Health Literacy in Surgery

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ABSTRACT

Background: Low health literacy is associated with poor health outcomes in many chronic diseases and may have an important role in determining surgical outcomes. This study aims to comprehensively review the current state of science on adult health literacy in surgery and to identify knowledge gaps for future research.

Methods: Using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, a systematic search was conducted to identify all studies from January 2002 through May 2018 that used validated instruments to assess health literacy among adult patients undergoing surgery. Studies were assessed for quality using the Newcastle-Ottawa scale and evaluated on findings by their focus on identifying health literacy levels, understanding associations with surgical outcomes, and/or developing interventions to address low health literacy. Key Results: There were 51 studies on health literacy with data from 22,139 patients included in this review. Low health literacy was present in more than one-third of surgical patients (34%, interquartile range 16%-50%). The most commonly used validated instrument for assessment of health literacy in the surgical population was the Newest Vital Sign. Most studies were focused on identifying the prevalence of low health literacy within a surgery population (84%, n = 43). Few studies focused on understanding the association of health literacy to surgical outcomes (12%, n = 6) and even fewer studies developed interventions to address health literacy (4%, n = 2). Discussion: Low health literacy is common among surgical patients. Important opportunities exist to better understand the role of health literacy in determining surgical outcomes and to develop more health literacy-sensitive models of surgical care. [HLRP: Health Literacy Research and Practice. 2020;4(1):e45-e65.]

Plain Language Summary: Health literacy has not been well-studied in surgery but likely plays an important role. In this article, we reviewed all current research on health literacy in surgery to help us understand where we are at and where we need to go. We found that low health literacy is common and we need more ways to address it in surgery.

Health literacy is a major determinant of health outcomes. Low health literacy is associated with increased risk for emergency care and hospitalizations, poor adherence to medication regimen, and higher mortality rates (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011). The US Department of Health and Human Services (HHS) and the National Academy of Medicine (NAM) define health literacy as the “degree to which individuals have the capacity to obtain, process, and understand health information and services needed to make health decisions” (Kindig, Panzer, & Nielsen-Bohlman, 2004). Failures by providers and health care systems to account for these capacities may contribute to poor outcomes (De Oliveira, McCarthy, Wolf, & Holl, 2015). Recognizing these deficiencies, HHS enacted the National Action Plan to Improve Health Literacy in 2010 to improve access to accurate and actionable health information and usable health services...
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The only review of health literacy studies in surgery was limited to 10 studies and found that low health literacy was present in certain surgical populations such as transplant and orthopedic patients (De Oliveira et al., 2015). Among these selected populations, low health literacy was associated with nonadherence to preoperative and/or discharge instructions as well as poor comprehension of surgical procedures (De Oliveira et al., 2015). The current state of science on health literacy in surgery since 2013 has not been readdressed. Therefore, the objective of this study was to systematically review the available research on health literacy in adult surgical patient populations and to identify the knowledge gaps to inform future research.

METHODS
Systematic Search
Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009), a comprehensive search of the National Library of Medicine's PubMed database, Embase, Scopus database, Proquest, PsychInfo, and the Cumulative Index of Nursing and Allied Health Literature (CINAHL) was performed through May 31, 2018. Through partnerships with Library Services at the University of Alabama Birmingham, keywords and medical subject heading (MESH) terms used in the search included “health literacy,” “surgical,” “post-operative,” and “surgery.” The entire search string for each database along with the number of screened abstracts can be found in Table A. Two authors (S.J.B. and I.C.D.S.M.) who are experienced researchers independently evaluated abstracts of the 673 articles obtained by the initial search. Article titles and abstracts were screened for a validated tool to measure health literacy and relevance to the aim of this systemic review. Discrepancies about inclusion of articles were resolved with a third person (D.I.C.) who was blinded regarding evaluation of the first two authors.

Inclusion and Exclusion Criteria
We included published articles that evaluated health literacy in the perioperative setting. Studies were included if they were peer-reviewed articles, available in their full length, and measured health literacy using a validated instrument. Studies were excluded if they did not use a validated instrument, were conducted on a pediatric population, conducted...
on a caregiver, or included procedures such as percutaneous coronary intervention, cataract surgery, or endoscopic procedures.

Validity Scoring

The Newcastle-Ottawa scale was used to assess the quality and risk of bias in cohort, case-control, and cross-sectional studies (Stang, 2010). Two authors (S.J.B., I.C.D.S.M.) independently read the included articles and scored articles with the Newcastle-Ottawa scale. Discrepancies in scores were resolved by a third author (D.I.C.) who scored the article, and a discussion was then held among the authors. Potential bias of each study was described according to the PRISMA guidelines.

Data Extraction and Analysis

Two authors (S.J.B. and I.C.D.S.M.) independently reviewed all included studies and extracted data using the same data collection form. Discrepancies in data extraction were resolved by discussion among the authors. The variables collected included surgical subspecialty, study design, sample size, time in relation to surgical procedure (preoperative, postoperative, or both), prevalence of patients with low health literacy, validated health literacy instrument used, and potential bias in the study. The primary objective of each study was also evaluated. Median and interquartile ranges (IQR) were calculated for number of patients enrolled per study, prevalence of low health literacy, and Newcastle-Ottawa Scale (NOS) scores.

RESULTS

The comprehensive search initially identified 1,048 abstracts from January 1, 2002 to May 31, 2018. After duplicates were removed and previous studies’ bibliographies were manually reviewed, 673 abstracts remained for initial screening. After the abstract/title screen, 73 articles were suitable for full-text review. Once these full-text articles were assessed for inclusion and exclusion criteria, 51 studies were eligible to be included in the review for data collection and reporting. The PRISMA flow diagram can be found in Figure 1.

The number of health literacy studies in surgery patient populations has increased over time from January 2002 until May 2018 (Figure 2). The 51 health literacy studies included data from 22,139 patients (Alokozai et al., 2017; Beitler et al., 2015; Cajita et al., 2017; Cayci et al., 2018; Chew, Bradley, Flum, Cornia, & Koepsell, 2004; Choi, 2011; Chu & Tseng, 2013; Conlin & Schumann, 2002; Dageforde, Box, Feurer, & Cavanaugh, 2015; Dageforde et al., 2014; Escobedo & Weismuller, 2013; Garcia-Marcinkiewicz, Long, Danielson, & Rose, 2014; Gordon & Wolf, 2009; Grubbs, Gregorich, Per-
al., 2015; Tang et al., 2017; Taylor et al., 2016; Turkoglu et al., 2019; Wallace et al., 2007; Weng et al., 2013; Winton et al., 2016; Wright et al., 2018; Zite & Wallace, 2011) The median NOS score was 7 (IQR, 7-8) (Alokozai et al., 2017; Beitler et al., 2010; Cajita et al., 2017; Cayci et al., 2018; Chew, Bradley, Flum et al., 2004; Chu & Tseng, 2013; Conlin & Schumann, 2002; Escobedo & Weismuller, 2013; Garcia-Marcinkiewicz et al., 2014; Gordon & Wolf, 2009; Grubbs et al., 2009; Halbach et al., 2016; Halleberg Nyman et al., 2018; Hallock et al., 2017; Huang et al., 2018; Izard et al., 2014; Jones et al., 2016; Kazley et al., 2015; Kazley et al., 2014; Keim-Malpass et al., 2018; Koster et al., 2017; Lambert et al., 2015; Menendez, Mudgal et al., 2015; Menendez et al., 2016; Menendez et al., 2017; Mercieca-Bebber et al., 2017; Parrish et al., 2016; Roh et al., 2018; Rosenbaum et al., 2015; Scarpato et al., 2016; Schmidt et al., 2016; Serper et al., 2015; Tang et al., 2017; Taylor et al., 2016; Tung et al., 2014; Turkoglu et al., 2019; Wallace et al., 2007; Weng et al., 2013; Winton et al., 2016; Wright et al., 2018), where a score of 7-9 indicates low risk of bias and high quality.(Stang, 2010)

Health Literacy Instruments

Health literacy instruments can be used to assess a person’s ability or perception of ability to read and comprehend medical information, to assess a person’s ability or perception of ability to perform mathematical operations, or both.
Most of the 18 tools included in these studies assessed literacy or reading comprehension \((n = 13)\) (Baker et al., 1999; Chew et al., 2008; Chung & Nahm, 2015; Ishikawa et al., 2008; Jordan et al., 2013; Kazley et al., 2014; Morris et al., 2006; Nakayama et al., 2015; Rosenbaum et al., 2015; Sörensen et al., 2012; Wangdahl & Martensson, 2015). A small number of health literacy tools measured numeracy \((n = 2)\) (Fagerlin et al., 2007; Weiss et al., 2005), a combination of numeracy and literacy/reading \((n = 2)\) (Baker et al., 1999; Parker, Baker, Williams, & Nurss, 1995), or a patient’s ability to comprehend information presented in graphic form \((n = 1)\) (Galesic & Garcia-Retamero, 2011). Numeracy is defined as the ability to perform mathematical tasks such as working with fractions and use of numerical information over prose. Across studies, 59% of these studies measured literacy or reading comprehension \((59\%, n = 30)\) (Cajita et al., 2017; Cayci et al., 2018; Chu & Tseng, 2013; Conlin & Schumann, 2002; Dageforde et al., 2015; Dageforde et al., 2014; Garcia-Marcinkiewicz et al., 2014; Halbach et al., 2016; Halleberg Nyman et al., 2018; Hallock et al., 2017; Huang et al., 2018; Keim-Malpass et al., 2018; Khan et al., 2018; Koster et al., 2017; Lambert et al., 2015; Mahoney et al., 2018; Mercieca-Bebber et al., 2017; Miller-Matero et al., 2015; Patzer et al., 2016; Scarpato et al., 2016; Schmidt et al., 2016; Tang et al., 2017; Taylor et al., 2016; Tung et al., 2014; Turkoglu et al., 2019; Wallace et al., 2007; Wallace et al., 2009; Wright et al., 2018; Zite & Wallace, 2011), 21.5% measured both reading comprehension and numeracy \((n = 11)\) (Beitler et al., 2010;
| Instrument | Description | Test Time (minutes) | Scoring | Number of Studies |
|------------|-------------|---------------------|---------|-------------------|
| NVS (Weiss et al., 2005) | Nutrition label with 6 questions measuring health literacy | 3 | Raw score converted to 3 categories of likelihood of low health literacy | 13 |
| REALM variations used | | | | |
| REALM (Davis et al., 1991) | 66-item health-related vocabulary test | 3-5 | Scale 0-66. Raw score converted by grade level: <3rd, 4th-6th grade, 7th-8th grade, and >9th | 6 |
| REALM-SF (Arozullah et al., 2007) | 7-item health-related vocabulary test | 3 | Scale 0-7. Raw score converted by grade level: <3rd, 4th-6th grade, 7th-8th grade, and >9th | 1 |
| REALM-T<sup>a</sup> (Gordon & Wolf, 2009) | 69-item transplant health-related vocabulary test | 3-5 | Scale 0 to 69. Scored based on number of words correct | 2 |
| REAL-VS (Wallace et al., 2009) | 75-item vascular health-related vocabulary test | 3-5 | Scale 0 to 75. Scored based on number of words correct | 1 |
| BHLS (Chew, Bradley, & Boyko, 2004) | 3 single-item screening questions identifying need for help with reading and comprehension | <7 | Sum of scores of 3 questions on a 5 value Likert scale | 9 |
| Test of Functional Health Literacy in Adults | | | | |
| TOFHLA (Parker et al., 1995) | 50-item reading comprehension and 17-item numerical ability test using actual health-related materials such as prescription bottle labels and appointment slips | 22 | Scale of 0 to 100. Score based on test performance, age, and years of education | 1 |
| S-TOFHLA (Baker et al., 1999) | 36 cloze items in 2 prose passages and 4 numeracy items to evaluate reading comprehension | 12 | Scale of 0 to 36. Score based on test performance, age, and years of education | 7 |
| Health Literacy Scale European Union | | | | |
| HLS-EU-Q47 (Nakayama et al., 2015) | 47 items of self-rating comfort with health literacy | No data available | 4-point Likert scale converted to low, problematic, or sufficient health literacy | 4 |
| HLS-EU-Q16 (Sorensen et al., 2012) | 16 items self-rating comfort with health literacy | 25-90 | 4-point Likert scale converted to low, problematic, or sufficient health literacy | 1 |
| LiMP<sup>a</sup> (Rosenbaum et al., 2015) | 9-item test specific to health literacy in musculoskeletal conditions | No data available | Raw score cutoff indicating adequate health literacy | 2 |
| HeLMS (Jordan et al., 2013) | 24 items that test four dimensions: (1) information acquisition ability, (2) communication and interaction ability, (3) willingness to improve health, and (4) economic support | No data available | 5-point Likert Scale, maximum 120 points | 2 |
| eHEALS (Chung & Nahm, 2015) | 8-item scale developed to measure consumers’ combined knowledge, comfort, and perceived skills at finding, evaluating, and applying electronic health information to health problems | No data available | 5-point Likert and the score ranges from 8 to 40, with a higher score indicating higher literacy | 1 |
| Subjective HLS (Chew et al., 2008) | Question identifying need for help with completing medical forms | <1 | 5-point Likert scale converted to adequate, marginal, and low health literacy | 1 |
| Instrument | Description | Test Time (minutes) | Scoring | Number of Studies |
|------------|-------------|---------------------|---------|------------------|
| SISL (Morris et al., 2006) | Question identifying need for help with reading and comprehension | <3 | 5-point Likert scale converted to adequate, marginal, and low health literacy | 1 |
| Swedish-FHL (Wangdahl & Martensson, 2015) | 5-item questionnaire identifying need for help with reading and comprehension | No data available | 5-point Likert scale converted to inadequate, problematic, and sufficient health literacy | 1 |
| Dutch version of FCCHL (Ishikawa et al., 2008) | 14-item assessment of perception of an individual's health literacy | No data available | 4-point Likert scale for functional, communicative, and critical aspects of health literacy | 1 |
| HLQ (Osborne et al., 2013) | 44 items cover nine conceptually distinct aspects of health literacy: (1) feeling understood and supported by health care providers; (2) having sufficient information to manage health; (3) actively managing health; (4) social support for health; (5) appraisal of health information; (6) ability to actively engage with health care providers; (7) navigating the health care system; (8) ability to find good health information; and (9) understanding health information well enough to know what to do | No data available | Provides scores for each of the 9 domains. Must obtain a license in order to access the tool and scoring | 1 |
| DMCAT (Kazley et al., 2014) | 7-item test specific to health literacy in kidney disease | No data available | 4-point Likert scale for health literacy in kidney disease | 1 |
| SNS (Fagerlin et al., 2007) | 8-item test that measures perception of math ability. The preference subdomain measures predilections for information in numeric versus prose formats. The ability subdomain measures a person's subjective capacity to perform calculations | No data available | 6-point Likert-type scale. Score is calculated as the average rating across the 8 questions | 1 |
| GLS (Galesic & Garcia-Retamero, 2011) | 13 items measuring whether individuals understand common graphic representations of numeric health information and is divided into 3 subdomains: (1) reading, (2) reading between the data, and (3) reading beyond the data | <10 | Score is calculated as the number correct out of 13 | 1 |
| THLS (Pan, Su, & Chen, 2010) | 66-item test using prose to assess comprehension | No data available | Sum score based on 5-point Likert-type scale | 1 |
| NLit-BCa (Gibbs et al., 2016) | Nutritional literacy test that measures 6 content areas: (1) nutrition and health, (2) macronutrients, (3) food portions, (4) label reading, (5) food groups, and (6) consumer skills | No data available | Each correct answer received a score of 1 with a maximum total score of 64 | 1 |

Note: BHLS = Brief Health Literacy Screen; DMCAT = Decision Making Capacity Assessment Tool; eHEALS = Electronic Health Literacy Scale; FCCHL = Functional Communicative Critical Health Literacy; FHL = Function Health Literacy; GLS = Graphic Literacy Scale; HeLMS = Health Literacy Management Scale; HLQ = Health Literacy Questionnaire; HLS = Health Literacy Screener; HLS-EU = European Health Literacy Scale; LiMP = Literacy in Musculoskeletal Patients; NLit-BCa Nutrition Literacy Assessment Instrument for Breast Cancer Patients; NVS = Newest Vital Sign; REAL-VS = Rapid Estimate of Adult Literacy–Vascular Surgery; REALM = Rapid Estimate of Adult Literacy in Medicine; REALM-SF = Rapid Estimate of Adult Literacy in Medicine–Short Form; REALM-T = Rapid Estimate of Adult Literacy in Medicine–Transplant; S-TOFHLA = Short Form Test of Functional Health Literacy in Adults; TOFHLA = Test of Functional Health Literacy in Adults; SILS = Single Item Literacy Screener; SNS = Subjective Numeracy Scale; THLS = Taiwan Health Literacy Scale; TOFHLA = Test of Functional Health Literacy in Adults. *Disease-specific health literacy measurement tool.
Health Literacy Has Been Assessed in Limited Surgical Populations

Health literacy was assessed to varying degrees in surgical subspecialties (Figure 3): 13 were in abdominal transplant (Dageforde et al., 2015; Dageforde et al., 2014; Escobedo & Weismuller, 2013; Gordon & Wolf, 2009; Grubbs et al., 2009; Izard et al., 2014; Jones et al., 2016; Kazley et al., 2015; Parekh et al., 2017; Rosenbaum et al., 2015; Weng et al., 2013), and 19.5% measured only numeracy (n = 10) (Alokozai et al., 2017; Escobedo & Weismuller, 2013; Menendez, Muddgal, et al., 2015; Menendez et al., 2016; Menendez et al., 2017; Parekh et al., 2017; Parrish et al., 2016; Roh et al., 2018; Serper et al., 2015; Winton et al., 2016). The most common tool that was used to measure health literacy was the Newest Vital Sign (NVS) (n = 13) (Alokozai et al., 2017; Escobedo & Weismuller, 2013; Kazley et al., 2015; Komenaka et al., 2014; Menendez, Muddgal, et al., 2015; Menendez et al., 2016; Menendez et al., 2017; Parekh et al., 2017; Parrish et al., 2016; Roh et al., 2018; Rosenbaum et al., 2015; Serper et al., 2015; Weiss et al., 2005; Winton et al., 2016). The second most common tool used was the Rapid Estimate of Adult Literacy (REALM) (n = 10) (Arozullah et al., 2007; Chu & Tseng, 2013; Davis et al., 1991; Gordon & Wolf, 2009; Izard et al., 2014; Kazley et al., 2015; Mahoney et al., 2018; Miller-Matero et al., 2015; Patzer et al., 2016; Wallace et al., 2009), followed by the Brief Health Literacy Screen (BHLS) (n = 9) (Chew, Bradley & Boyko, 2004; Conlin & Schumann, 2002; Dageforde et al., 2015; Dageforde et al., 2014; Garcia-Marcinkiewicz et al., 2014; Hallock et al., 2017; Keim-Malpass et al., 2018; Scarpato et al., 2016; Wallace et al., 2007; Wright et al., 2018; Zite & Wallace, 2011). The description of all studies using these various tools and others can be found in Table 2.

Low Health Literacy is Associated with Patient Characteristics Including Race/Ethnicity

Several studies examined factors associated with health literacy, finding that low health literacy was significantly associated with older age (Koster et al., 2017), male gender (Miller-Matero et al., 2015), lower socio-economic status (Koster et al., 2017), less education (Rosenbaum et al., 2015; Scarpato et al., 2016; Taylor et al., 2016), poor English flu-
| Reference            | Surgical Specialty | Health Literacy Instrument | Operative Stage | Study Design          | Patients in Study (n) | Prevalence of Low Health Literacy | Newcastle-Ottawa Scale Score | Potential Bias/ Limitations                                                                 |
|----------------------|--------------------|----------------------------|-----------------|------------------------|-----------------------|-------------------------------|-------------------------------|--------------------------------------------------------------------------------------|
| Roh et al. (2018)    | Hand               | NVS                        | Pre             | Prospective, cross-sectional | 133                   | 44% (n = 58)                  | 8                             | Low number and single provider                                                   |
| Akkozi et al. (2017) | Hand               | NVS                        | Pre             | Prospective, cross-sectional | 112                   | 27% (n = 30)                  | 8                             | Limited number of physicians, unknown referral patterns                                |
| Menendez et al. (2017)| Hand               | NVS                        | Pre             | Prospective, cross-sectional | 84                    | 26% (n = 22)                  | 7                             | Sample size, coder bias                                                            |
| Menendez et al. (2016)| Breast             | NVS, NUS-8 Ca               | Post            | Randomized controlled trial | 59                    | -                             | -                             | Pilot study, selection bias                                                        |
| Parish et al. (2016) | Hand               | NVS                        | Pre             | Prospective, cohort          | 224                   | 31% (n = 69)                  | 6                             | Were unable to quantify complexity of visit                                          |
| Menendez et al. (2016)| Hand               | NVS                        | Pre             | Prospective, cross-sectional | 112                   | 75% (n = 111)                 | 7                             | Single center, measure not discussed                                                |
| Winton et al. (2016) | Breast             | NVS                        | Post            | Retrospective review         | 403                   | 78% (n = 314)                 | 7                             | Selection bias                                                                     |
| Kazley et al. (2015) | Abdominal transplant| NVS, REALM-T, DMCA          | Pre and post    | Cross-sectional             | 92                    | 48% (n = 119, NVS) and 69% (n = 171, DMCA) | 7 | Caregiver present when assessed                                                   |
| Rosenbaum et al. (2015)| Orthopedics      | NVS, LMP                     | Pre             | Pre and post                | 248                   | 15% (n = 35)                  | 7                             | Participant bias, selection bias                                                    |
| Serper et al. (2015) | Abdominal transplant| NUS, LMP                     | Post            | Post                       | 105                   | 48% (n = 66)                  | 7                             | Self-reported nonadherence, self-selection bias                                     |
| Komenaka et al. (2014)| Hand               | NVS                        | Pre             | Cross-sectional             | 200                   | 43% (n = 103)                 | 7                             | Low number, potential for observer bias                                              |
| Escobedo & Weismuller(2013)| Abdominal transplant| NVS                        | Pre             | Cross-sectional             | 2025                  | 86% (n = 1634)                | 7                             | N/A                                                                               |
| Menendez, Mudgal et al. (2015)| Hand               | NVS                        | Pre             | Pre and post                | 44                    | 41% (n = 18)                  | 7                             | Small sample size                                                                  |
**TABLE 2 (continued)**

**Evaluation of All Studies Included in the Review**

| Reference                      | Surgical Specialty | Health Literacy Instrument | Operative Stage | Study Design          | Patients in Study (n) | Prevalence of Low Health Literacy<sup>a</sup> | Newcastle-Ottawa Scale Score<sup>b</sup> | Potential Bias/Limitations                                                                 |
|--------------------------------|--------------------|-----------------------------|----------------|------------------------|-----------------------|----------------------------------------------|------------------------------------------|------------------------------------------------------------------------------------------|
| Mahoney et al. (2018)          | Bariatric          | REALM-SF                    | Pre            | Prospective, cross-sectional | 95                    | 7% (n = 7)                                    | 7                                         | Low number                                                                              |
| Patzer et al. (2016)           | Abdominal transplant | REALM                      | Post           | Prospective, cross-sectional | 99                    | 25% (n = 24)                                  | 7                                         | Sample size, interviewer bias                                                           |
| Miller-Matero et al. (2015)    | Abdominal transplant | REALM                      | Pre            | Cross-sectional         | 398                   | 27.5% (n = 96)                                | 7                                         | Included patients with cognitive impairment                                               |
| Kazley et al. (2014)           | Abdominal transplant | REALM-T, DMCAT, NVS         | Pre and post   | Cross-sectional         | 92                    | -                                            | 7                                         | Caregiver present when assessed                                                           |
| Izard et al. (2014)            | Urology            | REALM, SNS, GLS             | Post           | Cross-sectional         | 50                    | -                                            | N/A                                       | Small sample size, convenience sample                                                    |
| Chu & Tseng (2013)             | Orthopedics        | Chinese version of REALM    | Pre            | Cross-sectional         | 144                   | 59% (n = 86)                                  | 4                                         | Translated health literacy tool                                                           |
| Gordon & Wolf (2009)           | Abdominal transplant | REALM-T, S-TOFHLA          | Post           | Cross-sectional         | 124                   | 9% (n = 11, S-TOFHLA) and 81% (n = 100, REALM-T) | 5                                         | Only high educated patients                                                              |
| Wallace et al. (2009)          | Vascular           | REALM-VS                    | Pre            | Validation study, cross-sectional | 152                   | -                                            | N/A                                       | Convenience sample, selection bias                                                       |
| Wallace et al. (2007)          | Vascular           | REALM, BHLS                 | Pre            | Cross-sectional, validation study | 100                   | 39% (n = 39)                                  | 5                                         | Selection bias, sample size                                                              |
| Conlin & Schumann (2002)       | Cardiac            | REALM                       | Pre            | Prospective cross-sectional | 30                    | 20% (n = 6)                                   | 7                                         | Small sample size                                                                        |
## Evaluation of All Studies Included in the Review

| Reference                      | Surgical Specialty            | Health Literacy Instrument | Operative Stage | Study Design       | Patients in Study (n) | Prevalence of Low Health Literacy<sup>a</sup> | Newcastle-Ottawa Scale Score<sup>b</sup> | Potential Bias/Limitations                                                                 |
|--------------------------------|-------------------------------|----------------------------|----------------|--------------------|-----------------------|-----------------------------------------------|------------------------------------------|------------------------------------------------------------------------------------------|
| Evaluation of studies using the Brief Health Literacy Screener                  |                               |                            |                |                    |                       |                                               |                                          |                                                                                           |
| Keim-Malpass et al. (2018)   | Breast                        | BHLS                       | Not stated      | Prospective, cross-sectional | 512                   | 26% (n = 131)          | 7                                           | No information about if patient was not a candidate for a particular surgery option      |
| Wright et al. (2018)          | General                       | BHLS                       | Pre            | Retrospective, cross-sectional | 1,239                 | 49% (n = 1,239)        | 9                                           | Single center, under-representation of minorities                                          |
| Hallock et al. (2017)         | Gynecology                    | BHLS                       | Pre            | Cross-sectional     | 150                   | 10% (n = 16)           | 9                                           | Use of a nonvalidated measure for knowledge                                               |
| Scarpato et al. (2016)        | Urology                       | BHLS                       | Pre            | Retrospective, cross-sectional | 368                   | 51% (n = 188)          | 8                                           | Under-representation of minorities                                                      |
| Dageforde et al. (2015)       | Abdominal transplant           | BHLS                       | Post           | Pilot               | 104                   | 23% (n = 24)           | N/A                                        | Convenience sample                                                                       |
| Garcia-Marcinkiewicz et al. (2014) | General               | BHLS                       | Pre            | Cross-sectional     | 460                   | 18% (n = 83)           | 8                                           | Selection bias: majority of participants had college level and above education; under-representation of minorities |
| Dageforde et al. (2014)       | Abdominal transplant           | BHLS                       | Post           | Retrospective review | 360                   | 11% (n = 36)           | N/A                                        | Retrospective review with differences between the study groups                            |
| Zite & Wallace (2011)         | Gynecology                    | BHLS                       | Pre            | Randomized control trial | 201                   | 50% (n = 101)          | N/A                                        | Single institution, selection bias                                                        |
| Wallace et al. (2007)         | Vascular                      | BHLS, REALM                | Pre            | Cross-sectional, validation study | 100                   | 39% (n = 39)           | 5                                           | Selection bias, sample size                                                               |
## TABLE 2 (continued)

### Evaluation of All Studies Included in the Review

| Reference                        | Surgical Specialty       | Health Literacy Instrument      | Operative Stage | Study Design       | Patients in Study (n) | Prevalence of Low Health Literacy<sup>a</sup> | Newcastle-Ottawa Scale Score<sup>b</sup> | Potential Bias/ Limitations                                                                 |
|----------------------------------|---------------------------|---------------------------------|-----------------|--------------------|----------------------|-----------------------------------------------|------------------------------------------|------------------------------------------------------------------------------------------|
| Jones et al. (2016)              | Abdominal transplant      | S-TOFHLA, TOFHLA                 | Pre             | Cross-sectional    | 40 (S-TOFHLA) and 36 (TOFHLA) | 5% (n = 2, S-TOFHLA) and 14% (n = 5, TOFHLA) | 4                                         | Sample size, under-representation of minorities                                           |
| Weng et al. (2013)               | Abdominal transplant      | S-TOFHLA                         | Post            | Cross-sectional    | 252                  | 2% (n = 6)                                      | 7                                         | Self-reported adherence, potential selection bias                                     |
| Choi et al. (2011)               | Orthopedic                | S-TOFHLA                         | Pre             | Focus group        | 15                   | 100% (n = 15)                                   | N/A                                      | Sampled patients with low health literacy                                                |
| Beitler et al. (2010)            | Ears, nose, and throat    | S-TOFHLA                         | Post            | Cross-sectional    | 8                    | 37% (n = 3)                                     | 4                                         | Sample size                                                                               |
| Gordon & Wolf (2009)             | Abdominal transplant      | S-TOFHLA, REALM                   | Post            | Cross-sectional    | 124                  | 9% (n = 11, S-TOFHLA) and 81% (n = 100, REALM-T) | 5                                         | Only highly educated patients                                                            |
| Grubbs et al. (2009)             | Abdominal transplant      | S-TOFHLA                         | Pre             | Cohort             | 62                   | 32% (n = 14)                                     | 5                                         | Sample size                                                                               |
| Chew, Bradley, Flum, et al. (2004)| General                  | S-TOFHLA                         | Pre             | Cohort             | 332                  | 12% (n = 40)                                     | 5                                         | Self-assessment measure of adherence, single center                                     |
| Cayci et al. (2018)              | Bariatric                 | HLS-EU-Q47                       | Pre             | Cross-sectional case control | 242 (138 vs. 104)    | 58% (n = 140)                                   | 7                                         | Single center and demographic differences between groups                                |
| Halleberg Nyman et al. (2018)    | Same day, multi-specialty| Swedish-FHL                      | Post            | Multicenter, single blinded, randomized controlled trial | 704                  | 39% (n = 277)                                   | N/A                                      | Selection bias                                                                           |
| Huang et al. (2018)              | Breast                    | HLS-EU-Q                         | Pre             | Prospective, cross-sectional | 475                  | -                                             | N/A                                      | Single center                                                                            |
| Khan et al. (2018)               | Cardiac surgery           | eHEALS                          | Post            | Mixed methods      | 33                   | -                                             | 9                                        | Sample size                                                                               |
| Turkoglu et al. (2018)           | Urology                   | HLS-EU-Q47                       | Post            | Prospective, cross-sectional | 126                  | 67% (n = 85)                                   | 10                                       | Single center                                                                            |
### TABLE 2 (continued)

**Evaluation of All Studies Included in the Review**

| Reference                  | Surgical Specialty | Health Literacy Instrument | Operative Stage | Study Design | Patients in Study (n) | Prevalence of Low Health Literacy<sup>a</sup> | Newcastle-Ottawa Scale Score<sup>b</sup> | Potential Bias/Limitations |
|----------------------------|--------------------|-----------------------------|-----------------|--------------|-----------------------|-----------------------------------------------|----------------------------------|----------------------------------|
| Cajita et al. (2017)       | Heart transplant   | Subjective HLS              | Post            | Cross-sectional, multicenter cohort | 1,365 | 33% (n = 451) | 10 | Secondary analysis |
| Koster et al. (2017)       | General            | FCCHL                        | Pre             | Cross-sectional | 225 | 37% (n = 84) | 7 | Adapted health literacy tool |
| Parekh et al. (2017)       | Breast             | NLit-BCa, NVS                | Post            | Randomized controlled trial | 59 | - | N/A | Small sample size |
| Tang et al. (2017)         | Breast             | HeLMS                        | Post            | Prospective, cross-sectional | 286 | N/A | 8 | Convenience sample, single center |
| Mercieeca-Bebber et al. (2017) | Breast             | HLQ                          | Post            | Cross-sectional | 38 | - | 7 | Selection bias |
| Halbach et al. (2016)      | Breast             | German HLS-EU-Q47            | Post            | Prospective, longitudinal, multi-center cohort | 1,060 | 12% (n = 127) | 6 | Participant bias, potential selection bias |
| Schmidt et al. (2016)      | Breast             | HLS-EU-Q16                   | Post            | Prospective, multi-center cohort | 1,248 | - | 7 | Selection bias |
| Taylor et al. (2016)       | Abdominal transplant | SILS                        | Pre             | Cross-sectional, multicenter cohort | 6,842 | 14% (n = 1,001) | 8 | Single item screener |
| Kazley et al. (2015)       | Abdominal transplant | DMCAT, NVS, REALM-T          | Pre and Post    | Cross-sectional | 92 | - | 7 | Caregiver present when assessed |
| Lambert et al. (2015)      | Abdominal transplant | HeLMS                        | Pre             | Cross-sectional | 153 | - | 7 | Single center |
| Rosenbaum et al. (2015)    | Orthopedic         | NVS, LIMP                    | Pre             | Cross-sectional | 248 | 48% (n = 119, NVS) and 69% (n = 171, LIMP) | 7 | Participant bias, selection bias |
| Izard et al. (2014)        | Urology            | SNS, GLS, REALM              | Post            | Cross-sectional | 50 | - | N/A | Small sample size, convenience sample |
| Tung et al. (2014)         | Vascular           | THLS                         | Post            | Cross-sectional | 105 | - | 7 | Small sample size |

<sup>a</sup> Low health literacy includes all patients defined as something other than adequate or high health literacy.

<sup>b</sup> Newcastle-Ottawa Scale is a scoring system based on the evaluation of case control or cohort studies in the areas of selection, comparability, and outcome/exposure, where 7 to 9 is high, 4 to 6 is moderate, and 1 to 3 is low quality. *Denotes a disease-specific health literacy measurement tool.

Note: BHLS = Brief Health Literacy Screen; DMCAT = Decision Making Capacity Assessment Tool; eHEALS = Electronic Health Literacy Scale; FCCHL = Functional Communicative Critical Health Literacy; FHL = Function Health Literacy; GLS = Graphic Literacy Scale; HeLMS = Health Literacy Management Scale; HLQ = Health Literacy Questionnaire; HLS = Health Literacy Screener; HLS-EU = European Health Literacy Scale; LiMP = Literacy in Musculoskeletal Patients; NLit-BCa = Nutrition Literacy Assessment Instrument for Breast Cancer Patients; N/A = not applicable; NVS = Newest Vital Sign; REALM = Rapid Estimate of Adult Literacy in Medicine; REALM-SF = Rapid Estimate of Adult Literacy in Medicine—Short Form; REALM-T = Rapid Estimate of Adult Literacy in Medicine—Transplant; REALM-VS = Rapid Estimate of Adult Literacy—Vascular Surgery; S-TOFHLA = Short Form Test of Functional Health Literacy in Adults; TOFHLA = Test of Functional Health Literacy in Adults; SNS = Subjective Numeracy Scale; THLS = Taiwan Health Literacy Scale; TOFHLA = Test of Functional Health Literacy in Adults.
ency/non-Western background (Schmidt et al., 2016; Taylor et al., 2016), being unmarried (Scarpato et al., 2016), and without car or home ownership (Taylor et al., 2016). Among hand surgery patients, Menendez et al. (2017) demonstrated that limited health literacy significantly affected native Spanish-speaking patients (100%) versus native English-speaking patients (33%). Two other studies (Miller-Matero et al., 2015; Scarpato et al., 2016) found that Black people were more associated with low health literacy than White people, whereas one study (Taylor et al., 2016) conducted in the United Kingdom found that White people rather than Black people were associated with low health literacy. These differences demonstrate the complex interplay between low health literacy and factors such as race/ethnicity and socioeconomic status.

Association of Health Literacy with Surgical Outcomes

The largest study to date that focused on the relationship of health literacy and surgical outcomes found that low health literacy in patients undergoing major abdominal surgery was associated with increased length of stay but not with 30-day emergency department (ED) visits or 90-day hospital readmissions (Wright et al., 2018). In patients undergoing urologic procedures, low health literacy was associated with higher minor postoperative complications at 30 days and higher pathological and biopsy staging (Scarpato et al., 2016). However, Mahoney et al. (2018), found no statistical difference in ED visits, readmissions, or hospital visits among bariatric surgery patients stratified by Rapid Estimate of Adult Literacy in Medicine–Short Form (REALM-SF) health literacy scores. Preoperatively, health literacy has been shown to affect whether patients undergo surgical procedures. In breast surgery, for example, low health literacy has been associated with lower reconstruction rates in patients (Winton et al., 2016). Kazley et al. (2015) has also demonstrated that level of health literacy is a predictor for whether a patient is listed for kidney transplantation.

Studies to date have not found an association between health literacy and patient satisfaction with respect to their hospital stay, outcomes, or interactions with care team (Komenaka et al., 2014; Menendez, Chen, Mudgal, Jupiter, & Ring, 2015; Perez-Brayfield et al., 2016); however, a single study did evaluate health literacy and patient satisfaction with his or her decision to undergo surgery and the informed consent process (Hallock et al., 2017). Hallock et al. (2017) measured patient satisfaction using a scale measuring “satisfaction with decisions” and found that highly satisfied patients scored higher on the informed consent questionnaire that measured knowledge of planned procedure; however, there was no statistically significant difference in health literacy rates between the patients who were highly satisfied versus those who were not. Additional studies (Tang et al., 2017; Turkoglu et al., 2019) have demonstrated a relationship between low health literacy and poor treatment compliance among surgery patients. For surgical populations such as patients receiving transplants, whose outcomes are dependent on compliance with medications, low health literacy has profound implications on graft rejection and loss (Gordon & Wolf, 2009; Patzer et al., 2016; Serper et al., 2015).

Interventions to Address Low Health Literacy in Surgical Patients

Studies (Choi, 2011; Zite & Wallace, 2011) focused on interventions in health literacy for surgical patients are emerging. Choi (2011) studied the use of Internet-based pictograph-formatted discharge instructions for older adults after hip replacement surgery and reported that participants found the website easy to use and understand. Zite and Wallace (2011) used a low health literacy consent form and compared knowledge retention of both the proposed operation and the consent process compared to those who underwent the standard consent process. They found that patients who underwent the consent process using the low health literacy consent form had better understanding without any additional counseling or educational materials.

DISCUSSION

The number of studies on health literacy in surgery has significantly increased from 2002 to 2018 (Figure 2). Since the last review in 2013, studies on health literacy in surgery have expanded to surgical subspecialties ranging from general surgery (García-Marcinkiewicz et al., 2014; Koster et al., 2017; Wright et al., 2018) to vascular (Tung et al., 2014) to breast (Halbach et al., 2016; Huang et al., 2018; Keim-Malpass et al., 2018; Komenaka et al., 2014; Mercieca-Bebber et al., 2017; Parekh et al., 2017; Schmidt et al., 2016; Tang et al., 2017; Winton et al., 2016), and urology (Izard et al., 2014; Scarpato et al., 2016; Turkoglu et al., 2019). Several health literacy instruments have also been developed that are unique for surgical subspecialties (Gibbs et al., 2016; Gordon & Wolf, 2009; Kazley et al., 2014; Wallace et al., 2009). Importantly, all of these studies show that more than one-third of surgical patients have low health literacy (Alokozai et al., 2017; Beittler et al., 2010; Cajita et al., 2017; Cayci et al., 2018; Chew, Bradley, Flum et al., 2004; Choi, 2011; Chu & Tseng, 2013; Conlin & Schumann, 2002; Dageforde et al., 2015; Dageforde et al., 2014; Escobedo & Weismuller, 2013; García-Marcinkiewicz et al., 2014; Gordon & Wolf, 2009; Grubbs et al., 2009; Halbach et al., 2016; Halleberg Nyman et al., 2018; Hallock et
al., 2017; Izard et al., 2014; Jones et al., 2016; Keim-Malpass et al., 2018; Komenaka et al., 2014; Koster et al., 2017; Mahoney et al., 2018; Menendez et al., 2016; Menendez et al., 2017; Miller-Matero et al., 2015; Patzer et al., 2016; Roh et al., 2018; Rosenbaum et al., 2015; Scarpato et al., 2016; Serper et al., 2015; Tang et al., 2017; Taylor et al., 2016; Turkoglu et al., 2019; Wallace et al., 2007; Weng et al., 2013; Winton et al., 2016; Wright et al., 2018; Zite & Wallace, 2011). These findings are important because recent studies are now beginning to link low health literacy to poor surgical outcomes, which suggests an opportunity for interventions. The paucity of these latter studies highlights a clear gap and need for more health literacy-sensitive care in surgery.

More than 20 years of studies in nonsurgical fields have shown that low health literacy is associated with poorer health outcomes, including increased hospitalizations and emergency care, decreased use of preventive services such as mammography, poorer global health, and higher mortality among the elderly (Berkman et al., 2011; Dewalt, Berkman, Sheridan, Lohr, & Pigone, 2004). Many of these studies have focused on chronic medical conditions such as heart disease (Ghisi, Chaves, Britto, & Oh, 2018), diabetes mellitus (Schillinger et al., 2002), and cancer (Oldach & Katz, 2014). The relationship between health literacy and surgical outcomes is much less defined but has been identified by the National Institutes of Health and American College of Surgeons as a research priority (Haider et al., 2016). Only recently has one study shown that low health literacy in patients undergoing abdominal surgery is linked to poor outcomes (Wright et al., 2018). However, this retrospective study was limited by a broad three-question literacy assessment, a single-institution cohort characterized by a low proportion of Black participants, generally well-educated patients, and it did not include patients undergoing emergency surgery (Wright et al., 2018). Additional studies have identified relationships between low health literacy and measures that would likely have an impact on surgical outcomes such as treatment compliance (Patzer et al., 2016; Chew, Bradley, Flum et al., 2004), patient satisfaction (Parrish et al., 2016), and physical activity (Tang et al., 2017), but they do not make direct correlations with measures such as readmission, length of stay, morbidity, and mortality. Further studies, both quantitative and qualitative, are needed to more clearly understand the relationship between health literacy and surgical outcomes.

Studies in nonsurgical fields have consistently demonstrated that low health literacy is common among vulnerable populations (Dewalt et al., 2004; Ghisi et al., 2017; Pleasant, 2014). Our review shows similar findings in surgical patients, where non-White surgical patients, for example, were observed to have lower health literacy abilities than White patients (Kazley et al., 2014; Miller-Matero et al.,...
Similarly, non-native English-speaking patients were assessed to have lower health literacy levels than native English speakers (Menendez et al., 2017). Other patient characteristics associated with low health literacy included older age (Kazley et al., 2014), male gender (Miller-Matero et al., 2015), poor education (Lambert et al., 2015; Rosenbaum et al., 2015), and cumulative medical comorbidities (Ghisi et al., 2017; Lambert et al., 2015; Schillinger et al., 2002). Effective care for vulnerable populations in surgery needs to account for many moving parts, but health literacy may represent a particularly important factor to target as it lies at the intersection of many patient, language, and socioeconomic factors.

Health literacy is ubiquitous and may also contribute to racial and ethnic disparities in surgical outcomes; therefore, targeting health literacy may be one actionable way to address racial and ethnic surgical disparities. As an example, our institution has demonstrated that adopt-
ing a standardized perioperative recovery protocol (ie, Enhanced Recovery Program) in patients with colorectal cancer eliminated racial and ethnic disparities in postoperative length of stay between Black and White patients (Wahl et al., 2017). Part of this effect may stem from the protocol’s emphasis on addressing patient education, understanding, and expectations of the surgical process. Therefore, efforts to address racial and ethnic surgical disparities may also overlap with efforts to address health literacy.

In our review of the surgical literature, we found that only a small sample of interventional studies exist that address adult health literacy. Zite and Wallace (2011) demonstrated that the use of a low health literacy consent form increased patients’ knowledge retention compared to the standard consent process. Scott et al. (2018) used a Delphi process to improve discharge instructions through consensus opinion on over 20 topics. This endeavor proved difficult as few topics reached consensus and the original materials were above the 6th-grade reading level. Naik et al. (2017) created a discharge warning tool through user-centered design to aid patients in health care decisions and facilitate discussions with the care teams. Choi (2011) increased understanding of the discharge process after hip-replacement surgery through the use of web-based pictograph-formatted discharge instructions. All studies demonstrated that simple interventions can be applied to improve patient comprehension and engagement, although no improvements in outcomes were specifically reported.

Future work in surgery should focus on the development or implementation of health literacy interventions and establishment of health-literate organizations in surgery (Koh, Brach, Harris, & Parchman, 2013). The completion of further prevalence studies will not advance the state of research, as studies to date consistently show low health literacy in the surgical population. Development of health-literate interventions should take best practices in health literacy and adapt them to surgical care at every phase of the perioperative period. Such adaptations could involve development of new surgical care programs or, perhaps more pragmatically, equip existing surgical care programs, such as Enhanced Recovery Programs, with focused health-literate interventions such as enhanced education material and discharge protocols. These interventions should be designed with engagement of patients, providers, and even institutions as we also seek to establish organizations that are health literate. Although funding for health literacy-specific studies are limited (the last National Institutes of Health Funding Opportunity Announcement on health literacy-specific studies was announced in 2013), the cross-disciplinary nature of health literacy and its impact on health disparities suggest an opportunity, and need, for broad support from national funding agencies such as the National Institutes of Health.

LIMITATIONS

Our review has several limitations. Most studies on health literacy were single-center studies with limited sample size of less than 100 patients. Furthermore, all studies involved surveys and recruitment of patients for the studies, which could be influenced by participation bias. The potential bias of each study is described in Table 2, but many of these are inherent to the study design. In addition, the validated health literacy tools included in this review are self-reported, which leads to bias inherent to self-reported data such as recall, response, and introspective ability. Furthermore, many questionnaires were written that would certainly influence participation and/or the quality of data collected from people with limited literacy and/or low English proficiency. There were also portions of the literature, particularly in some subspecialties like hand surgery, where the representation of data is dominated by a single group of investigators. For example, in the articles about health literacy in hand surgery, one group of authors contributed more than 50% of the published literature and exclusively used the NVS tool. This lack of diverse representation will also contribute to decreased variation in tool selection and lead to bias. Finally, there were also limitations in performing the systematic review. Although we attempted to find all information regarding the state of adult health literacy in surgery, we may not have captured all available data secondary to our search process and/or publication bias. A validated scoring tool was used in an attempt to mitigate the subjective assessment of the articles by the authors, but this individualized scoring has the potential to be biased as well.

CONCLUSIONS

Research on health literacy in surgery has increased significantly since 2002. Large parts of the surgical population have low health literacy and few interventions in surgery exist that address this problem. These findings highlight important opportunities for the development and implementation of surgical care that is more health literate and for the establishment of health-literate organizations in surgery.

REFERENCES

Alokozai, A., Bernstein, D. N., Sheikholeslami, N., Uhler, L., Ring, D., & Kamal, R. N. (2017). Impact of health literacy on time spent seeking hand care. Hand (N Y), 13(5), 538-546. https://doi.org/10.1177/1558944717708027 PMID:28513193
Conlin, K. K., & Schumann, L. (2002). Literacy in the health care system: A study on open heart surgery patients. *Journal of the American Academy of Nurse Practitioners, 14*(1), 38-42. https://doi.org/10.1111/j.1745-7599.2002.tb00069.x PMID:11845640

Dageforde, L. A., Box, A., Feurer, I. D., & Cavanaugh, K. L. (2015). Understanding Patient barriers to kidney transplant evaluation. *Transplantation, 99*(7), 1463-1469. https://doi.org/10.1097/TP.0000000000000543 PMID:25606794

Dageforde, L. A., Petersen, A. W., Feurer, I. D., Cavanaugh, K. L., Harms, K. A., Ehrenfeld, J. M., & Moore, D. E. (2014). Health literacy of living kidney donors and kidney transplant recipients. *Transplantation, 98*(1), 88-93. https://doi.org/10.1097/TP.000000000000027 PMID:24573114

Davis, T. C., Crouch, M. A., Long, S. W., Jackson, R. H., Bates, P., George, R. B., & Bainsfather, L. E. (1991). Rapid assessment of literacy levels of adult primary care patients. *Family Medicine, 23*(6), 433-435. PMID:1936717

De Oliveira, G. S., Jr., McCarthy, R. J., Wolf, M. S., & Holl, J. (2015). The impact of health literacy in the care of surgical patients: A qualitative systematic review. *BMC Surgery, 15*(1), 86. https://doi.org/10.1186/s12893-015-0073-6 PMID:26182987

Dewalt, D. A., Berkman, N. D., Sheridan, S., Lohr, K. N., & Pignone, M. P. (2004). Literacy and health outcomes: A systematic review of the literature. *Journal of General Internal Medicine, 19*(12), 1228-1239. https://doi.org/10.1111/j.1526-914X.2004.00153.x PMID:15610334

Escobedo, W., & Weismuller, P. (2013). Assessing health literacy in renal failure and kidney transplant patients. *Progress in Transplantation (Aliso Viejo, Calif.), 23*(1), 47-54. https://doi.org/10.7182/plit2013473 PMID:23448820

Fagerlin, A., Zikmund-Fisher, B. J., Ubel, P. A., Jankovic, A., Derry, H. A., & Smith, D. M. (2007). Measuring numeracy without a math test: Development of the Subjective Numeracy Scale. *Medical Decision Making, 27*(5), 672-680. https://doi.org/10.1177/0272989X07304449 PMID:17641437

Galesic, M., & Garcia-Retamero, R. (2011). Graph literacy: A cross-cultural comparison. *Medical Decision Making, 31*(3), 444-457. https://doi.org/10.1177/0272989X10373805 PMID:20671213

Garcia-Marcinkiewicz, A. G., Long, T. R., Danielson, D. R., & Rose, S. H. (2014). Health literacy and anesthesia: Patients’ knowledge of anesthesiologist roles and information desired in the preoperative visit. *Journal of Clinical Anesthesia, 26*(5), 375-382. https://doi.org/10.1016/j.jclinane.2014.01.013 PMID:25086485

Gishi, G. L. M., Chaves, G. S. D. S., Britto, R. R., & Oh, P. (2018). Health literacy and coronary artery disease: A systematic review. *Patient Education and Counseling, 101*(2), 177-184. https://doi.org/10.1016/j.pec.2017.09.002 PMID:28899710

Gibbs, H. D., Ellerbeck, E. F., Bafort, C., Gajewski, B., Bennett, A. R., Yu, Q., . . . Sullivan, D. K. (2016). Measuring nutrition literacy in breast cancer patients: development of a novel instrument. *Journal of General Internal Medicine, 31*(5), 672-680. https://doi.org/10.1007/s11606-015-3714-5 PMID:26248340

Gordon, E. J., & Wolf, M. S. (2009). Health literacy skills of kidney transplant recipients. *Progress in Transplantation, 19*(1), 25-34. https://doi.org/10.1177/152692480901901004 PMID:19341160

Grubbs, V., Gregorich, S. E., Perez-Stable, E. J., & Hsu, C. Y. (2009). Health literacy and access to kidney transplantation. *Clinical Journal of the American Society of Nephrology, 4*(1), 195-200. https://doi.org/10.2215/CJN.00720009.PMID:19056617

Haider, A. H., Dankwa-Mullan, I., Maragh-Bass, A. C., Torain, M., Zogg, C. K., Lilley, E. J., . . . Britt, L. D. (2016). Setting a national agenda for surgical disparities research: Recommendations from the National Institutes of Health and American College of Surgeons Summit. *JAMA Surgery, 151*(6), 554-563. https://doi.org/10.1001/jama-
use of a digital portal. *Health Education Journal*, 77(4), 482-494. https://doi.org/10.1177/0178969618756435

Kindig, D. A., Panzer, A. M., & Nielsen-Bohlman, L. (Eds.). (2004). *Health literacy: A prescription to end confusion*. Retrieved from National Academies Press website: https://www.nap.edu/catalog/10883

Koh, H. K., Brach, C., Harris, L. M., & Parchman, M. L. (2013). A proposed 'health literate care model' would constitute a systems approach to improving patients' engagement in care. *Health Affairs*, 32(2), 357-367. https://doi.org/10.1377/hlthaff.2012.1205

Komenaka, I. K., Nodora, J. N., Machado, L., Hsu, C. H., Klemens, A. E., Martinez, M. E., . . . Weiss, B. D. (2014). Health literacy assessment and patient satisfaction in surgical practice. *Surgery*, 155(3), 374-383. https://doi.org/10.1016/j.surg.2013.10.011

Koster, E. S., Schmidt, A., Philbert, D., van de Garde, E. M. W., & Bouvy, M. L. (2017). Health literacy of patients admitted for elective surgery. *Zeitschrift für Gesundheitswissenschaften*, 25(2), 181-186. https://doi.org/10.1007/s10389-016-0774-z

Lambert, K., Mullan, J., Mansfield, K., & Lonergan, M. (2015). A cross-sectional comparison of health literacy deficits among patients with chronic kidney disease. *Journal of Health Communication*, 20(Suppl. 2), 16-23. https://doi.org/10.1080/10810730.2015.1080329

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., . . . Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Journal of Clinical Epidemiology*, 62(10), e1-e43. https://doi.org/10.1016/j.jclinepi.2009.06.006

Mahoney, S. T., Tawfik-Sexton, D., Strassle, P. D., Farrell, T. M., & Duke, M. C. (2018). Effects of education and health literacy on postoperative hospital visits in bariatric surgery. *Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A*, 28(9), 1100-1104. https://doi.org/10.1089/lap.2018.0093

Menendez, M. E., Chen, N. C., Mudgal, C. S., Jupiter, J. B., & Ring, D. (2015). Physician empathy as a driver of hand surgery patient satisfaction. *Journal of Hand Surgery*, 40(9), 1860-1865.e2 https://doi.org/10.1016/j.jhsa.2015.06.010

Menendez, M. E., Mudgal, C. S., Jupiter, J. B., & Ring, D. (2015). Health literacy in hand surgery patients: A cross-sectional survey. *The Journal of Hand Surgery*, 40(4), 798-804.e2. https://doi.org/10.1016/j.jhsa.2015.01.010

Menendez, M. E., Parrish, R. C., II, & Ring, D. (2016). Health Literacy and time spent with a hand surgeon. *The Journal of Hand Surgery*, 41(4), e59-e69. https://doi.org/10.1016/j.jhsa.2015.12.031

Menendez, M. E., van Hoorn, B. T., Mackert, M., Donovan, E. V., Chen, N. C., & Ring, D. (2017). Patients with limited health literacy ask fewer questions during office visits with hand surgeons. *Clinical Orthopaedics and Related Research*, 475(5), 1291-1297. https://doi.org/10.1007/s11999-016-5140-5

Mercieca-Bebber, R., King, M. T., Boxer, M. M., Spillane, A., Winters, Z. E., Butow, P. N., . . . Rutherford, C. (2017). What quality-of-life issues do women with ductal carcinoma in situ (DCIS) consider important when making treatment decisions? *Breast Cancer*, 24(5), 720-729. https://doi.org/10.1017/s12282-017-0765-0

Miller-Materno, L. R., Hyde-Nolan, M. E., Eshelman, A., & Aubouiljoud, M. (2015). Health literacy in patients referred for transplant: Do patients have the capacity to understand? *Clinical Transplantation*, 29(4), 336-342. https://doi.org/10.1111/ctr.12519

Morris, N. S., MacLean, C. D., Chew, L. D., & Littenberg, B. (2006). The Single Item Literacy Screener: Evaluation of a brief instrument...
to identify limited reading ability. BMC Family Practice, 7(1), 21. https://doi.org/10.1186/s1471-2296-7-21 PMID:16563164

Naik, A. D., Horstman, M. J., Li, L. T., Paasche-Orlow, M. K., Campbell, B., Mills, W. L., . . . Berger, D. H. (2017). User-centered design of discharge warnings tool for colorectal surgery patients. Journal of the American Medical Informatics Association, 24(5), 975-980. https://doi.org/10.1093/jamia/ocx188 PMID:28340218

Nakayama, K., Osawa, W., Togari, T., Ishikawa, H., Yonekura, Y., Sekido, A., & Matsumoto, M. (2015). Comprehensive health literacy in Japan is lower than in Europe: A validated Japanese-language assessment of health literacy. BMC Public Health, 15(1), 505. https://doi.org/10.1186/s12889-015-1835-x PMID:26001385

National Institutes of Health. (2016). Clear & simple: Developing effective print materials for low-literacy audiences. Achieving quality and effectiveness in health communication. Retrieved from https://www.nih.gov/institutes-nih/nih-office-director/office-communications-public-liasion/clear-communication/clear-simple

Oldach, B. R., & Katz, M. L. (2014). Health literacy and cancer screening: A systematic review. Patient Education and Counseling, 94(2), 149-157. https://doi.org/10.1016/j.pec.2013.10.001 PMID:24207115

Osborne, R. H., Batterham, R. W., Elsworth, G. R., Hawkins, M., & Buchbinder, R. (2013). The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ). BMC Public Health, 13(1), 658. https://doi.org/10.1186/1471-2458-13-658 PMID:23855504

Pan, F. C., Su, L.-C., Chen, C.-H. (2010). Development of a health literacy scale for Chinese-speaking adults in Taiwan. International Journal of Health and Medical Engineering, 37, 4(1), 29-35. https://publications.waset.org/13713/pdf

Parekh, N., Jiang, J., Buchan, M., Meyers, M., Gibbs, H., & Krebs, P. (2017). Nutrition literacy among cancer survivors: Feasibility results from the Healthy Eating and Living Against Breast Cancer (HEAL-BCa) study: A pilot randomized controlled trial. Journal of Cancer Education: The Official Journal of the American Association for Cancer Education, 33(6), 1239-1249. https://doi.org/10.1007/s13187-017-1238-z PMID:28624900

Parker, R. M., Baker, D. W., Williams, M. V., & Nurss, J. R. (1995). The test of functional health literacy in adults: A new instrument for measuring patients’ literacy skills. Journal of General Internal Medicine, 10(10), 537-541. https://doi.org/10.1007/BF02640361 PMID:8576769

Parrish, R. C., 2nd, Menendez, M. E., Mudgal, C. S., Jupiter, J. B., Parker, R. M., Baker, D. W., Williams, M. V., & Nurss, J. R. (1995). Achieving quality and effectiveness in health communication. Patient Education and Counseling, 19(3), 685-695. doi:10.1016/j.jkint.2016.05.033 PMID:26718069

Patzer, R. E., Serper, M., Reese, P. P., Przytula, K., Koval, R., Ladner, D. P., . . . Wolf, M. S. (2016). Medication misunderstanding, non-adherence, and clinical outcomes among adult kidney transplant recipients. Clinical Transplantation, 30(10), 1294-1305. https://doi.org/10.1111/ctr.12821 PMID:27447351

Perez-Brayfield, M. R., Jorge, J. C., Avilés, L. A., Díaz, J., Ortiz, V., & Morales-Cosme, W. (2016). Concordance of expert and parental opinion about hypospadias surgical outcome is severity dependent. Frontiers in Pediatrics, 4, 2. https://doi.org/10.3389/fped.2016.00002 PMID:26835440

Pleasant, A. (2014). Advancing health literacy measurement: A pathway to better health and health system performance. Journal of Health Communication, 19(12), 1481-1496. https://doi.org/10.1080/10807300.2014.954083 PMID:25491583

Roh, Y. H., Koh, Y. D., Kim, J. O., Noh, J. H., Gong, H. S., & Baek, G. H. (2018). Patients with limited health literacy have similar preferences but different perceptions in surgical decision-making for carpal tunnel release. Clinical Orthopaedics and Related Research, 476(4), 846-851. https://doi.org/10.1099/1471-2296-846-851 PMID:29470230

Rosenbaum, A. J., Pauze, D., Pauze, D., Robak, N., Zade, R., Mulligan, M., & Uhl, R. L. (2015). Health literacy in patients seeking orthopaedic care: Results of the Literacy in Musculoskeletal Problems (LIMP) Project. The Iowa Orthopaedic Journal, 35, 187-192. PMID:26361464

Scarpato, K. R., Kappa, S. F., Goggins, K. M., Chang, S. S., Smith, J. A., Clark, P. E., . . . Moses, K. A. (2016). The impact of health literacy on surgical outcomes following radical cystectomy. Journal of Health Communication, 21(Suppl. 2), 99-104. doi:10.1080/10810730.2016.1193916

Schilling, D., Grumbach, K., Piette, J., Wang, F., Osmond, D., Daher, C., . . . Bindman, A. B. (2002). Association of health literacy with diabetes outcomes. Journal of the American Medical Association, 288(4), 475-482. https://doi.org/10.1001/jama.288.4.475 PMID:12132978

Schmidt, A., Ernstmann, N., Wesselmann, S., Pfaff, H., Wirtz, M., & Kowalski, C. (2016). After initial treatment for primary breast cancer: Information needs, health literacy, and the role of health care workers. Supportive Care in Cancer, 24(2), 563-571. https://doi.org/10.1007/s00520-015-2814-6 PMID:26108171

Scott, A. R., Sanderson, C. J., Rush, A. J., III, Alore, E. A., Naik, A. D., Berger, D. H., & Suliburk, J. W. (2018). Constructing post-surgical discharge instructions through a Delphi consensus methodology: Patient Education and Counseling, 101(S1), 917-925. https://doi.org/10.1016/j.jpec.2017.12.004 PMID:29254751

Serper, M., Patzer, R. E., Reese, P. P., Przytula, K., Koval, R., Ladner, D. P., . . . Wolf, M. S. (2013). Medication misuse, nonadherence, and clinical outcomes among liver transplant recipients. Liver Transplantation, 21(1), 22-28. https://doi.org/10.1002/lt.23403 PMID:23212046

Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., & Brand, H., & the (HLS-EU) Consortium Health Literacy Project European. (2012). Health literacy and public health: A systematic review and integration of definitions and models. BMC Public Health, 12(1), 80. https://doi.org/10.1186/1471-2458-12-80 PMID:22276600

Stang, A. (2010). Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. European Journal of Epidemiology, 25(9), 603-605. https://doi.org/10.1007/s10654-010-9491-z PMID:20652370

Tang, W., Li, Z., Tang, C., Wang, X., & Wang, H. (2017). Health literacy and functional exercise adherence in postoperative breast cancer patients. Patient Preference and Adherence, 11, 781-786. https://doi.org/10.2147/PPA.S127925 PMID:28458522

Taylor, D. M., Bradley, J. A., Bradley, C., Draper, H., Johnson, R., Metcalfe, W., . . . Roderick, P., & the ATTOM Investigators. (2016). Limited health literacy in advanced kidney disease. Kidney International, 90(3), 685-695. https://doi.org/10.1016/j.kint.2015.05.033 PMID:27521115

Tung H. H., Cheng, Y., Shih, C. C., Chen, L. K., Lee, J. Y., & Wang, T. J. (2014). Quality of life among patients with abdominal aortic aneurysm undergoing endografting in Taiwan. European Journal of Cardiovascular Nursing, 13(4), 369-377. https://doi.org/10.1177/1475113113495085 PMID:24013170

Turkoglu, A. R., Demirci, H., Coban, S., Guzelsoy, M., Toprak, E., Ayydos, M. M., . . . Ustundag, Y. (2019). Evaluation of the relationship between compliance with the follow-up and treatment protocol and health literacy in bladder tumor patients. The Aging Male, 22(4), 266-271. https://doi.org/10.1080/13685538.2018.1447558 PMID:29513058
Wahl, T. S., Goss, L. E., Morris, M. S., Gullick, A. A., Richman, J. S., Kennedy, G. D., . . . Chu, D. I. (2018). Enhanced recovery after surgery (ERAS) eliminates racial disparities in postoperative length of stay after colorectal surgery. *Annals of Surgery, 268*(6), 1026-1035. https://doi.org/10.1097/sla.0000000000002307 PMID:28594746

Wallace, L. S., Cassada, D. C., Rogers, E. S., Freeman, M. B., Grandas, O. H., Stevens, S. L., & Goldman, M. H. (2007). Can screening items identify surgery patients at risk of limited health literacy? *The Journal of Surgical Research, 140*(2), 208-213. https://doi.org/10.1016/j.jss.2007.01.029 PMID:17509266

Wallace, L. S., Ergen, W. F., Cassada, D. C., Freeman, M. B., Grandas, O. H., Stevens, S. L., & Goldman, M. H. (2009). Development and validation of the Rapid Estimate of Adult Literacy in Vascular Surgery (REAL_VS). *Annals of Vascular Surgery, 23*(4), 446-452. https://doi.org/10.1016/j.avsg.2008.10.005 PMID:19059757

Wångdahl, J. M., & Mårtensson, L. I. (2015). Measuring health literacy - the Swedish Functional Health Literacy scale. *Scandinavian Journal of Caring Sciences, 29*(1), 165-172. https://doi.org/10.1111/scs.12125 PMID:24628048

Weiss, B. D., Mays, M. Z., Martz, W., Castro, K. M., DeWalt, D. A., Pigone, M. P., . . . Hale, F. A. (2005). Quick assessment of literacy in primary care: The newest vital sign. *Annals of Family Medicine, 3*(6), 514-522. https://doi.org/10.1370/afm.405 PMID:16338915

Weng, F. L., Chandwani, S., Kurtyka, K. M., Zacker, C., Chisholm-Burns, M. A., & Demissie, K. (2013). Prevalence and correlates of medication non-adherence among kidney transplant recipients more than 6 months post-transplant: A cross-sectional study. *BMJ Nephrology, 14*(1), 261. https://doi.org/10.1186/1471-2369-14-261 PMID:24289809

Winton, L. M., Nodora, J. N., Martinez, M. E., Hsu, C. H., Djenic, B., Bouton, M. E., . . . Komenaka, I. K. (2016). Factors associated with surgical management in an underinsured, safety net population. *Surgery, 159*(2), 580-590. https://doi.org/10.1016/j.surg.2015.08.016 PMID:26444326

Wright, J. P., Edwards, G. C., Goggins, K., Tiwari, V., Maiga, A., Moses, K., . . . Idrees, K. (2018). Association of health literacy with post-operative outcomes in patients undergoing major abdominal surgery. *JAMA Surgery, 153*(2), 137-142. https://doi.org/10.1001/jamasurg.2017.3832 PMID:28979989

Zite, N. B., & Wallace, L. S. (2011). Use of a low-literacy informed consent form to improve women’s understanding of tubal sterilization: A randomized controlled trial. *Obstetrics and Gynecology, 117*(5), 1160-1166. https://doi.org/10.1097/AOG.0b013e318213cbb1 PMID:21508756

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**TABLE A**

| Database          | String                                                                 | Number of Articles | Number of Abstracts Screened (Duplicates Removed) | Number Eligible for Review | Number Included |
|-------------------|------------------------------------------------------------------------|--------------------|--------------------------------------------------|---------------------------|-----------------|
| Pubmed            | ((((((“Health Literacy”[Mesh]) OR “health literacy”[Title/Abstract])))) AND (((((“surgery”[Subheading] OR “Surgical Procedures, Operative”[Mesh]) OR ((“surgery”[Title/Abstract]) OR “post-operative”[Title/Abstract] OR “perioperative”[Title/Abstract])))) | 358                | 358                                              | 53             | 43              |
| Embase            | (((“surgical patient”/exp OR surger*ti,ab OR surgicalti,ab OR peroperative/ti,ab AND (‘health literacy’/exp OR ‘health literacy’/ti,ab)) AND (‘embase’/lim NOT (‘embase’/lim AND ‘medline’/lim)) | 253                | 117                                              | 9              | 2               |
| Scopus            | ( TITLE-ABS-KEY (“health literacy”) AND TITLE-ABS-KEY ( surger* OR surgical OR perioperative OR “post-operative” ) ) AND NOT INDEX ( medline ) | 317                | 85                                               | 4              | 3               |
| Proquest/PsychInfo| (MAINSUBJECT.EXACT(“HealthLiteracy”) OR ab(“healthliteracy”)) AND (MAINSUBJECT.EXACT.EXPLODE(“Surgery”)) OR ab(surger* OR surgical OR perioperative OR ”post-operative” OR “postoperative”) | 50                 | 50                                               | 3              | 1               |
| CINAHL            | (surger* OR surgical OR perioperative OR “post-operative” OR ”postoperative” ) AND (AB “health literacy”) | 60                 | 60                                               | 0              | 0               |
|                  | Cross Reference from previous review                                   | 10                 | 3                                                | 3              | 2               |
| **Total**         |                                                                        | 1,048              | 673                                              | 72             | 51              |

Note: CINAHL = Cumulative Index of Nursing and Allied Health Literature