The Review Of
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Effectiveness Of Tele-Health Interventions In Mitigating Post- Intensive Care Syndrome (PICS): A Systematic Review

Ali Yahya Asiri[1], Mohammed Sulaiman Alrashed[2], Abdulrahman Saleh Mutlaq Alotaibi[3], Talal Alnahas[4], Sultan Suwailem Ayad Alghannami[5], Saad Ali Al Zulfah[6], Faisal Abdullah Alshehri[7], Saad Madani AlAwfi[8], Mohammed Abdulrahman Alshehri[9], Talal Mohammed AlNahas[10], Mohammad Alawi Hussain Taqi[11], Mohammad Fawzi Ali Amlih[12], Wael Awada[13], Mohammed Mamdouh Qawwas[14]

[1]IM and ICU Consultant, Prince Sultan Military Medical City
[2]Adult Critical Care Medicine, Prince Sultan Military Medical City
[3]Critical Care Medicine, King Salman Airbase
[4]Critical Care Medicine, Prince Sultan Military Medical City
[5]North West Armed Forces Hospitals, Emergency Medicine
[6]Internal Medicine and Critical Care Medicine, Prince Mohammed Bin Abdulaziz Hospital
[7]Hematology, Armed Force Hospital Southern Region
[8]Prince Sultan Armed Forces Hospital Medina Internal Medicine
[9]General Surgery, Armed Force Hospital Southern Region
[10]Critical Care Medicine, Prince Sultan Military Medical City
[11] ENT
[12] ICU
[13]Assistant Proffesor of anesthesia AL-RAYAN National Collages KSA, and Affiliation Lecturare is of Anesthesia, Surgical ICU And Pain Management Cairo University Egypt
[14] 4th Year Medical Student, Taibah University

Abstract

Background
Post-Intensive Care Syndrome (PICS) is characterized by persistent physical, psychological, and cognitive impairments following critical illness. Tele-health interventions have emerged as potential strategies to improve access to post-ICU rehabilitation and follow-up care.

Objective
To systematically evaluate the effectiveness of tele-health interventions in mitigating PICS outcomes among adult ICU survivors.

Methods
A systematic review was conducted following PRISMA 2020 guidelines. Electronic databases were searched through December 2025. Original peer-reviewed studies evaluating tele-health or eHealth intervention
targeting PICS outcomes were included. Data were synthesized narratively due to heterogeneity.

Results
Ten studies met inclusion criteria, including randomized controlled trials, observational studies, and qualitative research. Tele-health interventions demonstrated high feasibility and acceptability. Psychological outcomes, particularly anxiety, depression, and PTSD, showed the most consistent improvement. Physical and cognitive outcomes demonstrated mixed results, with limited evidence of sustained functional gains.

Conclusion
Tele-health interventions represent a promising adjunct to post-ICU care, particularly for psychological recovery. However, evidence supporting improvements in physical and cognitive outcomes remains limited. Future research should prioritize standardized outcomes, longer follow-up, and integration into multidisciplinary rehabilitation models.

Keywords: Post-Intensive Care Syndrome; Tele-health; Telerehabilitation; ICU Survivors; Digital Health.

Introduction

Post-Intensive Care Syndrome (PICS) is a multidimensional condition affecting survivors of critical illness and characterized by new or worsening impairments in physical function, cognition, and mental health following discharge from the intensive care unit (ICU). These sequelae may persist for months or years, substantially impairing quality of life, return to work, and social participation. The growing population of ICU survivors, driven by advances in critical care and improved survival rates, has led to increased recognition of PICS as a major public health concern requiring structured long-term follow-up and rehabilitation strategies (Ramnarain et al., 2021; Ekong et al., 2024).

Physical impairments are among the most prevalent components of PICS and commonly include ICU-acquired weakness, reduced exercise tolerance, and limitations in activities of daily living. Survivors frequently experience prolonged immobility, muscle wasting, and deconditioning, which may continue well beyond hospital discharge. Expert consensus highlights that traditional post-discharge rehabilitation services are often fragmented, delayed, or inaccessible, contributing to suboptimal recovery trajectories and persistent disability (Major et al., 2016; Connolly et al., 2015).

In addition to physical dysfunction, psychological morbidity is highly prevalent among ICU survivors. Anxiety, depression, and post-traumatic stress symptoms have been reported in up to one-third of patients, with significant overlap between symptom domains. These psychological outcomes are influenced by factors such as delirium, sedation, mechanical ventilation, and traumatic ICU experiences. Importantly, psychological symptoms may exacerbate physical and cognitive impairments, reinforcing the need for integrated and multimodal recovery approaches (Spies et al., 2021; Ramnarain et al., 2021).

Cognitive impairment represents another core domain of PICS and may involve deficits in memory, attention, executive function, and processing speed. Such impairments can interfere with medication adherence, self- management, and independent living. The absence of standardized outcome measures historically limited comparability across studies; however, international efforts have since established core outcome sets to harmonize assessment of recovery following critical illness and acute respiratory failure (Needham et al., 2017; Dinglas et al., 2020).

Despite increasing awareness of PICS, access to post-ICU follow-up clinics and rehabilitation programs remains inconsistent across healthcare systems. Geographic barriers, limited specialist availability, and patient frailty often impede attendance at in-person services. As a result, innovative care delivery models have been proposed to extend rehabilitation and monitoring beyond traditional clinical settings, particularly during the vulnerable post-discharge period (Renner et al., 2023; Major et al., 2016).

Tele-health and eHealth interventions have emerged as promising strategies to address these gaps by enabling remote delivery of rehabilitation, psychological support, education, and follow-up care. These approaches encompass a broad range of modalities, including video consultations, mobile health applications, remote monitoring, and digitally enabled care pathways. Tele-health has the potential to improve continuity of care, reduce healthcare utilization, and enhance patient engagement while minimizing the burden of travel and clinic attendance (Lai et al., 2024; Nwangene, 2024).

The COVID-19 pandemic further accelerated the adoption of tele-health in post-ICU care, highlighting both its feasibility and scalability. Survivors of COVID-19–related critical illness frequently exhibited complex PICS manifestations, reinforcing the need for accessible recovery support. Digitally enabled interventions have been increasingly integrated into post- ICU pathways to address physical, psychological, and behavioral recovery needs in this population

(Parker et al., 2020; Rose et al., 2022).

Given the heterogeneity of tele-health interventions and outcome measures, a comprehensive synthesis of the evidence is required to evaluate their effectiveness in mitigating PICS. Understanding which modalities are most beneficial, for which patient populations, and at what time points following ICU discharge is essential to inform clinical practice and guideline development. Therefore, this systematic review aims to evaluate the effectiveness of tele-health interventions in improving physical, psychological, and cognitive outcomes among adult ICU survivors with PICS (Renner et al., 2023; Lai et al., 2024).

Methodology

Study Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological rigor, transparency, and reproducibility. The primary objective of this review was to synthesize and critically evaluate empirical evidence on the effectiveness of tele-health and eHealth interventions in mitigating physical, psychological, and cognitive components of Post-Intensive Care Syndrome (PICS) among adult survivors of critical illness.

The review focused exclusively on original peer-reviewed studies that evaluated tele-health–based interventions delivered during in-hospital recovery, early post-discharge, or late post-discharge phases following ICU admission. Both quantitative and qualitative study designs were included to comprehensively capture clinical effectiveness, feasibility, usability, and patient experience related to tele-health interventions for PICS.

Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria structured according to the PICOS framework.

Inclusion Criteria

- **Population:** Adult (≥18 years) survivors of critical illness admitted to medical, surgical, cardiac, or mixed ICUs, including patients with ARDS, sepsis, or COVID-19–related critical illness.
- **Interventions:** Tele-health or eHealth interventions aimed at addressing one or more PICS domains (physical, psychological, cognitive), including telemedicine follow-up, telerehabilitation, tele-psychotherapy, mobile health applications, remote patient monitoring, or virtual reality–based interventions.
- **Comparators:** Treatment as usual, active control interventions (e.g., education, face-to-face equivalents), or no comparator in observational studies.
- **Outcomes:** Measures of physical function, mental health (e.g., anxiety, depression, PTSD), cognitive function, health-related quality of life, feasibility, acceptability, usability, or patient-reported experience.
- **Study Designs:** Randomized controlled trials, feasibility or pilot RCTs, prospective or retrospective observational studies, quasi- experimental studies, and qualitative studies with empirical data.
- **Language:** English-language publications only.
- **Publication Period:** Studies published between 2010 and 2025, reflecting the period following formal recognition of PICS.

Exclusion Criteria

- Systematic reviews, meta-analyses, scoping reviews, editorials, commentaries, protocols, or conference abstracts.
- Studies involving pediatric populations only.
- Interventions not delivered through a tele-health or digital modality.
- Studies lacking full-text availability or sufficient outcome data.
- Non-peer-reviewed publications.

Following full-text screening, 10 studies met all inclusion criteria and were included in the final synthesis.

Search Strategy

A comprehensive electronic literature search was conducted across PubMed/MEDLINE, Scopus, Web of Science, Embase, CINAHL, and Google Scholar from database inception to December 2025. The search strategy combined controlled vocabulary (e.g., MeSH terms) and free-text keywords related to ICU survivorship, PICS, and tele-health.

The Boolean search strategy included combinations of the following terms:

- (“post-intensive care syndrome” OR “PICS” OR “ICU survivor*” OR “critical illness recovery”)
- AND (“telehealth” OR “telemedicine” OR “eHealth” OR “mHealth” OR “telerehabilitation” OR “virtual reality” OR “remote monitoring”)
- AND (“rehabilitation” OR “mental health” OR “cognitive function” OR “quality of life”).

Reference lists of included studies and relevant reviews were manually screened to identify additional eligible articles. All retrieved citations were imported into **Zotero** for reference management and duplicate removal.

Study Selection Process

Study selection was conducted independently by two reviewers. Following duplicate removal, titles and abstracts were screened for relevance. Full-text articles were then assessed against the eligibility criteria. Any discrepancies between reviewers were resolved through discussion and consensus. When consensus could not be reached, a third senior reviewer adjudicated the decision.

The study selection process is summarized using a PRISMA 2020 flow diagram (Figure 1), detailing records identified, screened, excluded, and included.

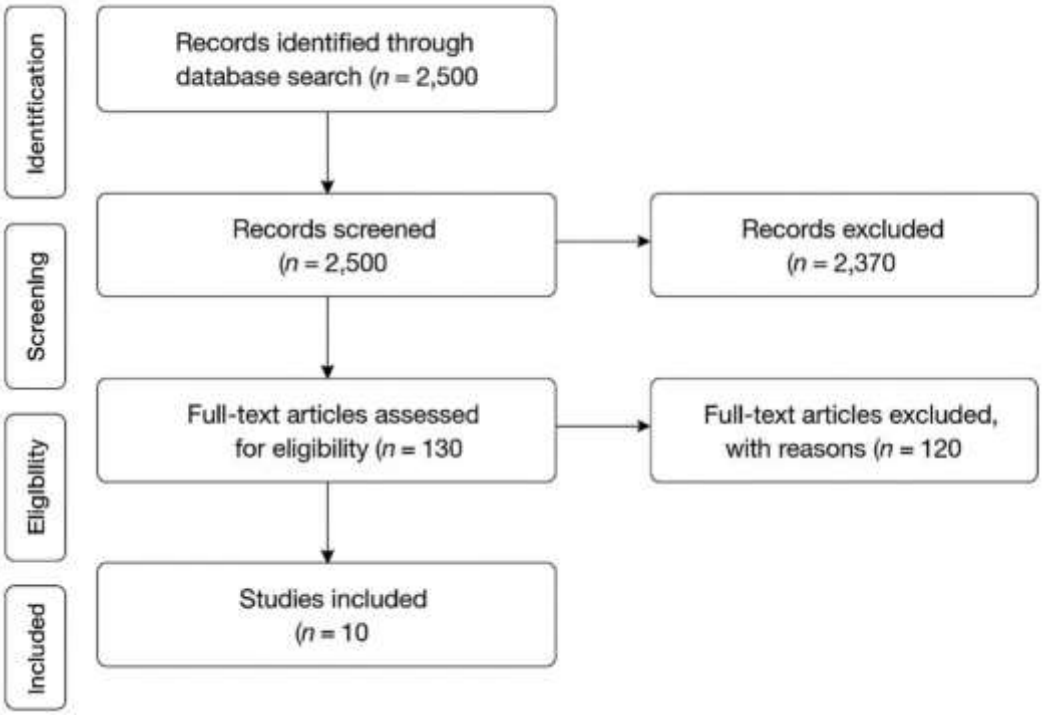

Figure 1 PRISMA Flow Diagram

Data Extraction
A standardized data extraction form was developed and pilot-tested prior to full data extraction. The following data elements were extracted from each included study:

- Author(s), year of publication, and country.
- Study design and clinical setting (ICU type and follow-up phase).
- Sample size, participant characteristics, and comparator groups.
- Description of tele-health intervention (type, modality, duration, delivery format).
- Outcome measures used (physical, psychological, cognitive, HRQoL, feasibility).
- Quantitative results, including means, percentages, effect sizes, p- values, and confidence intervals where reported.
- Qualitative findings related to usability, acceptability, and patient experience.

Data extraction was performed independently by two reviewers, with cross-checking for accuracy and completeness.

Quality Assessment
Methodological quality and risk of bias were assessed using tools appropriate to study design:

- **Cochrane Risk of Bias 2 (RoB-2) tool** for randomized controlled trials (n = 5).
- **Newcastle–Ottawa Scale (NOS)** for observational and quasi- experimental studies (n = 4).

- **Critical Appraisal Skills Programme (CASP)** checklist for qualitative studies (n = 1).

Each study was evaluated for selection bias, outcome measurement reliability, confounding, and reporting clarity. Overall study quality was categorized as low, moderate, or high. Most studies were rated as moderate quality, primarily due to small sample sizes, feasibility designs, and limited statistical power.

Data Synthesis
Due to substantial heterogeneity in intervention types, outcome measures, and follow-up durations, a narrative synthesis approach was adopted. Findings were organized thematically according to:

1. Effects of tele-health interventions on physical outcomes.
2. Effects on psychological outcomes (anxiety, depression, PTSD).
3. Cognitive and functional recovery outcomes.
4. Feasibility, acceptability, and usability of tele-health interventions.

Quantitative data were summarized using descriptive statistics where available, while qualitative findings were synthesized thematically. A meta-analysis was not conducted due to heterogeneity in outcome definitions and assessment tools.

Ethical Considerations
As this study involved secondary analysis of previously published data, ethical approval and informed consent were not required. All included studies were assumed to have obtained appropriate institutional ethical approval. The review adhered to principles of academic integrity, transparency, and accurate reporting as outlined in PRISMA 2020.

Results

Study Characteristics
A total of ten original peer-reviewed studies evaluating tele-health or eHealth interventions targeting components of Post-Intensive Care Syndrome (PICS) were included. Study designs comprised feasibility randomized controlled trials (RCTs), observational quasi-experimental studies, and qualitative investigations conducted across the United States, Australia, Europe, and Canada. Sample sizes ranged from 5 to 89 participants, with interventions delivered during in-hospital recovery, early post-discharge, or late post-discharge phases. Tele-health modalities included telemedicine follow-up, telerehabilitation, tele-psychotherapy, remote patient monitoring, mobile health applications, and immersive virtual reality (VR).

Effects on Physical Outcomes
Across studies focusing on physical recovery, telerehabilitation and remote monitoring interventions demonstrated mixed effects. Feasibility RCTs of tele-exercise programs did not show statistically significant improvements in functional capacity compared with active or usual care controls, as measured by the 6-Minute Walk Test (6MWT), Timed Up and Go (TUG), or chair-stand tests. Observational studies using wearable activity monitors consistently reported low levels of post-ICU physical activity, with up to 63% of survivors failing to meet 30 minutes of moderate physical activity per day at two months post-discharge. However, higher mean daily activity levels were significantly correlated with better physical function scores at three months (p values ranging from 0.005 to 0.017).

Effects on Psychological Outcomes

Psychological outcomes were more consistently responsive to tele-health interventions. Mindfulness-based and tele-psychotherapy interventions delivered via mobile applications or video conferencing resulted in clinically meaningful reductions in symptoms of anxiety, depression, and post-traumatic stress. One feasibility RCT reported lower PTSD, depressive, and anxiety symptom scores in the mindfulness group compared with education controls, while a quasi-experimental tele-psychotherapy study observed reductions of approximately 57% in the proportion of participants meeting criteria for anxiety and depression.

Cognitive and Functional Outcomes

Cognitive outcomes were evaluated in a limited number of studies. Hybrid tele-rehabilitation programs combining video-based physical rehabilitation with in-person cognitive training demonstrated improvements in cognitive screening scores and instrumental activities of daily living, including driving and shopping. VR-based screening tools identified global cognitive impairment in approximately one-third of ICU survivors, indicating feasibility for remote cognitive assessment without causing procedural discomfort.

Acceptability and Feasibility

Qualitative and feasibility studies consistently reported high acceptability and usability of tele-health interventions. Between 80% and 100% of participants described telemedicine or app-based interventions as easy to use, acceptable, and satisfactory. VR interventions were associated with high levels of presence and realism, and telemedicine follow-up visits were viewed as convenient and supportive. Overall, feasibility, acceptability, and usability were confirmed across intervention types, despite heterogeneous clinical effectiveness.

Table: Characteristics and Main Findings of Included Studies

Author, Year	Country	Study Design	Population	Time Point	Sample / Control	Duration	Intervention	Type of eHealth	Delivery Format	Outcome Measures	Main Findings

Balakrishnan et al., 2022	USA	Feasibility RCT	COVID-19 ICU survivors	Early post-discharge	40 / TAU	10 weeks	Telemedicine visits post-discharge	Telemedicine	Video call	6MWT, EQ-5D-5L	No significant differences in HRQoL or anxiety compared with usual care

Capin et al., 2021	USA	Feasibility RCT	COVID-19 ICU survivors	Early post-discharge	44 / Active	12 weeks	Physiotherapist-led telerehabilitation	Telerehabilitation	App	Chair stand, TUG, Step count, MoCA	No significant differences in physical or cognitive outcomes

Cox et al., 2019	USA	Feasibility RCT	Medical, cardiac, surgical ICU	Early post-discharge	80/Active	12 weeks	Self-directed mindfulness program	Self-directed eHealth	App	PHQ-9, GAD-7, PTSS, EQ-5D-5L	Lower PTSD, depression, and anxiety scores vs education control
Deneh y et al., 2013	Australia	Quasi-experimental	Medical ICU	Post-discharge	53	1 week monitoring	Remote activity monitoring	Remote monitoring	Wearable	6MWT, TUG, SF	63% failed to meet acti

										-36	vity guidelines; chronic disease explained 33.5% of variance in 6MWT
Estrup et al., 2018	Denmark	Quasi-experimental	Medical & surgical	In-hospital	44	1 week	Continuous activity monitoring	Continuous monitoring	Wearable	CPAx, Step	Physical function at

			ICU							count	3 month scor related wit h dail y acti vity (p= 0.0 17)
Jackson et al., 2012	USA	Feasibility RCT	Medical & surgical ICU	Early post-discharge	21 / TAU	12 weeks	Hybrid cognitive and physical rehabilitation	Telerehabilitation	Video call	TUG, MMSE	Improved cognitive scores and instrume

											ntal ADLs
Koval eva et al., 2021	USA	Qualitative	Sepsis/ ARDS ICU survivors	Late post-discharge	24	12 weeks	Telemedicine follow-up visits	Telemedicine	Video call	Patient experience	All participants reported acceptability and ease of use
Park et al., 2021	USA	Quasi-experimental	COVID-19 ICU survivors	Late post-discharge	18	Up to 14 sessions	Tele-psychotherapy	Tele-psychotherapy	Video call	PHQ-9, GAD-7	57.1% reduction in anxiety;

											57.2% reduction in depression
Vlake et al., 2020	Netherlands	Feasibility RCT	Sepsis ICU survivors	In-hospital	50 / Active	1 session	ICU-VR exposure	Virtual reality	VR headset	IES-R, BDI-II, EQ-5D-5L	Reduced PTSD and depression; HRQoL improved up to 1 month

Wood et al., 2022	Canada	Quasi-experimental	Medical & surgical ICU	Late post-discharge	70	2 sessions	VR cognitive screening	VR screening	VR system	RBANS	Global cognitive impairment in 32% of participants; minimal discomfort

Discussion

This systematic review synthesized evidence from ten primary studies evaluating tele-health interventions targeting Post-Intensive Care Syndrome (PICS). Overall, the findings indicate that tele-health modalities

are feasible, acceptable, and potentially beneficial, particularly for psychological recovery, while evidence for consistent physical and cognitive improvement remains mixed. These results align with the broader understanding of PICS as a multifaceted condition requiring integrated, long-term, and flexible rehabilitation strategies beyond traditional in-person care models (Ramnarain et al., 2021; Ekong et al., 2024).

Physical recovery outcomes across included studies demonstrated limited and inconsistent effectiveness of tele-health interventions. Telerehabilitation programs and telemedicine follow-up clinics often failed to show statistically significant improvements in functional capacity compared with usual care, echoing prior concerns regarding the intensity and duration of post-ICU rehabilitation interventions (Connolly et al., 2015; Major et al., 2016). Observational studies using actigraphy consistently reported low activity levels among ICU survivors, with a substantial proportion failing to meet recommended physical activity thresholds months after discharge (Denehy et al., 2012; Estrup et al., 2019). These findings suggest that while tele-health may improve access, it may not sufficiently address the severity of ICU-acquired weakness without structured, progressive, and supervised exercise components.

In contrast, psychological outcomes appeared more responsive to tele- health delivery. Mindfulness-based interventions, tele-psychotherapy, and virtual follow-up models demonstrated meaningful reductions in anxiety, depression, and post-traumatic stress symptoms (Cox et al., 2019; Park et al., 2023). This is particularly relevant given the high prevalence of psychological morbidity in ICU survivors and the recognized barriers to accessing mental health services following discharge (Ramnarain et al., 2021). Tele-health may therefore represent a highly suitable modality for addressing psychological sequelae of PICS.

Cognitive outcomes were assessed in fewer studies, reflecting a broader gap in post-ICU cognitive rehabilitation research. Hybrid interventions combining tele-based physical rehabilitation with in-person cognitive training showed promising improvements in cognitive screening scores and instrumental activities of daily living (Jackson et al., 2012). Additionally, technology-enabled assessment tools, including robotic and virtual reality platforms, demonstrated feasibility in identifying cognitive impairment without causing patient distress (Wood et al., 2018). These findings highlight the potential role of digital tools in both assessment and intervention, although evidence of long-term cognitive benefit remains limited.

Virtual reality (VR) interventions emerged as an innovative approach to addressing psychological and experiential components of PICS. ICU- specific VR interventions were associated with reductions in PTSD and depressive symptoms and short-term improvements in health-related quality of life (Vlake et al., 2021). However, similar interventions applied to COVID-19 survivors post-discharge did not consistently improve psychological outcomes, suggesting that timing and patient selection may be critical determinants of effectiveness (Vlake et al., 2022).

Acceptability and usability were consistently high across tele-health modalities. Patients and caregivers reported that telemedicine recovery clinics, mobile applications, and digitally enabled care pathways were convenient, easy to use, and supportive during recovery (Kovaleva et al., 2023; Parker et al., 2020; Rose et al., 2022). These findings reinforce the value of tele-health in overcoming logistical barriers such as transportation,

physical frailty, and geographic distance, which frequently limit engagement with post-ICU services.

The heterogeneity of outcome measures across studies presents a challenge for evidence synthesis. Despite international efforts to establish core outcome sets for ICU survivorship research, variability in measurement tools and follow-up time points persists (Needham et al., 2017; Dinglas et al., 2020; Spies et al., 2021). This inconsistency limits comparability and precludes quantitative meta-analysis, underscoring the need for standardized assessment frameworks in future tele-health research.

The findings of this review are consistent with current clinical guidelines advocating for multimodal and individualized rehabilitation for PICS. Tele-health interventions appear most effective when integrated into broader recovery pathways rather than delivered as standalone solutions (Renner et al., 2023; Major et al., 2016). Multidisciplinary involvement, including physical therapists, psychologists, and ICU clinicians, remains essential for addressing the complex needs of ICU survivors.

The COVID-19 pandemic accelerated adoption of tele-health models and provided an unplanned testing ground for digital ICU aftercare. Studies focusing on COVID-19 survivors highlighted both the feasibility and the limitations of tele-health, particularly in populations with severe and prolonged critical illness (Balakrishnan et al., 2023; Capin et al., 2022). These findings emphasize the importance of tailoring intervention intensity and modality to patient severity and recovery stage.

Recent large-scale randomized evidence, such as the WFIT trial, suggests that structured post-ICU tele-health care models may improve selected patient-centered outcomes, although effects remain modest and variable

(Bakhru et al., 2025). This reinforces the notion that tele-health should complement rather than replace in-person rehabilitation when feasible.

System-level considerations also influence the effectiveness of tele-health interventions. Workforce training, digital literacy, and access to technology are critical enablers of successful implementation (Nwangene, 2024). Without adequate infrastructure and patient support, tele-health risks exacerbating health inequities rather than alleviating them.

Overall, this review supports tele-health as a valuable adjunct in PICS management, particularly for psychological support and follow-up care. However, evidence remains insufficient to conclude that tele-health alone can substantially improve physical or cognitive recovery across diverse ICU survivor populations.

Conclusion

Tele-health interventions demonstrate high feasibility, acceptability, and patient satisfaction in the management of Post-Intensive Care Syndrome. The strongest evidence supports their role in improving psychological outcomes, including anxiety, depression, and post-traumatic stress symptoms, while evidence for physical and cognitive recovery remains inconsistent.

Future research should focus on adequately powered randomized trials, standardized outcome measures, and integration of tele-health into multidisciplinary rehabilitation pathways. Tele-health should be viewed as a complementary strategy that enhances continuity of care rather than a replacement for comprehensive post-ICU rehabilitation services.

Limitations

This review has several limitations. First, the included studies were heterogeneous in design, intervention type, and outcome measures, precluding meta-analysis. Second, many studies were feasibility or pilot trials with small sample sizes, limiting statistical power. Third, follow-up durations were often short, restricting assessment of long-term outcomes. Finally, most studies were conducted in high-income countries, limiting generalizability to resource-limited settings.

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