies met applicable criteria for blinding of participants. 11 studies clearly described blinded allocation. 12 studies described outcomes for subjects who withdrew. 9 studies reported blinded assessment procedures and 4 studies were unclear. 12 studies demonstrated group equivalency at baseline. 10 studies adequately described both intervention and control groups. All studies met criteria for consistent and clear measurement of outcomes across groups and analyzed appropriately.
Patel et al. 2020[31]	Orthopedic-led care (13 studies) Geriatrics-led care (4 studies)	Ortho-geriatrics co-management or orthopedic care led model	17 total studies: 9 retrospective studies, 6 prospective studies, 1 RCT, 1 non-RCT (n=146 to 23,973)	Oxford quality-scoring system (Jadad) for RCTs and Newcastle Ottawa grading system for non-RCTs	
Pannick et al. 2015[32]	Interdisciplinary team care	Usual, routine, or standard care	30 total studies: 8 RCTs, 9 cluster-RCTs, 8 non-RCT cluster, 4 before-after, 1 interrupted time series (n=66,548)	Cochrane ROB	No study had a low risk of bias, medium ROB (7 studies), high ROB (23 studies)
Van Craen et al. 2010[39]	Geriatric evaluation unit	Usual care	7 RCTs	Delphi list for RCTs	Most studies low risk of bias
White et al. 2011[33]	Hospitalist service	Traditional attending physician structures	65 total studies: 1 RCT, 8 non-randomized controlled trials, 1 interrupted time series, 37 cohort, 18 pre-post	Modified Downs and Black checklist, 32 items	Mean score across studies: 15; range: 5–26

Author Year	Intervention	Comparator	Primary Studies: N, Design	Risk of Bias Assessment Tool	Detailed Risk of Bias Data
Zhu et al. 2015[12]	Nurse-led early discharge planning	Usual care	10 RCTs (n=3,438)	Yes, Cochrane ROB	Sequence generation, selection bias due to failures of allocation concealment: Low ROB Performance bias related to blinding of participants and personnel: Low ROB (4 RCTs), unclear ROB (5 RCTs), high ROB (1 RCT) Detection bias: Low ROB (2 RCTs) Attrition: Low ROB (8 RCTs) Selective reporting: Low ROB (4 RCTs), high ROB (1 RCTs), unclear ROB (5 RCTs)
Zhang et al. 2013[40]	Multicomponent interventions	Usual care	38 total RCTs; 10 studies reported LOS, only 2 used a systemic intervention (others were pharmacologic)	Modified Jadad tool	Both studies scored 9/12

EPOC = effective practice and organization of care; GRADE = Grading of Recommendations Assessment, Development and Evaluation; JBI-MAStARI = Joanna Briggs Institute Meta-analysis Statistics Assessment and Review Instrument; LOS = length of stay; RCT = randomized controlled trial; ROB = risk of bias; US = United States

Table C-6. Strength of evidence for quantitative findings not assessed for systematic review authors

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
LOS (Low)	Eagles et al. 2020[41] 2 US retrospective cohort studies (n=5,414)	Medium (1 study scored all points for selection, comparability, and outcome domains. 1 study scored all points for only the selection and outcome domains.)	Direct	Consistent	Imprecise (wide CI)	Undetected	None	Geriatric trauma consultation vs. standard trauma care MD: -1.11 days; 95% CI: -1.43 to -0.79, I^2=0%, favors intervention
LOS (Low)	Baratloo et al. 2018[25] 6 retrospective controlled studies, 2 prospective controlled studies, 1 RCT (6 of 9 US) (n=2,850)	Medium (Retrospective and prospective studies low ROB on Newottowa scale. RCT low ROB for random sequence generation, incomplete outcome data, selective reporting, but high ROB for blinding participants and personnel.)	Direct	Consistent	Imprecise (wide CI)	Undetected	None	Telestroke-based systems vs. bedside (face-to-face) MD: -0.55 days; 95% CI: -1.02 to -0.07, p=0.02, I^2=38%, favors intervention
LOS (Low)	Gonçalves-Bradley et al. 2016[38] 2 RCTs (1 of 2 US) (n=184)	Medium (Both RCTs unclear ROB for random sequence generation, allocation concealment, and selective reporting. Low ROB for attrition and baseline data. 1 RCT unclear ROB and 1 RCT low ROB for blinding.)	Direct	Consistent	Imprecise (wide CI)	Undetected	None	Discharge planning vs. standard care (older surgical patients) MD: -0.06; 95% CI: -1.23 to 1.11, I^2=0%, no difference
LOS (Moderate)	Huntley et al. 2016[28] 8 RCTs, 1 non-randomized controlled study (6 of 9 US) (n=1,765)	Low	Direct	Inconsistent (>50% heterogeneity)	Precise	Undetected	None	Case management vs. usual care Mean reduction: 1.28 days; 95% CI: 0.52 to 2.04, I^2=63%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
LOS (Low)	Pannick et al. 2015[32] 2 RCTs, 2 non-RCT cluster studies, 2 before/after studies (4 of 6 US) (n=NR)	High (2 studies medium ROB, 4 studies high ROB)	Direct	Consistent	Imprecise (wide CI)	Undetected	None	Altering interdisciplinary team composition vs. usual care WMD: 0.087 days; 95%CI: -0.083 to 0.257, no difference
LOS (Low)	Pannick et al. 2015[32] 2 cluster RCTs, 3 non RCT cluster studies, 2 interrupted time series (6 of 7 US) (n=NR)	High (2 studies medium ROB, 5 studies high ROB)	Direct	Consistent	Precise	Undetected	None	Altering interdisciplinary team practice vs. usual care WMD: 0.001 days; 95% CI: -0.035 to 0.037, no difference
LOS (Moderate)	Zhu et al. 2015[12] 5 RCTs (4 of 5 US) (n=1,912)	Medium (All studies low ROB for random sequence generation, allocation concealment, attrition bias. 2 studies each unclear ROB and low ROB for blinding, and 1 high ROB for blinding.)	Direct	Consistent	Precise	Undetected	None	Nurse-led early discharge planning vs. usual care SMD: 0.03 days; 95% CI: -0.06 to 0.12, p=0.540, I^2=0%, no difference
LOS (Very Low)	Gillaizeau et al. 2013[27] 8 RCTs, 1 alternating time series study (7 of 9 US) (n=18,507)	High	Direct	Inconsistent (>50% heterogeneity)	Imprecise	Undetected	None	Computerized decision support vs. usual care SMD: -0.15; 95% CI: -0.33 to 0.02, I^2=57%, no difference in reduction of LOS, but leans towards favoring intervention
LOS (Low)	Kul et al. 2012[29] 1 RCT, 1 interrupted times series, 3 non-randomized controlled studies (3 of 5 US) (n=2,095)	High	Direct	Consistent	Precise	Undetected	None	Clinical pathways vs. usual care Mean reduction: 1.89 days; 95% CI: 1.33 to 2.44, I^2=42%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
LOS (High)	Van Craen et al. 2010[39] 7 RCTs (4 of 7 US) (n=4,759)	Low	Direct	Consistent	Precise	Undetected	None	Geriatric evaluation unit vs. usual care Mean reduction measured by Hedges g 0.07 days; 95% CI: -0.11 to 0.26, no difference
Readmissions (Moderate)	Mabire et al 2017[15,30] 3 US RCTs/pre-post studies (n=465)	Medium (1 study answered yes to 6 of 10 questions, 1 study answered yes to 9 of 10, and 1 study answered yes to 8 of 10. All studies included in SR met criteria for consistent and clear measurement of outcomes across groups and analyzed appropriately.)	Direct	Consistent	Precise	Undetected	None	Nursing discharge planning intervention OR: 0.57; 95% CI: 0.40 to 0.81, p=0.01, I^2=0%, favors intervention
Readmissions (Low)	Mabire et al 2017[15,30] 4 RCTs (3 of 4 US) (n=1,030)	Medium (1 study answered yes to 6 of 10 questions, 1 study answered yes to 8 of 10, 1 study answered yes to 9 of 10, and 1 study answered yes to all questions. All studies included in SR met criteria for consistent and clear measurement of outcomes across groups and analyzed appropriately.)	Direct	Inconsistent (>50% heterogeneity)	Imprecise (wide CI)	Undetected	None	Nursing discharge planning intervention (transitional care) vs. usual care OR: 0.70; 95% CI: 0.38 to 1.27, I^2=69.2%, no difference
Readmissions (Moderate)	Huntley et al. 2016[28] 12 RCTs, 1 non-randomized controlled study (8 or 13 US) (n=3,346)	Low	Direct		Precise	Undetected	None	Case management vs. usual care RR: 0.74; 95% CI: 0.60 to 0.92, I^2=69%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
Early Readmissions (Low)	Pannick et al. 2015[32] 2 cluster RCTs, 1 non-RCT (all US) (n=NR)	High (All studies high ROB)	Direct	Consistent	Precise	Undetected	None	Altering interdisciplinary team composition vs. usual care RR: 1.341; 95% CI: 1.120 to 1.607, intervention tended to increase early readmissions (authors noted there were important confounding factors, factors not specified)
Early Readmissions (Low)	Pannick et al. 2015[32] 2 non-RCT cluster studies, 2 interrupted time series, 1 before/after study (all US) (n=NR)	High (2 studies medium ROB, 3 studies high ROB)	Direct	Consistent	Precise	Undetected	None	Altering interdisciplinary team practice vs. usual care RR: 0.995; 95% CI: 0.912 to 1.085, no difference
Readmissions (Low)	Zhu et al. 2015[12] 10 RCTs (5 of 10 US) (n=3,376)	Medium (All studies low ROB for random sequence generation and allocation concealment. 5 studies unclear ROB for blinding of participants, personnel, and outcome assessors. 1 study high ROB and 4 studies low ROB for blinding of participants and personnel. 2 studies low ROB and 3 studies unclear ROB for blinding of outcome assessors. 7 studies low ROB for attrition bias. 4 studies low ROB, 4 studies unclear ROB for selective reporting.)	Direct	Inconsistent (>50% heterogeneity)	Precise	Undetected	None	Nurse-led early discharge planning vs. usual care RR: 0.72; 95% CI: 0.58 to 0.89, p=0.002, I^2=66%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
Readmissions (Moderate)	Zhu et al. 2015[12] 2 US RCTs (n=768)	Medium (Both studies low ROB random sequence generation and allocation concealment. 1 study high ROB for blinding participants and personnel and unclear ROB for blinding outcome assessors, unclear ROB for attrition bias and low ROB for selective reporting. 1 study unclear ROB for blinding of participants, personnel, and outcome assessors, low ROB for attrition bias, and unclear ROB for selective reporting.)	Direct	Consistent	Precise	Undetected	None	Nurse-led early discharge planning vs. usual care (Non-older adults <65 years) RR: 0.69; 95% CI: 0.51 to 0.92, p=0.010, I^2=0%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
Readmissions at 1 month (Low)	Zhu et al. 2015[12] 3 RCTs (2 of 3 US) (n=2,013)	Medium (All studies low ROB random sequence generation, allocation concealment, and selective reporting. 1 study unclear ROB for blinding of participants, personnel, and outcome assessors but low ROB attrition bias. 1 study high ROB for blinding participants and personnel and low ROB blinding outcome assessors and unclear ROB for attrition bias. 1 study low ROB for blinding participants and personnel, attrition bias, selective reporting and unclear ROB for blinding outcome assessors.)	Direct	Inconsistent (>50% heterogeneity)	Precise	Undetected	None	Nurse-led early discharge planning vs. usual care RR: 0.73; 95% CI: 0.46 to 1.15, p=0.170, I^2=75%, no difference
Readmissions at 6 months (Moderate)	Zhu et al. 2015[12] 2 US RCTs (n=393)	Medium (1 study low ROB for all domains. 1 study low ROB for random sequence generation, allocation concealment, and attrition bias and unclear ROB for blinding of participants, personnel, and outcome assessors and selective reporting.)	Direct	Consistent	Precise	Undetected	None	Nurse-led early discharge planning vs. usual care RR: 0.48; 95% CI: 0.37 to 0.63, p<0.001, I^2=0%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
Readmissions (Moderate)	Kul et al. 2012[29] 2 RCTs, 1 interrupted time series, 2 non-randomized controlled studies (3 of 5 US) (n=3,006)	Medium	Direct	Consistent	Precise	Undetected	None	Clinical pathways vs. usual care RR: 0.81; 95% CI: 0.66 to 0.99, I^2=16%, favors intervention
Readmissions (Moderate)	Van Craen et al. 2010[39] 2 RCTs (1 of 2 US) (n=668)	Low	Direct	Consistent	Imprecise	Undetected	None	Geriatric evaluation unit vs. usual care RR: 0.85; 95% CI: 0.65 to 1.11, no difference
In-hospital Mortality (Low)	Eagles et al. 2020[41] 6 retrospective cohort studies (5 of 6 US) (n=7,408)	Medium All 6 studies scored at 3 points for selection domain (max 4 pts.) or outcome domain (max 3 pts.). Only 2 studies scored a max of 2 points for the comparability domain.	Direct	Consistent	Imprecise (wide CI)	Undetected	None	After vs. before implementation of GTC service Unadjusted OR: 0.91; 95% CI: 0.70 to 1.18, I^2=18%, no difference
In-hospital Mortality (Low)	Eagles et al. 2020[41] 2 US retrospective cohort studies (n=482)	High Both studies scored 3 out of 4 for selection domain, a max of 3 for the outcome domain, and 0 out or 2 for the comparability domain.	Direct	Consistent	Precise	Undetected	None	GTC vs. without GTC Unadjusted OR: 0.24; 95% CI: 0.12 to 0.52, $I^{2=}$0%, favors intervention
In-hospital Mortality (Low)	Baratloo et al. 2018[25] 15 retrospective controlled: studies, 2 prospective controlled studies, 1 RCT (10 of 18 US) (n=4,907)	Medium (Retrospective and prospective studies low ROB on Newottowa scale. RCT low ROB for random sequence generation, incomplete outcome data, selective reporting, but high ROB for blinding participants and personnel.)	Direct	Consistent	Imprecise (wide CI)	Undetected	None	Telestroke-based systems vs. bedside (face-to-face) OR: 1.21; 95% CI: 0.98 to 1.49, p=0.08, I^2=0%, no difference

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
Early Mortality (Low)	Pannick et al. 2015[32] 4 cluster RCTs, 2 non-RCTs, 1 RCT (4 of 7 US) (n=NR)	High (1 study medium ROB, 6 studies high ROB)	Direct	Consistent	Precise	Undetected	None	Altering interdisciplinary team composition vs. usual care RR: 0.925; 95% CI: 0.816 to 1.049, no difference
Early Mortality (Low)	Pannick et al. 2015[32] 2 non-RCT cluster studies (1 of 2 US) (n=NR)	High (Both studies high ROB)	Direct	Consistent	Precise	Undetected	None	Altering interdisciplinary team practice vs. usual care RR: 0.665; 95% CI: 0.449 to 0.986, intervention tended to reduce early mortality
All-cause Mortality (index admission to within 30 days) (Moderate)	Zhu et al. 2015[12] 5 RCTs (3 of 5 US) (n=2,729)	Medium (All studies low ROB random sequence generation and allocation concealment. 2 studies unclear ROB for blinding of participants, personnel, and outcome assessors. 1 study high ROB for blinding participants and personnel and low ROB for blinding outcome assessors. 1 study low ROB for blinding participants, personnel, and outcome assessors. 4 studies low ROB for attrition bias, 3 studies low ROB for selective reporting.)	Direct	Consistent	Precise	Undetected	None	Nurse-led early discharge planning vs. usual care RR: 0.70; 95% CI: 0.52 to 0.95, p=0.020, I^2=0%, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
In-hospital Mortality (Low)	Kul et al. 2012[29] 3 RCTs, 1 interrupted times series, 1 non-randomized controlled study (3 of 5 US) (n=2,343)	Medium	Direct	Inconsistent (>50% heterogeneity)	Precise	Undetected	None	Clinical pathways vs. usual care Hospital mortality RR: 0.45; 95% CI: 0.21 to 0.94, I^2=73%, favors intervention
In-hospital Mortality (High)	Van Craen et al. 2010[39] 6 RCTs (3 of 6 US) (n=4,108)	Low	Direct	Consistent	Precise	Undetected	None	Geriatric evaluation unit vs. usual care Hospital Mortality at 12 months RR: 0.97; 95% CI: 0.88 to 1.08, no difference
Symptomatic Intracranial Hemorrhage (Low)	Baratloo et al. 2018[25] 14 retrospective controlled studies, 6 prospective controlled studies, 1 RCT (10 of 21 US) (n=4,022)	Medium (Retrospective and prospective studies low ROB on Newottowa scale. RCT low ROB for random sequence generation, incomplete outcome data, selective reporting, but high ROB for blinding participants and personnel.)	Direct	Consistent	Imprecise (wide CI)	Undetected	None	Telestroke-based systems vs. bedside (face-to-face) OR: 1.10; 95% CI: 0.79 to 1.53, p=0.58, I^2=0%, no difference
Functional Decline at Discharge (High)	Van Craen et al. 2010[39] 2 US RCTs (n=2,182)	Low	Direct	Consistent	Precise	Undetected	None	Geriatric evaluation unit vs. usual care Functional decline at discharge RR: 0.87; 95% CI: 0.77 to 0.99, favors intervention

Outcome (Strength of Evidence Grade)	Author Study Design: No Studies (N)	Study Limitations	Directness	Consistency	Precision	Reporting Bias	Other Issues	Finding
Functional Decline at 12 months (Moderate)	Van Craen et al. 2010[39] 2 US RCTs (n=1,654)	Low	Direct	Consistent	Imprecise	Undetected	None	Geriatric evaluation unit vs. usual care Functional decline at 12 months RR: 0.84; 95% CI: 0.69 to 1.03, no difference

CI = confidence interval; GTC = geriatric trauma consultation; LOS = length of stay; MD = mean difference; OR = odds ratio; RCT = randomized controlled trial; ROB = risk of bias; RR = risk ratio; SMD = standardized mean difference; US = United States; WMD = weighted mean difference

Table C-7. Research in progress

Title	Intervention	Patient Population	Expected Completion Date	Source
Activity Monitor Feedback and Interactive Tours to Improve Postoperative Ambulation	Technologically-supported feedback	Older adults; patients not fluent in English	December 2019	ClinicalTrials.gov
The Effect of Standardizing the Definition of a Clinically Significant Cardiopulmonary Event on Length of Stay	Standardization of care	Premature infants	December 2020	ClinicalTrials.gov
Comparing Two Ways for Hospitals to Help Patients Recover During and After Stroke	Integrated stroke practice unit	Patients with socioeconomic vulnerability	February 2024	PCORI
Care in the CCP [Comprehensive Care Physician] Program versus Care in the C4P [Comprehensive Care, Community and Culture] Program versus Care in Traditional Care Coordinator Program	Care coordination	Chronic co-morbid illness; older adults	April 2024	PCORI

PCORI = Patient-Centered Outcomes Research Institute