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# An overview of the effect of telehealth on mortality: A systematic review of meta-analyses

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**Abstract**

**Introduction:** Telehealth is recognised as a viable way of providing health care over distance, and an effective way to increase access for individuals with transport difficulties or those living in rural and remote areas. While telehealth has many positives for patients, clinicians and the health system, it is important that changes in the delivery of health care (e.g. in-person to telehealth) do not result in inferior or unsafe care. In this review, we collate existing meta-analyses of mortality rates to provide a holistic view of the current evidence regarding telehealth safety.

**Methods:** In November 2020, a search of *Pretty Darn Quick* Evidence portal was conducted in order to locate systematic reviews published between 2010 and 2019, examining and meta-analysing the effect of telehealth interventions on mortality compared to usual care.

**Results:** This review summarises evidence from 24 meta-analyses. Five overarching medical disciplines were represented (cardiovascular, neurology, pulmonary, obstetrics and intensive care). Overall, telehealth did not increase mortality rates.

**Discussion:** The evidence from this review can be used by decision makers, in conjunction with other disease-specific and health economic evidences, to support and guide telehealth implementation plans.

**Keywords**

Telehealth, telemedicine, digital health, virtual health, mortality, systematic review, meta-analysis, outcomes

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## Introduction

Telehealth is the delivery of health care between participants in different locations. Telehealth is recognised as an effective tool to increase access for individuals with transport difficulties or those living in rural and remote areas.[1] Telehealth provides an alternate model of care delivery for many services, and can provide care to patients who previously did not have convenient local access.[2] In most situations it is cost-effective for society as a whole, with cost-effectiveness for health care providers being discipline and service dependent.[3,4] However, despite evidence for positive patient impacts[5] and societal cost-effectiveness,[3] evidence for the safety of telehealth is required to demonstrate that patients are not disadvantaged or put at unnecessary risk when used as a substitute for an in-person consultation.

Using mortality rates is one way of measuring patient safety in telehealth. There are many discipline-specific studies and systematic reviews reporting on the safety of telehealth services, however, due to the volume of literature, very few reviews have synthesised all available evidence. A systematic review by Ekeland et al.[6] reported telehealth to be safe for patients, providing comparable or better care in most situations but concluded some disciplines would require more specific evidence in the future for mortality. The Whole of System Demonstrator project involved thousands of patients in the United Kingdom and reported lower mortality rates for telehealth patients in secondary

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care.[7] On a discipline-specific level, pulmonary[8] and cardiac disciplines[9] have more successful examples of routine telehealth services due to the available evidence regarding mortality rates either reducing or staying constant when usual care is augmented with telehealth.

In this review, we collate existing meta-analyses of mortality rates to provide a holistic overall picture of the current evidence regarding telehealth safety. By drawing together the level 1A evidence[10] from the past decade since the Ekeland review which reported that there was insufficient evidence to gauge the effect of telehealth on mortality, a summary of the existing safety information around telehealth can be collated. The aim of this review is to determine if mortality rates change when telehealth is compared with usual care.

## Methods

To achieve the aims of this study, we synthesised findings from published systematic reviews including meta-analyses.[11] Due to a large number of scientific publications across disease states and outcome measures, this study only reviewed meta-analyses pertaining to the changes in mortality when telehealth interventions are used.

### Protocol and registration

A systematic literature search was conducted in accordance with the published International Prospective Register of Systematic Reviews (PROSPERO) protocol ID: CRD42020149280.[12] The protocol provides the original details outlined for the methods of this review. However, due to the substantial yield of publications from systematic searches the inclusion criteria were amended to focus only on effectiveness publications with meta-analyses.

### Eligibility criteria

*Population.* Study participants of any age or life stage (including children and pregnant women) were included. There were no limits on clinical conditions or treatment goals placed on study inclusion.

*Intervention.* Systematic reviews with a meta-analysis were sought where a telehealth intervention was used to deliver healthcare. Review papers met inclusion when >75% of the included studies fulfilled the criteria of an intervention where participants interacted with a health professional. Modalities of telehealth identified in the studies included videoconferencing, store and forward (e.g. encrypted emails with images for review), remote monitoring (RM) and mobile health (mHealth) applications involving synchronous or asynchronous interaction with a clinician. Reviews with a focus exclusively on telephone, static/non-interactive websites or serious game interventions were excluded.

*Comparator.* Studies that compared telehealth interventions with usual care, otherwise known as standard or traditional care provided in-person, were included. Studies without a usual care comparator were excluded.

*Outcome.* The primary outcome of interest was: the overall safety of the telehealth intervention described as reduced, increased or unchanged mortality rates extracted from the meta-analyses examined. Results reported within the reviews from a single study (rather than a meta-analysis) were not included.

### Search strategy and article selection

The search was conducted and results screened as guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[13] A systematic search of 'Pretty Darn Quick'-Evidence portal[14] was conducted in November 2020 given its efficiency in sourcing systematic reviews and meta-analyses. Search terms included digital health keywords, such as 'telehealth', 'telemedicine' and 'remote monitoring' together with 'effectiveness' and 'efficacy'. The strategy utilised truncation and phrase searching to maximise search relevance.

Database search references were downloaded into an EndNote database (Clarivate Analytics, v9). Duplicates and papers published before 2010 and after 2019 were excluded. Full-text articles not available in English were also excluded. Two researchers independently reviewed the titles and abstracts of sources against the review criteria, with consensus required to exclude items. A large number of articles were retained after the first round of screening which led all authors to agree to further refine the inclusion criteria to only articles that included a meta-analysis. Full-text copies of the articles were obtained and added to the EndNote database for two researchers to determine eligibility against the criteria. During this stage, details including the type of intervention, disease state, and key outcome measures were documented to assist screening. Consensus for inclusion was reached through discussion between the original two researchers and a third senior researcher, with reasons for study exclusion documented.

### Data extraction

One researcher extracted descriptive and quantitative data from the included meta-analyses, with a crosscheck of details by two other members of the research team. Data extraction from final full-text meta-analysis papers included author, year, country of review publication, discipline (determined by research team), focus condition (as stated), telehealth modality or technology, mortality outcomes included in meta-analyses and their effect (reduction, increase and no change).

## Quality assessment

The quality of each study was appraised using the PRISMA checklist, with each checklist criterion scored as 1 (checklist criterion satisfied) or 0 (checklist criterion not satisfied, or unclear) yielding a quality score across all criteria for each study. A single author completed the reporting of quality assessment with input from a second author to resolve any concerns. To validate the reporting of quality scores, 30% of the papers were scored by a second independent researcher.

## Data synthesis

The findings of the final articles were synthesised using descriptive statistics. Articles were categorised by disease state, telehealth modality and country of publication. Using the results of the meta-analyses presented in the studies, each article was assigned a broader disease state category. Mortality associated with the telehealth intervention was collated and reported by characterising as either an increase, decrease or no change in the telehealth intervention group compared to usual care. As the telehealth interventions and the disease states were highly heterogeneous and very context specific, an overall meta-analysis was not conducted.

Telehealth modalities were reported as per author descriptions in the meta-analysis, however, common language was used to categorise the interventions described. Categories included RM, videoconference, store and forward, telephone and other. Services that used email (e.g. for teleradiology) were classified as store and forward.

# Results

We included 24 meta-analyses that met inclusion criteria in this study. The results of screening and selection process are shown in Figure 1.

## Study characteristics

The most commonly reported modalities used as part of the interventions were telephone, videoconferencing and RM (Figure 2). Many projects used multiple ways of communicating with patients within one overall model of care. The majority of cardiovascular studies included the use of non-invasive RM and structured telephone interventions.

Included studies reported mortality rates for telehealth interventions in five clinical disciplines: cardiovascular ($n = 13$), neurology ($n = 3$), pulmonary ($n = 5$), obstetrics ($n = 1$) and intensive care ($n = 2$).[8,15–37] The majority of these meta-analyses found that when comparing telehealth interventions with usual care, there was no increase in mortality rates. Evidence across the five disciplines is summarised in Table 1.

## Discipline-specific mortality meta-analyses outcomes

*Cardiovascular* ($n = 13$). Of the 13 studies which described the effects of telehealth on cardiovascular health outcomes, nine examined heart failure.[16,18–20,23,25,30,34,36] Although all reviews included some RM modalities, six focused solely on RM using a variety of communication formats including smartphone apps, telephone calls, interactive voice response calls, game consoles, web pages and videoconferencing.[16,18,19,23,30,36] These formats could be used in combination or accompanied by other modalities of communication.

Eight of the 13 meta-analyses showed a significant reduction in all-cause mortality in patients with heart failure utilising telehealth, compared with usual care.[16,18,19,23,25,30,34,36] Three studies reported a reduced risk of heart failure-specific mortality compared with usual care.[23,25,36] Each meta-analysis attributed this effect to how a patient remotely monitored at home allowed for early detection of heart failure signs, and therefore earlier intervention. Further, Yun et al.[36] observed the greatest reduction in mortality risk in studies including patients over 65 years, when three or more biometrics were monitored, and when daily transmission of vitals occurred. Parthiban et al.[29] reported no significant effect on all-cause or disease-specific mortality, while Yun et al.[36] reported a statistically significant reduction in all-cause mortality with long-term follow-up (≥ 12 months) but not for short or medium-term (<3 or 3–12 months). One suggestion for this effect was that being monitored meant more frequent contact with healthcare staff in general over the long term, separate from the effect of the actual intervention itself.[36] Lower hospitalisation rates were reported in eight of nine heart failure meta-analyses,[16,18–20,23,25,30,34] with the other study reporting no significant reductions in the relative risk of all-cause or heart failure-specific hospitalisations (emergency department (ED) or inpatient admission).[36] Additionally, when hospitalisation did occur, telehealth patients were shown to have a reduced length of stay when compared to usual care in two meta-analyses.[25,34]

Two remaining cardiovascular meta-analyses reported outcomes of general cardiovascular disease. One showed a non-significant reduction in mortality risk for general coronary heart disease (CHD) patients, likely influenced by telehealth affecting other health outcomes that were risk factors for CHD.[28] The other study showed a reduced risk of in-hospital mortality for patients with acute myocardial infarction by transmitting patient electrocardiograms.[17]

One meta-analysis involved RM of implantable cardiac defibrillators (ICDs).[29] Clinical outcomes for in-office

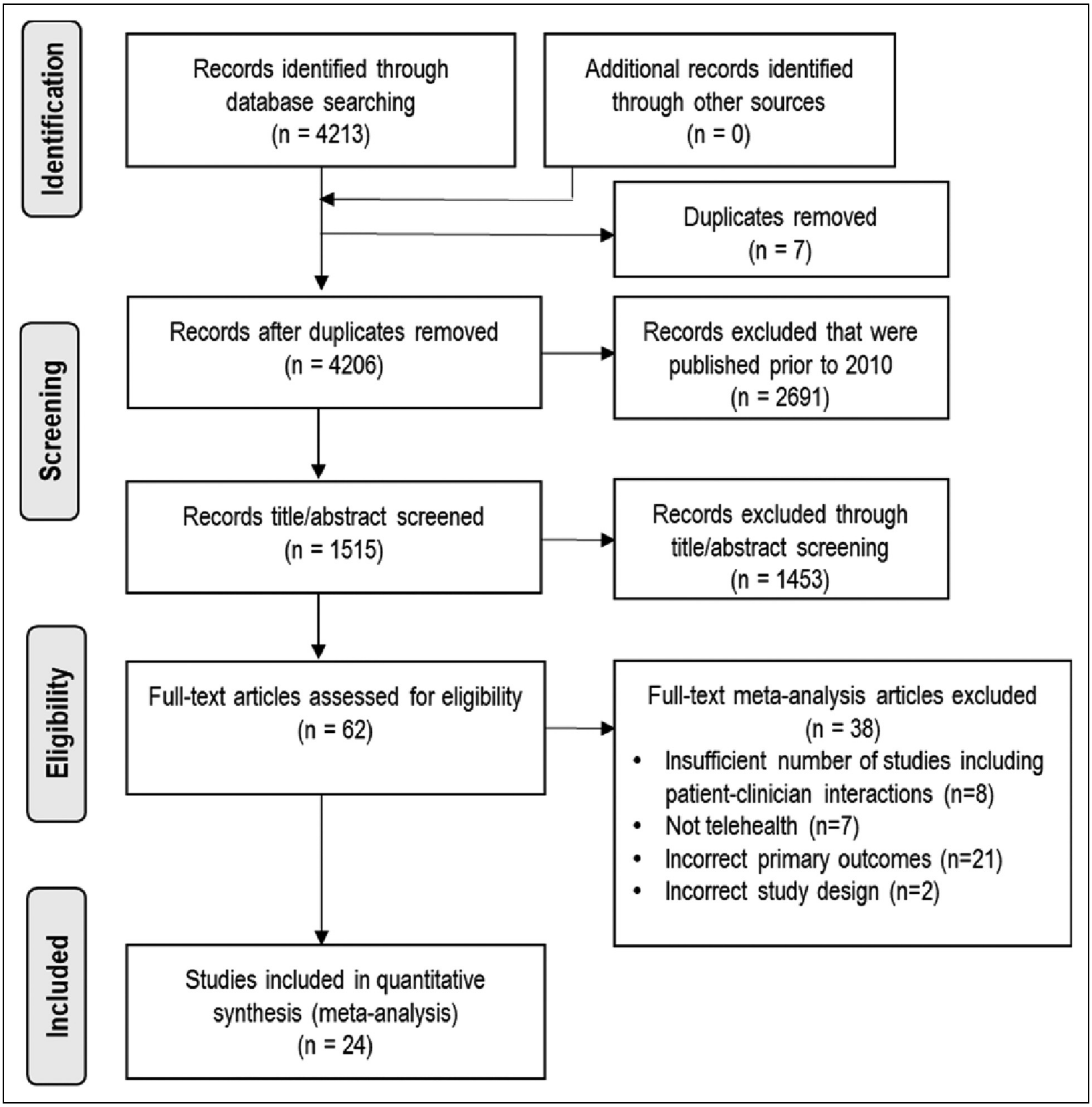


**Figure 1.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.

follow-up were similar to telehealth when examining all-cause and cardiovascular-specific mortality rates.[29] The only notable reduction in all-cause mortality was when home monitoring was paired with daily verification of the patient information being sent and received.[29] However, RM patients were reported to have significantly less inappropriate ICD shocks compared with the control.[29] Explanations for this observation were an earlier detection of technology malfunctions as well as noticing and treating atrial arrhythmias more promptly.

One meta-analysis examined the general effect of telehealth for oral anticoagulation management and found no significant differences in mortality.[38] The study concluded that higher quality evidence and more randomised controlled trials were required to better evaluate telehealth's effectiveness on anticoagulation management, as six of the seven included studies were cohort design rather than randomised controlled trials.

*Neurology (telestroke)* ($n = 3$). Three meta-analyses examined the effect of neurology (telestroke) interventions on mortality outcomes.[15,22,37] Telestroke interventions are where a patient suffering from a stroke or early warning signs of one is reviewed via videoconference by a stroke

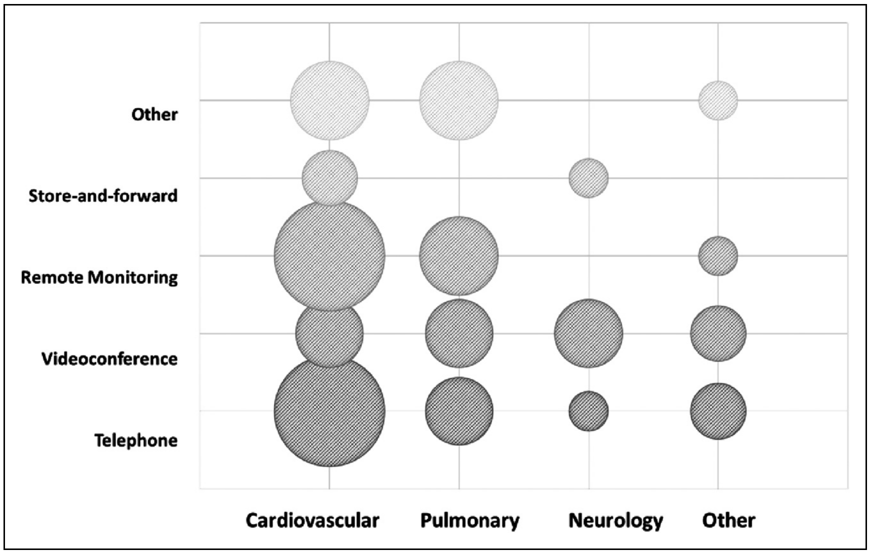


**Figure 2.** Telehealth modalities are included in studies by discipline (circle size indicates the number of meta-analyses).

specialist. Patient images or scans will often be reviewed by the specialist before thrombolysis occurs. Each of the studies reported no significant change in mortality in the telestroke group compared to usual care when thrombolysis was indicated.[15,22,37]

*Pulmonary* ($n = 5$). Five meta-analyses reviewed how telehealth affected mortality outcomes for patients living with chronic-obstructive pulmonary disorder (COPD, $n = 5$).[8,21,26,27,31] While these meta-analyses did not exclusively focus on a single telehealth modality, the majority of telehealth interventions for COPD include the RM of symptoms with or without the addition of videoconferencing, telephone and web-based platforms. Overall, there appeared to be no significant difference in mortality for COPD when telehealth interventions were employed. Only one meta-analysis reported a non-significant increase in the relative risk of mortality for COPD compared with usual care, although the authors noted there were only a few studies included in this meta-analysis and that the finding may be attributable to the small sample sizes.[31] The authors found that deaths were primarily related to COPD exacerbations, which is an expected outcome for this high-risk population.[31] Overall, the reviews did conclude that RM modalities reduced ED visit ($n = 3$)[21,26,27] and hospital admission rates ($n = 4$)[8,21,26,27] for COPD patients, demonstrating a strong motivation for implementation given the similar mortality rates.

*Obstetrics* ($n = 1$). A single meta-analysis examined the effect of prenatal home uterine RM on mortality.[32] The authors reported no difference in the relative risk of perinatal mortality, and a significant reduction in neonatal intensive care unit (ICU) admissions between the telehealth and the usual care groups.[32] It should be noted that the analysis demonstrated a significant increase in unscheduled antenatal visits compared with the control group.[32] Varying levels of supplemental nursing support among the groups was thought to have influenced outcomes, however, the authors did not explain what mechanisms might be responsible for the observed effects.

*Intensive care* ($n = 2$). Two meta-analyses examined the effect of telehealth on mortality in critically ill patients being treated within ICUs.[33,35] These studies examined tele-ICUs which involve an off-site specialist using videoconference, RM of vitals, and the patient's electronic medical record to direct further investigations and treatment. ICU mortality was reduced by telehealth in both studies,[33,35] however, Young et al.[35] did not observe a significant reduction of in-hospital mortality when connecting to a tele-ICU.

## Quality assessment

Overall, the reporting quality was high with an average total score across all studies of 22 out of 27, and 4 studies scoring 27. Figure 3 describes the quality of articles according to the PRISMA 2009 checklist. The meta-analyses with the higher reporting quality provided sufficient detail about their study protocol, the interventions assessed and clearly outlined the study characteristics and implications from their results which other studies failed to report fully.[18–20,32,36] Studies that exhibited lower reporting quality on average (score range: 17–20)[16,17,28–31,37] did not report their protocol registration information or clearly articulate their search strategy in line with the PRISMA format. Additionally, poorly performing studies including their comparison of meta-analysis results with other

**Table 1.** Characteristics of included articles.

| First author (year), country | Number of original articles included in meta-analyses | Discipline; disease state or condition | Telehealth modality | Mortality outcomes included in meta-analysis (units), effect of telehealth intervention |
|---|---|---|---|---|
| Cardiovascular | | | | |
| Conway (2014), Australia | 25 | Cardiovascular, heart failure | RM via interactive voice message, automated data capture and transfer or videoconference | • All-cause mortality (RM via telephone), reduction<br>• All-cause mortality (RM via Int. voice response), no difference<br>• All-cause mortality for conventional RM, reduction |
| de Waure (2012), Italy | 5 | Cardiovascular, coronary artery disease, acute myocardial infarction | RM of tele-ECG data | • Mortality in hospital, reduction |
| Inglis (2015), Australia, Belgium, UK | 41 | Cardiovascular, heart failure | RM and structured telephone calls | • Mortality all-cause for RM (RR), reduction<br>• Mortality all-cause for telephone (RR), reduction |
| Inglis (2011), Australia, Canada, UK | 25 | Cardiovascular, heart failure | RM and structured telephone calls | • Mortality all-cause for RM (RR), reduction<br>• Mortality all-cause for telephone; no difference |
| Jin (2019), Australia, UK, Canada | 32 | Cardiovascular, heart failure | Telehealth via telephone, smartphone app, short message system, RM and videoconference | • Mortality all-cause (RR), no difference |
| Klersy (2010), Italy, Switzerland | 32 | Cardiovascular, heart failure | RM and telephone calls | • Mortality all-cause (RR), reduction<br>• HF mortality after HF hospitalisation (RR), reduction |
| Lin (2017), China | 39 | Cardiovascular, heart failure | RM and telephone calls | • All-cause mortality, reduction<br>• HF mortality, reduction |
| Neubeck (2010), Australia | 11 | Cardiovascular, general cardiovascular disease | Telephone calls and website services | • All-cause mortality (cases, RR), no difference |
| Parthiban (2015), Australia, Ireland, Malaysia | 9 | Cardiovascular, patients with implantable cardiac devices | RM of implantable cardiac device | • All-cause mortality (OR), no difference (except in sub-analysis examining daily transmission)<br>• Cardiovascular mortality (OR), no difference |
| Polisena (2010a), Canada | 21 | Cardiovascular, heart failure | RM | • Mortality all-cause (RR), reduction |
| Xiang (2013), US | 33 | Cardiovascular, heart Failure | RM and telephone calls | • Mortality all-cause (RR), reduction |
| Yun (2018), Korea | 37 | Cardiovascular, heart failure | RM automated messaging systems, email, telephone, and videoconference | • All-cause mortality (RR), reduction<br>• All-cause mortality >12 months (RR), reduction<br>• HF mortality (RR), reduction |
| Lee (2018), Canada | 6 | Cardiovascular, anticoagulation medication management | Telehealth (any telecommunication) including RM, telephone and videoconference | • Mortality (RR), no difference |

(continued)

**Table 1. (continued)**

| First author (year), country | Number of original articles included in meta-analyses | Discipline; disease state or condition | Telehealth modality | Mortality outcomes included in meta-analysis (units), effect of telehealth intervention |
|---|---|---|---|---|
| Neurology | | | | |
| Baratloo (2018), Egypt | 26 | Neurology, stroke | Telestroke services via email for teleradiology, telephone and videoconference | • Mortality (OR), no difference |
| Kepplinger (2016), Germany | 7 | Neurology, stroke | Telestroke via IV thrombolysis | • Mortality, no difference |
| Zhai (2015), China | 8 | Neurology, stroke | Telestroke (not defined) | • Overall mortality, no difference |
| Pulmonary | | | | |
| Cruz (2014), Portugal, Canada | 9 | Pulmonary, COPD | RM | • Mortality rates non-COPD (RR), no difference |
| Kamei (2013), Japan | 9 | Pulmonary, COPD | RM, videoconference and website-based interactions | • Mortality (RR), no difference |
| McLean (2012), UK | 10 | Pulmonary, COPD | RM, telephone, videoconference and website-based interactions | • Mortality (OR), no difference |
| McLean (2011b), UK | 10 | Pulmonary, COPD | RM, telephone, videoconference and website-based interactions | • Mortality (OR), no difference |
| Polisena (2010b), Canada | 10 | Pulmonary, COPD | RM and telephone calls | • Mortality all cause (RR), no difference |
| Obstetrics | | | | |
| Urquhart (2017), UK | 15 | Obstetrics, preterm labour | RM and telephone calls | • Perinatal mortality (RR), no difference |
| Intensive care | | | | |
| Wilcox (2012), Canada | 11 | Intensive care | Tele-ICU via RM, videoconference and external access to the ieMR | • ICU mortality (RR), reduction<br>• Hospital mortality (RR), reduction |
| Young (2011), US | 13 | Intensive care | Tele-ICU via RM, telephone, videoconference and external access to the ieMR | • ICU mortality with tele-ICU coverage (OR), reduction<br>• Hospital mortality with tele-ICU monitoring (OR), no difference |

Abbreviations: COPD: chronic obstructive pulmonary disorder; ECG: electrocardiogram; EMR: electronic medical record; HF: heart failure; ICT: intensive care team; ICU: intensive care unit; ieMR: integrated EMR; OR: odds ratio; PDA: personal digital assistant; RM: remote monitoring; RR: risk ratio; SMS: short messaging service; VC: videoconference.

publication findings was limited, as was the discussion of bias within and across studies examined.[16,17,28–31,37]

## Discussion

This overview brings together evidence from 24 meta-analyses that were published between 2010 and 2019 and reported changes in mortality rates when telehealth interventions were compared to usual care. Five medical disciplines were represented (cardiovascular, neurology, pulmonary, obstetrics and intensive care). Overall, telehealth did not increase mortality rates, and in some studies, the rates of mortality even reduced for patients who were managed by telehealth. The purported mechanism for reducing mortality was often suggested to be early detection of disease exacerbation as a result of RM.

In 2010, Ekeland et al.[6] published a review (comprising 80 systematic reviews) that examined the effectiveness of telehealth interventions. Due to the extensive literature published during the proceeding 10 years – from 2010 to 2019, this review could focus entirely on meta-analyses (1A evidence)[10] which examined mortality as an outcome measure. Overall, the results of both reviews have similarities, although the heterogeneity of the 2010 review prevented a specific focus on mortality. The six systematic reviews that Ekeland et al.[6] described that did include mortality outcomes, reported either a reduction in mortality rates or equivalent rates between telehealth and usual care groups. This review demonstrates that a decade later while the evidence around the topic has increased, the observed effect has generally stayed the same, maintaining that telehealth interventions are safe.

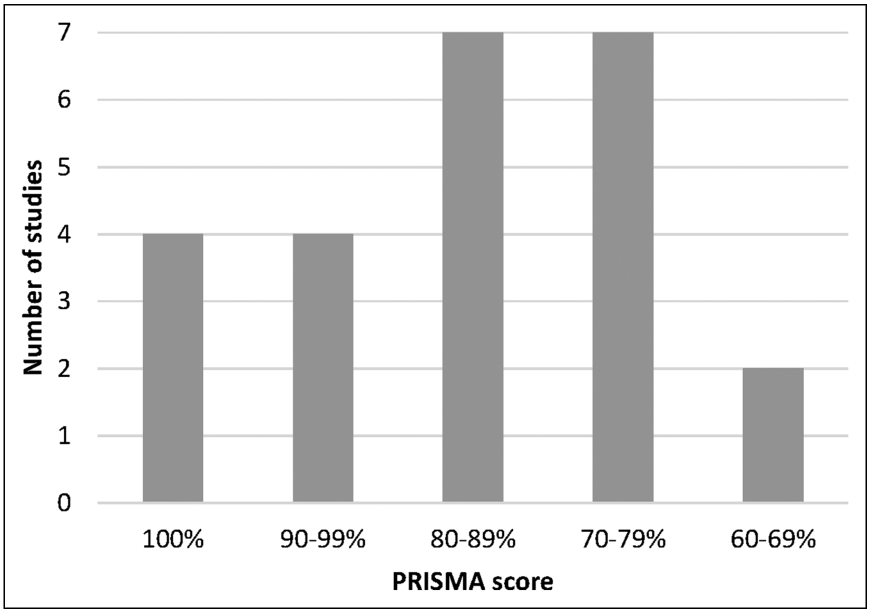


**Figure 3.** Quality of reporting according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.

The evidence presented in this review is of relevance to decision makers responsible for the planning and implementation of telehealth. The coronavirus disease 2019 (COVID-19) pandemic has caused rapid changes in the way that clinicians and patients interact, with telehealth becoming routinely used as a way of reducing the risk of disease transmission.[39,40] Many consumers and clinicians have reported positive experiences with telehealth, especially during COVID-19.[41,42] Decision makers are actively navigating the 'new-normal' that has evolved since the onset of the pandemic. In doing so, it is important to maintain the momentum of telehealth, by supporting strategies that promote telehealth adoption and safety in the clinical service environment. Some of these strategies include developing a skilled health workforce, empowering patients, reforming funding models, improving our digital ecosystems, and developing new clinical models of care.[43]

Any decisions regarding the implementation or funding for new services should seek to include a broad range of evidence beyond the results presented here.[3] It is important to include consultation of disease-specific literature which focuses on the intervention under consideration. The time period at which results were collected in the original studies and meta-analysed in the included reviews may have impacted the results. For chronic conditions, longer follow-up periods demonstrated greater impacts from telehealth interventions and increased the likelihood of a statistically significant result being found.[17] Similarly, the meta-analyses results showed that severity of disease (e.g. COPD[21]), discipline and telehealth modality (RM vs. telephone) influenced the size of the observed effect on mortality.

### *Limitations*

While all meta-analyses included in this review reported mortality outcomes, the heterogeneity in terms of telehealth modality, disease state and disease severity mean that caution should be taken before generalising the results broadly. This review includes a wide variety of telehealth interventions, and while only those that were largely interactive met the inclusion criteria, the range of the interventions represented should be acknowledged when the results presented here are applied. It must also be noted that meta-analyses might have included overlapping references.

Due to the focus on meta-analyses of mortality outcomes, a large volume of systematic reviews that did not include a meta-analysis were excluded. Potential meta-analysis studies might also have been missed due to the limit on papers published in English, and the use of only one search engine. Additionally, meta-analyses specifically focusing on clinical outcome measures, economic measures, or satisfaction by clinicians and patients, were also excluded. As there were no exclusion criteria applied to the reporting quality of included meta-analyses, there are some studies included which exhibited lower reporting quality. While this may not necessarily indicate that these reviews were conducted poorly, all results should be critically appraised before they are applied in or routinely introduced in a mainstream service and supported by policy-makers.

## Conclusion

Implementation of telehealth services aims to positively augment health care so that patients receive the most appropriate treatment using the right method and technology, all within a timely manner. While it is not appropriate for all healthcare to be diverted to telehealth, this review demonstrates that for the five disciplines included (cardiovascular, neurology, pulmonary, obstetrics and intensive care), telehealth interventions do not detrimentally effect the mortality rates for patients. Safety has to be considered according to specific clinical discipline, disease state, patient type and application. As telehealth becomes integrated in mainstream health services, the same quality procedures should apply to monitor clinical effectiveness, user experience and quality of care. The evidence from this review can be used by decision makers, in conjunction with other disease-specific and health economic literature, to formulate and guide telehealth implementation plans.

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