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Review Article

Telemedicine and Telehealth in Nursing Homes: An Integrative Review

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A B S T R A C T

Objectives: Telemedicine and telehealth are increasingly used in nursing homes (NHs). Their use was accelerated further by the COVID-19 pandemic, but their impact on patients and outcomes has not been adequately investigated. These technologies offer promising avenues to detect clinical deterioration early, increasing clinician’s ability to treat patients in place. A review of literature was executed to further explore the modalities’ ability to maximize access to specialty care, modernize care models, and improve patient outcomes.

Design: Whittemore and Knaff’s integrative review methodology was used to analyze quantitative and qualitative studies.

Setting and Participants: Primary research conducted in NH settings or focused on NH residents was included. Participants included clinicians, NH residents, subacute patients, and families.

Methods: PubMed, Web of Science, CINAHL, Embase, PsycNET, and JSTOR were searched, yielding 16 studies exploring telemedicine and telehealth in NH settings between 2014 and 2020.

Results: Measurable impacts such as reduced emergency and hospital admissions, financial savings, reduced physical restraints, and improved vital signs were found along with process improvements, such as expedient access to specialists. Clinician, resident, and family perspectives were also discovered to be roundly positive. Studies showed wide methodologic heterogeneity and low generalizability owing to small sample sizes and incomplete study designs.

Conclusions and Implications: Preliminary evidence was found to support geriatrician, psychiatric, and palliative care consults through telemedicine. Financial and clinical incentives such as Medicare savings and reduced admissions to hospitals were also supported. NHs are met with increased challenges as a result of the COVID-19 pandemic, which telemedicine and telehealth may help to mitigate. Additional research is needed to explore resident and family opinions of telemedicine and telehealth use in nursing homes, as well as remote monitoring costs and workflow changes incurred with its use.

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Globally, the number of adults aged 85 years and older is projected to increase 351% between 2010 and 2050.\textsuperscript{1} As the population ages, the need for specialized facility and home-based care will increase.\textsuperscript{2} Even today, nursing homes (NHs) struggle with staff shortages and access to specialty care expertise, while simultaneously facing increased pressures to reduce avoidable hospital admissions and emergency department (ED) visits.\textsuperscript{3,4}

Health technology is frequently championed as a modality to improve care delivery in order to meet the demands of providing complex care in the setting of limited internal resources. The United States Office of the National Coordinator for Health Information Technology (ONC) defines telehealth as the use of video-conferencing, remote patient monitoring (RPM), store-and-forward technologies (eg, sending wound images for evaluation), and mobile health (mHealth) applications.\textsuperscript{5} The term telemedicine refers to the use of live synchronized videoconferencing, allowing for interactive video communications between a provider and a patient.\textsuperscript{5}

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Telehealth and telemedicine are a potential tool for scaling caregiving capacity and business efficiency for NHs. In the United States, 39% of NHs currently use some form of telehealth or telemedicine, whereas 76% of acute care hospitals use telemedicine and telehealth. The use of these technologies has become even more salient recently as NHs have been in the spotlight as a result of the emergence of COVID-19. NH residents are among the most at-risk groups for COVID-19 fatality. This combined with stringent infection control practices such as lockdowns, and other concerns such as staffing and availability of specialty care, presents an even greater impetus for exploring telemedicine and telehealth as modalities in the NH setting. One recent approach to COVID-19 used telemedicine and remote monitoring to treat residents in place, resulting in lower hospitalizations and mortality compared with other NHs. Moreover, there have been increasing calls to focus research on the use of technology to enhance care in NHs and other settings from the National Institutes of Health, the IMPACT Collaboratory, Health Resources and Services Administration, and others both previous to and in response to the pandemic. Therefore, it is important to synthesize the most recent literature to provide groundwork for the future design, implementation, and expansion of telehealth services in NHs.

Previous systematic reviews have explored the use of technology in the care of older adults with chronic conditions, persons living with dementia in supportive environments, ambulatory care, and in long-term care settings. Another international review focused on assistive technology, alarms, and surveillance technology. Outcomes in the reviews were generally positive, though most call for further research. Overall, a gap was found in published reviews of NH telemedicine and technology studies from 2014 to 2020. Given the pace of technology development, a re-evaluation of the current evidence is needed.

The purpose of this integrative review is therefore to evaluate and appraise the outcomes of recent primary research involving telemedicine and telehealth in NHs. This integrative review adds to the knowledge base by evaluating and synthesizing recent studies and will conclude with recommendations for practice and future research.

**Methods**

Whittemore and Knafl’s methodology was used as the framework for this integrative review. Studies capturing clinician, patient, and family feedback on the technology’s usability and user experience were analyzed within the context of the Technology Acceptance Model.

**Search Strategy**

Medline via PubMed, Web of Science, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Excerpta Medica Database (Embase), PsycNET, and the Journal Storage (JSTOR) were searched for relevant articles. A medical librarian was consulted for the search strategy. A combination of the terms remote patient monitoring, telehealth, telecare, telemonitoring, telemedicine, videoconferencing, skilled nursing facilities, SNF, long-term care, LTC, and nursing home were searched using Boolean logic in these databases. In PubMed, the medical subject heading (MeSH) terms Skilled Nursing Facilities, Nursing Homes, and Telemedicine were used, including their automatic explosion functionality to include a larger array of articles. CINAHL major headings Nursing Homes+, and Telehealth+, as well as Embase subject terms exp telehealth/ and ‘nursing home’ found additional articles.

**Inclusion and Exclusion Criteria**

The search included studies in the English language published from January 2014 through October 2020. Because of limited results specific to the United States, international studies were included. Primary quantitative and qualitative studies using telemedicine and telehealth were included. Studies were required to involve NH clinicians or NHs as the primary setting. Exclusion criteria omitted conference abstracts, magazine articles, and protocol proposals. Painstakingly, a Cochrane Systematic Review of telemedicine’s effects on health outcomes was referenced but only included studies published before 2013.

**Search Results**

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram is shown in Figure 1. A total of 933 results were screened by study title. Fifty-six were included for full-text review. A final sample of 16 articles meeting inclusion and exclusion criteria were kept for data extraction and evaluation. A Cochrane Systematic Review of telemedicine’s effects on health outcomes was referenced but only included studies published before 2013.

**Data Evaluation**

A constant comparative method was undertaken to discover patterns, themes, variations, and relationships. Table 1 summarizes extracted data by purpose, study design, technology used, and main findings. Because of the variety present in the research studies, a table organizing studies by focus, intervention details, roles involved, and demographics was used to discover common elements (see Table 2).

**Results**

The NH settings included locations in Canada, France, Italy, Australia, Singapore, and the United States. NH settings were not reliably described for each study, but those that reported spanned across rural, suburban, and urban settings (Table 2). Studies involved patient, family members, and clinician participants.

**Telemedicine and Telehealth Processes**

Studies varied in regard to patient populations, technology used, and scheduling of telehealth services. Four studies focused on telemedicine consultations with geriatricians, another presented telemedicine services delivered by neurologists and psychologists. Palliative care specialists trialed video consultations with patients living with dementia. A quality improvement study implemented a telemedicine group practice offering numerous specialists and another implemented asynchronous messages between NH providers and 100 consulting specialty groups. The remaining studies enabled access to heart failure, musculoskeletal, and wound care specialists. Eight studies implemented video capabilities only, whereas 3 studies used Bluetooth stethoscopes for remote auscultation.

The scheduling of telemedicine was varied. In 2 studies, persons living with dementia received weekly counseling.
Other programs scheduled geriatrician consults individually as needed. Another held biweekly 120-minute case-based teleconsultations where 3 to 4 cases were reviewed between NH providers and specialists at a medical center.

RPM studies undertook varied approaches. Subacute patients collected their own daily weights, pulse oximetry, heart rate, and blood pressure readings in anticipation of discharging to home with the same wireless equipment. The same study deployed multiparameter continuous monitoring patches, point-of-care lab testing, and video visits with heart failure specialists. De Luca et al deployed Bluetooth blood pressure cuffs and pulse oximeters to collect vitals 3 times a week, sending data to a remote-monitored dashboard to supplement the monitoring provided within the NH. Another study used sensors to detect urinary incontinence episodes and display data on a telemonitoring application.

Clinical Outcomes

Patient-level outcomes

Patients experienced improved self-report measures as well as objective improvements in blood pressure and incontinence. In a study combining psychiatric teleconsultations with remote monitoring, persons living with dementia showed improvement in Geriatric Depression Scale, Brief Psychiatric Rating Scale, and quality of life measurements. Another study combined telemedicine counseling with activity and heart rate monitoring and found that persons living with dementia achieved 92% of the care management program’s wellness goals, 89% of behavioral goals, and 82% of cognitive goals. In facilities with access to geropsychiatric specialists via telemedicine, persons living with dementia were 75% less likely to be physically restrained, 17% less likely to be prescribed antipsychotic medications, and 23% less likely to develop a urinary tract infection than similar residents in control facilities.

Clinically significant results were found in reductions in hospitalizations and improved time to intervention. A 10-point decrease in systolic blood pressure ($P < .001$) and heart rate ($P = .02$) was found in an RPM intervention group. This improvement indicated that telehealth provider collaboration with NH staff improved patient care. In a store-and-forward study, telehealth wound care was found to be noninferior to in-person care in relation to wound healing, while incurring substantial cost benefits. Remote monitoring of urinary incontinence showed improved scheduling of toileting assistance with a decrease in incontinence episodes.
| Lead Author                  | Purpose                                                                 | Study Design                    | Sample and Strategy | Data Collection                                                                 | Technology Used | Statistical Analysis | Main Findings                                                                 |
|-----------------------------|-------------------------------------------------------------------------|---------------------------------|---------------------|---------------------------------------------------------------------------------|-----------------|----------------------|--------------------------------------------------------------------------------|
| **Telemedicine Consults**   | Evaluate telemedicine consultations as musculoskeletal care to long-term care patients. | Descriptive cross-sectional study | $N = 32$ consults    | Telemedicine Satisfaction Scale (TeSS) Telemedicine Usability Questionnaire (TUQ) | Video sessions  | ● Descriptive statistics | Reporting percentages of survey results only  
- 64% and 71% patients/liaisons described visual quality as excellent  
- 79% of patients rated comfort level as excellent with telemedicine  
- 92% of patients rated attending physician’s explanation of treatment and skill as excellent  
- 59% of liaisons said devices were easy to learn to use  
- 70% of liaisons said it improved productivity  
- 70% of liaisons rated consultations as similar to in-person  
- 81.5% of liaisons strongly agreed would use TeleMSK again  
Subjectively describes increase in family members joining the appointment; distance previously a barrier |
| Cheng et al., 2020          |                                                                         |                                 |                     |                                                                                |                 |                      |                                                                                  |
| **Driessen et al., 2018**   | Quantify the specific types of medical specialists that NH providers would request or find useful  
Survey attitudes regarding specialty care delivered through telemedicine | Cross-sectional survey          | N = 524 physicians and advanced practice providers (APPs)  
Convenience sample. Survey made available to all attendees of AMDA Long-Term Care Medicine and Annual Care Conference.  
41% response rate | Author-developed paper survey measuring likelihood of ordering telemedicine consults for 26 medical specialties. Likelihood ordering ancillary services and nonmedical specialties. Responses related to perceived benefits and concerns. Participant demographics | N/A             | ● Means and SDs of survey responses | Most likely to use telemedicine for dermatology consults and geriatric psychiatry. Infectious disease, cardiology, and neurology were the next most likely to be requested through telemedicine  
High level of agreement that subspecialty telemedicine may fill existing service gaps and access to and improve timeliness of care  
Authors report enthusiasm |
|                            |                                                                         |                                 |                     |                                                                                |                 |                      |                                                                                  | (continued on next page)
| Lead Author | Purpose | Study Design | Sample and Strategy | Data Collection | Technology Used | Statistical Analysis | Main Findings |
|-------------|---------|--------------|---------------------|-----------------|-----------------|----------------------|---------------|
| Georgeton et al, 2015 | Determine the factors associated with adherence of general practitioners to recommendations made by specialists in teleconsultation | Prospective cohort study | N = 69 Included patients had received a geriatric teleconsultation and resided at one of 3 NHs | Histories, demographics, and reason for consult Geriatrician’s assessment data and recommendations recorded CIRS-G, BMI, ADL, GDS, NPI, history of falls | Dedicated teleconsult room in NH High-definition camera Computer with broadband Internet | | for telemedicine but “few respondents actually had access to telemedicine in their facilities.” In introduction, quoted to be 40%. Majority of respondents were medical directors 83% of teleconsults were for neuropsychological reasons. GPs followed recommendations for 58 teleconsults (84%). 86% of patients received pharmacologic recommendations, 78% received nonpharmacologic recommendations, and 7% received expert medical advice (eg, hospitalization, referral to specialist recommendations.) Expert medical advice was associated with GP adherence to recommendations (OR = 7.71, 95% CI 1.57-37.98, P = .04) Risk of depressive syndrome (OR = 8.00, 95% CI 1.10-58.10, P = .004) and expert medical advice recommendation (OR = 17.97, 95% CI 1.10-58.10, P = .04) were associated with GP adherence to recommendations Lack of adherence to teleconsult recommendations is a serious potential barrier to effectiveness of telemedicine programs. | |
| Gordon et al, 2016 | Determine ECHO-AGE intervention’s impact on quality of care for NH residents with dementia | 2:1 prospective matched cohort study | N = 11 NHs in Massachusetts and Maine. Each ECHO-AGE SNF matched with 2 other similar facilities based on size. 115 cases discussed during study period | Minimum Data Set (MDS) outcomes: - Percentage of long-stay residents who were physically restrained - Percentage of long-stay residents who received antipsychotic | Video consult | Descriptive statistics across 6 quarters | ECHO-AGE residents were 75% less likely to be physically restrained than in control facility (OR = 0.25, P = .05). ECHO-AGE residents were 17% less likely to receive antipsychotic medications than in control facilities (OR = 0.73, P = .07) ECHO-AGE residents were | |
medication over the last 7 d
- Quality measures related to ADL, pain, weight loss, incontinence, UTI, depressive symptoms, and falls

23% less likely to experience UTI during follow up period (OR = 0.77, P = .01)

Preliminary evidence shows reduction in primary outcomes (physical and chemical restraint usage). Both changed most dramatically between baseline and the first quarter after the intervention’s initiation. Antipsychotic use continued to gradually decline throughout the remaining quarters, whereas physical restraints remained lower overall but fluctuated quarter to quarter.

Helmer-Smith et al, 2020
- Evaluate feasibility of the Champlain BASE eConsult service in long-term care

Mixed Methods
N = 64 eConsults requested from
- 34 physicians
- 18 nurse practitioners

Specialty consulted and response time
Specialist billing time
PCP responses on mandatory close-out survey
Focus groups

Asynchronous communication between NH providers and specialists

Descriptive statistics
- Dermatology (19%), geriatric medicine (11%), infectious disease (9%)

Specialists responded in median of 0.6 days with a median billing time of 15 minutes (Can$50/case)

Consult results: 60% new course of action, 31% no change. 70% were resolved without face-to-face visit, and 2% initiated new referrals.

Perceived value: improved access, cost reductions, enhanced quality of care, reduced transfers, shorter wait periods.

Hofmeyer et al, 2016
- Evaluate eLTC pilot program’s impact on decreasing potentially avoidable hospitalizations

Quality improvement pilot study
736 two-way video consultations (they don’t count this in participants)
863 telephonic encounters

Utilization of eLTC services
Averted transfers as a percentage of total encounters
Quality improvement staff surveys

Video consult 2-way stethoscope
High-definition camera

Descriptive statistics
- 500 potential transfers deemed unnecessary
- decreased potentially avoidable hospitalizations (PAHs)
- saved $5 million in admission-related charges to CMS

Nursing staff believed eLTC improved quality of patient care, positively impacted workload
Clinician buy-in achieved with after-hours eLTC support

Chief complaints: 24% shortness of breath, 24% skin complaint, 14% upper respiratory infection, 13% fever, 12% neurologic, 10% joint pain, 10% GI complaint, 10% urologic

(continued on next page)
| Lead Author | Purpose | Study Design | Sample and Strategy | Data Collection | Technology Used | Statistical Analysis | Main Findings |
|-------------|---------|--------------|---------------------|----------------|-----------------|----------------------|---------------|
| Low et al, 2020<sup>20</sup> | • Describe patient profile, presenting diagnoses, management provided, and processes involved in teleconsults | Descriptive cross-sectional study | N = 1673 consults with 850 unique patients (95% scheduled, 5% ad hoc) All NH patients referred for teleconsult from December 2010 to May 2017 | Resident assessment form categorize patients by functional status Data from health record | Video sessions | • Descriptive Statistics | Highest proportions of CC transfers: 66% of neurologic transferred, 45% GL, 4% shortness of breath Reason for consult: 27% medication review, 15% behavioral, 15% symptom review, 13% follow-up review Session length: 20-129 min Outcomes: A month after teleconsult, 84% remained in NH, 3.4% passed away, 6.3% referred to outpatient specialist, and 6.2% sent to ED |
| Perri et al, 2020<sup>21</sup> | • Evaluate telemedicine delivery of palliative care early in resident illness trajectory | Pre-post nonrandomized experimental study | N = 61 residents at 2 pilot facilities (includes all residents at the facilities) 11 palliative care video consults | Demographics PPS CHESS ADL Surveys for patient and family experience Clinical staff survey on confidence in palliative care, and video satisfaction surveys. | Video consult Dedicated room for video consult Widescreen monitor, video camera, external microphone | • Descriptive statistics | 55% of the telemedicine conferences were triggered by quarterly review screening. Next most common triggers were 27% clinical judgement and 18% readmission from acute care 11 families joined by videoconference: - 86%-100% felt technical, privacy, and comfort were satisfactory with video visit. And would use it again. - 70% would have preferred in-person physician - 71% would prefer video consult if their loved one could be seen by a palliative care specialist faster, or more frequently than in-person visits 17 of 22 clinical staff completed survey - Palliative care video conference averaged 45 min - Confidence with introducing supportive care topic to residents and family increased (P = .03) - More video sessions clinical staff participated in, the higher they rated visit - 65% reported noise as a barrier, 22% had difficulty receiving |
Piau et al., 2020
- Evaluate health workers’ perception on telemedicine
  
  **Qualitative**
  - N = 10 NHs using geriatrician telemedicine consults for 2 y
  - Total of 180 sessions across NHs
  - 90 patients benefited from 2 sessions each
  
  **Semistructured interviews**
  - Video sessions
  
  • N/A

Stern et al., 2014
- Evaluate clinical and cost-effectiveness of an enhanced multidisciplinary intervention (EMDT) supported by telemedicine vs usual care for the treatment of pressure ulcers in long-term care
  
  **Pragmatic stepped-wedge cluster randomized trial**
  - N = 137 SNF residents with PU
  - Stage II or greater pressure ulcers
  
  **Digital wound photography**
  - Visual analog scale (VAS) – pain
  - EQ5D (QOL) VAS-pain
  - Rates of hospitalization and ED visits
  - Ethnographic observations and in-depth interviews with NH staff
  
  • Descriptive statistics
  • Linear mixed effects models
  • Mixed effects models
  • Cox proportional hazard frailty models

Grabowski and O’Malley, 2014
- Determine whether off-hours physician coverage by telemedicine reduced hospitalizations and investigate cost savings from telemedicine
  
  **Randomized controlled trial with pre-post design**
  - Treatment group = 6 NHs
  - Control group = 5 NHs
  
  **NH EHR: transfers, demographics, resident days**
  - Monthly data from telemedicine provider
  - CMS NH’s 5-star rating, number of beds
  
  • Not specified

- After-hours support and remote assessments

- Technical support; 72% said they prefer designated person for technical support
- Improvements seen in greater involvement of staff in managing neuropsychiatric symptoms, greater involvement of families, and promotion of nonpharmacologic treatments
- Staff felt telemedicine improves the quality of care; barriers include providers not accepting specialist’s advice and lack of time and workforce for telemedicine visits

- No difference in rate of healing with and without the EMDT telemedicine intervention
- Telemedicine-delivered EMDTs found to be cost-effective. Results similar to usual care but less expensive to deliver
- In-person nurse practitioner visits were preferred by NH staff
- Concluded that strengthening primary care within the NH is more advantageous than using a multidisciplinary specialty wound care team

- Qualitative: Inadequate staff time allocated for study implementation; unavailable wound care supplies; frequent staff turnover was prohibitory

(continued on next page)
| Lead Author            | Purpose                                                                 | Study Design                  | Sample and Strategy          | Data Collection | Technology Used                                                                 | Statistical Analysis | Main Findings                                                                 |
|------------------------|-------------------------------------------------------------------------|-------------------------------|-------------------------------|-----------------|---------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------|
| Stephens et al., 2020  | • Explore formal and informal caregiver perspectives on challenges transferring NH patients to the ED and the role of emerging health care technology. | Exploratory qualitative – grounded theory | N = 8 focus groups with an average of 5 participants | Purposive sampling to construct groups of NH nurses. After themes arose, focus groups then convened with providers, families, and other stakeholders together. | Focus groups | • N/A | Focus group results support that telehealth would be useful in NHs to aid communication between family members and staff to avert avoidable ED transfers when care could be provided in the NH environment. |
| Remote monitoring      | • Evaluate whether continuous monitoring via telehealth would decreaserehospitalizations and improve patient self-care knowledge and satisfaction. | Prospective nonrandomized trial | Convenience sample – patients screened on admission | Intervention group: n = 49 | Patient satisfaction questionnaire, Self-care knowledge questionnaire, Number or type of video conferences, Number of on-site visits by SNF provider, Number of patient transports, Number of provider office visits, Length of stay from hospital and NH EHR | Video sessions, Chest patch (HR, RR, body position, single-lead ECG), BP cuff, weight scale, pulse-oximeter, Cloud-based clinician dashboard, Bluetooth stethoscope, i-STAT labs (BNP, Chem 8+/BMP), Tablet with video camera | 17.39% of case group rehospitalized within 30 days post discharge in comparison with 23.9% of control group. Telemedicine group had 6.51% absolute risk reduction and 27.24% relative risk reduction. 70% of patients felt telehealth intervention was “good”; 30% rated as “excellent”. Time to intervention for medication adjustmentsignificantly reduced (clinically significant but not statistically significant due to sample size): - From 1080 to 6 min for ACE-I - 5760 to 5 min for beta blocker - 3641 to 5 min for diuretics. Time to ED reduced from 84 to 15 min. New diagnoses of atrial fibrillation and pneumonia through video session assessment, ECG, and stethoscope. |
| Dadosky et al., 2018   | • Determine if incorporating the use of point-of-care (POC) testing within the SNF would allow for quicker medical intervention. | Exploratory qualitative – grounded theory | N = 8 focus groups with an average of 5 participants | Purposive sampling to construct groups of NH nurses. After themes arose, focus groups then convened with providers, families, and other stakeholders together. | Focus groups | • N/A | Focus group results support that telehealth would be useful in NHs to aid communication between family members and staff to avert avoidable ED transfers when care could be provided in the NH environment. |
| De Vito et al., 2020   | • Examine acceptability and feasibility of wearable devices and         | Mixed methods                  | n = 18 residents n = 6 caregivers |                     | Bristol ADL NPI-Q QoL-AD Fitbit activity monitor Video sessions | Descriptive statistics | 88% daytime adherence to wearing activity monitor across 6 mo; poor adherence |
De Luca et al., 2015

Develop telehealth care model and evaluate its effectiveness. Include multiparametric vital signs monitoring and teleconsulting for neurologic and psychological conditions.

Randomized controlled trial

59 residents were randomly divided into 2 groups: experimental group (tele-dem dementia care) vs standard care group.

Outcomes tracked:
- Falls
- Medication changes
- Behavioral episodes
- PC with webcam and microphone
- Bluetooth pulse-oximeter, BP cuff, ECG
- Bluetooth stethoscope
- Audio files

Mann-Whitney U test
- c2 tests for equality of proportions between means

Admission to healthcare service was higher in the standard care group than in the experimental group (c2 = 3.96, P < .05).

**Results:**
- Statistically significant reduction of GDS (P < .01) and BPRS (P < .05) in the experimental group.
- Quality of life scores improved in both groups, but more significantly for the experimental group (P < .001) compared to the control group (P < .01).
- Reduced BP (P < .001) and HR (P < .05).
- Reduced time of care and step counts: could encourage exercise if they needed a low step count. Additional time of 3 min per patient required to clean and charge the device.
- Presence of telehealth care professional may help local nurses and caregivers.
- Caregivers liked the ability to check the resident's heart rate and step counts; could encourage exercise if they needed a low step count. Additional time of 3 min per patient required to clean and charge the device.

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| Table 1 (continued) | **Lead Author** | **Sample and Study Design** | **Purpose** | **Main Findings** | **Statistical Analysis** |
|---------------------|----------------|---------------------------|-------------|------------------|------------------------|
| 1794                | L.L. Groom et al. | Nonrandomized experimental design | Explore the effect of a telemonitoring system on symptoms and care plan adherence in 32 NH residents with UC | **Provider-level outcomes** | - NH providers reported increased compliance with prescribed care plans after intervention (P = .015), though results were not statistically significant. |
|                     |                 |                           | Investigate whether individual UC care plans were effective | **Facility-level outcomes** | - Reduced ED and hospital transfers was a common outcome in 5 of the studies, with reductions in hospitalizations being clinically and statistically significant. |
|                     |                 |                           | Investigate the effect of telemedicine on facility-level outcomes | **Clinician, Family, and Resident Perspectives** | - Feedback from clinicians, families, and residents was collected in several studies (Tables 3 and 4). NH providers responded that they |
| Study                        | Focus                                      | Intervention Details                                                                 | Diagnoses                                      | Roles Involved                                                                                           | Resident Mean Age in Study, y | NH Beds                  | Setting | Country     |
|-----------------------------|--------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------|--------------------------|---------|-------------|
| **Telemedicine Consults**   |                                            |                                                                                       |                                               |                                                                                                        |                              |                          |         |             |
| Cheng et al., 2020          | Access to orthopedic specialist            | 32 musculoskeletal consults delivered over videoconferencing telemedicine solution    | Musculoskeletal                               | Orthopedic surgeon (n = 1)                                                                            | —                            | 26 NHs                   | Rural    | Canada      |
|                             | Patient and Provider perceptions of quality and utility of telemedicine | Included 26 long-term care facilities                                                |                                               | NH RN                                                                                                  |                              |                          |         |             |
|                             |                                            | 8-mo study period (September 2018 through April 2019)                                 |                                               | Patient and patient family (n = 14)                                                                    |                              |                          |         |             |
|                             |                                            | Patient and Provider perceptions of quality and utility of telemedicine                |                                               | Unknown ("representatives from Ontario Telehealth Network")                                           |                              |                          |         |             |
| Driessen et al., 2018       | Provider perceptions of quality and utility of telemedicine                           | N/A (study is reviewing results from a survey distributed at a conference)           | Interest in teleconsults                       | NH providers (N = 524)                                                                                 | —                            | —                        | —       | United States |
| Georgeton et al., 2015       | Telemedicine access to geriatrician specialists                                     | Dedicated rooms with high-def cameras in 3 NHs                                      | Dementia                                      | Residents (N = 69)                                                                                       | 86                           | 220 beds (across 3 NHs) | —       | France      |
|                             | Adherence to specialist advice and recommendations                                    | Teleconsultations between patients and remote geriatricians and advice for GPs.     | High burden of comorbidities                  | General practitioners                                                                                    |                              |                          |         |             |
|                             |                                            | 8-mo study period (July 2013 to March 2014)                                           |                                               | Geriatricians                                                                                          |                              |                          |         |             |
| Gordon et al., 2016         | Access to geriatricians and geropsychiatric specialists                              | 120-min biweekly case-based video consultation                                       | Dementia                                      | Telemedicine assistant (undefined)                                                                    | —                            | 16 NHs (min 46, max 335 beds) | —       | United States |
|                             | Focus on quality measure results between telemedicine and control groups            | Connecting frontline NH staff with Beth Israel Medical Center in Boston               | Restraint use                                 | Geriatrics                                                                                             |                              |                          |         |             |
|                             | Physical and chemical restraint usage                                               | 3-4 NH residents presented each session                                              |                                               | Geropsychiatrists                                                                                        |                              |                          |         |             |
|                             |                                            | 18-mo study period                                                                    |                                               | Nurses                                                                                                 |                              |                          |         |             |
|                             |                                            | Online application allows NH providers to submit nonurgent questions to specialists from 100 specialty groups. | Not limited                                   | Nursing assistants                                                                                      |                              |                          |         |             |
|                             |                                            | 24/7 pilot model of telephone- and video-based consultations in rural areas           | Transfers for syncope, neurologic issues, respiratory distress                         | Activities directors                                                                                  |                              |                          |         |             |
|                             | Decreasing preventable hospitalizations                                              | 2-way video, stethoscope, high-definition camera                                     |                                               | Social workers                                                                                         |                              |                          |         |             |
|                             |                                            | Specialties included infectious disease, wound care, cardiology, nephrology, and others |                                               |                                                                                                        |                              |                          |         |             |
|                             |                                            | Used interventions to reduce acute care transfers tool                                 |                                               |                                                                                                        |                              |                          |         |             |
| Helmer-Smith et al, 2020    | Asynchronous eConsults                    | Online application allows NH providers to submit nonurgent questions to specialists from 100 specialty groups. | Not limited                                   | Residents (n = 64)                                                                                      | 80                           | 3400 beds (across 18 NHs) | —       | Canada      |
| Hofmeyer et al, 2016        | Access to infectious disease, wound care, cardiology, nephrology, and other specialists | 24/7 pilot model of telephone- and video-based consultations in rural areas           | Transfers for syncope, neurologic issues, respiratory distress                         | NH providers (n = 52)                                                                                  |                              |                          |         | United States |
|                             | Decreasing preventable hospitalizations                                              | 2-way video, stethoscope, high-definition camera                                     |                                               | Administrators                                                                                         |                              |                          |         |             |
|                             |                                            | Specialties included infectious disease, wound care, cardiology, nephrology, and others |                                               | Nurse champion                                                                                         |                              |                          |         |             |
|                             |                                            | Used interventions to reduce acute care transfers tool                                 |                                               | Residents (N = 736)                                                                                    |                              |                          |         |             |
| Low et al, 2020             | Clinical workings of teleconsult program   | 1673 consults                                                                         | Not limited                                   | Director of eLTC                                                                                        | -                            | 5000 beds (across 34 NHs) | Rural   | United States |
|                             |                                            | 8 NHs                                                                                 |                                               | Service line manager                                                                                   |                              |                          |         |             |
|                             |                                            | 6.5-y study period (December 2010 through March 2017)                                 |                                               | Advanced practice providers                                                                             |                              |                          |         |             |
|                             |                                            |                                                                                       |                                               | Specialist physicians                                                                                    |                              |                          |         |             |
|                             |                                            |                                                                                       |                                               | Registered nurses                                                                                      |                              |                          |         |             |

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| Study                       | Focus                                                                 | Intervention Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Diagnoses                                                                 | Roles Involved                                                                 | Resident Mean Age in Study, y | NH Beds | Setting | Country   |
|-----------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------------------------------------------------------------|-------------------------------|---------|---------|-----------|
| Perri et al, 2020          | • Access to palliative care specialists                               | • Clinical staff at 2 pilot sites monitored residents weekly for predefined events that trigger a palliative care consult  
• Gold Standard Framework Pro-Active Identification Guidance tool used to evaluate palliative care needs  
• Dedicated conference room at NH with videoconferencing included computer, widescreen monitor, external microphone, high-definition camera  
• Family given choice to join via videoconference or in person  
• 6-mo study period (November 2017–April 2018)                                                                 | • Dementia                  | • Residents (n = 61)  
• Medical doctors  
• Registered nurses  
• Social workers  
• Palliative care specialists  
• Patient families | 87                             | 472                          | Urban | Canada |
| Piau et al, 2020           | • Management of neuropsychiatric symptoms via telemedicine            | • Telemedicine consult visits within 72 h of disruptive neuropsychiatric symptom between NH and geriatricians at expert memory centers  
• Interview NH staff before and after telemedicine experience  
• 2-y study period (2015-2017)                                                                 | • Neuropsychiatric symptoms                                                                 | • Residents (N = 90)  
• NH providers  
• NH nurses  
• NH psychologists  
• Consulting geriatricians | –                              | 10 NHs (min 60, max 133 beds) | –      | France |
| Stern et al, 2014          | • Access to wound care specialists                                   | • Each facility appointed wound care lead to be primary contact for study team  
• Wound care nurse practitioner in person for phase 1 (3 mo)  
• NP was primarily remote and provided wound care via digital photos, video visits, e-mail, and phone conversations (1-11 mo)  
• Compared usual care to intervention                                                                 | • Pressure injury            | • Residents (N = 137)  
• Advanced practice nurses specialized in wound care  
• NH registered nurses | 82                             | 1902 beds (across 12 NHs) | –      | Canada |
| After-Hours Support and Remote Assessments  
Grabowski and O’Malley, 2014 | • Coverage of nights and weekend hours for NHs                       | • Provider coverage for NHs through telemedicine group to cover urgent and emergent weekend calls from 5p-11pm, and weekend day coverage (10am-7pm).  
• Cart with videoconferencing and high-res camera  
• NH providers not informed that would be studying hospitalizations  
• 13 month study period (October 2009 through November 2010)                                                                 | • Reducing hospitalizations  
• Financial savings                                                                 | • NH physicians (primary group practices typically covered off-hours care)  
• Telemedicine group registered nurse, nurse practitioner, physician  
• NH-level patient data | –                              | 11 NHs (min 140, max 175 beds) | –      | United States |
| Study                        | Methods                                                                 | Findings                                                                                     |
|------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Stephens et al, 2020³⁶      | Explore experiences of NH resident transfers to ED through qualitative methods | Transfers from NH to ED  
  - NH resident family members (n = 6)  
  - NH providers and nursing staff (n = 30)  
  - ED and hospital providers (n = 5)  
  - NH administrators |
| Dadosky et al, 2018³⁵       | Access to HF specialists  
  - Improving time to intervention in SNF  
  - Collaboration between HF clinic, SNF, and HHC  
  - Evaluate patient provider acceptance of telehealth  
  - HF clinicians in office setting  
  - Heart failure assessed patient in SNFs with telemedicine sessions.  
  - A sensor worn on the chest provided HR, RR, body position, and single-lead ECG.  
  - BP, pulse-oximeter, and weight were monitored via Bluetooth devices.  
  - The HF and SNF providers used a Bluetooth stethoscope to remotely auscultate heart and lung sounds.  
  - POC lab testing used to measure BNP, BMP  
  - Data viewable on dashboard for SNF and HF clinic clinicians  
  - 21-mo study period (March 2014–December 2015) | Patients (N = 141)  
  - HF office clinicians (unknown roles)  
  - NH providers  
  - NH nursing staff  
  - HHC staff |
| De Luca et al, 2016³⁷        | Access to neurology and psychology specialists  
  - Telehealth impact on psychological measures, quality of life, and neurobehavioral symptoms  
  - Improving vital signs and clinical management  
  - BP, pulse-oximeter, ECG via Bluetooth devices  
  - Recorded sounds from Bluetooth stethoscope  
  - Dashboard for providers  
  - Videoconferencing solution for telemedicine visits  
  - Study period undefined, T₀ = before telecare protocol  
  - T₁ = after telecare protocol | Residents (N = 59)  
  - Neurologist  
  - Psychologist  
  - NH nursing staff |
| De Vito et al, 2020³⁶        | Activity monitors and monthly wellness telemedicine visits with PLWD  
  - Activity monitor to track steps, HR, and sleep data  
  - Monthly telemedicine visits with neuropsychologists and PLWD and their caregiver: setting wellness goals, care recommendations  
  - Monthly questionnaires  
  - 6-mo study period | Residents (n = 18)  
  - NH caregiver (n = 6)  
  - Neuropsychologists (n = 1) |

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would be most likely to use telemedicine for dermatology, geriatric psychiatry, infectious disease, cardiology, and neurology consults. NH staff who did not use telemedicine opined that it would be a powerful tool to influence medical decision making. Palliative care specialists and NH physicians, nurses, personal support workers, and rehabilitative therapists’ knowledge of using palliative care \( r = 0.565, P = \cdot018 \), confidence in using palliative telemedicine \( r = 0.673, P = \cdot003 \), and overall telemedicine acceptance \( r = 0.698, P = \cdot002 \) was positively correlated with an increased number of videoconferences. More frequent usage seemed to improve satisfaction with the modality.

Two studies collected feedback from NH residents directly, who reported their experiences as positive. Family perspectives were explored in 3 of the articles. Family members considered telemedicine visits advantageous if they resulted in quicker access to a provider or resulted in more frequent visits. There was also agreement that families would benefit from joining consultations through videoconferencing.

**Facilitators and Barriers**

Clinician-identified facilitators to telehealth implementation included having adequate technical support, integration into the electronic health record, and strong facility leadership. Perceived benefits included improved timeliness of resident’s care, elevated productivity, improved access to specialist advice, increased connection opportunities between NH nurses and providers, and subjective gains from involving families in care. Resident- and family-identified facilitators included being able to see a provider sooner, high-quality audio and video, and functionality to allow family participation during visits.

Clinician-identified barriers included poor audio quality, missing functionality, technical difficulties slowing time to connect, time required to clean and charge devices, reimbursement challenges, and lack of workforce allocation for telemedicine. Residents and families noted barriers as charging devices, preferences for in-person visits, and difficulties in connecting to Wi-Fi or cellular broadband.

**Discussion**

This integrative review of 16 international studies illustrates the modes in which telemedicine and telehealth potentially expand access, cover gaps in care, improve resident outcomes, reduce unnecessary trips to the hospital, and generate cost savings for NHs. Throughout the studies, there is consensus in benefits to patient care, and enthusiasm or at least curiosity for its use from providers, residents, and family. In no study was there unequivocal evidence that telemedicine or telehealth negatively affected resident outcomes or presented an excessive cost burden. This appraisal finds wide methodologic heterogeneity and low generalizability because of small sample sizes with poorly described characteristics, and study designs that fail to collect or report sufficient intervention data. These aspects impair the ability to construct overarching evidence-based recommendations and highlight the need for conducting future research with more comprehensive and consistent study designs.

Geriatric, wound care, psychiatric, and palliative specialist tele-consults were found most effective in this review. Some NH clinicians preferred in-person wound care nurse practitioners and palliative care providers over telemedicine providers. Results suggest that telemedicine enables rapid specialist consultations and allows on-call NH providers to evaluate residents from home. Similarly, ED telemedicine research programs found reductions in unnecessary
Table 3
Analysis of Clinician Perspectives in Accordance with the Technology Acceptance Model

| Concept               | Facilitators and Benefits                                                                 | Barriers and Disadvantages                                                                 |
|-----------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Experience            | • As providers used telemedicine more frequently, their satisfaction scores increased (Perri et al34) | —                                                                                         |
| Job relevance         | • Improve timeliness of resident’s care (Driessen et al25)                                | • Difficulty coping with change, feeling of intrusion (Piau et al31)                      |
|                       | • Improve service gap (Driessen et al25)                                                  | • Audio quality—unable to hear each other (Perri et al44)                                 |
| Output quality        | • Better valuation of NH staff’s work (Piau et al31)                                      | • Unable to complete all functions clinician wants done (Cheng et al26)                   |
| Result demonstrability| • Numerous residents said they were willing to use telemedicine again (Perri et al34)    | • Intention to use                                                                       |
|                       | • Clinicians initially feared dehumanization of medicine, but did not report this after 2 y of use (Piau et al31) | • Improved access to specialist advice, cost reductions, improved quality of care (Helmer-Smith et al28) |
| Perceived usefulness  | • Involvement of families in care (Piau et al31)                                         | • Lack of time and workforce for telemedicine (Piau et al31)                              |
|                       | • Measured by TUQ (Cheng et al24)                                                         | • Inadequate allocation of staff time to implementation (Stern et al32)                   |
|                       | • Aid making decision to transfer (Stephens et al34)                                     | • Residents more frequently removed activity monitors in late afternoon or evening due to agitation (De Vito et al36) |
|                       | • Patient may be able to see provider more often (Stephens et al34)                      | • Preference to see provider in person if given option (Perri et al34)                    |
|                       | • Improved access to specialist advice, cost reductions, improved quality of care (Helmer-Smith et al28) | • Physician and APP reimbursement and licensure (Driessen et al36)                        |
|                       | • Tackles lack of specialized care in remote areas (Piau et al31)                        | • Involvement of families in care (Piau et al31)                                         |
|                       | • Able to use resident’s activity monitor to easily check heart rate; more aware of sleep patterns (De Vito et al36) | • Technical support person available in the moment (Perri et al34)                        |
| Perceived ease of use | • 81% found software easy or moderately easy to learn (Cheng et al24)                    | • Amount of time it takes to connect, adds median 3 min per resident during their shift (De Vito et al36) |
|                       | • Ease of sending a message to a specialist; increased confidence in care decisions (Helmer-Smith et al28) | • Activity monitor cleaning and charging added 5 min per resident (De Vito et al36)       |
| Intention to use      | • Technical support person available in the moment (Perri et al34)                      | • Lack of time and workforce for telemedicine (Piau et al31)                              |
| Usage behavior        | • Technical support person available in the moment (Perri et al34)                      | • Inadequate allocation of staff time to implementation (Stern et al32)                   |
|                       | • Measured by TeSS (Cheng et al24)                                                       | • Residents more frequently removed activity monitors in late afternoon or evening due to agitation (De Vito et al36) |
|                       | • Measured by TeSS (Cheng et al24)                                                       | • Preference to see provider in person if given option (Perri et al34)                    |
|                       | • Ability of family to join patient in consultation (Cheng et al24)                      | • Involvement of families in care (Piau et al31)                                         |
|                       | • Potential to include family in decision to transfer to hospital and increase trust in provider decision (Stephens et al25) | • Preference to see provider in person if given option (Perri et al34)                    |
|                       | • Liked activity monitor because it also served as a watch (De Vito et al36)             | • Some residents appeared neutral or had no awareness of activity monitor (De Vito et al36) |
| Perceived ease of use | • Measured by TUQ (Cheng et al24)                                                        | • Bothered by changing battery, charging the tablet, taking daily vital signs (Dadosky et al35) |
| Intention to use      | • Would prefer videoconference if it meant their loved one could be seen by palliative care faster, or more often than in person visits (Perri et al34) | • Preference to see provider in person if given option (Perri et al34)                    |
|                       | • Be able to see provider sooner, increase trust in NH (Stephens et al34)                | • Some residents appeared neutral or had no awareness of activity monitor (De Vito et al36) |
| Usage behavior        | • 88% daytime compliance wearing activity monitor (De Vito et al36)                      | • Difficulty connecting to Wi-Fi or 4G connections (Dadosky et al35)                      |

APP, advanced practice provider; TUQ, Telemedicine Usability Questionnaire.

transfers and that 18% to 66% of teleconsultations influenced patient diagnosis or management.41

Limited qualitative work explores telemedicine and telehealth in the NH setting. This scarcity may be due to the technologies’ relatively recent emergence in the NH setting. Qualitative research emphasizes the experiences of residents, clinicians, and other users, which is beneficial to technology developers improving the usability and utility of systems. Although limited in this setting, in other settings, patients

Table 4
Analysis of Resident and Family Perspectives in Accordance with the Technology Acceptance Model

| Concept               | Facilitators and Benefits                                                                 | Barriers and Disadvantages                                                                 |
|-----------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Experience            | • Technical, privacy, and comfort met (Perri et al34)                                     | —                                                                                         |
| Output quality        | • Visual and audio quality rated as excellent (Cheng et al24)                            | —                                                                                         |
| Result demonstrability| • Willing to use it again (Perri et al34)                                                | —                                                                                         |
| Perceived usefulness  | • Some patients did not want intervention to end (Dadosky et al35)                       | —                                                                                         |
|                       | • Measured by TeSS (Cheng et al24)                                                       | —                                                                                         |
|                       | • Ability of family to join patient in consultation (Cheng et al24)                      | —                                                                                         |
|                       | • Potential to include family in decision to transfer to hospital and increase trust in provider decision (Stephens et al25) | —                                                                                         |
|                       | • Liked activity monitor because it also served as a watch (De Vito et al36)             | —                                                                                         |
| Perceived ease of use | • Measured by TUQ (Cheng et al24)                                                        | • Bothered by changing battery, charging the tablet, taking daily vital signs (Dadosky et al35) |
| Intention to use      | • Would prefer videoconference if it meant their loved one could be seen by palliative care faster, or more often than in person visits (Perri et al34) | • Preference to see provider in person if given option (Perri et al34)                    |
|                       | • Be able to see provider sooner, increase trust in NH (Stephens et al34)                | • Some residents appeared neutral or had no awareness of activity monitor (De Vito et al36) |
| Usage behavior        | • 88% daytime compliance wearing activity monitor (De Vito et al36)                      | • Difficulty connecting to Wi-Fi or 4G connections (Dadosky et al35)                      |

4G, fourth-generation broadband cellular; TeSS, Telemedicine Satisfaction Scale; TUQ, Telemedicine Usability Questionnaire; Wi-Fi, wireless fidelity.
and caregivers have highly rated telehealth’s impact on information sharing, consumer focus, and overall satisfaction. However, given the NH setting’s unique nature, future work is needed to better understand these issues.

Difficulties related to staff turnover introduce training issues that impair the consistent implementation of telehealth interventions. Despite such issues, there appear to be numerous opportunities for telehealth and telemedicine in NH settings, especially given the relatively low rollout and operational costs. According to the survey data included in this integrative review, participants are generally enthusiastic toward the use of telemedicine and telehealth in NHs.

The results of the present review are consistent with the Society for Post-Acute and Long-Term Care Medicine’s standards document that guides NHs on the use of telemedicine to evaluate and manage changes of condition for residents. Reductions in hospitalizations and emergency visits in particular are further supported by this review. This review adds new perspectives on remote monitoring in NHs and potential new metrics such as reductions in restraint use.

An earlier systematic review of telemedicine services for residents in NHs from 1990 to 2013 found that dermatology, geriatrics, psychiatry, and other specialties were successfully delivered via telemedicine while also showing economic savings. This review extends this prior work’s findings as our included studies also found financially and clinically efficacious results with asynchronous dermatology teleconsultations, geriatric specialist teleconsultations, and psychiatric care delivered over telemedicine.

COVID-19 has brought new difficulties as NH residents are at high risk because of resident age, comorbidities, and proximity to other residents and staff. Visitation restrictions meant to limit potential contagion from unnecessary in-person contact created a push for telehealth to enable family visitation, mental health services, and allow remote assessments by specialists. Hospital COVID-19 programs indicate that telemedicine helps preserve personal protective equipment, limits exposures bidirectionally, encourages fast triage, and allows a specialist group to service multiple facilities. A COVID-19 collaborative model between an academic hospital and NH enabled telemedicine consultations, infection advisory consultations, and nursing liaisons to prevent or limit outbreaks.

Limitations of the Included Studies

Overall, there was a general lack of rigorous experimental study designs. Studies using a historical group for comparison lacked matching procedures or propensity scores, which results in a risk of a study’s internal validity due to selection bias. A large number of studies used author-developed surveys, which present risks of measurement bias. In other cases, advanced statistical methods may have given more robust results by for example using Poisson regression models for the analysis of count data and multiple hospitalizations. This would have permitted predictions around the effectiveness of the intervention.

No studies in this sample used a theoretical framework to guide their approach. Sampling strategies frequently were not described. Baseline characteristics of samples were poorly described, with few consistently captured demographic, psychometric, and physiological measures. This limited the analysis of person-level differences between groups. Inclusion of these data could help to identify disparities related to rurality, socioeconomic, or language barriers.

Sample sizes were frequently small, with one study reporting results from a single orthopedic surgeon. Most studies involved a small number of sites, thus limiting generalizability. Others involved multiple co-occurring treatments (eg, RPM, telemedicine, point-of-care testing) but lacked representation as independently measured covariates. A full critical analysis may be reviewed in Supplementary Tables 1 and 2.

Limitations of this Review

Encouraging telepharmacy, teledentistry, and telerehabilitation studies exist in NH settings but were out of scope for this review because of its focus on the medical-nursing nexus of telemedicine. This review used the ONC’s definition of telehealth and did not include surveillance technology, passive monitoring, and robotics, though these are promising areas of research. Videconferencing for connection between NH residents and family was not included. Telehealth support of family caregivers of persons living with dementia in residential care was not included, though interesting work is ongoing in this area.

Implications

Practice

Stakeholders may choose to implement a pilot program to validate telehealth’s suitability for their NH. Quality improvement outcomes such as number of unnecessary hospital transfers, satisfaction surveys, and changes in selected clinical measures may be the most appropriate outcomes to track. Further, technology implementations are more readily accepted when they are interoperable with existing system architecture.

Geriatric psychiatry and dermatology teleconsultations specialties can be effectively delivered through telemedicine. Other work suggests after-hours telemedicine services help facilities maintain census and decrease patient transportation costs.

Research

NH resident perceptions of telemedicine are absent from recent literature. Only 1 study used a patient-focused questionnaire. Community-based studies eliciting feedback from older participants indicated that telehealth was well-received. Similar studies may be undertaken in NHs. Furthermore, given the small size of many of the studies, performing embedded pragmatic clinical trials of those technologies with an underlying evidence base could provide more generalizable outcomes as well as information on effective implementation methods and intervention fidelity. Qualitative research could illuminate specifications for types of alerts that may be most beneficially triggered from RPM-collected data for NH residents.

Conclusions and Implications

This integrative review presents a comprehensive synthesis of empirical evidence regarding the state of the science on telemedicine and telehealth in NHs. There is evidence that telemedicine and telehealth may improve outcomes for patients, staff, and administrators in NHs, provide broader full-time coverage, and decrease costs. Telemedicine may help reduce the exposure to COVID-19 in NHs and decrease unnecessary hospitalizations. As may be expected, certain kinds of diagnostic support are better suited to remote settings than others. The research is far from comprehensive, indicating that this is a nascent field for future investigations into the implementation and adoption of these technologies.

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| Study                          | Purpose                                                                 | Methods                                                                 | Variables and Measures                                                                 | Statistical Analyses                                                                 | Results                                                                 | Discussion                                                                 |
|-------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Cheng et al, 2020[24]          | Clear focus on one specialty (orthopedics and musculoskeletal)         | Wide range of respondents: surveyed providers, nurses, patients, families | Used validated telemedicine satisfaction questionnaires, which shows effort toward objective measurement | Survey results presented visually                                                  | Survey results clearly described in percentages with specific reference to the survey question | Discusses lack of generalizability due to small sample size (population validity) and rural setting (ecological validity) |
| Weaknesses                    | No theoretical framework proposed                                     | No demographic data collected                                           | Only 1 provider (surgeon) was surveyed                                                  | No descriptive statistics reported                                                | Study subjects poorly described                                        | Interpretation section includes statements unrelated to study’s results |
|                               |                                                                         | No sampling strategy described, potential for selection bias            | Potential for information bias due to unclear measurement of exposure (diagnosis, time of consult not reported) | No inferential statistics reported                                                 | No demographic data reported                                           | Potential bias due to TeleMSK initiative, though authors were not paid and did not own stock in company or institution |
|                               |                                                                         | Inclusion and exclusion criteria not reported                           | Potential for measurement error (eg, comorbidities, age) were included in statistical analyses | No comparisons between groups for different facilities                             | Visualizations fail to reliably describe members of sample included in each graph (varied between patients, provider, liaisons) | Does not discuss potential for reporting bias except to emphasize that only 1 provider was surveyed |
| Dadosky et al, 2018[35]        | Objectives clearly stated                                               | Power analysis for moderate effect size and 0.8 power (target sample    | Clearly defined independent and dependent variables                                    | t tests and χ² tests to detect differences between groups                           | Outcome variable for regression was 30-d readmission events, clearly reported electrolyte imbalance as predictor in both groups | Transparently reports that some measurements were not frequently recorded, such as time to intervention |
|                               |                                                                         | Threats to validity due to sample size                                  | Multiple regression analysis with clear independent variables and dependent variable (30-d readmission) | Risk reduction calculations for each group’s likelihood for readmission              | Other outcome variables reported but not statistically significant        | Describes limitations of study, including sample size                      |
| Weaknesses                    | Background and problem identification not clearly described            | Only 49 patients met criteria                                            | Some measures did not have results reported (eg, number on-site visits by SNF provider) | Demographic variables not collected beyond age and sex                              | Did not indicate if some variables (eg, comorbidities, age) were included in statistical analyses | Because of low power of study, in some cases results are reported as clinically significant, though they were not statistically significant |
|                               | Used many types of technology in 1 study, may affect ability to report outcomes | Matching, not effectively used, several statistical differences between intervention and comparison group (threat to internal validity) | Control group did not have mortality or HF-cause rehospitalization data collected, no opportunity for comparison though results for intervention group were reported (threat to internal validity) | No use of stratification by age or other variables to control for confounders        | Stratified results would have improved interpretability and demonstrated controlling for confounders | Limited generalizability and threat to external validity due to small sample size |
|                               | No theoretical framework presented                                      | Study design purports to follow patient from SNF to home, measures do not clearly state which data are from SNF and which from home setting, potential measurement error | Study design purports to follow patient from SNF to home, measures do not clearly state which data are from SNF and which from home setting, potential measurement error | Study lacks a table clearly showing regression analysis, r² not reported            | Threats to validity due to failure to reach target sample size           | Implications do not recommend areas for future research                  |

Supplementary Table 1
Quantitative Study Critical Appraisal
| Strengths | Weaknesses |
|-----------|------------|
| De Luca et al, 2016 | Length of study period undefined<br> No theoretical framework presented |
| Strengths | Weaknesses |
|-----------|------------|
| De Vito et al, 2020 | Theoretical framework not stated |
| Driessen et al, 2018 | Clear description of problem and purpose |

(continued on next page)
| Study          | Purpose                                                                 | Methods                                                                 | Variables and Measures                                                                 | Statistical Analyses                                                                 | Results                                                                 | Discussion                                                                 |
|---------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Georgeton et al, 2015²⁶ | - Strong introduction and background  
- Clear statement of purpose | Reported following STROBE guidelines                                      | Patient baseline characteristics including BMI, dementia, falls, CIRS, ADL, GDS measured | t tests and χ² to compare between-group comparisons of outcome Yes/No following recommendations per each clinical dependent variable  
- Univariate and multiple logistic regression to examine outcome variable with dependent variables | Statistically significant results around increased likelihood of following expert medical advice clearly reported  
- Logistic regression results showed risk of depressive syndrome associated with GP likelihood of following geriatrician recommendations | Results are compared to existing research around GP adherence  
- Discussed results within context of other studies  
- Includes discussion of limitations: small sample size, assessed only complete adherence to recommendations instead of each recommendation individually, lack of data on verbal and written communications between GP and geriatrician  
- The abstract and discussion describe study as cohort study, but the methods section describes it as cross-sectional study  
- Authors describe their higher percentage of GP adherence due to “good relationship between GP and geriatrician” but this is not measured or elsewhere described |
| Weaknesses     | - No theoretical framework                                               |                                                                         |                                                                                        |                                                                                      |                                                                        |                                                                           |
| Gordon et al, 2016²⁷ | - Clear description of problem and purpose                               | Matching criteria described (each intervention facility matched with 2 similar facilities with number of beds, for-profit status, region, nursing home chain status, staff rating, 5-star quality rating)  
- Described inclusion criteria of intervention facilities having at least 1 case and 1 follow-up case | Described length of telemedicine sessions and format  
- Details of MDS quality measure outcome data included | t tests to evaluate differences between intervention and control groups, statistically significant higher number patients with pressure ulcers in intervention group  
- Logistic regression to examine relation between each intervention and quality measure  
- Accounted for clustering across repeated measures over time with generalized estimating equations | Clear tables reporting statistical methods, results, and P values  
- Preliminary statistically significant evidence showing telemedicine intervention associated with decreased restraint usage | Through discussion of limitations including potential for selection bias due to nonrandomized nature, potential confounders, and sources of bias such as not matching on baseline physical restraint or antipsychotic usage  
- Emphasizes repeated measures over time, 2:1 prospective matching design, matching of controls  
- Recommendations for further research included |

**Supplementary Table 1** (continued)
Weaknesses | No theoretical framework | Potential confounding variables between nursing homes not described | Total number of facilities small, underpowered to detect small effect sizes
---|---|---|---
Grabowski and O'Malley, 2014
| Clear purpose statement and objectives | Randomization of SNFs to telemedicine vs standard on-call coverage | Study outcomes concealed from telemedicine and SNF providers
---|---|---|---
| Strengths | Descriptive characteristics of nursing homes including 5-star rating, number of beds, resident demographic and health data, hospital transfers, resident days in facility per month | Intervention and control groups did not have significant differences in characteristics measured, which improved internal validity
---|---|---|---
| Limitations discussed such as lack of generalizability due to study within single for-profit chain | Recommendations for future research provided

Weaknesses | Brief background and significance would have been strengthened with more cited references and statistics
---|---
Helmer-Smith et al, 2020
| Novel approach to using asynchronous eConsults in NH setting
---|---|---|---
| Strengths | Setting and study period are well described | Clearly describes measures collected | Descriptive statistics
---|---|---|---
| Limitations discussed such as lack of generalizability due to study within single for-profit chain | Recommendations for future research provided

Weaknesses | Background information is brief and lacks detail to provide strong rationale
---|---|---|---
Hofmeyer et al, 2016
| Clear background and summary of available knowledge
---|---|---|---
| Strengths | Contextual elements describe rural areas access issues and review of historical cases where hospitalizations were potentially avoidable | Time effectively used as a variable | Describes key economic findings
---|---|---|---
| Limitations discussed such as lack of generalizability due to study within single for-profit chain | Recommendations for future research provided

Weaknesses | No explicit purpose statement | No theory or framework
---|---|---|---
Low et al, 2020
| Effectively presents relevant background to support rationale
---|---|---|---
| Strengths | Study period of ~6.5 mo Authors state data collection form available | Data collected on each resident participant clearly stated and appears comprehensive | Descriptive statistics
---|---|---|---
| Limitations discussed such as lack of generalizability due to study within single for-profit chain | Recommendations for future research provided

(continued on next page)
Supplementary Table 1 (continued)

| Study | Purpose | Methods | Variables and Measures | Statistical Analyses | Results | Discussion |
|-------|---------|---------|------------------------|----------------------|---------|------------|
| Weaknesses | Objectives and purpose not explicitly stated; goal of study not specific | Cases for teleconsults selected by senior nurses but inclusion or exclusion criteria not described | Inconsistent documentation between providers | Limited quantitative analysis; inferential statistics not reported | Outcome measures self-reported by NHs | Potential sources of bias not listed; External validity not stated |
| Perri et al, 2020 | Adequate background and significance | Multiple measurement of outcome both pre- and postintervention | Use GSF-PIG screening tool as valid and reliable measure | Descriptive statistics | Clear discussion of technical implementation factors | Limitations summarized including low generalizability of results |
| | Address sensitivity of delivering palliative care over telemedicine | Solicit feedback from family and clinical staff | Group differences measured with independent t test | Pearson correlation to examine associations | States family responses should be interpreted with caution because of small sample | Results compared to existing research |
| | | | | | | Provides suggestions for future research |
| | | | | | | Implications for policy and education not discussed |
| Strengths | | | | | | |
| Weaknesses | No theoretical framework | Pre-post study design weaker than RCT | Surveys subject to selection bias because of tendency to respond if results favorable | Low survey response rate but no description of handling of missing data | Staff outcome data measures confidence, which is subject to selection bias | |
| | | No control group | Surveys not tested for reliability and validity | | Family survey were yes/no responses, data not rich | |
| Stern et al, 2014 | Clearly gives background and rationale for telemedicine EMDT | Clearly described randomized process | Clear description of wound healing rate measurement | Includes study powered to detect 40% difference in rate of healing | Reflexive and descriptive interpretations | |
| | | Statement that blinding of residents and staff not possible | Outcomes measured in the same way for treatment groups | Cox proportional hazard frailty models | Detailed cost-benefit analysis and economic evaluation | |
| | | Adhered to methodologic recommendations for comparative effectiveness research | | Kaplan-Meier method | | |
| | | | | | | |
| | | | | Frequent NH staff turnover and insufficient managerial attention affected results | Results may not be generalizable |
| Weaknesses | Theoretical framework not used to guide study design | Control groups not treated identically (NH had different “usual care” wound care norms) | Each SNF had different wound care teams, so the usual care was likely varied between those practitioners and not accounted for in the article | Missing data not described | Limited to 1 expert wound care team | |
| Yu et al, 2014 | Aims clearly described | Clear inclusion criteria | Clear description of data collected related to continence | Includes study powered to detect 40% difference in rate of healing | Reflective and descriptive interpretations | |
| | | Hypothesis clearly stated | Sensor used to determine patient elimination habits | Cox proportional hazard frailty models | Detailed cost-benefit analysis and economic evaluation | |
| | | Power analysis conducted | Paired t test and Wilcoxon U-test | Kaplan-Meier method | | |
| | | | | | | |
| | | | | 6 outcome measures reported for pre/post with P values | Transparency; reports large proportion of censored observations (53%) |
| | | | | | | |
| | | | | Describes increase in offered toilet assistance from 2 to 6 times in 24 hrs | Limitations described in discussion |
| | | | | | | |
| | | | | | Practice, policy, education, and future research implications suggested |
| Strengths | Theoretical framework not used to guide study design | Exclusion criteria not stated | Role of continence consultant unclear—description of care plan incomplete | Regression analysis not completed | Describes ambiguity/multiple sources of outcome: training, the act of measuring voiding symptoms, or feedback from tele-monitoring system |
| | | Efforts to reduce bias not described | Pre-post design, no control group data collected | Confounder not discussed | Reports limitations |
| | | No control group | | Participants not described | Software and clinical dashboard not well described |
| | | | | Causal methods not described | Recommendations for future research, policy, and education not discussed |

ADL, activities of daily living; BANS, Bedford Alarm Nursing Severity; BMI, body mass index; BPRS, Brief Psychiatric Rating Scale; CIRS, Cumulative Illness Rating Scale; ECG, electrocardiogram; EHR, electronic health record; EMDT, enhanced multidisciplinary teams; GDS, Geriatric Depression Score; GP, general practitioner; GSF-PIG, Gold Standards Framework Proactive Identification Guidance; HF, heart failure; MDS, Minimum Dataset; MMSE, Mini-Mental State Examination; MSK, musculoskeletal; NH, Nursing home; RCT, Randomized controlled trial; RPM, remote patient monitoring; SD, standard deviation; SNF, skilled nursing facility; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; TM, telemedicine.

Appraisal tools used: The Joanna Briggs Institute’s (JBI) Checklist for Randomized Controlled Trials was used to evaluate 3 RCTs included in the review (JBI, 2020). Nonrandomized experimental studies were evaluated with the JBI Checklist for Quasi-Experimental Studies. Research engaging cross-sectional study designs were evaluated with JBI’s Checklist for Analytical Cross-Sectional Studies. JBI’s Checklist for Cohort Studies aided the evaluation of cohort studies, and the Critical Appraisal Skills Programme (CASp) Qualitative Checklist was used to appraise the qualitative study (CASp, 2018). Critical appraisal of a quality improvement was completed with the Revised Standards for Quality Improvement Reporting Excellence (SQUIRE) tool.
## Supplementary Table 2
### Qualitative Study Critical Appraisal

| CASP Checklist Item | Stephens et al, 2020 | Weaknesses | Piau et al, 2020 | Weaknesses |
|---------------------|----------------------|------------|-----------------|------------|
| **Was there a clear statement of the aims of the research?** | • Interpretive approach evidenced by statement of exploratory qualitative approach  
• Importance of topic well supported in introduction | • Philosophical perspective not stated | • Background describes neuropsychiatric symptoms in the setting of PLWD in nursing homes  
• Describes paucity of research of NH staff perspectives, need for sociological considerations | • Purpose statement not stated directly |
| **Is a qualitative methodology appropriate?** | • Clear description of grounded theory methodology  
• Inductive reasoning enables findings to emerge from data  
• Excerpts from focus group guide were provided and in line with aims of research | • Did not directly explain why grounded theory approach was selected over other methodologies | • Used conventional content analysis and summative qualitative content analysis | |
| **Was the research design appropriate to address the aims of the research?** | • Grounded theory congruent with stated purpose and objectives  
• Clear description of focus group and inclusion of demo video  
• Observations of nursing staff during transfers not included | • Unclear description of decision to include emergency department provider perspectives and if asked different questions  
• Voice of the patient is absent; not recruited in the study (expressed by authors as limitation) | • Novel use of social evaluation approach  
• Compares 2 regions | |
| **Was the recruitment strategy appropriate to the aims of the research?** | • Purposive sampling appropriate for aims  
• Allows for multivocality due to inclusion of family members, nurses, nurse practitioners, physicians, and administrators  
• Described planning of single-role focus groups to minimize power differentials in first groups, then planned multirole groups  
• Described iterative modification of interview guide | • Snowball sampling may have increased risk of individuals self-selecting due to interest in technology  
• Did not describe why some individuals chose not to take part | • Half-day interviews in face-to-face group setting; described as staff meeting  
• Collecting data at staff meeting with semistructured interview allowed exploration of staff perspectives  
• Describes how the second interview session was modified to include a questionnaire based on results from first interview sessions | • Staff participant recruitment strategy not described  
• Did not describe which staff roles were selected for the interview or why  
• Data saturation not described |
| **Was the data collected in a way that addressed the research issue?** | • Focus group method appropriate for exploratory qualitative approach and grounded theory methodology  
• Setting for data collection was justified  
• Described planning of single-role focus groups to minimize power differentials in first groups, then planned multirole groups  
• Described iterative modification of interview guide | • Individual interviews may have elicited more reflective and personal accounts  
• Observations of nursing staff during transfers not included | • States that labeling of statements by social science researchers were clearly positioned and had agreement with participants  
• Group dynamics between interviewer and participants during the focus group sessions not described  
• No ethical issues evident | • No ethical issues evident |
| **Has the relationship between researcher and participants been adequately considered?** | • Self-reflexivity noted in data analysis  
• Researchers critically examined own role and potential bias during analysis phase  
• Many direct quotes promote authenticity and credibility  
• Procedural ethics reported such as IRB approval  
• Informed consent and confidentiality described | • Researcher role and influence not described in creation of research questions and interview guide  
• Group dynamics between interviewer and participants during the focus group sessions not described  
• No ethical issues evident | • Researcher role and influence not described in creation of research questions and interview guide  
• Group dynamics between interviewer and participants during the focus group sessions not described | |
| **Have ethical issues been taken into consideration?** | • Informed consent and confidentiality described | • Received ethical approval  
• Informed consent described | | |

(continued on next page)
| CASP Checklist Item | Stephens et al, 2020 | Piau et al, 2020 | |
|---------------------|----------------------|------------------|------------------|
| Was the data analysis sufficiently rigorous? | • Reflexivity used to address pre-conceptions and biases  
• Transparent discussion of limitations and potential for bias from self-selecting to participate due to interest in technology  
• Constant comparative analysis, line-by-line coding, memo writing, and integrative diagramming techniques described | • Composition of multirole focus groups not reported. Article alluded to complexity of these groups’ interactions but were not specifically described.  
• Potential contradictory responses not reported | • Provides example codes that went into the key themes  
• Composition of group interviews not reported  
• Does not describe whether researcher critically examined their own role or potential bias |
| Is there a clear statement of findings? | • Theoretical constructs effectively demonstrate findings such as trust, validation, role misunderstanding, remote presence, and “the power of the visual”  
• Described research team members’ regular meetings to reach consensus on codes  
• Findings thoroughly discussed in relation to original research question | • Respondent validation and member checking not described | • Visualization using SWOT analysis nicely summarizes and presents the data  
• States that labeling of statements by social science researchers were clearly positioned and had agreement with participants  
• States positive impact on NPS but clinical assessments or measurements not explicitly reported |
| How valuable is the research? | • Timely and significant topic  
• Paucity of research in nursing home perspectives, especially in regard to telehealth  
• Transferable findings  
• Identified new areas for further research | • Authors note limitation of generalizability due to small sample and limited geographic area  
• Focuses on benefits of technology but concerns and barriers not explored in results | • Provides helpful discussion of the study results in context of previous research  
• 2 years of field experience produces valuable results  
• As described in limitations, only 1 researcher carried out interviews, limits generalizability |

CASP, Critical Appraisal Skills Program; IRB, institutional review board; NH, nursing home; NPS, neuropsychiatric symptoms; PLWD, person living with dementia; SWOT, strengths, weaknesses, opportunities, and threats.