Hospitalized Patients' Knowledge of Care: a Systematic Review

Arielle E. Sommer, MD[1], Blair P. Golden, MD[2], Jonna Peterson, MLIS[3], Claire A. Knoten, PhD[4], Lyndsey O'Hara, RN[5], and Kevin J. O'Leary, MD, MS[5]

[1]Department of Medicine, Ronald Reagan UCLA Medical Center, Los Angeles, CA, USA; [2]Department of Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, USA; [3]Galter Health Sciences Library and Learning Center, Northwestern University Feinberg School of Medicine, Chicago, IL, USA; [4]Northwestern Memorial Healthcare, Chicago, IL, USA; [5]Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, USA.

BACKGROUND: Patients' comprehension of their medical conditions is fundamental to patient-centered care. Hospitalizations present opportunities to educate patients but also challenges to patient comprehension given the complexity and rapid pace of clinical care. We conducted a systematic review of the literature to characterize the current state of inpatients' knowledge of their hospitalization, assess the methods used to determine patient comprehension, and appraise the effects of interventions on improving knowledge.

METHODS: We searched MEDLINE, EMBASE, and the Cochrane Library for articles published from January 1, 1995 through December 11, 2017. Eligible studies included patients under inpatient or observation status on internal medicine, family medicine, or neurology services. We extracted study characteristics (author, year, country, study design, sample size, patient characteristics, methods, intervention, primary endpoints, results) in a standardized fashion. The quality of observational studies was assessed using the NIH Quality Assessment Tool for Observation Cohort and Cross-Sectional Studies and the quality of interventional studies was assessed using adapted EPOC criteria from the Cochrane Collaboration.

RESULTS: Twenty-eight studies met the criteria for inclusion, including 17 observational studies and 11 interventional studies. Patient knowledge of all aspects of their hospitalization was poor and patients often overestimated their knowledge. Older patients and those with lower education levels were more likely to have poorer knowledge. Intervention methods varied, but generally showed improvements in patient knowledge. Few interventional studies assessed the effect on health behaviors or outcomes and those that did were often underpowered.

DISCUSSION: Clinicians should be aware that comprehension is often poor among hospitalized patients, especially in those with lower education and advanced age. Our results are limited by overall poor quality of interventional studies. Future research should use objective, standardized measures of patient comprehension and interventions should be multifaceted in approach, focusing on knowledge improvement while also addressing other factors influencing outcomes.

KEY WORDS: health knowledge; comprehension; hospitalization; patient education; patient adherence; patient-centered care.

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BACKGROUND

Patient-centered care has received increasing emphasis in recent years and can be defined as a partnership between patients and providers in which patients have the knowledge and opportunity to engage in shared decision-making.[1–3] Patients' comprehension of their disease, current therapies, and expected outcomes is fundamental to patient-centered care. Hospitalizations present not only opportunities for patient-centered care but also unique challenges given the complexity and rapid pace of clinical care. For some patients, the capacity to learn new information may be impaired by acute illness, medications, or prior knowledge gaps.

Perhaps not surprisingly, several studies have found that hospitalized patients have incomplete knowledge of important components of their care, such as admission diagnoses, planned tests and procedures, the names and purposes of their medications, and the names and roles of hospital team members.[4–8] Furthermore, the literature describing patient knowledge differs in methods of assessment and domains measured.

We were unable to identify any prior systematic reviews on the state of patient knowledge in the inpatient setting. A summary of this issue is an important step in achieving patient-centeredness in the inpatient setting. Thus, we conducted a systematic review to characterize the current state of inpatients' knowledge of their hospitalization, methods of knowledge assessment, and where applicable, effects of interventions on improving knowledge. Given the scope of this subject, we chose to focus on patient knowledge during hospitalization and shortly after discharge. When available, we sought to elucidate any association between patient

knowledge and health behaviors (e.g., medication adherence) and clinical outcomes (e.g., hospital readmission), though this was not the primary aim of the review.

METHODS

Registration, Protocol, and Disclosures

This review was registered with Prospero (CRD42017059933). The authors declare that they do not have a conflict of interest.

Literature Search and Study Selection

A medical librarian (J.P.), with training in systematic review methodology, searched MEDLINE, EMBASE, and the Cochrane Library for articles published from January 1, 1995 through December 11, 2017. The following subject terms and keywords were used: inpatients, knowledge, comprehension, hospitalization, patient discharge, discharge planning, and goals of patient care (Appendixes 1, 2, and 3). We limited results to English language publications of randomized controlled trials, prospective analyses, retrospective analyses, case control, cohort, cross-sectional, and non-controlled before-and-after studies that were published in peer-reviewed journals. During review, eligible studies included patients under inpatient or observation status on internal medicine, family medicine, or neurology services. Studies on pediatric, surgical, obstetric, emergency room, or psychiatric patients were excluded, as were descriptions of patient perceptions, systematic reviews, and qualitative studies. We also excluded studies evaluating patient knowledge more than 7 days post-discharge.

Review Process

We used a three-step review process. One of the four authors (A.S., B.G., C.K., and L.O.) independently reviewed each title for inclusion using a web-based tool (Covidence systematic review software; Veritas Health Innovation). Early on, five authors (A.S., B.G., C.K., L.O., and K.O.) reviewed 80 studies as a group to ensure standardization of the review process. Subsequently, pairs of reviewers independently screened all remaining abstracts. When disagreements arose and primary reviewers could not reach a consensus, the other authors were consulted to resolve the disagreement. For abstracts identified as potentially relevant, two authors (A.S. and B.G.) reviewed the full-text articles, determining final inclusion of studies by consensus. When consensus could not be reached, a third reviewer (K.O.) resolved the disagreement.

Data Extraction and Synthesis

Two authors (A.S. and B.G.) extracted study characteristics (first author, year, country, study design, sample size, patient characteristics, methods, intervention, primary endpoints, results) from the final list of included studies. The authors independently abstracted the data and then reviewed and confirmed the accuracy of the others' work. Studies were categorized by domain of knowledge assessed (e.g., medications, diagnosis) and method of assessment (e.g., self-report, comparison to primary source). The quality of each observational study was assessed by K.O. and A.S. or K.O. and B.G., using the NIH Quality Assessment Tool for Observation Cohort and Cross-Sectional Studies.[9] The quality of each interventional study was assessed by both A.S. and B.G. using an adapted EPOC criteria from the Cochrane Collaboration tool for assessing risk of bias.[10]

Analysis

Whenever possible, we calculated Cohen's *d* to estimate the effect size for continuous variables and odds ratios with confidence intervals for dichotomous variables. Due to the variation in domains of knowledge assessed and the heterogeneity of methods used, we were unable to pool results and conduct a meta-analysis.

RESULTS

Study Selection and Description

A total of 18,017 unique records were identified, 11 of which were identified from citations during full-text reviews (Fig. 1). A total of 17,439 records were excluded due to lack of relevance during title reviews and 432 were excluded during abstract review. The remaining 146 articles underwent full-text review, yielding 28 articles for inclusion.

The majority (17) of studies were observational. Of these, 15 were cross-sectional or descriptive and two were prospective cohort studies (Table 1). Eleven studies were interventional, among which five were randomized controlled trials, five were non-randomized controlled trials, and one was a historically controlled trial (Table 2).

Most studies focused on general adult populations; however, some evaluated patients admitted to a specialty ward or with a particular diagnosis. The most common specific diagnoses (9 of 27 studies) were heart failure, acute coronary syndrome, and pneumonia.[17, 19–21, 23, 24, 29, 30, 35] Other studies focused on patients with HIV infection, stroke, organ transplantation, or patients taking warfarin.[16, 26, 33, 36]

Observational Studies

Among the 17 observational studies, 15 were cross-sectional or descriptive and two were prospective cohort studies (Table 1). The quality was assessed using the NIH Quality Assessment Tool for Observation Cohort and Cross-Sectional Studies.[9] One study was rated as good quality, 11 were rated as fair, and 5 were rated as poor (Table 3).

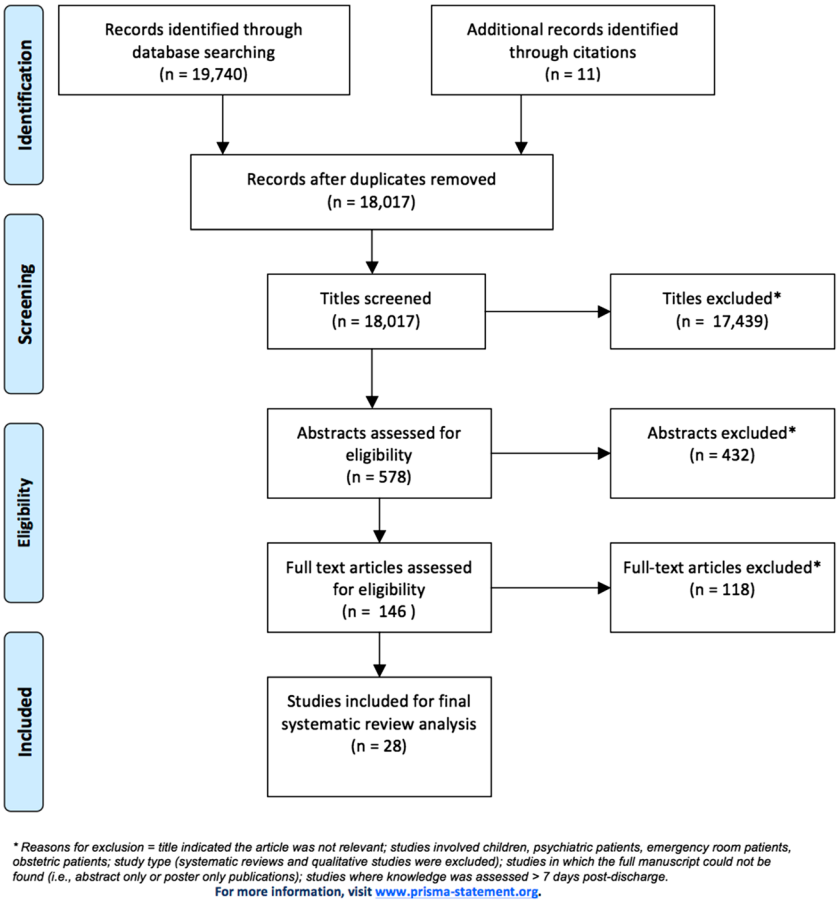

Figure 1 PRISMA flow diagram.

Medication-Focused Studies. Eleven out of 27 studies assessed knowledge of prescription medications and generally found it to be poor (Table 1).[6, 13, 15, 16, 20, 22, 27, 31, 32, 36, 37]

Holloway assessed knowledge of prescribed medications in 20 hospitalized patients at admission and discharge.[37] Upon admission, 63% of patients did not know the name, 95% did not know the dosage, 26% did not know the frequency, and 47% did not know the side effects of at least one of their medications. At discharge, 50% of patients did not know the name, 75% did not know the dosage, 30% did not know the frequency, and 45% did not know the side effects of at least one of their medications.

Makaryus and Friedman found similar results from discharge interviews of 43 patients.[6] Only 28% knew their medication names, 37% the purpose, and 14% the common side effects.

Vrhovac et al. evaluated 183 inpatients' medication knowledge (name, dosage, indication), separating medications prescribed prior to the hospitalization from those initiated during the hospitalization.[13] Responses were deemed as fully correct, partially correct, or incorrect. Patients showed significantly better knowledge of medications taken prior to their hospitalization compared to those started during it. Patients responded with the correct name for 38% of their pre-hospitalization medications compared to 17% of medications during hospitalization, with the correct dosage for 77% of pre-hospital medications compared to 49% of medications during hospitalization, and with the correct indication for 72% of pre-hospital medications compared to 42% of medications during hospitalization ($p < 0.001$ for all comparisons). Patients older than 70 ($p < 0.001$) and those with lower educational attainment ($p < 0.001$) had significantly worse overall knowledge. Other variables, such as gender, total number of medications, and duration of treatment were not statistically associated with knowledge.

Similar to Vrhovac, Eibergen et al. evaluated 124 patients' knowledge of changes to chronic medications.[38] One week after discharge, 42% could correctly recall all of the medication changes. Recall was better for dose and frequency changes (51%) than for switched medications (40%) and discontinued medication (38%). Patient characteristics, including age, sex, education level, length of stay, number of medications, and number of medication changes were not associated with knowledge.

Cheah and Martens examined 50 patients on warfarin 1 week after discharge using a ten-part open-ended questionnaire.[36] When asked, 75% of patients were unable to describe the meaning of the term "blood thinner" and many believed they were not at risk for bleeding if their INR was within therapeutic range. Only one-third understood the need to monitor vitamin K intake and one-third were unable to name three vitamin K-rich foods. In one-way ANOVA analysis, correct responses were significantly higher for those under the age of 65 ($F = 6.28$, $p < .05$).

Table 1 Non-interventional Studies

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Quality	Primary endpoint	Findings
1	Holloway et al., 1996 [37]	Scotland	20	General medicine adult inpatient sample	Descriptive/ cross-sectional	Medication knowledge: name, dose, frequency, side effects Ability to read medication labels	Patient interview and questionnaire	Patient checklist adapted from prior study[11]	Poor	Medication knowledge	50% did not know name, 75% did not know dosage, 30% did not know frequency, and 45% did not know side effects of at least one medication
2	Rose et al., 2000 [12]	USA	37 pairs of nurses and patient caregivers	Bedside nurses and family caregivers of inpatients	Descriptive/ cross-sectional	Perception of patient's post-discharge care needs	Interviews of nurses and caregivers consisting of semi-structured and open-ended questions	Interview guide developed by authors	Poor	Nurse and family caregiver perceptions about the patient's health condition, needs to stay healthy, and problems in self-care at admission and discharge	Kappa values (nurse/ caregivers) for diseases were 0.23 at admission and 0.06 at discharge
3	Vrhovac et al., 2000 [13]	Croatia	183	Patients in nephrology, cardiology, hematology, and gastroenterology wards 13% had a university degree	Descriptive/ cross-sectional	Medication knowledge: name, dose, and reason for prescription	Patient interview, corroborated by physician or medical record	Author developed: responses graded as fully, partially or not correct	Poor	Medication knowledge and attitudes towards pharmacotherapy	During hospitalization, patients knew the correct name of 17% of their inpatient medications vs. 34% of pre-hospital medications ($p < 0.001$), correct dosage for 49% of inpatient medications vs. 77% pre-hospitalization medications ($p < 0.001$), and correct indication for 42% of inpatient medications vs. 72% of pre-hospitalization medications ($p < 0.001$). Patients older than 70 ($p < 0.001$) and those with lower educational attainment ($p < 0.001$) had significantly worse overall knowledge
4	Cheah et al., 2003 [36]	USA	50	General medicine adult inpatient sample	Descriptive/ cross-sectional	Medication knowledge (warfarin)	Post-discharge telephone survey	Survey based on "What do you know about Warfarin?" tool. Score as percent correct answers.[14]	Poor	Knowledge regarding warfarin therapy 1 week after hospital discharge	Scores ranged from 6.3 to 87.5 (M 46.9, SD 20.9); authors do not state what constitutes an acceptable score One-way ANOVA analysis showed statistically higher number of correct responses regarding warfarin were obtained from patients under 65 years of age (($F = 6.28$, $p < 0.05$)

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Table 1. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Quality	Primary endpoint	Findings
5	Makaryus et al., 2005 [6]	USA	43	General medicine adult inpatient sample	Descriptive/ cross-sectional	Medication knowledge at discharge: name, purpose, side effects Recall of diagnoses	Patient interview, corroborated by discharge summary forms	Author developed: binary stratification of knowledge into all or nothing	Poor	Knowledge of medications, treatment plan, and discharge diagnoses	28% knew all their discharge medication names, 37% knew the purpose of all their medications, and 14% were able to name the common side effects
6	Donihi et al., 2008[15]	USA	100	Patients with complex medication regimens (greater than 10 medications)	Descriptive/ cross-sectional	Medication knowledge at discharge: name, indication, dose, frequency, side effects	Patient interview, corroborated by medical chart	Author developed: credit given to partially correct answers for dose, side effects, and frequency	Fair	Effect of timing of discharge medication education by pharmacist on medication knowledge	Patients educated on the day of discharge did not recall medication information better than those educated prior to the day of discharge
7	O'Leary et al., 2010[8]	USA	241 patients; 44 physicians	General medicine adult inpatient sample	Descriptive/ cross-sectional	Care team (physician name, nurse name) and plans of care (primary diagnosis, planned tests and procedures, medication changes, consultants, expected length of stay)	Patient interview corroborated by physician interview	Author-developed structured interview tool. Responses graded as complete agreement, partial agreement, no agreement	Fair	Knowledge of plan of care Knowledge of names and roles of healthcare team	45% of patients knew primary diagnosis, 52% planned tests, 39% medication changes, and 39% their anticipated length of stay
8	Chau et al., 2011[16]	France	55	17 transplant recipients and 38 HIV-infected patients 35% of patients had "higher" education level	Descriptive/ cross-sectional	Medication knowledge: name, dose, indication, and administration guidelines	Self-administered patient questionnaire corroborated by pharmacist and medical chart	Author-developed questionnaire	Fair	Medication knowledge	57% of the prescribed drugs were adequately known (name, dose, indication, and administration guidelines) Older age (OR 0.7, $p < 0.01$) and low education level (OR 0.4, $p = 0.10$) were associated with poor medication knowledge in all four domains

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Table 1. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Quality	Primary endpoint	Findings
9	Dennison et al., 2011[17]	USA	95	Community dwelling adults hospitalized with primary HF diagnosis 35% had less than a high school education 67% African American	Descriptive/ cross-sectional	Knowledge pertaining to a particular diagnosis	Patient interviews	For health literacy: Test of Functional Health Literacy in Adults, short form (S-TOFHLA) For heart failure (HF) knowledge: Dutch HF Knowledge scale (DHFKS) and Self-care of HF Index (SCHFI)	Fair	To determine the prevalence of inadequate health literacy Secondary endpoints: To determine the reliability of the Dutch HF Knowledge Scale (DHFKS) and the Self-care of Heart Failure Index (SCHFI) The differences in HF knowledge, HF self-care, and 30-day readmission rate by health literacy level	S-TOFHLA scores rated as adequate were found in 19% of those with less than high school education (vs. 81% for high school education or more; $p = 0.035$, $n = 35$ patients out of 95) total). Age was inversely correlated with literacy ($r = 0.352$; $p < 0.001$), whereas education level was positively correlated with literacy ($r = 0.245$; $p = 0.017$). Health literacy was also positively correlated DHFKS and SCHFI scores ($r = 0.465$; $p < 0.001$) Marginal health literacy trended towards higher 30-day readmission ($p = 0.116$)

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Table 1. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Quality	Primary endpoint	Findings
10	Ní Chróinín et al., 2011[18]	Ireland	336	General medicine adult inpatient sample	Descriptive/ cross-sectional	Knowledge of hospitalization diagnosis and self-reported understanding	Patient interviews, corroborated by discharge letters and medical charts	Author developed: scored from 1 to 6 and dichotomized as good (≥5) or poor (<5) Abbreviated AMTS score for mental ability was completed for each patient	Fair	Patients understanding of their discharge diagnosis and factors influencing this understanding	72% of patients had good understanding of their diagnosis (CI 67.5–77.1%, 243/336) 36.2% (CI 29.1–43.2%; 64/177) aged ≥65 had poor understanding of their diagnosis compared to 18.2% CI 12.2–24.2%, 29/159) aged <65 ($p < 0.001$) 78.2% (233/297) of patient with AMTS ≥8 had good understanding vs. 22% (9/36) with AMTS <8 ($p < 0.001$) 16.7% (CI 12.1–21.2%, 43/258) who reported good understanding achieved a score <5 ($p < 0.001$). Self-reporting of poor understanding was independently associated with scores <5 ($p < 0.001$) Residing in a nursing home ($p < 0.001$) and lack of recall of presenting complaint ($p = 0.02$) were associated with poor knowledge
11	Horwitz et al., 2013[19]	USA	377	Patients >64 years old admitted with acute coronary syndrome, heart failure, or pneumonia and discharged to home	Descriptive/ cross-sectional	Discharge diagnosis and discharge instructions	Patient interviews, corroborated by discharge instructions and medical record	Author developed	Fair	Discharge practices (e.g., follow-up appointments and discharge instructions) Patient understanding of diagnosis and follow-up appointment Patient perceptions of and satisfaction with discharge care	90% of patients stated they understood the reason for admission and self-care after discharge Upon comparison with the medical record, 59.6% fully understood their diagnosis, 32% partially understood it and 8.2% had no understanding
12	Ziaeian et al., 2012[20]	USA	377	Patients ≥65 years old admitted with acute coronary syndrome, heart failure, or pneumonia and discharged to home	Descriptive/ cross-sectional	Medication knowledge: names of old and new medications and frequency	Patient interviews, corroborated by discharge instructions	Author developed: full, partial or absent understanding based on correct drug name, frequency, and changes made during hospitalization	Good	Prevalence of medication reconciliation errors Patient understanding of discharge medications	For intended medication changes, 19.1% (178/225) of patients had no understanding of at least one change Patients had no understanding of 69.3% (142/205) of re-dosed medications, 81.6% (182/223) of stopped medications and 62% (493/795) of new medications.

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Table 1. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Quality	Primary endpoint	Findings
13	Calkins et al., 1997[21]	USA	99 patients and their physicians	Patients discharged with acute myocardial infarction or pneumonia	Descriptive/ cross-sectional	Post-discharge treatment plan	Patient and physician interviews	Author developed	Poor	Patient and physician perceptions of time spent prior to discharge discussing post-discharge plan Patient understanding of post-discharge plan	Physicians believed that 88.9% of patients understood potential side effects of medications, but only 57.4% of patients reported that they understood ($p < 0.001$) Physicians believed 94.7% of patient knew when to resume normal activities versus 57.9% of patients reporting this knowledge ($p < 0.001$)
14	Alibhai et al., 1999[22]	Canada	47 (45 patients, 2 caregivers)	General medicine adult patients ≥ 65 years old	Descriptive/ cross-sectional	Medication knowledge: name, frequency, dose, purpose, side effects	Patient interviews, corroborated by discharge orders and medical record	Author-developed, pilot-tested questionnaire	Fair	Patient demographics, medication use, time spent receiving or providing medication education, barriers to education, and satisfaction scores	Patients reported that physicians spent a mean of 10.5 min on medication education (vs. 13.0 physician-reported minutes, $k < 0.1$) and pharmacists spent a mean of 5.3 min (vs. 14.3 pharmacist-reported minutes, $k = 0.54$) on medication education 43% (20/47 patients) could name all their medications, 7% (3/47) could not name any The most common physician-cited barrier to patient education was lack of time (9/25 encounters). The most common pharmacist-reported barrier was not being informed about discharge plans (20/39 encounters) followed by lack of time (19/39)
15	Eibergen et al., 2017[38]	Netherlands	124	Patients admitted to pulmonary, internal medicine, cardiology or neurology wards and on at least one chronic medication	Descriptive/ cross-sectional	Medication knowledge: changes in dose, discontinued medications, new medications	Interview at discharge and interview within 1 week of discharge, corroborated by medical record	Author-developed interview guide	Fair	Knowledge of medications (changes, new meds, discontinuations) at discharge and 1 week after discharge	49% of patients were able to recall whether and which medications were changed during the hospitalization

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Table 1. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Quality	Primary endpoint	Findings
16	Regalbuto et al., 2014[23]	USA	145	Patients admitted with primary diagnosis of acute decompensated heart failure 67% of patients had educational attainment of high school or less	Prospective cohort study	Discharge instructions (diet, exercise, weight monitoring, what to do if symptoms return, follow-up appointments and discharge medications)	Written survey, corroborated by discharge instructions	Author developed survey based on 6 required elements of Joint Commission discharge instructions	Fair	Comprehension of discharge instructions	10% of patients understood all 6 components of discharge instructions Patients with complete comprehension of their discharge instructions were significantly less likely to be readmitted within 30 days ($p = 0.044$), but this was not significant after controlling for level of education and English as a second language
17	White et al., 2013[24]	USA	276	Patients over 65 admitted with primary or secondary diagnosis of heart failure	Prospective cohort study	Knowledge pertaining to a particular diagnosis	Patient interviews	Author developed: a correct answer was defined as correctly getting 3–4 of 4 questions related to heart failure knowledge	Fair	Ability to recall educational information on heart failure while hospitalized and during follow-up approximately 7 days after hospital discharge Whether teach-back education was associated with hospital readmission	87.6% of patients discharged home (197/225) vs. 69% (29/42) discharged to nursing facilities answered teach-back correctly ($p = 0.005$) A non-significant number of readmission occurred more often in patients incorrectly answering questions 7-days post-discharge (16.3% ($n = 7$) vs. 12.4% ($n = 18$) with correct answers ($p = 0.609$))

Table 2 Interventional Studies

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Intervention	Risk of bias	Primary endpoint	Findings
1	Tan et al., 2013[25]	USA	106 (58 received intervention)	General medicine adult inpatient sample	Pilot study/ quality improvement report	Hospitalization knowledge: reason for admission, physician name, plan of care, estimated date of discharge	Patient interview, with answers confirmed for correctness by authors	Patient self-assessment using Likert scale	Whiteboard containing primary physician name, nurse name, medical assistant name, date, daily goals, estimated discharge date, family contact and patient/family questions	Low	Patient understanding of physician name, goals of care, estimated discharge date Patient satisfaction	Whiteboards significantly increased the proportion of patients who knew their physician name (4.7 vs. 4.0; $p <$ 0.001) and goals for admission (4.7 vs. 4.2; $p < 0.0016$).
2	Winans et al., 2010[26]	USA	40 (20 received intervention)	Patients newly started on warfarin as inpatients	Pilot study/ non-randomized controlled trial	Knowledge of warfarin	20-question validated assessment tool	Oral anticoagulant knowledge (OAK) test. Reported as a percentage of 20 questions correct	Structured educational session with pharmacist	High	Whether adequate education is given to patients newly started on warfarin during their hospitalization Whether a structured educational program improved knowledge versus usual care education	OAK score was 74% for intervention vs. 55% usual care ($p = 0.004$) Sex, age, years of education not significantly associated with knowledge
3	Louis-Simonet et al., 2004[27]	Switzerland	809 (193 received intervention)	General medicine adult inpatient sample	Pre-post study	Medication knowledge	Patient interviews, corroborated by pharmacist using medical record	Author-developed instrument with open-ended questions	Patients received structured pre-discharge interviews by resident physicians using computer-generated treatment cards listing patient medications	High	Effect of structured discharge interviews on medication knowledge	Interviews increased knowledge of medication indication (adjusted difference 6% (95% CI 3–8%); $p < 0.001$) and side effects (adjusted difference 19% (95% CI 9–29%); $p < 0.001$) No change the number of self-discontinued medications between the groups ($p = 0.69$) but the study not designed to rigorously assess compliance

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Table 2. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Intervention	Risk of bias	Primary endpoint	Findings
4	Murphy et al., 2015[28]	New Zealand	200 (100 received intervention)	General medicine adult inpatient sample	Non-randomized controlled trial	Diagnosis, care plan, clinical criteria for discharge, estimated discharge date	Patient interviews, corroborated by laminated sheets or medical record	Author developed questionnaire	Patients were provided with laminated sheet providing information on their diagnosis, management plan for the day, clinical criteria for discharge and, estimated date of discharge	High	Patient knowledge regarding plan of care	90% of patients in the intervention group knew their diagnosis (vs. 59%; $p < 0.01$), 76% knew their treatment plan (vs. 41%; $p < 0.01$), 76% knew the discharge criteria (vs. 25%; $p < 0.01$) and 83% knew the estimated date of discharge (vs. 52%; $p < 0.01$)
5	Dilles et al., 2011[29]	Belgium	37 patients (21 received intervention)	Patients hospitalized on cardiology ward with a primary or secondary diagnosis of heart failure	Single-center, non-randomized quasi-experimental	Disease-specific knowledge	Patient questionnaire	Dutch Heart Failure Knowledge Scale and European Heart Failure Self-Care Behavior questionnaire	Patients received computer assisted learning program on heart failure instead of standard education (brochures and oral info from nurses)	High	Heart failure knowledge and self-care scores at admission and discharge	Patients in the intervention group had improved knowledge score from 10.0 at baseline to 12.5 at discharge, similar to the improvement in the usual care group from 8.9 at baseline to 12.1 at discharge. p values not provided for these results
6	Domingues et al., 2011[30]	Brazil	120	Heart failure patients with left ventricular ejection fraction less than 45%	Randomized trial	Disease-specific knowledge	Patient questionnaire	HF and self-care information questionnaire (range 0–10 points) adapted from 4 instruments found in the literature (see Domingues et al. Citations)	Compared heart failure educational intervention during hospital plus telephone contact after discharge to educational intervention alone	High	Heart failure knowledge and self-care Secondary endpoint: Frequency of visits to the emergency room, re-hospitalization, and deaths in a three-month period	No difference in knowledge between patients who received telephone contact after discharge and those who did not (6.1 ± 2.1 vs. 5.8+/0 1.9, $p = 0.41$) Re-hospitalization or death due to all causes was 46% (22/48 patients) in the intervention group vs. 51% (32/63) in the control group (RR 0.9, 95% CI 0.61–1.34, $p = 0.74$): no power calculation reported

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Table 2. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Intervention	Risk of bias	Primary endpoint	Findings
7	O'Leary et al., 2016[31]	USA	202 (100 received intervention)	General medicine adult inpatient sample	Controlled study	Knowledge regarding hospitalization (name of physician and nurse, changes to medications, planned tests and procedures)	Patient interview, corroborated by physician interviews and medical records	Author developed questionnaire Patient activation assessed using Short Form of Patient Activation Measure	Patients received tablet computers with a mobile patient portal application containing information on general patient information (e.g., documented allergies, problem list), care team, medication list, and agenda for the day	High	Patient ability to correctly name their nurse, primary service physicians, physician roles, planned tests and procedures, and changes to medications	Patients in the intervention were more likely to identify their physician (56% vs. 29.4%; $p < 0.001$) and one physician role (47 vs. 15.7%, $p < 0.001$) Knowledge of nurses' names, planned tests, planned procedures, and medication changes was generally low and did not significantly differ between groups
8	Marini et al., 2014[32]	USA	56 (20 received intervention)	General medicine adult inpatient sample	Single-center randomized trial	Knowledge pertaining to a particular diagnosis	Patient interviews	Author developed 10-part questionnaire derived from Le Sage, et al. (knowledge of VTE prevention among hospitalized patients. J Vasc Nurs 2008;26:109–17)	Patients randomized to watch a 5-min educational video on venous thromboembolism	High	VTE knowledge (risk, symptoms, and preventative measures) and satisfaction	Patients who watched the video had significant improvements in VTE knowledge (83% ± 13% vs. 62%± 17%, $p < 0.0001$). Cohen's $d = 1.34$ Compliance with VTE prophylaxis was similar between groups (20% wearing SCDs in intervention group vs. 14% in control, $p > 0.05$ and 75% vs. 75% for VTE medication compliance, $p > 0.05$): no power calculation reported for this measure
9	Eames et al., 2013[33]	Australia	119 (60 received intervention)	Acute stroke units of two public tertiary care hospitals	Multi-site randomized trial	Disease-specific knowledge	Patient questionnaire	Knowledge of Stroke Questionnaire	Education package with computer-generated, information booklet and verbal reinforcement provided prior to and for 3 months following discharge	Unclear	Stroke knowledge	At baseline, patients in intervention and control group scored mean (SD) of 17.2 (3.9) and 17.5 (3.1) respectively on 25 point questionnaire

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Table 2. (continued)

	Source	Country	No. of patients	Study population	Study design	Domain of knowledge assessed	Method of knowledge assessment	Assessment tool used	Intervention	Risk of bias	Primary endpoint	Findings
10	Lin et al., 2014[34]	Australia	67 (32 received intervention)	Adult inpatients on cardiology, respiratory, and endocrinology wards	Randomized trial	Hospitalization knowledge: reason for admission, tests performed, treatments received and recommendations following discharge	Patient questionnaire Responses score for correctness by comparison to patient-directed discharge letter (PADDLE)	Author-developed instrument with open-ended questions	Patients received PADDLE during a brief discussion prior to discharge	Low	Self-reported and objective patient understanding of reasons for hospitalization and treatments Responses graded from 1 (no understanding) to 5 (full understanding)	Total knowledge score increased from 11.7 ± 2.6 to 15.5 ± 3.2 ($p < 0.001$), Cohen's $d = 1.30$. Readmission rates did not differ between groups, but study underpowered for this outcome
11	Gwadry-Sridhar et al., 2005[35]	Canada	134 (68 received intervention)	Patients with a clinical diagnosis of heart failure and left ventricular ejection fraction less than 40% requiring long-term medical treatment	Randomized trial	Disease-specific knowledge	Patient questionnaire	Author-developed knowledge Acquisition Questionnaire (KAQ) Health care quality of life using Short Form 36 (SF-36) and Minnesota Living with Heart Failure questionnaire (MLHFQ)	In-hospital heart failure education consisting of 2 heart failure information booklets, an educational video and an educational session delivered by a team consisting of a nurse or educator and a pharmacist	Low	Heart failure knowledge Health-related quality of life Medication compliance (based on pharmacy refill records) Composite end point of 1 year all-cause mortality, hospital readmissions, and emergency department visits	Mean change in knowledge score was 2.24 ± 2.46 (95% CI 1.63–2.85) in intervention and 1.38 ± 2.16 (95% CI 0.85–1.91) in control: Cohen's $d = 0.37$ There were not statistically significant differences in medication compliance or the composite endpoint between groups but study underpowered for these measures

Table 3 NIH Quality Assessment Tool for Observation Cohort and Cross-Sectional Studies

	Source	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
		Research question or objective clear	Population clearly defined	Participation rate ≥ 50%	Subject recruited from same population. Inclusion and exclusion applied uniformly	Sample size, power, variance, and effect estimates provided	Exposure of interest measured prior to outcome	Timeframe sufficient to see association b/t exposure and outcome	Study examination different levels of exposure as related to outcome	Exposure measures clearly defined	Exposure assessed over time	Outcome measures clearly defined	Outcome assessors blinded	Loss to follow up ≤ 20%	Potential confounding variables measured and adjusted for impact	Rating overall
1	Holloway et al., 1996 [37]	Yes	No	N/A	N/A	No	No	No	N/A	N/A	N/A	No	N/A	N/A	N/A	Poor
2	Rose et al., 2000 [12]	Yes	Yes	No	Yes	No	No	No	N/A	N/A	N/A	Yes	N/A	N/A	N/A	Poor
3	Vrhovac et al., 2000 [13]	Yes	Yes	N/A	N/A	No	No	No	Yes	No	N/A	No	N/A	N/A	No	Poor
4	Cheah et al., 2003 [36]	Yes	Yes	Yes	Yes	No	No	No	No	Yes	N/A	No	N/A	N/A	No	Poor
5	Makaryus et al., 2005 [6]	Yes	Yes	Yes	Yes	No	No	No	N/A	N/A	N/A	No	N/A	N/A	N/A	Poor
6	Donihi et al., 2008 [15]	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	N/A	Yes	N/A	N/A	No	Fair
7	O'Leary et al., 2010 [8]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	N/A	Yes	N/A	N/A	No	Fair
8	Chau et al., 2011 [16]	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	N/A	Yes	N/A	N/A	Yes	Fair
9	Dennison et al., 2011 [17]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	N/A	Yes	N/A	N/A	No	Fair
10	Ní Chróinín et al., 2011 [18]	Yes	Yes	Yes	Yes	No	N/A	N/A	Yes	Yes	N/A	Yes	N/A	N/A	Yes	Fair
11	Horwitz et al., 2013 [19]	No	Yes	Yes	Yes	No	N/A	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	Fair
12	Ziaeian et al., 2012 [20]	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	N/A	Yes	N/A	N/A	Yes	Good
13	Calkins et al., 1997 [21]	Yes	Yes	Yes	Yes	No	No	No	N/A	N/A	N/A	No	N/A	N/A	N/A	Poor
14	Alibhai et al., 1999 [22]	Yes	Yes	Yes	Yes	No	No	No	N/A	N/A	N/A	Yes	N/A	N/A	N/A	Fair
15	Eibergen et al., 2017 [38]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	N/A	Yes	N/A	N/A	Yes	Fair
16	Regalbuto et al., 2014 [23]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	N/A	No	N/A	N/A	Yes	Fair
17	White et al., 2013 [24]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	N/A	No	N/A	N/A	No	Fair

Author-derived key for standardization: ≤ 50 = poor, 50–75 = fair, > 75 = good

Knowledge of General Aspects of Hospitalization. Seven of 27 studies focused on knowledge of care teams, plans of care, and discharge planning (Table 1).[8, 18, 19, 25, 28, 31, 34]

O'Leary et al. assessed multiple domains of knowledge in 241 patients on their second inpatient day.[8] In regard to care teams, only 32% of patients correctly named their hospital physician and 11% knew her/his role, yet 60% were able to correctly name their nurse. For diagnosis and plans of care, patients' responses were rated as being in total agreement, partial agreement, or no agreement with the primary hospital physician. There was no agreement between patients and their physicians 36% of the time for the diagnosis, 38% of the time for planned tests, 10% of the time for planed procedures, and 54% of the time for medication changes. Interestingly, on self-assessment, the overwhelming majority (95–99%) of patients indicated they knew their diagnosis, planned tests, planed procedures, and medication changes. There was no significant difference in agreement scores based on age, ethnicity, sex, or education level.

In a similar study, Horwitz et al. asked 377 patients to describe their diagnosis, discharge instructions, and post-discharge follow-up plan and compared their answers to the medical record.[19] All participants were over the age of 65 with admitting diagnoses of pneumonia, acute coronary syndrome, or heart failure. Though 95% of patients indicated they understood their hospital diagnosis, only 60% were accurate when compared with the medical record.

Ní Chróinín et al. rated 336 patients' understanding of their discharge diagnosis using a score ranging from 0 to 6.[18] Understanding was dichotomized as good (≥ 5) or poor (< 5). Overall, 72% (243/336) had a good understanding of their discharge diagnosis (CI 67.5–77.1%). In patients 65 and older, 36% (64/177) (CI 29.1–43.2%) had a poor understanding of their diagnosis compared with 18% (29/159) (CI 12.2–24.2%) younger than 65 ($p < 0.001$). Worse understanding was also associated with residing in a nursing home, not recalling the presenting complaint, male gender, and having an Abbreviated Mental Test Score (AMTS) less than 8 ($p < 0.001$).

Patient Variables Affecting Knowledge. Two of 27 studies focused on patient-specific variables affecting knowledge, emphasizing education level and health literacy.[17, 23]

Regalbuto et al. characterized demographic and clinical features that predicted patient understanding of heart failure discharge instructions.[23] A binary score of 0 or 1 was given for each of 6 Joint Commission requirements for heart failure discharge instructions. Overall, mean understanding was 4.1 (SD 1.2). Symptoms of heart failure exacerbation and weight and management were the best understood, whereas medications were least. Mean understanding for English speakers was 4.2 (SD 1.1) compared to 3.4 (SD 1.0) for non-native English speakers ($p < 0.001$). Mean understanding for patients with a college education or greater was 4.6 (SD 0.9) compared to 3.8 (SD 1.2) for those with a high school education or less ($p < 0.001$). Age, sex, race, and recent hospitalization were not associated with understanding. Of the patients studied, 23.4% were readmitted within 30 days. No patients with complete understanding were admitted within 30 days compared to 24.1% of patients with imperfect understanding ($p = 0.044$); however, this finding was no longer significant after adjusting for level of education and English as a second language.

Similarly, Dennison et al. surveyed 95 heart failure patients in an urban teaching hospital.[17] Only 39% of interviewed patients had "adequate" health literacy as assessed by the Short Test of Functional Health Literacy in Adults (S-TOFHLA). Age was inversely correlated with literacy ($r = 0.352$; $p < 0.001$), whereas education level was positively correlated with literacy ($r = 0.245$; $p = 0.017$). Health literacy was also positively correlated to both heart failure knowledge (measured via the Dutch Heart Failure Knowledge Scale) and self-care knowledge (measured via the Self-Care of Heart Failure Index) ($r = 0.465$; $p < 0.001$). Participants with marginal health literacy had higher 30-day readmission rates, though this did not reach statistical significance ($p = 0.116$).

Interventional Studies

The 6 non-randomized studies ranged in size, enrolling 37 to 809 patients, of which 20 to 193 received interventions. The 5 randomized controlled studies enrolled 56 to 134 patients, of which 20 to 68 patients received interventions (Table 2). We used the seven EPOC domains to classify each interventional study as low, unclear, or high risk for bias, as it pertained to the primary outcome (Table 4). Overall, 3 studies were at low risk of bias, 1 was unclear, and 7 were at high risk of bias.

Some groups sought to improve health behaviors and outcomes through enhancing knowledge. Uniformly, interventions increased knowledge, but few studies evaluated the effect on health behaviors or outcomes.

Non-randomized Studies. Tan et al. aimed to increase knowledge of care teams, plans of care, and discharge planning using hospital room whiteboards.[25] On a 1 to 5 ordinal scale, patients' self-reported admission goal knowledge improved from 4.23 to 4.66 ($p = 0.004$).

Murphy et al. attempted a similar intervention using informational sheets completed during bedside rounds and left with the patient.[28] Compared to controls, a greater proportion of patients in the intervention group knew their diagnosis (90% vs. 59%; $p < 0.01$), treatment plan (76% vs. 41%; $p < 0.01$), discharge criteria (76% vs. 25%; $p < 0.01$) and estimated date of discharge (83% vs. 52%; $p < 0.01$).

Louis-Simonet et al. studied the effect of structured patient-centered interviews on medication knowledge.[27] The intervention group (193 patients) received individualized treatment cards and education emphasizing clarification of treatments and answering patient questions. The control group (616 patients) received usual instructions. The interviews significantly increased knowledge of medication indication (adjusted

Table 4 Cochrane Effective Practice and Organization of Care (EPOCH): Summary of the Risk of Bias in Interventional Studies

	Study	Study type	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other sources of bias	Overall risk of bias
1	Tan et al., 2013[25]	Pilot study/ quality improvement report	Low risk	N/A	High risk: 1) The medical team that maintained the white boards were aware of the study 2) Consent took place during the hospitalization, thus patients may have paid better attention to white boards	Moderate risk: Primary investigator administered all surveys	Low risk	Low risk	Post hoc power analysis using effect size	Low risk
2	Winans et al., 2010[26]	Pilot study/non-randomized controlled trial	High risk	High risk	High risk	High risk	High risk	Low risk	High risk	High risk
3	Louis-Simonet et al., 2004[27]	Pre-post study	High risk: Patients allocated based on medical unit	N/A	High risk: Not blinded	High risk: Not blinded	High risk: ~30% of intervention group excluded. No intention to treat analysis	N/A	High risk: Used self-reported medication compliance	High risk
4	Murphy et al., 2015[28]	Non-randomized controlled trial	High risk: Patients assigned based on medical team	N/A	High risk: Participants and personnel not blinded	Unclear: Not stated	N/A	N/A	High risk: 1) Intervention group led by "nominated consultants" 2) Allocation to medical teams possibly demographic or disease-based	High risk
5	Dilles et al., 2011[29]	Single-center, non-randomized quasi-experimental	High risk: Convenience sample based on location. LVEF differed between groups (47% in intervention vs. 25% in control, $p = 0.11$) and the median length of stay (13 days in the intervention group vs. 9 days in the control, $p = 0.05$). There was also a trend towards more class I HF in the control group ($p = 0.06$)	Low risk	High risk	High risk	Low risk: Equal between groups	High risk: Drop out rate of 19%	It was a pilot study. Mostly male patients	High risk
6	Domingues et al., 2011[30]	Randomized trial	High risk (randomization not described)	High risk	High risk (participants knew whether they received phone calls)	Unclear	Unclear	Unclear	Participants were located though "active daily searches in the hospital wards"	High risk

(*continued on next page*)

Table 4. (continued)

	Study	Study type	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other sources of bias	Overall risk of bias
7	O'Leary et al., 2016[31]	Controlled study	High risk: Based on ward allocation, which is not always random	Low risk	Unclear	Low risk: Patient responses were written verbatim. Researchers were blinded when reviewing patient data	High risk: Many excluded because of visual/physical deficits, declining to participate, disorientation or not speaking English. Those who did not complete the interview were discharged early, deteriorated clinically or had scheduling conflicts	High risk: 1/5 of the intervention unit patients did not actually use the portal	1. Age of the intervention patients were 46.7 years vs. 51.4 years ($p = 0.05$) in controls	High risk
8	Marini et al., 2014[32]	Single-center randomized trial	Low risk (pre-generated random number sequence)	Unclear	High risk (participants and personnel not blinded)	Unclear	Unclear	Unclear	None	High risk
9	Eames et al., 2013[33]	Multi-site randomized trial	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear: Article does not give detailed methods
10	Lin et al., 2014[34]	Randomized trial	Low risk	High risk: Researchers who gave surveys at discharge were not blinded	N/A	Low risk: Outcome researchers were blinded	Unclear	Unclear	None	Low risk
11	Gwadry-Sridhar et al., 2005[35]	Randomized trial	Low risk	Low risk	Unclear: 1) Patients were aware they would receive education but did not know if it was usual care vs. enhanced intervention 2) The educator was aware of allocation	Low risk: Blinded investigators included: Pharmacists who collected med refill data, outcome coordinator, and outcomes evaluators Data analysts not blinded	Low risk	Low risk	None	Low risk

difference 6% (95% CI 3–8%); $p < 0.001$) and side effects (adjusted difference 19% (95% CI 9–29%); $p < 0.001$). Although there was no difference in the number of self-discontinued medications between the groups ($p = 0.69$), the study was not designed to rigorously assess compliance.

Randomized Controlled Trials (RCTs). All but one of the RCTs increased knowledge. Although none resulted in improved health behaviors or outcomes, studies were either underpowered or did not report power calculations.

In Canada, Gwadry-Sridhar et al. randomized 134 heart failure patients to 2.5 h of individualized heart failure education in addition to standard care with an informational booklet and video (19). Using the Minnesota Living with Heart Failure questionnaire, the intervention group had significantly improved knowledge immediately after the intervention. Change in knowledge score was 2.24 ± 2.46 (95% CI 1.63–2.85) among intervention patients compared to 1.38 ± 2.16 (95% CI 0.85–1.91) in the control group ($p = 0.02$). Cohen's d was 0.37, consistent with a small to moderate effect. There was no difference in 30-day utilization or medication adherence, although the authors comment that their sample size was likely too small to detect a significant difference in the composite outcome.

Marini et al. also used an educational video to affect knowledge about venous thromboembolism (VTE).[32] The video increased VTE knowledge scores from 62 ± 17 to 83 ± 13% ($p < 0.0001$) with a Cohen's d of 1.34 for VTE knowledge, consistent with a very large effect. However, there was no improvement in VTE prophylaxis adherence.

Domingues et al. evaluated the effect of a pre- and post-hospitalization nurse-led educational intervention on heart failure patients' disease-specific knowledge, self-care knowledge, and post-discharge utilization.[30] Both intervention and control groups had increased knowledge after discharge but there was no difference in knowledge scores or post-discharge utilization between groups.

In Australia, Lin et al. used a Patient-Directed Discharge Letter (PADDLE) to increase knowledge of diagnoses, tests, treatments, and discharge recommendations among 67 inpatients.[34] They used a 1–5 rating scale for a maximum knowledge score of 20. Median total knowledge increased from 11.7 ± 2.6 to 15.5 ± 3.2 ($p < 0.001$) in the intervention group. Cohen's d was 1.30, but change in knowledge for the control group was not reported. In a single domain, the percentage of patients attaining a 5 on the rating scale increased from 71 to 100% ($p = 0.09$) for diagnoses, 50 to 88% ($p < 0.001$) for tests, 50 to 100% ($p = 0.001$) for treatments, and from 27 to 80% ($p < 0.001$) for discharge recommendations. Readmission rates did not differ between the groups; however, there was insufficient power to detect a small difference in readmissions.

O'Leary et al. aimed to increase patient knowledge and activation, as measured by the Patient Activation Measure (PAM), by randomizing 202 medical patients to usual care or to an interactive patient portal.[31] The portal provided information on the care team, medication list, and plans of care. More patients in the intervention group could name their physician (56% versus 29.6%; $p < 0.001$) and her/his role (47% versus 15.7%; $p < 0.001$); however, there was no difference in medication knowledge, knowledge of planned tests and procedures, or patient activation.

DISCUSSION

In summary of the available literature, we found that the current state of inpatients' knowledge of their hospitalization is poor, especially when it comes to knowledge of medications, diagnoses, and plans of care. Domains of knowledge assessed varied across studies and methods of evaluating knowledge were often author-derived and study specific. Interventions aimed at improving knowledge generally worked, but evidence to support an effect on behaviors and outcomes is limited by the fact that most studies were either underpowered or did not report power estimates for these measures. Several themes and important inferences arose.

Patient characteristics were variably associated with comprehension. Older individuals (usually defined as 65 years and older) and those with lower levels of education (usually defined as less than a college degree) appeared more likely to have significant knowledge gaps.[6, 13, 18, 36] Although less frequently assessed, lower health literacy and cognition were also associated with knowledge deficits.[10, 38] Other demographic factors, such as gender, marital status, length of hospital stay, and total number of medications prescribed were not associated with patient understanding.[6, 8, 13, 16] Given these findings, providers could consider targeting educational interventions to older patients and those with barriers to learning about their health.

The inpatient setting could provide a particularly valuable opportunity to focus on improving medication knowledge, as this was consistently poor across studies. Though patients' capacity to learn may be adversely affected by acute illness, educational interventions were able to increase knowledge and patients may be uniquely motivated to learn while recovering from an acute episode of illness. A variety of interventions appeared to be successful. Further research should compare strategies to identify an optimal approach.

We also found that patients are generally poor estimators of their own knowledge. The literature suggests that patients overestimate their knowledge when compared against objective measures.[8, 18] The discrepancy between patient perception of their knowledge and objective assessments of this knowledge is an important reminder that physicians should routinely confirm patient comprehension during clinical discussions.

Though many interventions increased patient knowledge, the existing evidence is not robust enough to make

conclusions regarding improvement in health behaviors or outcomes. Relatively few studies assessed health behaviors or outcomes and those that did include these measures, either did not report power calculations or reported that they were underpowered. Importantly, health behaviors such as medication adherence are influenced not only by knowledge but also the patient's agreement with the medication, activation (self-efficacy, motivation), and access (coverage, expense, etc.).[39–41] Clinical outcomes, such as hospital readmissions are influenced by many factors as well, including underlying illness, social support, home health resources, access to outpatient care, and patient and location-specific factors.

Our systematic review has several limitations. First, we found relatively few high-quality studies. Second, studies varied with regard to methodology and domains of knowledge assessed. Hence, we were unable to conduct a meta-analysis. Third, while most interventional studies were adequately powered to detect improvements in knowledge, few were powered to detect significant differences in health behaviors or outcomes. Finally, few studies in English-speaking countries included non-English-speaking patients, a group at especially high risk for deficits in comprehension.

In summation, we found that studies do not use a standard method of knowledge assessment and that patient comprehension of hospital care is overall poor, especially in certain demographics. Given that patient comprehension is a fundamental principle of patient-centered care, we are reassured that interventions generally improve knowledge. Thus, we recommend targeted interventions at hospitalized patients, using standardized methods of assessment, that aim to improve knowledge while also addressing factors influencing health behaviors and outcomes.

Corresponding Author: *Arielle E. Sommer, MD; Department of Medicine Ronald Reagan UCLA Medical Center, Los Angeles, CA, USA (e-mail: asommer@mednet.ucla.edu).*

Compliance with Ethical Standards:

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