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Telerounding: A Scoping Review and Implications for Future Healthcare Practice

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Abstract

Introduction: Telerounding is slated to become an important avenue for future healthcare practice. As utilization of telerounding is increasing, a review of the literature is necessary to distill themes and identify critical considerations for the implementation of telerounding. We provide evidence of the utility of telerounding and considerations to support its implementation in future healthcare practice based on a scoping review.

Method: We collected articles from nine scientific databases from the earliest dated available articles to August 2020. We identified whether each article centered on telerounding policies, regulations, or practice. We also organized information from each article and sorted themes into four categories: sample characteristics, technology utilized, study constructs, and research outcomes.

Results: We identified 21 articles related to telerounding that fit our criteria. All articles emphasized telerounding practice. Most articles reported data collected from surgical wards, had adult samples, and utilized robotic telerounding systems. Most articles reported null effects or positive effects on their measured variables.

Discussion: Providers and patients can benefit from the effective implementation of telerounding. Telerounding can support patient care by reducing travel expenses and opportunities for infection. Evidence suggests that telerounding can reduce patient length of stay. Patients and providers are willing to utilize telerounding, but patient willingness is influenced by age and education. Telerounding does not appear to negatively impact satisfaction or patient care. Organizations seeking to implement telerounding systems must consider education for their providers, logistics associated with hardware and software, scheduling, and characteristics of the organizational context that can support telerounding. Considerations provided in this article can mitigate difficulties associated with the implementation of telerounding.

Keywords: *Telemedicine, Medical devices, Robotics, Patient-provider communication, Health-information technology*

1 Introduction

Technology is changing how patients and healthcare providers interact. A growing number of organizations are augmenting their avenues for patient care with digital modalities, such as telemedicine and related telemedical services. In recent years, the WHO has provided recommendations for using telemedicine (i.e., a term used to describe any care provided that involves the element of distance from the patient (World Health Organization, 2020)), and certain federal privacy regulations have been expanded to support flexibility and broadening access to services for patients (Rockwell & Gilroy, 2020). Actions have also been taken by the Health and Human Services (HHS), Office for Civil Rights (OCR), and the Centers for Medicare & Medicaid Services (CMS) to expand the use of telemedicine and for coverage of services to extend to Medicaid patients (United States Department of Health & Human Services, 2020). Subsequently, many health professionals have increasingly relied on telemedicine to ensure appropriate care is provided to patients (Bashshur et al., 2020). Although telemedicine is not a new avenue to care delivery and has been reported in the literature as early as the late 1970s (Grundy et al., 1977), it has taken on a new spotlight as improved technology and networking capabilities have become more accessible for patients and hospital environments.

In particular, telerounding is slated to become an important avenue for future healthcare practice as telerounding systems become more accessible. Telerounding utilizes robotic systems or real-time audiovisual communications to facilitate patient-provider interactions at a patients' bedside. Some telerounding formats make use of robotic devices that mimic the visual of a person (see Figure 1), or they can use a hub and spoke model as depicted in Figure 2. Vilendrer and colleagues (2020) describe a hub and spoke system at Stanford wherein computer workstations with video capability or full-size tablets such as iPads (Apple Computer Inc., 2021) are mounted on wheels and serve as "hubs" that may be centrally located in a ward. The "spokes" are full-sized tablets mounted on wheels, which remain in individual patient rooms and are disinfected periodically. Regardless of the specifications of the system, telerounding inherently entails that providers interact with technology to complete the telerounding task. Considering that providers must rely on technology for telerounding, it is imperative that human factors understand the relationship between telerounding providers and patients especially since the prevalence of telemedicine is mounting.

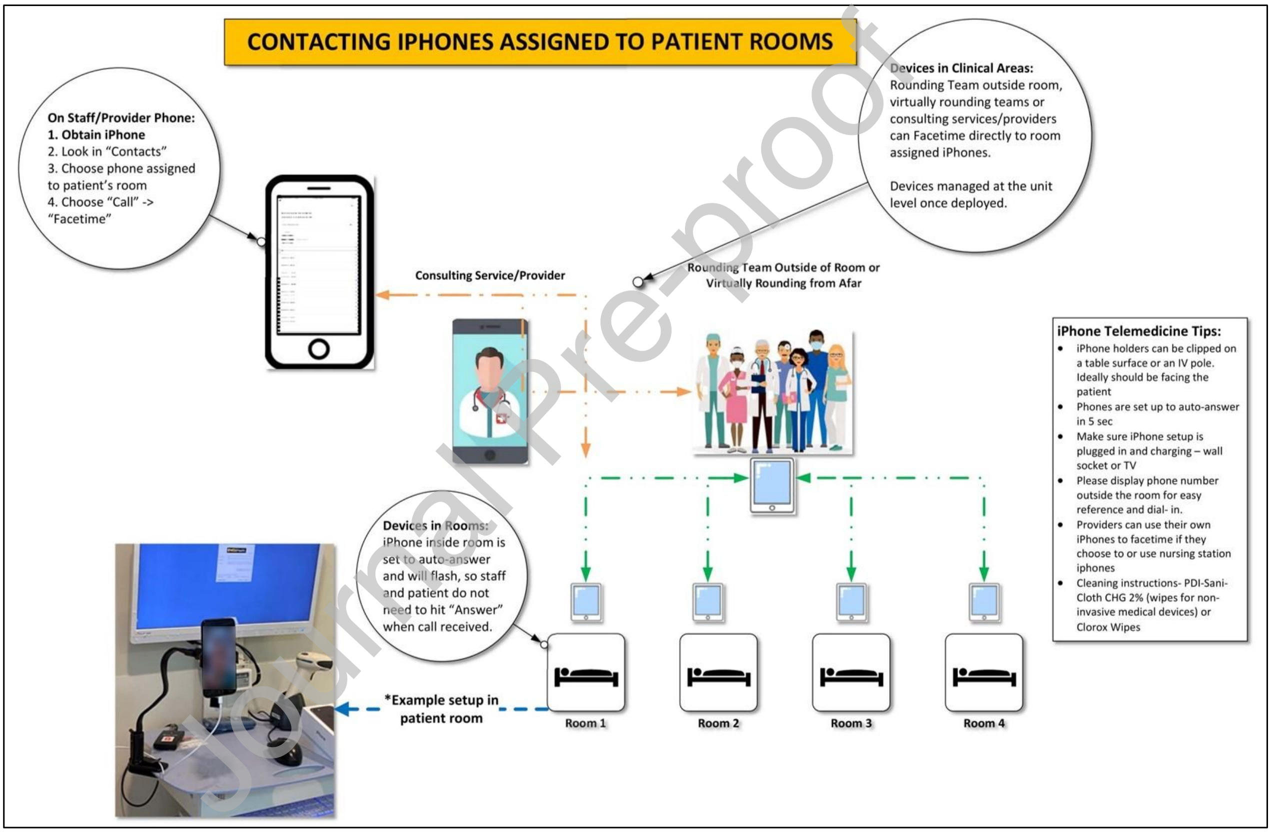
Figure 1

Example Robotic Telerounding System

Note. From "Ellison, L. M., Pinto, P. A., Kim, F., Ong, A. M., Patriciu, A., Stoianovici, D., Rubin, H., Jarrett, T., & Kavoussi, L. R. (2004). Telerounding and patient satisfaction after surgery. *Journal of the American College of Surgeons*, *199*(4), 523-530. https://doi.org/10.1016/j.jamcollsurg.2004.06.022 Copyright 2004 by Elsevier.

Figure 2

Example Non-Robotic Telerounding System



1.1 Problem Statement

Telemedicine technology continues to be implemented, and telemedicine is arguably a prototypical application of human factors since it encompasses the intersection of individuals and technology. Therefore, a more advanced understanding from a human factors lens is greatly needed concerning evidence of telerounding's ability to support patient care as well as considerations for its implementation. Therefore, the purpose of this study is to conduct a scoping review of the literature to distill themes regarding the policies, regulations, and practices of telerounding within hospitals and to identify critical considerations for its implementation. The scope of this review is centered only on the available literature that can provide evidence-based insight into telerounding's influence on patient care and that can inform best practices for the implementation of telerounding.

2 Materials and Methods

2.1 Search Strategy

We used the following search string to query multiple scientific databases to identify articles related to telerounding in the literature: ("telerounding") OR ("telemedicine" AND "rounding") AND ("policy" OR "policies" OR "regularization" OR "regulation" OR "practice") AND ("distance" OR "remote" OR "dispersed"). We collected articles from nine scientific databases using this search string, including Google Scholar, Psychinfo, Pubmed, PlosOne, ProQuest Central, Sage, Scopus, SpringerLink, and Web of Science. We collected publications from 1971 (the earliest available date in our search results) to August 2020. After locating articles using the above search string, we performed backwards literature searches of systematic reviews to locate additional articles related to telerounding published in the literature. Finally, we deleted duplicate entries among our set of publications and began to apply our inclusion and exclusion criteria.

2.2 Inclusion and Exclusion Criteria

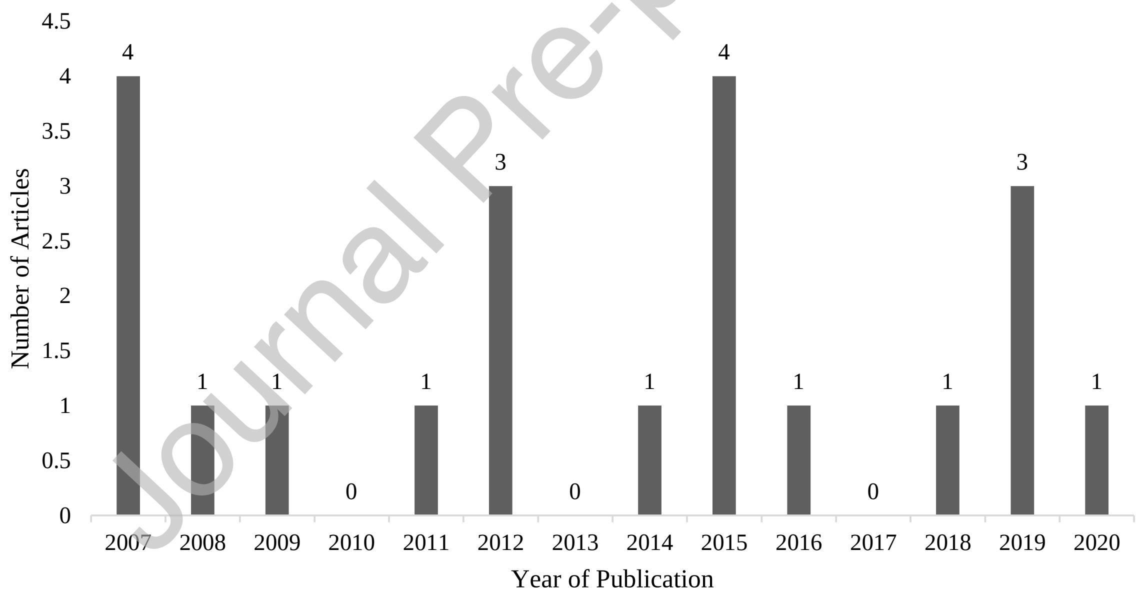
We utilized multiple criteria to determine which articles should be included or excluded from this review. Specifically, we considered articles for inclusion if 1) they utilized a sample of healthcare providers or patients, 2) data in the study were collected in a hospital setting, 3) technology in the study was used to facilitate telerounding, and 4) providers in the study were in an isolated working environment (i.e., providers were not co-located with patients in the same room; however, they could still be in the same hospital or further physically distanced). After identifying a set of articles published in the literature related to telerounding, we began to isolate studies for further review by applying a set of exclusion criteria. We excluded articles if 1) they were not available in English, 2) they were not published in a peer-reviewed publication, 3) the publication was only available as an abstract or an otherwise incomplete publication, or 4) technology in the study was leveraged for other clinical use cases besides telerounding, such as triage or intake. Following the application of our inclusion and exclusion criteria, we began to review the literature for emergent themes.

2.3 Article Identification

We conducted our search in August of 2020, leading to the identification of 4,671 total publications with 3,839 unique publications from the years of 1971-2020. The application of our inclusion and exclusion criteria to our search results was iterative and took place across three stages, beginning with a review of publication titles, then their abstracts, and finally their full texts. At the publication title phase of screening, most of the results (N = 3,674) were deemed to be unrelated to telerounding by our team of reviewers (i.e., inclusion criteria #3). Many additional publications were excluded during the abstract (N = 66) and full-text phases (N = 78) as their reported results were not the result of a telerounding intervention specifically or data that were reported as resulting from a telerounding intervention were confounded with other telemedical technologies, precluding our ability to make claims about outcomes related to telerounding explicitly from these publications (i.e., exclusion criteria #4). Out of the 3,839 unique publications, 3,818 were removed based on our inclusion and exclusion criteria (see Figure 3 for further details), leaving 21 peer-reviewed articles included in our final review. Table 1 reports the distribution of articles included in our review published from 2007 to August 2020.

Figure 3

Distribution of Articles by Year

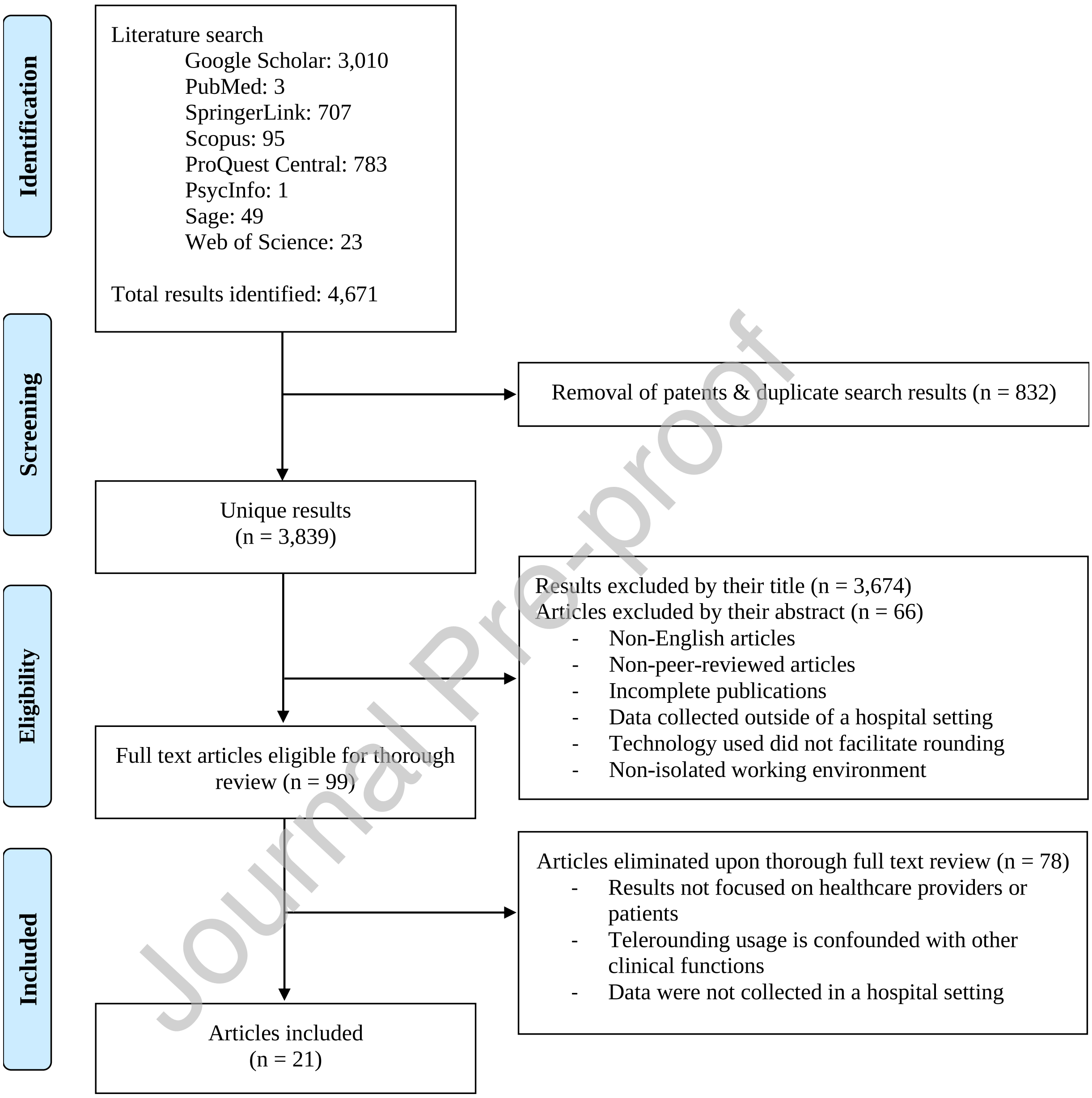


2.3.1 Inter-Rater Reliability

Before coding information from our collected articles, we assessed the reliability of our article selection process using Fleiss' kappa (K_F) (Fleiss & Cohen, 1973). Fleiss' kappa is used to assess inter-rater agreement between two or more raters using nominal data, such as rater judgements of include or exclude for each article in this study. Fleiss' kappa can range from 0.00 to 1.0, with values approaching 1.0 indicating higher levels of agreement between raters. Typical cutoff ranges for Fleiss' kappa are as follows: < 0.20 *Poor*; 0.21-0.40 *Fair*; 0.41-0.60 *Moderate*; 0.61-0.80 *Good*; 0.81-1.00 *Very good*. Using inclusion and exclusion ratings from 5 research team members rating a sample of 20 titles, 15 abstracts, and 10 full texts from our collected results ($n = 45$ cases in total) we achieved a Fleiss' Kappa value of .777, indicating good agreement among raters. Additionally, during our full text review, a sample of 18 articles was reviewed by two raters each to identify any inconsistencies in data that were coded from each article. Disagreements concerning information collected from articles were minimal, and these disagreements were discussed until a complete consensus was reached.

Figure 4

PRISMA Flowchart



2.4 Literature Review and Synthesis

We organized information from each of the 21 articles including: hospital type, hospital location, number of patients and providers involved in the study, type of patients and providers involved in the study, form of telerounding system used, experimental design, clinical outcomes, patient/family perceptions, provider perceptions, limitations, and calls for future research. We also sorted the findings of articles included in our review into multiple categories. First, we sought to discern between articles which reported on and emphasized *policies* related to telerounding (e.g., changes to organizational procedures involving the use of telerounding technology), *regulations* that influence telerounding (e.g., changes in governmental regulations or insurance compensation that enable greater access to telerounding services) or telerounding *practice* within hospitals (e.g., the effects telerounding services and technologies have on the delivery and efficacy of patient care). Next, we classified the findings of each article based on the following four categories: sample characteristics, technology utilized, study constructs, and research outcomes. In these results, we denote the number of variables or the number of outcomes across articles as "*n*" and the number of articles as "*N*". Both are presented to provide an accurate depiction of the information disseminated from articles in this scoping review.

3 Results

3.1 Sample Characteristics

Each publication in the final set of reviewed articles dealt primarily with telerounding practice (*N* = 21); there were no articles that focused on policies or regulations related to telerounding specifically. The clinical characteristics identified within the articles include the type of unit, location of the study, demographics of patients, and the type of providers who participated in the study. The surgical unit (*N* = 8, 38%) was the most common unit type studied in regards to telerounding, and most patient subjects in these studies were adults (*N* = 10, 48%). Eight studies did not provide explicit age ranges or demographics of the patients included in their studies; therefore, this information could not be extracted. Medical doctors (*N* = 14, 67%) were the most common provider included. Further, most of these studies occurred in the United States of America (*n* = 11, 52%). Seven studies did not explicitly state the location in which they collected data; therefore, this information could not be extracted.

Table 1

Sample Characteristics of Reviewed Studies

Location Type	**N**
USA	11
Non-USA	3
Not Listed	7
Type of Patients	**N**
Adult	10
Pediatrics	2
Neonates	1
Not Listed	8
Types of Providers	**N**
MD	14
Nurse	11
Not Listed	5
Other Providers	5

3.2 Data Collection Methods

The articles analyzed included a variety of data collection methods. Surveys and questionnaires, hospital metrics, observations, and interviews were used alone or in conjunction with each other. The most frequently used data collection method was surveys/questionnaires only (*N* = 8, 38%). This was closely followed by surveys/questionnaires in conjunction with hospital metrics (*N* = 6, 29%). Hospital metrics alone accounted for 14% of the data collection methods (*N* = 3). Surveys/questionnaires in combination with observational assessment made up 10% of the data collection methods (*N* = 2). One article used observational assessment in conjunction with interviews (5%), and another article used a combination of surveys/questionnaires, hospital metrics, and observational assessment (5%).

3.3 Technology Utilized

All 21 articles included telerounding systems that facilitated both audio and visual communication. Telerounding as defined within the inclusion criteria used in this review did not surface in the literature until 2007. Overall, two styles of telerounding systems were identified within the articles, which included robotic-based and non-robotic-based systems. Robotic systems are technologies and machines specifically designed to be controlled by an individual in a remote location, without requiring on-site assistance. Conversely, non-robotic systems are telepresence systems that use computers or mobile devices and require the assistance of an on-site individual to be physically relocated. There were 14 studies that used robotic systems and 7 studies that used non-robotic systems. Of the robotic systems, the RP7 (InTouch Health, 2020) was the most commonly used technology (N = 9). In fact, the RP7 was used throughout the entire period of included articles; that is, the RP7 was utilized from 2007 to 2019 suggesting that there is a consistent trend within the robotic systems. There were no primary themes among software utilized in non-robotic systems from the articles.

Table 2

Technology Utilized in Reviewed Studies

Non-Robotic Systems Used	N
FaceTime	1
iChat	1
InTouch Vici	1
Microsoft NetMeeting	1
R.E.A.C.T.S.	1
Zoom	1
Non-specified Software	1
Robotic Systems Used	**N**
RP7	9
RP6	2
DoubleRobotics	1
Non-specified System	2

3.3 Study Constructs

A total of 87 outcomes were reported across this study sample among 55 unique dependent variables. Of these, 45 were reported as null effects, 35 positive, 4 negative, 1 mixed, and 2 did not have sufficient details to accurately determine the direction of effect. Of the 55 variables, 28 consisted of clinical variables (i.e., related to a medical outcome), while the other 27 were non-clinical (i.e., unrelated to a medical outcome) in nature. Of the clinical outcomes, 21 were reported as null effects, 14 positive, 3 negative, 1 mixed, and 1 was not reported. Of non-clinical outcomes, 24 were reported as null, 21 positive, 1 negative, and 1 was not reported. Null effects suggest no difference between telerounding and traditional rounds. These outcomes are further reported on in the following sections and in Table 4 as they related to themes identified across studies.

3.4 Research Outcomes

3.4.1 Patient Care

Telerounding does not seem to negatively impact the delivery of care and may reduce length of stay. No negative effects were identified in outcomes related to patient care. The most frequently reported outcome related to patient care was length of stay, with seven total outcomes reported (four positive, three null effects). The second most common was mortality rates, investigated in three studies and reported as null in each. Self-reported need for assistance was assessed in two studies and reported as null in both. In single studies, telerounding was found to have positive effects in the number of unexpected events, interventions made, improved care, exposure (decreased exposure), and interventions ordered. Null effects were reported for respiratory support, phototherapy, nutrition information, staff explaining to a patient what to expect, APACHE II scores, transactive memory system, age at discharge, pain control, morbidity, and number of days on antibiotics. Readmission rates were assessed in one study, but the results were not sufficiently documented for reporting.

3.4.2 Perceptions

Overall, providers and patients are willing to use telerounding. It does not negatively impact visit satisfaction, and individuals report it is easy to communicate through robotic devices. Ease of communication (n = 7) and provider satisfaction (n = 7) were the most reported perception variables across studies. For ease of communication, there were six positive effects and one effect not reported. Provider satisfaction resulted in four positive effects, two null effects, and one negative effect. Patient satisfaction resulted in four positive effects and two null effects. Willingness to accept a telerounding visit was investigated in three studies, and all reported positive effects. Confidentiality was investigated in two studies and reported null effects. Two studies identified positive effects for provider perceptions of patient care. Individual studies found positive effects in patient perceptions of care, educational experience (from medical students or residents participating in rounds); and null effects in self-rated health, psychological safety, trust, comfort level, knowledge of supervising doctor, data quality, quality of technical support, system benefits, system quality, educational effectiveness (from medical students or residents participating in rounds), acceptability, ability to ask questions, and support for continued use of the robot. There were no additional negative perception effects reported outside of the one associated with provider satisfaction noted above.

3.4.3 Time and Logistics

Telerounding may increase the efficiency of visits and afford more time for documentation and patient care. Only two outcomes were reported in more than one study: round duration (n = 3) and efficiency of visit (n = 2). Both outcomes on efficiency of visits had positive effects, while round duration effects were varied, with two negative (longer with telerounding) and one null reported. Outcomes found in individual studies included positive effects in provider response time, reduction of costs, average contribution margin, subsequent calls, and face-to-face time; null effects in number of encounters, system usage, hospital charges/fees, technical difficulties, patients evaluated, and radiologic studies; a negative effect on time at bedside, and a mixed effect on coordination effectiveness. Although the longer round duration effects found here may seem as though they are poor outcomes and indicators of decreased efficiency, it is important to note that studies anecdotally reported decreases in physician travel time as a direct result of robotic rounding. Presumably, this accounts for the positive effects on related outcomes (such as efficiency, face-to-face time, reduced cost, etc.) identified across studies.

Table 3

Summary of Research Outcomes

Study[a]	Design[b]	Emphasis on Policy, Regulation, or Practice?	Sample	Telerounding Technology Used	Variable Class	Variables Included in the Study	Outcome
Beane & Orlikowski (2015)	SICU; Cohort: Telephone and RP-7	Practice	*n* = 424 surgical patients	RP-7 (InTouch Health, Santa Barbara, CA).	Time and Logistics	Duration Coordination effectiveness (clinical activities performed in rounds)	Negative Mixed
Bettinelli et al. (2015)	SICU; Randomized Crossover-Controlled Trial: Telephone and RP-7	Practice	*n* = 20 nurses	RP-7 (InTouch Health, Santa Barbara, CA).	Perceptions	Provider satisfaction	Positive
Croghan et al. (2018)	Surgery Ward; Case-Control: Conventional and Double Telepresence Robot	Practice	*n* = 26 surgical patients	Double Telepresence Robot (DoubleRobotics, Burlingame, CA, 2013)	Perceptions	Acceptability Confidentiality Easy to use and communicate with provider through robot	Null Null Positive
					Time and Logistics	Duration	Null
Ellison et al. (2004)	Post-Operative Care, Urology Clinic; RCT: Conventional and NetMeeting	Practice	*n* = 85 surgical patients	Laptop using Microsoft NetMeeting	Perceptions	Patient (or parent/guardian) satisfaction	Positive
Ellison et al. (2007)	N/A; Randomized Stratified Block: Conventional and Proprietary Device	Practice	*n* = 270 surgical patients	Proprietary device consisting of a robotic motor base, HD camera, microphone, and a wheel-driven base	Patient Care	Assistance score Morbidity Mortality Patient length of stay	Null Null Null Null
					Perceptions	Patient (or parent/guardian) satisfaction	Null
Gandsas et al. (2007)	Surgical Ward; Case-Control: Conventional and RP-7	Practice	*n* = 376 surgical patients	RP-7 (InTouch Health, Santa Barbara, CA)	Patient Care	Patient length of stay Readmission rates	Positive Not Reported
					Time and Logistics	Average contribution margin	Positive

Garingo et al. (2016)	NICU; Randomized Stratified Block: Conventional and RP-7	Practice	*n* = 20 neonatal patients; matched patients = 20	RP-7 (InTouch Health, Santa Barbara, CA)	Patient Care	Age at discharge	Null
						Days on antibiotics	Null
						Nutrition information	Null
						Patient length of stay	Null
						Phototherapy	Null
						Respiratory support	Null
					Perceptions	Patient (or parent/guardian) satisfaction	Null
						Provider satisfaction	Null
					Time and Logistics	Hospital charges/fees	Null
						Number of encounters	Null
						Number of radiologic studies	Null
						Technical difficulties	Null
						Time at bedside	Negative
Hain et al. (2009)	Post-Operative Surgical Units; Interrupted Time Series: Conventional and Software	Practice	*n* = 10 surgical patients (2006/2007); 23 surgical patients (2008)	Internet-based chat software	Perceptions	Ease of communication	Positive*
						Willingness to accept telerounding visit	Positive
					Time and logistics	Efficiency of visit	Positive
						Face-to-face time	Positive
Kaczmarek et al. (2012)	Post-Operative Unit; One Group Pre-Post: Conventional and FaceTime	Practice	*n* = 32 surgical patients	iPad using Facetime (iPad 2, iOS 5.1, Apple, Cupertino, CA)	Perceptions	Ease of communication	Positive*
						Patient (or parent/guardian) satisfaction	Positive
						Willingness to accept telerounding visit	Positive
Kau et al. (2008)	Post-Operative Unit; One Group Pre-Post: Conventional and iChat	Practice	*n* = 10 surgical patients *n* = 14 nurses	Laptop (Macbook Pro© 15 inch/2.16GHz by Apple Inc, Cupertino, CA) and video conferencing software (iChat AV© by Apple Inc, Cupertino, CA)	Patient Care	Improved care	Positive
					Perceptions	Ease of communication	Positive*
						Willingness to accept telerounding visit	Positive
Lazzara et al. (2015)	Trauma ICU; Interrupted Time Series: Conventional and RP-7	Practice	*n* = 32 providers	RP-7 (InTouch Health, Santa Barbara, CA)	Patient Care	Transactive memory system	Null
					Perceptions	Ease of communication	Positive*
						Psychological safety	Null
						Trust	Null

Marini et al. (2015)	SICU; One Group Pre-Post: Conventional and RP-6	Practice	RT *n* = 42 patients CT *n* = 37 patients	RP-6 (InTouch Health, Santa Barbara, CA)	Patient Care Perceptions	Mortality Patient length of stay Educational effectiveness Patient care Provider satisfaction	Null Null Null Null Negative
McNelis et al. (2012)	SICU; One Group Pre-Post; Conventional, Telephone, and RP-7	Practice	N/A	RP-7 (InTouch Health, Santa Barbara, CA)	Patient Care Perceptions Time and Logistics	APACHE II scores Interventions made Mortality Patient length of stay Unexpected events Provider satisfaction Duration Number of patients evaluated Subsequent calls	Null Positive Null Positive Positive Positive Negative Null Positive
Nadar et al. (2019)	PICU; Observational: Telephone and REACTS	Practice	*n* = 14 providers	REACTS (Remote Education, Augmented Communication, Training and Supervision)	Perceptions Time and Logistics	Perceived data quality Perceived quality of technical support Perceived system benefits Perceived system quality Provider satisfaction System usage	Null Null Null Null Null Null
Oh et al. (2019)	N/A; Cohort: Conventional and RP-7	Practice	*n* = 40 surgical patients	RP-7 (InTouch Health, Santa Barbara, CA)	Patient Care Perceptions	Assistance Pain control Care Patient (or parent/guardian) satisfaction Self-rated health	Null Null Positive Positive Null
Petelin et al. (2007)	N/A multiple units; Observational: Unknown and RP-7	Practice	N/A	RP-6 (InTouch Health, Santa Barbara, CA, USA)	Patient Care Perceptions Time and Logistics	Patient length of stay Patient (or parent/guardian) satisfaction Provider satisfaction Efficiency of visit	Positive Positive* Positive* Positive
Rincon et al. (2012)	Neuro-ICU; Cross Sectional: Conventional and RP-7	Practice	*n* = 34 nurses (pre-survey); 40 nurses (post-survey)	RP-7i (InTouch Health, Santa Barbara, CA, USA)	Perceptions	Provider satisfaction	Positive

Sucher et al. (2011)	SICU; One Group Pre-Post; Unknown and RP-7	Practice	*n* = 24 patients, *n* = 26 family members	RP-7 (InTouch Health, Santa Barbara, CA, USA)	Perceptions	Comfort level Ease of communication Support for continued use of robot	Null Positive* Null
Umoren et al. (2020)	ICU; Observational: Unknown and InTouch	Practice	N/A	InTouch Vici and Microsoft Surface Pro tablet	Patient Care	Exposure	Positive
Vespa et al. (2007)	ICU; Pre-Post Cohort: Conventional and Robot	Practice	*n* = 640; matched patients = 578	N/A	Patient Care Time and Logistics	Patient length of stay Types of interventions ordered Face-to-face time Provider response time Reduction of cost	Positive Positive Positive Positive Positive
Yenikomshian et al. (2019)	Pediatric Burn Unit, Burn Acute Care Ward; Observational Cohort: Zoom Only	Practice	*n* = 33 patients/ family members; *n* = 69 providers	Zoom (Zoom, San Jose, CA)	Patient Care Perceptions	I knew my supervising MD Staff explained what to expect Able to ask questions Confidentiality Ease of communication Educational experience	Null Null Null Null Not Reported Positive

Note. "N/A" or "Unknown" implies the information could not be located from the publication
[a]*Superscripts in the study column denote the location of articles in the reference list*
[b]*Information in the design column is presented as unit(s); design: rounding comparator(s)*

4 Discussion

Although the field is nascent regarding telerounding, there is some preliminary evidence that can be leveraged to glean some insights. Specifically, evidence suggests that there are some benefits to conducting telerounds compared to bedside rounds, or at a minimum, telerounding does not seem to be detrimental to care overall. Nonetheless, healthcare institutions need to consider certain issues before implementing telerounding. Below we describe the evidence related to the utility of telerounding for remotely facilitating bedside patient-provider interactions. Following, we describe the limitations of our review. Finally, we describe considerations to support the implementation of telerounding in future healthcare practice.

4.1 Evidence of Telerounding

4.1.1 Teams are Impacted by Telerounding

Because rounds are being conducted remotely, telerounding can alter the participation within rounds. For example, individuals found communication through the robotic devices easy to use (Croghan et al., 2018; Hain et al., 2009; Kaczmarek et al., 2012; Kau et al., 2008; Lazzara et al., 2015; Sucher et al., 2011). Meanwhile, Petelin et al. (2007) found that telerounding increased the efficiency of the visit, and Sucher and colleagues (2011) indicated that most of their respondents were comfortable participating in robotic telerounds. Comfort may have been maintained because providers could participate in rounds remotely. Similarly, efficiency may be due to being able to connect remotely. Although not explicitly stated, we posit that comfort, ease of communication, and efficiency may be attributable to having greater variability in locations, which could enable better team participation than exclusively face-to-face rounds. Many providers care for patients across multiple units or floors, which can make attending rounds difficult at times. Moreover, providers spend significant time completing documentation, which is often done away from the bedside. Because telerounding allows providers to stay in the same location as they are completing documentation and attending telerounds, it becomes easier to attend and participate in rounds. Similarly, caretakers, family members, or other individuals that would otherwise normally be unable to participate in rounds can be included while remaining physically distanced from the hospital environment. Therefore, those interested in participating in rounds can save on time and money associated with transportation while simultaneously reducing opportunities for potential exposure to infection due to physical distancing.

4.1.2 Telerounding is Time Effective

Telerounds may allow more patients to be admitted by enabling greater throughput of patients (Gandsas et al., 2007). Because providers do not have to physically navigate units to complete their rounds, more time can be dedicated to actual patient care or documentation, a time-intensive task. Maximizing time devoted to documentation without sacrificing time for actual patient care is beneficial, particularly when patients' documentation must be reported to multiple organizations, such as insurance agencies or government health agencies. There is also evidence that suggests that telerounds can reduce length of stay (Gandsas et al., 2007; Petelin et al., 2007; Vespa et al., 2007), which is advantageous for patients as well as organizations.

4.1.3 Providers and Patients are Willing to Use Telerounding

Providers and patients are willing to use telerounding (Croghan et al., 2018; Hain et al., 2009). Although this willingness is initially promising, there are caveats. Regarding patients' perceptions of video consultations, Viers et al. (2015) have examined patients' willingness to use video visits and found that younger college educated individuals reported the highest willingness to use a video visit to augment their care. From the providers' perspective, physicians are usually the ones engaging in telerounding; therefore, reports of being willing to participate in rounds are stemming from physicians. Having engagement from physicians is obviously welcomed.

Fortunately, this willingness to participate in rounds is coupled with provider satisfaction while still maintaining the same level of care after implementing telerounding. Of note, Marini et al. (2015) found that nurses had significantly worse views of telerounding compared to the intensivists, medical students, residents, and physicians' assistants that participated in the study. Residents and medical students may be primarily concerned with the attending's ability to deliver the same teaching quality during telerounds as compared to conventional rounds. On the other hand, nurses may be more invested in the practical aspects of patient care, such as having an intensivist at the bedside when needed (Marini et al., 2015). Although Marini et al. (2015) was limited by a small sample size, special consideration and further study of how telerounding impacts providers in different roles is warranted. Nurses and other allied health professionals are frequently at the bedside, so incorporating other providers into telerounding would also have merit.

4.1.4 Telerounding Reduces Opportunities for Infection

As mentioned previously, telemedicine inherently increases physical distance; physical distance supports the ability to reduce opportunities for infection while introducing avenues for telerounding to deliver patient care remotely. In fact, one reviewed study found evidence that telerounding decreased opportunities for infection for a pediatric population (Umoren et al., 2020). More research is needed to determine if telerounding can reduce exposure for adults. Given the nature of telerounding, it seems plausible that the findings would be consistent with adults.

4.2 Limitations

All of these benefits aside, our review possesses limitations which mirror limitations in the telerounding literature. Every article included in this scoping review emphasized telerounding practice, with no articles focusing on policies or regulations related to telerounding specifically. As such, we are not able to provide practitioners and institutions any guidance on what policies serve to strengthen telerounding and patient care. Our sample is relatively small (*N* = 21 studies); the application and research surrounding telerounding is limited and heterogenous. The technology utilized in telerounding systems, the clinical protocols surrounding their use, the context in which they are used, as well as the study designs used to assess telerounding are highly varied across articles and are not consistently reported, leading to difficulties in performing a scoping review of telerounding research. Further, many articles report results in which telerounding was confounded with other telemedical technologies, limiting the scope of evidence relating solely to telerounding. Despite the limited and heterogenous nature of research regarding telerounding, we postulate that findings related to telerounding reported in the literature are still relevant for future healthcare practice.

4.3 Considerations for Implementation

As mentioned previously, telerounding necessitates that providers interact with technology to complete the rounding task. As such, telerounding is positioned to receive valuable insights from the human factors community as they approach such systems and tasks with a robust lens considering all facets. Essentially, there are a variety of factors healthcare institutions should consider before telerounding systems can be implemented effectively within their practice. The following sections describe some of these considerations based on the scoping review that was performed as well as our expertise as human factors and industrial-organizational psychology professionals.

4.3.1 Individuals May Need Education on Using New Hardware or Software

Although Hain et al. (2009), Kau et al. (2008), and even others indicated that individuals are willing and satisfied with conducting telerounds, Garingo et al. (2016) and Marini et al. (2015) have found that some individuals lack satisfaction. One possible explanation could be that telerounds involve technology that is often unfamiliar to patients or providers. Consequently, individuals may need education or training on how to use the technology properly. For example, it may take time for users to get accustomed to the dynamics of maneuvering a robotic device.

4.3.2 Administrations Should Invest in the Infrastructure to Support Technology-Mediated Communication

Many studies have found that patient outcomes were not hampered by telerounding (Ellison et al., 2007; Garingo et al., 2016; Marini et al., 2015); however, maintaining adequate care is contingent upon proper infrastructure that supports telerounding (i.e., hardware and software of telerounding systems). Tablets or robotic devices, such as the RP-7 (InTouch Health, 2020) are often employed. Within the robotic systems employed for telerounding, the RP-7 was the most frequently employed, which suggests that there might be a cause to provide resources for users to strengthen their ability to interact with such devices. Similarly, extra tablets for remote participants may be necessary. Telerounding requires telecommunication technology, which in turn requires good bandwidth but is susceptible to data breaches. Thus, organizations should use tools to protect patient health data (e.g., encryption, multifactor authentication, and data integrity tools).

4.3.3 Scheduling Needs to go Beyond the Traditional Team

Telerounding research often focused on patients (Beane & Orlikowski, 2015; Croghan et al., 2018; Ellison et al., 2004; Garingo et al., 2016). Although there is merit in understanding patients' perspectives as they should be the focus of all care, others are certainly integral members of the care team and are involved in rounds and direct patient care. In fact, the Institute for Healthcare Improvement deemed multidisciplinary rounds (i.e., rounds that focus on planning and evaluating patient care with a variety of health disciplines) as a "valuable tool in improving the quality, safety, and patient experience of care" (Institute for Healthcare Improvement). With institutions adopting the model of multidisciplinary rounds, scheduling becomes paramount. Scheduling is often difficult to coordinate for team-based activities (Xie et al., 2015), sometimes necessitating the use of scheduling tools (Kipps et al., 2020). Indeed, some believe that scheduling is the "biggest stumbling block" when it comes to conducting multidisciplinary rounds (Dillard, 2008). Co-located rounds require physical proximity which can exacerbate these scheduling difficulties. Even though multidisciplinary rounds are valuable, physical proximity may be a barrier for some individuals to participate (Østervang et al., 2019), but telecommunication technology may be one tool to remedy this barrier by enabling greater participation of a larger group of people (e.g., technicians, pharmacists, or patient's family members). Clinical care decision making is not always the sole responsibility of the patient and the attending; oftentimes, decisions are made by family members and patient care advocates. Therefore, the timing and scheduling of rounds may need to include a broader consideration of attendants and individuals beyond the attending physician need to be informed of the timing of telerounds.

4.3.4 Organizations Need to Foster the Proper Context for Mobile Technologies

From an organizational perspective, there are several considerations. The first consideration is that all individuals need some level of confidence that telerounding can at least maintain a suitable level of care. From the clinicians' viewpoint, they need assurance that they can continue to provide adequate, safe care. From the stance of patients and their families, they need to feel secure in their interactions with a clinical care team. Many studies found positive benefits of telerounding (Kau et al., 2008; McNelis et al., 2012; Petelin et al., 2007; Umoren et al., 2020; Vespa et al., 2007), but all individuals involved need to be made aware of these benefits to make them more secure with the decision to rely on telerounding. The second consideration is that the telerounding workflow needs to be integrated within the clinical workflow. Beane & Orlikowski (2015) found that telerounding had a mixed effect on coordinating activities, and others determined that telerounding had a positive effect on efficiency of visits (Hain et al., 2009; Petelin et al., 2007) as well as provider response time (Vespa et al., 2007). Even though telerounding does not have to be a hindrance, adherence and compliance with telerounding will be seen as an obstacle and its use will wane if the workflow is cumbersome and time consuming. Relatedly, healthcare institutions need to carefully select the contexts and cases that are most appropriate for telerounding, as not all situations may warrant it. For example, most research has been conducted within the surgical context (Croghan et al., 2018; Ellison et al., 2007; Gandsas et al., 2007) or intensive care units (Beane & Orlikowski, 2015; Bettinelli et al., 2015; Lazzara et al., 2015; Marini et al., 2015; McNelis et al., 2012; Vespa et al., 2007), but little research has been devoted to understanding telerounding within other units (e.g., burn units (Yenikomshian et al., 2019)).

Table 4

Considerations for Implementation of Telerounding

Consideration	Rationale	Relevance to Patient Care	Role of Human Factors
• Individuals may need education or training on using new hardware or software	• Telerounding is inherently dependent on hardware or software that may be unfamiliar to some providers or patients	• Telerounding will not benefit the treatment of patients unless providers and patients are educated or trained on the system(s)	• Develop a program of training to ensure that providers are adequately equipped to effectively navigate the technology
• Administrations should invest in the infrastructure to support technology-mediated communication	• Telerounding requires the implementation of hardware and software that must be supported by an organization's infrastructure, such as Internet bandwidth	• Implementation of telerounding will not benefit patients unless the system(s) used have adequate resources needed to function	• Conduct a needs analysis to determine what resources are needed as well as how to appropriately allocate the resources to maximize the benefits of telerounding
• Scheduling needs to go beyond the traditional team	• Telerounding supports greater opportunities for collaboration between multiple patients and providers	• Telerounding enables greater collaboration while minimizing opportunities for infection and logistics associated with travel	• Perform a person analysis to establish which individuals should be included in the telerounding task • Offer education to providers, patients, and caregivers to elucidate the strengths of teams and specifically communication
• Organizations need to foster the proper context for mobile technologies	• Telerounding systems must be accommodated in their context for providers to deliver effective care	• Telerounding systems that are adequately supported by their environment and carefully consider the organizational context enable greater throughput of patients and reduced length of stay, which can minimize hospital overcrowding	• Solicit input from individuals from the frontlines (e.g., clinicians and patients) to determine which organizational contexts would contribute to improving telerounding while not negatively impacting care or resources

5 Conclusions

Telemedicine will continue to be an important tool for effectively providing care for patients at a distance. More specifically, telerounding will be an important strategy to enable remote patient-provider interactions at a patients' bedside. We sorted the findings of our review based upon study constructs, technology utilized, sample characteristics, and research outcomes. Based upon these findings, we extrapolated four benefits of employing telerounding and four considerations to support the implementation of telerounding in future healthcare practice. Although we acknowledge that many questions remain unanswered, we hope that this scoping review provides a first step towards better understanding telerounding and relevant factors to consider during its implementation.

Table 5

Summary Table

What was already known on the topic:	What this study added to our knowledge:	Takeaways for Practitioners and HF professionals
• Telemedical services are a useful avenue for delivering patient care remotely while minimizing opportunities for infection	• The results of our review demonstrate that telerounding research is highly heterogenous; a variety of telerounding modalities, clinical variables, and non-clinical variables have been studied	• Medicine and HF should collaborate to design scientifically sound studies to investigate the effects of telerounding. • Institutions that are implementing telerounding in multiple units should leverage similar technological systems and variables when possible to facilitate cross-comparisons.
• Telerounding is slated to become an important avenue for future healthcare practice as telerounding systems become more accessible, federal privacy regulations expand, and networking technologies improve	• Trends in the reviewed articles showed that telerounding does not seem to negatively impact patient care, that providers and patients are willing to use telerounding, and that telerounding may increase the efficiency of patient visits	• Investigations should incorporate a multi-level approach (e.g., assess the impact on individuals, teams, and the organization)
• Little is known about	• The differential outcomes	• Researchers should

what factors are most commonly studied in telerounding research and trends in evidence supporting the use of telerounding have not been identified	observed in our review (e.g., mixed outcomes observed in Time and Logistics and Perceptions variable groups) suggests that considerations should be carefully scrutinized to guide effective implementation of telerounding in current and future healthcare practice	employ a multi-method approach given that previous findings indicate differential effects.

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Declaration of interests

☐The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A.1

Summary of Study Variables, Definitions, and Effect Directions

Variable Class	Variable	Definition(s)	Direction	Reported by:
Patient Care	Age at Discharge	Postmenstrual age at discharge. No additional detail provided in paper.	Null	Garingo et al., 2016
Patient Care	APACHE II Scores	Acute Physiology and Chronic Health Evaluation II data.	Null	McNelis et al., 2012
Patient Care	Assistance	Patient self-reported need for assistance.	Null	Ellison et al., 2007
		No additional detail provided in paper.	Null	Oh et al., 2019
Patient Care	Days on Antibiotics	No additional detail provided in paper.	Null	Garingo et al., 2016
Patient Care	Exposure	"Reduction in potential exposures estimated by the typical number of providers who might be involved in face-to-face care over a 24-hour period if not for telerounding."	Positive	Umoren et al., 2020
Patient Care	I Knew My Supervising MD	Patient/family Likert scale rating for the item "I knew my supervising MD."	Null	Yenikomshian et al., 2019
Patient Care	Improved Care	Provider Likert ratings regarding patient care.	Positive	Kau et al., 2008
Patient Care	Interventions Made	Total number of interventions that occurred during a session.	Positive	McNelis et al., 2012
Patient Care	Morbidity	Postoperative morbidity. No additional detail provided in paper.	Null	Ellison et al., 2007
Patient Care	Mortality	Generally defined as the number/frequency of deaths across the study period. This was not explicitly stated in any of these studies. Marini et al. (2015) assessed both actual and predicted mortality.	Null	Ellison et al., 2007
			Null	Marini et al., 2015
			Null	McNelis et al., 2012
Patient Care	Nutrition Information	Total parenteral nutrition. No additional detail provided in paper.	Null	Garingo et al., 2016
Patient Care	Pain Control	Numerical rating scale from 1 (poor) - 5 (excellent). No additional detail provided in paper.	Null	Oh et al., 2019
Patient Care	Patient Length of Stay	No additional detail provided in paper.	Null	Ellison et al., 2007
		Inpatient stay, in days.	Positive	Gandsas et al., 2007
		Hospital stay, in days.	Null	Garingo et al., 2016
		No additional detail provided in paper.	Null	Marini et al., 2015
		ICU and hospital length of stay, in days.	Positive	McNelis et al., 2012

		Time required (in hours) to discharge patients on their discharge day.	Positive	Petelin et al., 2007
		ICU length of stay, in days.	Positive	Vespa et al., 2007
Patient Care	Phototherapy	Days on phototherapy. No additional detail provided in paper.	Null	Garingo et al., 2016
Patient Care	Readmission Rates	Readmission rates within 7 days after discharge.	Not Reported	Gandsas et al., 2007
Patient Care	Respiratory Support	Days of mechanical support and days of nasal cannula.	Null	Garingo et al., 2016
Patient Care	Staff Explained What to Expect	Patient/family completed Likert rating for the item “Staff explained what to expect.”	Null	Yenikomshian et al., 2019
Patient Care	Transactive Memory System	“Shared understanding about who knows what information.”	Null	Lazzara et al., 2015
Patient Care	Types of Interventions Ordered	“The interventions ordered by the attending were categorized by the reasons for paging the physician and the type of intervention ordered.”	Positive	Vespa et al., 2007
Patient Care	Unexpected Events	“Unanticipated deteriorations or crises in the patient’s condition occurring during overnight hours.”	Positive	McNelis et al., 2012
Perceptions	Able to Ask Questions	Patient/family Likert rating for the item “able to ask questions.”	Null	Yenikomshian et al., 2019
Perceptions	Acceptability	Participant Likert ratings of whether robotic ward rounds were a “satisfactory solution when a consultant could not be physically present.”	Null	Croghan et al., 2018
Perceptions	Care	Patient rating from 1 (poor) - 5 (excellent).	Positive	Oh et al., 2019
Perceptions	Comfort Level	Patient and family Likert rating of comfort level with the robot.	Null	Sucher et al., 2011
Perceptions	Confidentiality	Patient Likert rating of whether doctors “maintained their confidentiality on the round.”	Null	Croghan et al., 2018
		Patient self-reported ratings of whether their privacy was respected.	Null	Yenikomshian et al., 2019
Perceptions	Ease of Communication	Patient Likert rating of whether they could communicate with their doctor (on the round).	Positive	Croghan et al., 2018
		Patient self-reported ease of communicating with provider.	Positive*	Hain et al., 2009
		Patient self-reported ease of communicating with provider.	Positive*	Kaczmarek et al., 2012
		Patient self-reported ease of communicating with provider.	Positive*	Kau et al., 2008
		The amount of information exchanged between a sender and a receiver, based on number of meaningful, task-related utterances identified in video recordings.	Positive*	Lazzara et al., 2015
		Patient Likert rating of statement “I feel like the robot makes it more difficult for me to communicate the way I would like to.”	Positive*	Sucher et al., 2011
		Thematic analysis of open-ended question responses.	Not Reported	Yenikomshian et al., 2019
Perceptions	Educational Effectiveness	Learner/physician Likert ratings of effectiveness.	Null	Marini et al., 2015

Perceptions	Educational Experience	Respondents' commentary on the learning experience facilitated by virtual burn rounds.	Positive	Yenikomshian et al., 2019
Perceptions	Patient Care	Provider Likert-ratings of patient care.	Null	Marini et al., 2015
Perceptions	Patient (or Parent/Guardian) Satisfaction	Patient-reported satisfaction with hospitalization.	Null	Ellison et al., 2007
		Patient-reported satisfaction with hospitalization.	Positive	Ellison et al., 2004
		Parent satisfaction with telemedicine measured via Likert scales.	Null	Garingo et al., 2016
		Patient self-reported satisfaction with telerounding.	Positive	Kaczmarek et al., 2012
		Patient-reported satisfaction with "MD confidence, medical communication, explanation understanding, explanation. satisfaction, mutual communication, and mutual response."	Positive	Oh et al., 2019
		Assessment of qualitative data from patients.	Positive*	Petelin et al., 2007
Perceptions	Perceived Data Quality	"Completeness (one item), reliability and validity (two items), availability (one item), safety (one item), and the quality of inter-site integration of the data generated by the various sites (two items)."	Null	Nadar et al., 2019
Perceptions	Perceived Quality of Technical Support	"Quality of technical support was assessed with one variable (five items) concerning the whole system."	Null	Nadar et al., 2019
Perceptions	Perceived System Benefits	"Measured in terms of improved productivity (seven items), quality of medical services (two items), and access to medical services (three items)."	Null	Nadar et al., 2019
Perceptions	Perceived System Quality	"User perceptions of system quality (ease of use (five items), screen quality (two items), REACTS-SYNAPSE-SOFTLAB integration (three items), response time (three items), reliability (three items), accessibility (three items), and perceived usefulness (three items)."	Null	Nadar et al., 2019
Perceptions	Provider Satisfaction	Nurse satisfaction with collaboration and care decisions in the SICU.	Positive	Bettinelli et al., 2015
		NICU staff satisfaction with telemedicine measured via Likert scales.	Null	Garingo et al., 2016
		Provider satisfaction with robotic tele rounding measured via Likert scales (10 items).	Negative	Marini et al., 2015
		User evaluation scores. No additional detail provided in paper.	Positive	McNelis et al., 2012
		Overall user satisfaction with telemedicine platform.	Null	Nadar et al., 2019
		Assessment of qualitative data from nurses.	Positive*	Petelin et al., 2007
		Neuro-ICU nurse team satisfaction measured through a questionnaire.	Positive	Rincon et al., 2012

Perceptions	Psychological Safety	"A shared sense it is acceptable to take interpersonal risks."	Null	Lazzara et al., 2015
Perceptions	Self-Rated Health	Numerical rating scale from 1 (poor) - 5 (excellent). No additional detail provided in paper.	Null	Oh et al., 2019
Perceptions	Support for Continued Use of Robot	Patient and family Likert ratings of support for continued use of the robot.	Null	Sucher et al., 2011
Perceptions	Trust	"Willingness to be vulnerable based on the positive expectations of others' intentions and behaviors."	Null	Lazzara et al., 2015
Perceptions	Willingness to Accept Telerounding Visit	Physician and nurse Likert rating to whether telerounding was "an acceptable method of communication if direct physician contact wasn't possible."	Positive	Hain et al., 2009
		Patient Likert rating to questions such as whether "telerounding should be a regular part of patient care in the hospital" and "I would feel comfortable with telerounding...on an everyday basis."	Positive	Kaczmarek et al., 2012
		Patient, physician, and nurse Likert ratings of whether video rounding was an "acceptable alternative if a physician was unable to make direct contact with the patient."	Positive	Kau et al., 2008
Time and Logistics	Average Contribution Margin	"The average profit of all new hospital admissions, with the exception of those admitted to the ICU, regardless of their health plan or diagnosis."	Positive	Gandsas et al., 2007
Time and Logistics	Coordination Effectiveness (Clinical Activities Performed During Rounds)	Qualitative analysis of interview and observational data.	Mixed	Beane & Orlikowski, 2015
Time and Logistics	Duration	Average time per night round.	Negative	Beane & Orlikowski, 2015
		Total duration of ward rounds in minutes.	Null	Croghan et al., 2018
		Time spent in rounding.	Negative	McNelis et al., 2012
Time and Logistics	Efficiency of Visit	Time to discharge patient on discharge day.	Positive	Hain et al., 2009
		Amount of time spent round trip per visit.	Positive	Petelin et al., 2007
Time and Logistics	Face-to-Face Time	Duration of face-to-face supervision of patients by a senior level physician.	Positive	Vespa et al., 2007
Time and Logistics	Hospital Charges/Fees	Compared by dollar amount. No additional detail provided in paper.	Null	Garingo et al., 2016
Time and Logistics	Number of Encounters	The number of times an on-site physician at the bedside and an off-site telemedicine physician using a remote-controlled robot evaluated a	Null	Garingo et al., 2016

		patient.		
Time and Logistics	Number of Patients Evaluated	Number of patients evaluated per round.	Null	McNelis et al., 2012
Time and Logistics	Number of Radiologic Studies	Number of x-rays and ultrasounds.	Null	Garingo et al., 2016
Time and Logistics	Provider Response Time	Attending physician response latency via face-to-face interactions versus telerounding.	Positive	Vespa et al., 2007
Time and Logistics	Reduction of Cost	A calculation of reduction of cost based on reduction in ICU LOS [(the mean number of ICU days saved) x (the number of patients with that diagnosis per year) x (cost per day for the particular diagnosis)].	Positive	Vespa et al., 2007
Time and Logistics	Subsequent Calls	"Number of subsequent calls (SUBC) from the SICU regarding patients present in the SICU at time of rounding (calls regarding new admissions or consultations were excluded)."	Positive	McNelis et al., 2012
Time and Logistics	System Usage	"Use of the platform was measured with two variables: frequency of use (one item) and intensity of use (three items)."	Null	Nadar et al., 2019
Time and Logistics	Technical Difficulties	Poor audio or visual quality and disconnections.	Null	Garingo et al., 2016
Time and Logistics	Time at Bedside	Time the neonatologist spent at the bedside.	Negative	Garingo et al., 2016

** Denotes a reported positive effect that was not compared to conventional rounding*