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Interventions to Decrease Hospital Length of Stay

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Key Messages

Purpose

The goals of this Technical Brief (TB) are to: 1) categorize and evaluate current knowledge regarding strategies to reduce length of stay (LOS) for patients at increased risk of extended LOS; 2) examine contextual factors (e.g., resources, costs, staffing, and 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 high-risk or vulnerable patient populations.

Key Messages

- Few studies have evaluated system-level interventions focused on high-risk or vulnerable patient populations, including frail elderly and patients with complex or chronic illness. Strategies assessed in multiple systematic reviews include geriatric consultation services and early, specialized discharge planning.
- Systematic reviews have found inconsistent evidence on the effectiveness of interventions to reduce LOS. Evidence is also limited regarding post-discharge adverse outcomes including hospital readmission and mortality.
- Substantial research gaps need to be addressed. These include: interventions for socially and 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.
- The overall evidence base examining strategies for reducing LOS is large and focuses primarily on average-risk patients undergoing elective surgery or specialized procedures. These populations were not the focus of this Technical Brief.

This report is based on research conducted by an Evidence-based Practice Center under contract to the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD (Contract No. xxxx-xxx-xxxxx). 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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This report may periodically be assessed for the currency of conclusions. If an assessment is done, the resulting surveillance report describing the methodology and findings will be found on the Effective Health Care Program website at www.effectivehealthcare.ahrq.gov. Search on the title of the report.

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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 solely based 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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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 patients at high risk for prolonged LOS due to clinical, social, or economic barriers to timely discharge.

Methods. A structured search for published and unpublished studies was conducted. We also 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 total 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 3,975 potential studies. After screening, we included 19 systematic reviews reported in 20 articles. The reviews described nine strategies for reducing LOS: geriatric assessment or consultation; discharge planning; medication management; clinical pathways; inter- or multi-disciplinary care; case management; decision support; 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, with similarly inconsistent results.

Conclusions. A broad range of strategies have been employed to reduce LOS, but rigorous systematic reviews have not consistently demonstrated their effectiveness within high risk and vulnerable populations.

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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 the 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 length of hospitalization may impact negatively 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 after surgery (ERAS) protocols,[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 risk of readmission 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, treatment for exacerbation of a complex chronic condition may benefit from interventions to reduce LOS different from those needing during treatment of an acute illness or elective surgical care.

Particular patient populations, such as patients who are socioeconomically vulnerable 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 focus on addressing the distinctive challenges of LOS reduction in these populations might increase the efficiency of patient throughput while improving 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 contributing to unnecessary delays in hospital discharge.[3] We categorized and evaluated current knowledge regarding the multitude of strategies to reduce LOS; examined contextual factors (e.g., resources, costs, staffing, and 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

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 (LHS) 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 and incorporated their feedback into a final protocol that was posted on the Effective Care Web site (https://effectivehealthcare.ahrq.gov). The protocol was also submitted to the PROSPERO database, but was not prioritized for immediate inclusion due to COVID-19.

1. Data Collection:

A. Discussions with Key Informants

The intent of Key Informant (KI) interviews is to provide context and guidance on areas most important to consider. Seven KIs provided input on this review, representing diverse leadership experiences, including in hospital administration, patient safety organizations, community-based healthcare initiatives, policy analysis, and patient advocacy. We sought KI feedback on the review's scope, including the proposed populations, interventions, comparators, outcomes, timing/setting (PICOTS). We asked about vulnerable populations at risk for unnecessary increases in LOS such as those with specific clinical conditions and demographic risk factors, as well as key components to capture for 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 some of our KI responses were written submissions.

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 a single clinical diagnosis. Therefore, we included comorbid psychiatric or behavioral health conditions, comorbid substance abuse disorder, frailty, and multi-morbidity 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 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 hospitalized for non-emergent elective procedures or surgeries, as 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 multi-component interventions initiated within an inpatient hospital setting to

directly impact 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.

Regarding outcomes, the KIs agreed that LOS metrics that provide a standardized comparison amongst 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 GQ 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 that are featured in this technical brief (TB). Table 1 presents the questions asked to the KIs.

Table 1. Questions for Key Informants

1. What clinical conditions are top priorities for you when thinking about efforts to reduce 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?

B. 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, AHRQ, The Centers for Medicare and Medicaid [CMS]). The information from this search helped to orient the team to work being conducted to reduce hospital LOS.

C. 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 May 12, 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 if refinement of the search strategy was needed to include these articles.

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 every abstract and full-text was reviewed by both a clinician and a methodologist. All disagreements were resolved by consensus discussion among the two original screeners. The literature searches will be updated during the Peer Review process, before finalization of the review.

D. Inclusion of Published Literature

Published systematic reviews (SRs) of both randomized and non-randomized primary studies were included if they met the inclusion criteria in Table 2 and certain methodological 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 non-emergent elective procedures or exclusively set in intensive care units (ICUs), emergency departments (EDs), 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. SRs 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 has a list of 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 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, ERAS, 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 ICU 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.

2. Data Organization and Presentation:

A. Information Management

We abstracted and tabled descriptive characteristics from the 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 which data points for abstraction, and how they might be organized. KI interviews were documented during each call by a designated member of the project team.

- 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 SRs)
- 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)

B. Data Presentation

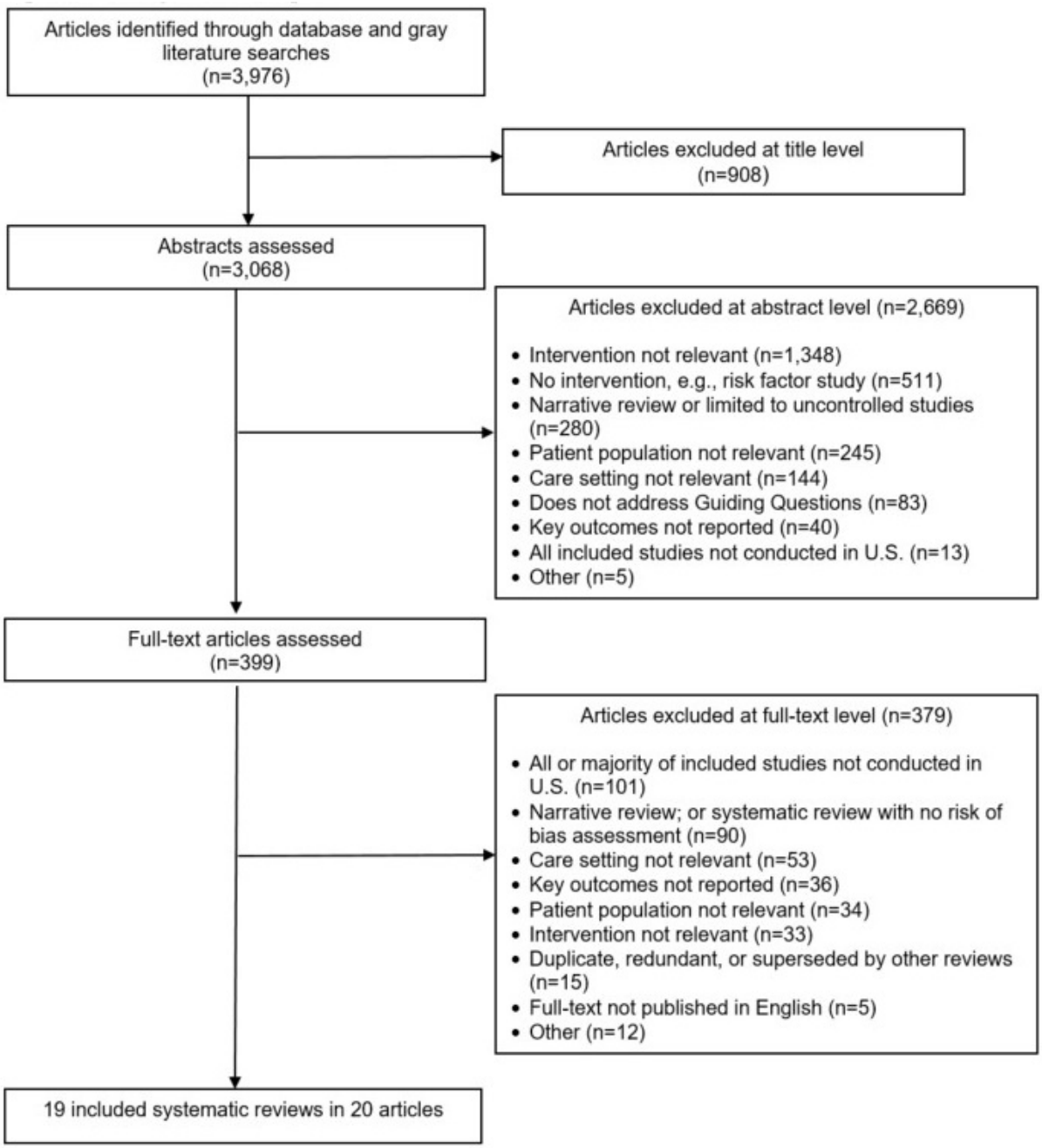
We designed a series of visual evidence maps that summarize the volume and quality of existing research for each intervention category, and describe their effects on LOS, readmissions, mortality, and other outcomes as reported. Characteristics of published SRs of randomized and non-randomized primary 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 EPC 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 3,975 potentially relevant studies, of which we excluded 908 at the title level (not relevant). We excluded 2,619 studies during abstract screening for one of the following reasons: the 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, 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 LOS were conducted outside the United States. The most common reason that 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 399 articles. We excluded 379 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 included 19 systematic reviews in 20 publications, one 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.

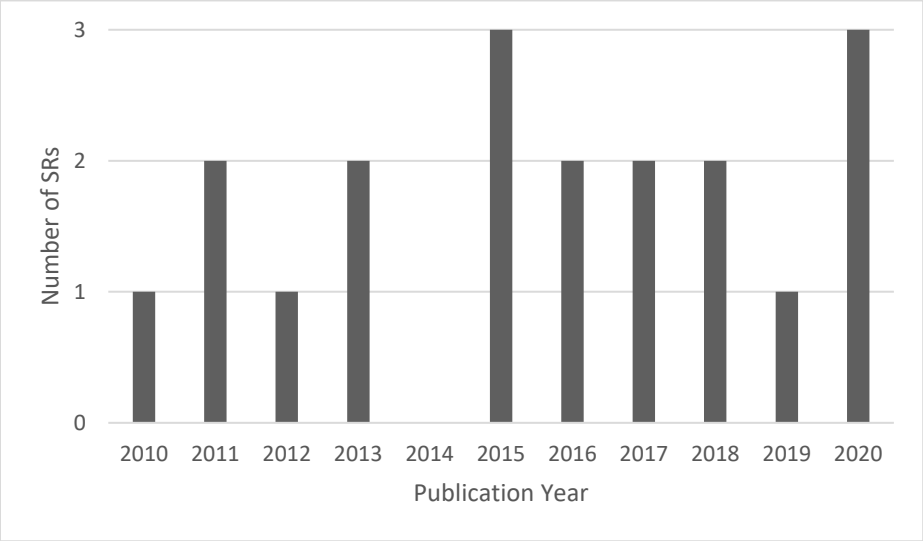
Figure 1. Study Attrition Diagram



Ten systematic reviews included a mix of study designs (e.g., RCTs, observational cohort studies),[15,24-33] eight included RCTs,[12,34-40] and one included retrospective cohorts.[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 GQ3.

Figure 2. Publication Year of Included Systematic Reviews



A search of ClinicalTrials.gov and the database of the Patient-Centered Outcomes Research Institute (PCORI) identified 11 trials of interventions to decrease hospital length of stay (LOS) currently underway in the United States. Four of these trials are evaluating system-level interventions and include patients at higher risk for poor outcomes. These trials are listed in Appendix C.

Characteristics of Interventions to Decrease Length of Stay (GQ 1)

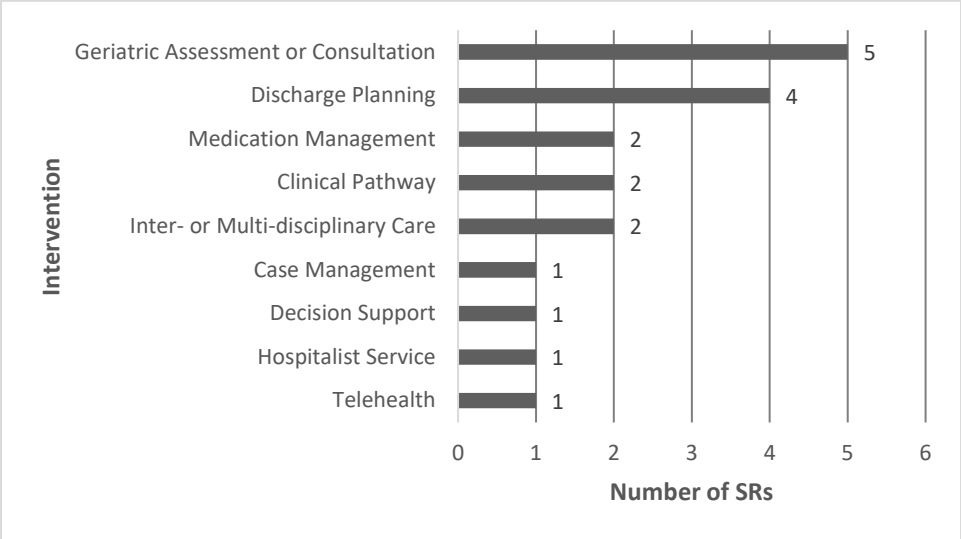
Type of Interventions

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

- geriatric assessment or consultation,[26,31,36,39,41]
- discharge planning,[12,15,30,35,38]
- medication management,[24,37]
- clinical pathways,[29,34]
- inter- or multi- disciplinary care,[32,40]
- case management,[28]
- decision support,[27]
- hospitalist service,[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 GQ4.

Figure 3. Number of Systematic Reviews per Intervention Type



Geriatric Assessment or Consultation

Geriatric assessment or consultation was assessed in five systematic reviews.[26,31,36,39,41] This type of intervention often included a geriatrician or multi-disciplinary healthcare professional team (e.g., geriatrician, advanced nurse, physicians, pharmacist, social workers) providing consultation on patient management or participating in various stages of care (e.g., initial assessment, developing treatment plans, goal setting, post-discharge plan). Patel et al. 2020[31] assessed a co-managed orthopedic-led and geriatric-led intervention which 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 post-operative follow-up for patients with co-morbidities.

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 post-discharge follow-up. Follow-up care involved a phone call within 24-hours of discharge, scheduling outpatient visits, home visits, and/or on-call services.

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 physician order entry (CPOE), clinical decision support systems (CDSS), dashboard utilization, and electronic medical record (EMR) 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 the appropriateness of CPOE 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).

Clinical Pathway

In the two systematic reviews examining clinical pathways, Agarwal et al. 2018[34] included studies on multi-component 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 post-discharge. 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 Multi-Disciplinary Care

Pannick et al. 2015[32] and Zhang et al. 2013[40] examined inter- or multi-disciplinary interventions to decrease LOS compared with usual care. The interventions assessed in the systematic review by Pannick et al. included an altered team composition which required additional specialists (e.g., psychiatry, stroke) or professionals to provide advice or embedding specialists in rounding teams. The authors also assessed an inter-disciplinary 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

In the systematic review by Huntley et al. 2016[28] case management was assessed 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.

Decision Support

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

Hospitalist Service

White et al. 2011[33] assessed hospitalist physician structures that have significantly redesigned delivery of inpatient care over the past 25 years. The 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 stroke patients by linking healthcare providers at the point of care to clinical expertise outside of the 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

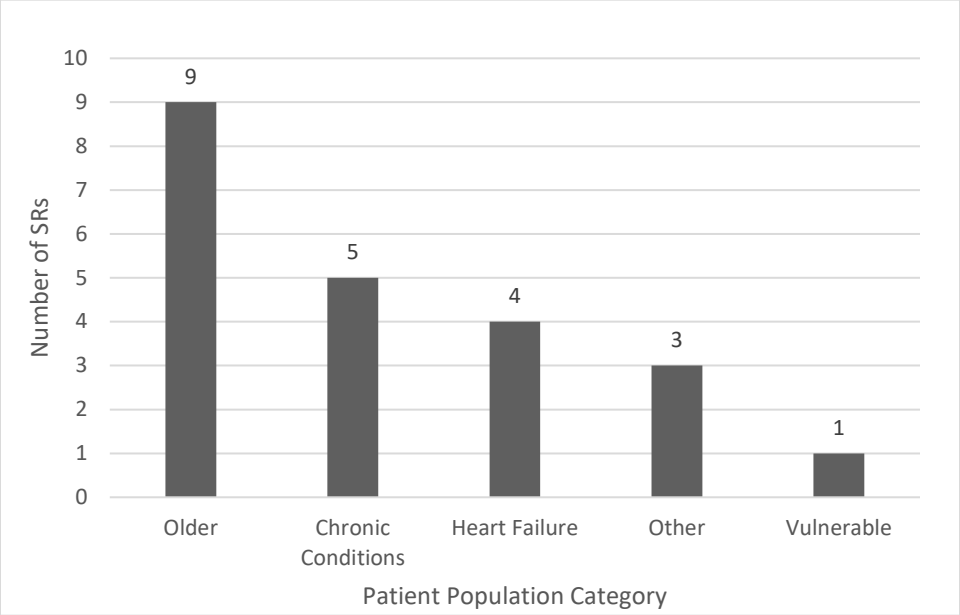
Systematic reviews reported only limited information about the setting of included studies. Thirteen reviews all described interventions conducted in multiple types of hospitals, including academic medical centers, community hospitals, and, less frequently, Veterans Affairs hospitals. One systematic 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

The population of interest for this report included vulnerable and medically complex 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 multi-morbidity, patients with heart failure, vulnerable patients (e.g., low socioeconomic status), and patients with other conditions (e.g., stroke).

Nine systematic reviews in ten 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 birth weight infants,[35] acute ischemic stroke patients,[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 one 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 non-clinical 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 to Decrease Length of Stay (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 prior to 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 delivery of the intervention (e.g., physician, nurse, multi-disciplinary team).

Effectiveness of Interventions to Decrease Length of Stay (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 of the systematic reviews quantitatively synthesized their results, with some instead presenting either a narrative synthesis or data from individual studies. Table 3 displays outcomes reported in the included systematic reviews. The interventions are organized alphabetically. The shaded circles indicate the type of synthesis performed for each outcome that was reported. A solid black circle indicates a meta-analysis was performed, while a shaded grey circle indicates the authors conducted a meta-analysis and either narratively synthesized some findings or reported individual study data. A white (i.e., unshaded) circle indicates only a narrative synthesis or reporting of individual study data.

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
Case Management	Huntley et al. 2016[28]	Heart failure	**Q**		**Q**				**N**
Clinical Pathway	Agarwal et al. 2018[34]	Heart failure	**N**	**N**	**N**	**N**	**N**		
Clinical Pathway	Kul et al. 2012[29]	Heart failure	**Q**		**Q**	**Q**			**N**
Decision Support	Gillaizeau et al. 2013[27]	Chronic conditions	**Q**						**N**
Discharge Planning	Mabire et al 2017[30] Mabire et al. 2016[15]	Older	**Q**		**Q**				
Discharge Planning	Gonçalves-Bradley et al. 2016[38]	Older	**Q**		**Q**		**N**	**N**	**N**
Discharge Planning	Bryant-Lukosius et al. 2015[35]	Older, heart failure, vulnerable (high-risk pregnant women), other (infants)	**QN**		**QN**	**Q**	**Q**		**N**
Discharge Planning	Zhu et al. 2015[12]	Chronic conditions	**Q**		**Q**	**Q**	**N**		**N**
Geriatric Assessment or Consultation	Bakker et al. 2011[26]	Older	**N**	**N**	**N**	**N**			**N**
Geriatric Assessment or Consultation	Eagles et al. 2020[41]	Older	**Q**			**QN**			
Geriatric Assessment or Consultation	Ellis et al. 2017[36]	Older				**Q**			
Geriatric Assessment or Consultation	Patel et al. 2020[31]	Older	**N**		**N**	**N**			
Geriatric Assessment or Consultation	Van Craen et al. 2010[39]	Older	**Q**	**Q**	**Q**	**Q**			

Type of Intervention	Author Year	Population Category	LOS	Patient Functional Return	Readmissions	Patient Harms	Patient/ Family Experience	Clinician/Staff Satisfaction	Resource Use
Hospitalist Service	White et al. 2011[33]	Chronic conditions	**N**		**N**	**N**	**N**		**N**
Inter- or Multi-disciplinary Care	Pannick et al. 2015[32]	Chronic conditions	**Q**		**Q**	**Q**			
Inter- or Multi-disciplinary Care	Zhang et al. 2013[40]	Older	**N**						
Medication Management	Austin et al. 2020[24]	Other (prescribed anticoagulants)	**N**		**N**	**N**		**N**	
Medication Management	Frazer et al. 2019[37]	Chronic conditions	**N**		**N**	**N**			**N**
Telehealth	Baratloo et al. 2018[25]	Other (stroke)	**Q**			**Q**			

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

Below, we present reported information on effectiveness from SRs providing quantitative synthesis of outcomes of interest (e.g., LOS, readmissions), organized by type of intervention. 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 type of intervention.

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 for key outcomes, and patient population addressed for each intervention. In the left panel, direction of effect is represented by an arrow pointing up (an increase), down (a decrease), or a horizontal arrow (inconclusive). The strength of evidence (SOE) is represented by different shading within the arrows, specifically: High SOE (solid black arrow); Moderate SOE (grey arrow); Low/Very Low SOE (unshaded arrow). The right panel denotes the patient population for each systematic review.

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

Figure 5. Number of RCTs and non-RCTs in Systematic Reviews with a Quantitative Synthesis for Length of Stay

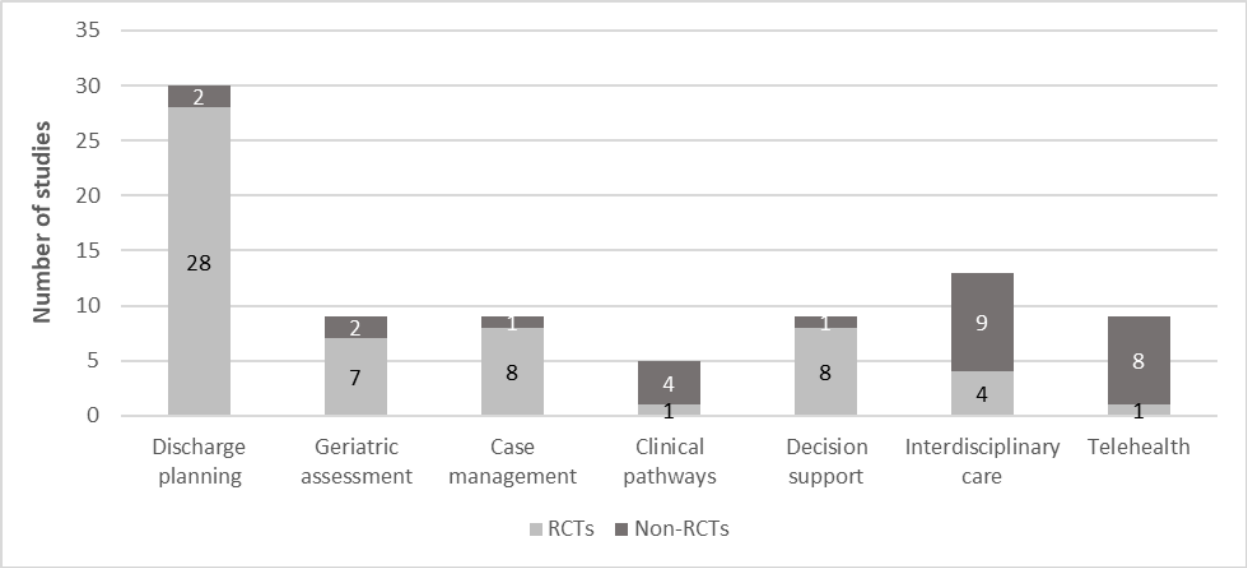


Figure 6. Evidence Map for Length of Stay, Readmissions, Mortality, and Other Adverse Events

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		√							
Case Management	*Huntley 2016*	↓M	↓M						√				
Clinical Pathways	*Kul 2012*	↓L	↓M	↓M					√				
Decision Support	*Gillaizeau 2013*	↔L										√	
Interdisciplinary Care	*Pannick 2015 (altering team composition)*	↔M	↑L	↔M								√	
	Pannick 2015 (altering team practice)	↔M	↔L	↓M								NR	
Telehealth	*Baratloo 2018*	↓M		↔M	↔M								√

Direction of Effect: (arrow direction)	↑ Increase	*Strength of Evidence: (superscript letter)*	H High
	↓ Decrease		M Moderate
	↔ Inconclusive		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 post-partum 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*

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
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*
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*
Decision Support	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 towards favoring intervention	Very 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*
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 SRs 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)	Re-hospitalizations at 2 and 8 weeks post-discharge 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	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
			disease, hospitalized psychiatric patients			
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*
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*
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*

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 SRs 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 follow-up 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 post-discharge 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]	Geriatric trauma consultation (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 months' follow-up RR: 1.00, 95% CI: 0.93 to 1.07, I^2=0%, no difference	High

Type of Intervention	Author Year	Comparison	Population	Study Design: No. Studies (N)	Findings and Direction of Effect	Strength of Evidence
Geriatric Assessment	Van Craen et al. 2010[39]	Geriatric evaluation unit vs. usual care	Frail elderly	6 RCTs (n=4,108)	Hospital Mortality at 12 months RR: 0.97, 95% CI: 0.88 to 1.08, no difference	High*
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 SRs 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 post-partum 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 SRs 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 there were findings within an intervention category that the authors summarized narratively or reported individual trial data, we included this information in the summary below. Furthermore, some authors did not assess the strength of evidence for the quantitative findings of a given outcome. Therefore, we used AHRQ EPC guidance[23] to assess the strength of evidence for these outcomes.

Reviews of two intervention types, medication management and hospitalist services, only provided narrative syntheses or findings from individual studies. A summary of the findings from systematic reviews assessing these interventions is located at the end of the section.

Discharge Planning

Four systematic reviews assessed discharge planning. All of 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).[37] Another review found no difference in LOS based on 3 RCTs (SOE: Low),[34] while one review reported that LOS increased, based on 4 RCTs and 2 observational studies (SOE: Low).[14,29] A review that combined results for older adults, patients with chronic disease, and patients with psychiatric illness found no difference in LOS based on 5 RCTs (SOE: Moderate).[11] Finally, one review found a reduction in LOS in high-risk pregnant women based on 2 RCTs (SOE: Moderate) and in very-low birth weight infants based on 1 RCT (SOE: Low).[35]

These four systematic reviews also examined readmissions but measured the outcome in different ways, such as unscheduled readmissions within three months or re-hospitalization 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 2 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 1 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 (SOE: High).[11] Conversely, Bryant-Lukosius et al. 2015[35] found no difference in mortality at six months or one year for patients with heart failure based on two RCTs (SOE: Low), and no difference at six and eight weeks post-discharge in older patients, based on 2 RCTs (SOE: Low).

Two reviews examined patient satisfaction. One review found that patients with heart failure had better satisfaction with care at four and six weeks in the intervention group, based on 2 RCTs (SOE: Moderate).[34] Furthermore, the findings suggest that high-risk pregnant women in the discharge planning group were more satisfied with care at discharge and eight weeks post-partum, based on 2 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 short-term health care 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 2 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 7 RCTs (SOE: High). Of note, the interventions assessed by Van Craen 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 ten 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 the risk of readmissions 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 that 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 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 that there is no difference in the risk of hospital mortality 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 one 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 five studies showed a decrease in postoperative mortality rates while eleven studies showed no difference.

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 2 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. The findings suggested that most functional measures found no difference in older patients, but one study found favored the intervention using the Self Rating Depression Scale and one study favored the intervention using the Mini-Mental State Examination.[42]

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

Case Management

Case management in patients with congestive heart failure was examined in a systematic review of 8 RCTs and one observational study.[28] Case management reduced LOS (SOE: Moderate) and also suggested a lower risk of readmission (SOE: Moderate). The authors also described costs reported in the primary studies, although a meta-analysis of these data was not performed. One study found that costs were reduced, however limited details were provided. Another study found that case management saved a hospital $225 per Medicare patient. A third study reported that the overall savings after 18 months of implementing the intervention totaled $1.6 million. Six studies found no difference in cost between case management and usual care.

Clinical Pathway

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 two of three 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.

Decision Support

A systematic review of 8 RCTs and one observational study examined computerized decision support in patients with chronic illnesses such as diabetes, chronic kidney disease, and chronic obstructive pulmonary disease (COPD)[27] The authors found no difference in the reduction of LOS, although the findings leaned towards favoring the intervention (SOE: Very Low). Two primary studies included in the review also reported findings related to cost of implementation. One study found that computerized decision support resulted in a cost of $7,103 per patient compared with $13,759 in the usual care group. Another study found no difference in costs between groups.

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 risk of readmission (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, but one study found that mean LOS was reduced from 38 to 28 days.

Telehealth

Telestroke-based systems were compared with bedside (face-to-face) care in one systematic review.[25] The authors found reduced LOS in patients with acute ischemic stroke treated with tissue plasminogen activator, based on one RCT and 8 observational studies (SOE: Low). No difference in the risk of mortality was reported, based on one RCT and 17 observational studies (SOE: Low), and there was no difference in symptomatic intracranial hemorrhage reported in one RCT and 20 observational studies (SOE: Low).

Medication Management

Two systematic reviews examined strategies for managing anticoagulant prescribing compared with usual care.[24,37] One review assessed computerized physician order entry (CPOE) systems and clinical decision support systems (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 one large observational study but no difference in three smaller studies in the same review.[24] The other review also found no effect on mortality.[37] Medication management was viewed as having a positive effect on patient safety in one review.[24] Finally, one study reported that the cost of an anticoagulant prescribing intervention per patient per day was $31.36 compared to $27.10 for the usual care group.

Hospitalist Service

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 a reduction in LOS 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, and 2 studies reported a reduction in complications while 5 found no difference and one study reported that complications increased. Patient satisfaction improved in one study but yielded no difference in 7 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.

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 that require acute and immediate medical care, and populations that 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 that include primary studies of which at least a majority were conducted in the United States. These limits on our scope resulted in only 19 systematic reviews that addressed our Guiding Questions, out of nearly 4,000 studies identified 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 indeed 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 the effectiveness of one type of medication compared with another, such as various anesthesia regimens or analgesic drugs, to improve patient recovery times and thus reduce length of stay. While these studies are important, they address issues that are fundamentally clinical rather than systemic, and are generally managed by hospital formulary committees, clinical departments, and individual physicians. Similarly, we 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, but these interventions are primarily about selecting a technique rather than implementing a process of care, and tend to be provider-driven rather than organizational interventions; therefore, we defined them as beyond the scope of this Technical Brief.

Another common strategy designed largely to reduce LOS is a bundle of surgical processes often referred to as enhanced recovery after surgery (ERAS). Our searches identified 122 articles that examined ERAS 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 ERAS, rather than systematic reviews. In the end, we did not identify any systematic reviews of ERAS applied to medically complex or otherwise vulnerable patients.

In contrast to the large body of work published on ERAS, 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 16 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. All of these reviews were excluded 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 type of intervention, 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 COPD patients, and 19 reviews of patients with chronic kidney disease. These reviews were not included because they focused on nonsystematic interventions, were conducted in outpatient or specialized inpatient settings (such as intensive care units), or lacked sufficient methodological rigor.

The second main challenge presented by the current state of evidence is the almost complete lack of research incorporating patients who face severe social or economic barriers to achieving and maintaining wellness before, during, and after a hospitalization. We identified no reviews in our searches – regardless of whether they were included or excluded from our analysis – that explicitly included 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 114 reviews because at least half their primary studies were not based in the U.S. This highlights the need for additional funding of both primary research and evidence synthesis that is applicable to the unique characteristics of American 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 197 systematic reviews. Of these, 122 were based in intensive care settings, while 49 were in the emergency department. This suggests strong interest in designing interventions to improve patient flow through the bottleneck of the emergency department and the resource-intense critical care unit, but further research is needed on interventions that impact 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 see if 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 in 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 or 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 370 articles that were narrative reviews, or 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 a surprisingly large number of the 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 U.S. 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, there remains a need for additional primary research on interventions to reduce hospital LOS in the United States.

Summary and Implications

In this report, we summarize evidence from SRs assessing structural interventions that health systems can implement broadly across departments or entities for medically complex and vulnerable patients requiring acute medical care. We identified 19 systematic reviews in 20 articles that assessed nine interventions: geriatric assessment or consultation, discharge planning, medication management, clinical pathways, inter- or multi-disciplinary care, case management, decision support, hospitalist service, 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 psychiatric comorbidities.

Frequently Studied Interventions

Identifying a broad system-level intervention or approach to reduce 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 SRs examined geriatric assessment and this intervention often included a patient management consultation by a geriatrician or multi-disciplinary healthcare team to assess needs, develop or review treatment plans, set goals, and/or develop post-discharge plans. Discharge planning was assessed in four SRs and this intervention was often nurse-led and included an initial assessment and plan for in-hospital care, patient education, and a plan for post-discharge care and follow-up (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 were focused on non-systematic 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., COPD, diabetes). We identified very few reviews that addressed non-clinical 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 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 suggests 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 fourteen 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 implementation process and resources used to support implementation were often not reported. Not all primary studies informing the SRs 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, SRs simply indicated a provider (e.g., nurse, clinician) or multi-disciplinary team led or participated in implementing the intervention. Availability of current resources, such as staff with particular expertise will undoubtedly impact the feasibility of successfully implementing many interventions. For example, several SRs 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 impact ultimate success.

Trade-Offs and Implications

System-level interventions have the potential to create trade-offs between outcomes, such as LOS and post-discharge 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 to also standardize the way outcomes are reported.

Our findings suggest that at present there is no existing intervention or approach which can be implemented to decrease LOS for broad populations of medically complex or otherwise vulnerable patient populations. In fact, attempting to implement an unfocused broad-based intervention may have unintended consequences and lead to worse outcomes. Instead, hospitals and health systems may need to carefully consider their own local contexts and populations when assessing if particular interventions would be a good fit. Input from our KI's 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 high-risk and vulnerable patients post-discharge.

Overall, understanding the key challenges and needs of a hospital or health system and its surrounding community may help to inform the development of a strategic plan when seeking 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:

- Understand different populations with varying risk levels within hospitals attempting to reduce LOS
- Explore specific interventions matched to 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 high risk and vulnerable populations and other patient-centered outcomes (e.g., functional decline, patient experience, mortality, and readmissions) and other patient safety and quality metrics
- Evaluate opportunities to support research and implementation of system-level interventions targeting high risk or vulnerable populations
- Engage community leaders to leverage the breadth of community resources to manage high-risk and vulnerable populations
- Work with policy makers to identify best approaches to reducing hospital LOS in the American healthcare delivery systems

Researchers can:

- Conduct research focused on traditional medical inpatient wards
- 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
- Include and subgroup patients facing severe social and economic barriers to achieving and maintaining wellness before, during, and after a 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 after surgery (ERAS) protocols and patient mobility programs in medically complex or otherwise vulnerable patient populations
- Conduct well-designed systematic reviews, such as assessing the risk-of-bias of primary studies and providing the strategy for the literature search

Policymakers can:

- Support new research and development with additional funding of both primary research and evidence synthesis applicable to the unique characteristics of the American healthcare delivery system

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