**Virtual Wards as Alternatives to Hospital Care**

**Economic Evidence Review**

**HTA Innovation Laboratory Report**

*October 2023*

**Disclaimer**

Readers should be aware that issues and considerations outlined in HTA lab reports cannot be taken as indicative or suggestive of any future position and will not be regarded as relevant to any future decision that may be taken by NICE.

The contents of HTA lab reports are based on, scientific knowledge that is publicly available and engagement with stakeholders at the time of writing the reports and cannot account for future changes and developments in scientific knowledge or any referenced material from external sources.

**Virtual Wards Economic Evidence Review**

|  |
| --- |
| Contents[1. Cost Effectiveness of Virtual Wards as alternatives to Hospital Care 3](#_Toc149663706)[1.1 Executive Summary 3](#_Toc149663707)[1.2. Review question 5](#_Toc149663708)[1.3 Introduction 5](#_Toc149663709)[1.3.1 Summary of the protocol…… 5](#_Toc149663710)[1.3.2 Definitions 6](#_Toc149663711)[1.4 Methods 7](#_Toc149663712)[1.5 Results 8](#_Toc149663713)[1.6 Discussion and interpretation 18](#_Toc149663714)[1.6.1 Benefits and harms 18](#_Toc149663715)[1.6.2 Cost effectiveness 18](#_Toc149663716)[1.6.3 Impact on carers 20](#_Toc149663717)[1.6.4 Health inequalities 21](#_Toc149663718)[1.6.5 People’s preferences 21](#_Toc149663719)[1.6.6 Applicability and limitations 22](#_Toc149663720)[1.7 Conclusion 23](#_Toc149663721)[1.8 References 25](#_Toc149663722)[Appendices 27](#_Toc149663723)[Appendix A – Review protocol 27](#_Toc149663724)[Appendix B – Literature search strategies 32](#_Toc149663725)[Appendix C – Economic evidence study selection 35](#_Toc149663726)[Appendix D – Economic evidence tables 36](#_Toc149663727)[Appendix E – Excluded Studies 56](#_Toc149663728) |
|  |

# 1. Cost Effectiveness of Virtual Wards as alternatives to Hospital Care

## Executive Summary

The implementation of virtual wards within the National Health Service (NHS) in England has recently expanded, with NHS England’s commitment to fund this model of care. The aim has been to release inpatient bed capacity and increase the number of people who can receive hospital level care at home. Virtual wards operate based on identifying those who can be safely and effectively cared for at home while being closely monitored, using remote monitoring technology and clinical supervision, for any signs of deterioration that necessitates action, including where required, inpatient admission. NICE is producing a number of related products to support and inform the expansion of virtual ward provision and other intermediate care areas.

In 2018, NICE published its guideline NG94 which included a recommendation that supported the use of alternatives to hospital care including virtual wards. The results showed that these models are safe and effective to deliver care to patients who are carefully selected to ensure the suitability of this model of care delivery. The economic evidence supported the potential of these alternatives to hospital care to produce cost saving in the longer term. However, at this time, almost all virtual ward provision in the UK was without technological enablement.

In this report, we updated the review of economic evidence to assess whether the same conclusion still stands in relation to how cost-effective virtual wards are compared to hospital care, based on the most up-to-date evidence. The review considered over 1,000 studies and applied inclusion criteria which identified 15 studies that met them. A major exclusion criteria was the date of publication as we were looking for evidence produced within the last decade, others included the research being undertaken outside the OECD or in the USA, due to the desire to match with health care systems with a high degree of similarity to the NHS.

The evidence identified showed that virtual wards and hospital at home models of care are usually reported as cost saving, and this was the case in 13 out of 15 studies. A key driver of cost savings is through a reduction in hospital bed days achieved and the lower per diem cost of virtual wards and hospital at home.

Most of the included studies, however, have been assessed as having potentially serious limitation in relation to their methodological quality. These studies usually have a short time horizon raising the possibility that important long-term outcomes and costs may not have been considered. It is therefore possible that the savings attributed to virtual wards within these studies may be overestimated.

To guarantee the success of implementation and maximise the value from using these models of care, the population selected for a virtual ward needs to be appropriate. Therefore, having clearly defined eligibility criteria to determine which people can be safely treated with a virtual ward or hospital at home is an essential aspect of their implementation.

Further considerations about the key drivers of acceptability and cost effectiveness based on the findings of the studies included the need for monitoring the impact on health inequalities carefully, given the reliance of these models on the use of remote monitoring technologies, requiring access to specific infrastructure such as Wi-Fi and broadband capabilities or ability to use smart devices and platforms. Often platform providers working within the NHS ensure that devices (such as tablets or smartphones), connectivity (via data enabled SIM cards or dongles) and ongoing customer training and support are provided to ensure people without technology provision at home, or high levels of digital confidence, can be supported. Remote monitoring platforms may in the very near future also include artificial intelligence capabilities. No studies comparing the value of the different levels of technology capabilities, platforms or providers were identified, and we would recommend that an evaluation of this is undertaken.

Of the included studies, 13 assessed/used the term “hospital at home” and 2 assessed/used the term “virtual wards”. They covered a range of therapeutic areas including respiratory conditions and infections, heart failure, geriatrics/frailty, mental health, and infections requiring antimicrobial treatment. The findings of the review showed that there continue to be a number of definitions that exist for alternatives to hospital care including but not limited to virtual wards, hospital at home, step up / down care, and others. This can make it difficult to draw conclusions from the published studies that apply to the current model implemented in NHS practice, and that uses the NHS England definition of Virtual Wards. While a number of studies were from outside the UK, it is recommended that within the NHS there is alignment of terms used in practice and agreement of both definitions and key data sets, as that would assist in future evaluations.

Overall, the findings of this review highlight that, from the studies reviewed, using virtual wards and hospital at home models of care appears to be cost effective, but some uncertainty around the costs and benefits remains.

A post-implementation, real world evaluation of these models of care and how they are operationalised in practice is, thus, needed. This should provide answers to the critical questions about how much implementation costs NHS trusts, how long new services take to become established, how many additional people they enabled trusts to care for, the impact on waiting times and staff time, and the level of cost-effectiveness achieved.

## 1.2. Review question

How cost effective are virtual wards, as alternatives to hospital care?

## 1.3 Introduction

In 2018, NICE published its guidance on [Emergency and acute medical care in over 16s: service delivery and organisation](https://www.nice.org.uk/guidance/ng94). This guideline includes a review of [alternatives to hospital care](https://www.nice.org.uk/guidance/ng94/evidence/12alternatives-to-hospital-care-pdf-172397464599) and recommends the use of virtual wards.

As part of the suite of products NICE is developing to support and inform the expansion of virtual ward provision, we updated the economic evidence review to assess the cost effectiveness of alternatives to hospital care, including virtual wards. The aim of this review is to provide an up-to-date overview of the economic evidence, highlight its strengths and limitations and identify the key drivers of cost effectiveness of virtual wards to inform their expansion within the NHS.

This update identified publications that fulfilled the criteria outlined in Table 1. See Appendix A for full details of the review protocol.

### 1.3.1 Summary of the protocol

Table 1: PICO table for the review of the cost-effectiveness of virtual wards as alternatives to hospital care

|  |  |
| --- | --- |
| Population | Adults and young people (16 years and over) in need of medical care   |
| Intervention | Alternatives to hospital care including the following:* Virtual wards
* Hospital at home including care at home led by:
	+ Secondary care
	+ Primary care
	+ Both

For definitions of each intervention please refer to Definitions belowStrata:* Early discharge
* Admission avoidance
 |
| Comparator | Hospital-based care/services |
| Outcome | Primary outcomes:* Quality of life
* Mortality
* Resource use and cost
* Cost effectiveness

Secondary outcomes: * Avoidable adverse events
* Patient satisfaction
* Length of hospital stay
* Length of stay in programme
* Number of presentations to Emergency Department
* Number of admissions to hospital
* Number of GP presentations
* Readmission (up to 30 days since admission)
 |

### 1.3.2 Definitions

Although the concept of receiving care somewhere other than a clinical setting is not new, there are a number of terms and definitions that exist to describe this type of care, and it is not always clear what is meant by these terms or how they differ or overlap. Although our review intended to focus on “virtual wards” as used in the NHS, given the blurred boundaries between how these models of care are described in the literature, we have opted to search for all the terms used in NICE guideline [NG94](https://www.nice.org.uk/guidance/ng94/evidence/12alternatives-to-hospital-care-pdf-172397464599), which this review updates. The following are the operational definitions for the two key terms: Virtual wards and Hospital at Home:

***Virtual Wards***

The NHS England defines a virtual ward as “an alternative to NHS bedded care that is enabled by technology. Virtual wards support patients who would otherwise be in hospital to receive the acute care, monitoring and treatment they need in their own home. This includes either preventing avoidable admissions into hospital, or supporting early discharge out of hospital.” It is important to note that within this definition of virtual wards, services may well include physical care by clinicians in the home as well as care being delivered remotely. This is typically the case for frailty virtual wards.

In NG94, virtual wards were defined as a form of preventive hospital-at-home for patients at high predicted risk of unplanned hospital admission. A model of home-based coordinated care with the aim of reducing hospital admissions in a relatively low-cost manner. The "virtual ward" program provides multidisciplinary case management services to people who have been identified, using a predictive model, as at high risk of future emergency hospitalisation. Virtual wards use the systems, staffing and daily routine of a hospital ward to deliver preventive care to patients in their own homes. The Virtual Wards work just like a hospital ward, using similar staffing, systems and daily routines, except that the people being cared for stay in their own homes throughout.

Virtual wards seek to improve integration through a number of strategies, including a shared record, multidisciplinary team meetings ("ward rounds") and an automated alert system for informing virtual ward staff when a patient accesses another care service, such as attending local ED. Another strategy for promoting integration was to include a social worker as a core member of the virtual ward staff. In this regard, it could be argued that virtual wards are an adaptation of the public health model of chronic disease management described by Kendall et al. (2010) but rather than integrating health and education, virtual wards instead aim to provide patients with a well organised and coordinated service that crosses the health care and social care sectors.

Virtual wards also seek to improve integration through a number of strategies, In this regard, it could be argued that virtual wards are an adaptation of the public health model of chronic disease management described by Kendall et al. (2010) but rather than integrating health and education, virtual wards instead aim to provide patients with a well organised and coordinated service that crosses the health care and social care sectors.

***Hospital-at-home (HaH) or Hospital in the home (HITH)***

Generally defined as the community-based provision of services usually associated with acute inpatient care, these can include significant overlap with Virtual Wards

“Hospital-at-home” programmes are defined by the provision, in patients’ own homes and for a limited period, of a specific service that requires active participation by health care professionals. The care tends to be multidisciplinary and may include technical services, such as intravenous services. Many disparate models have been developed under the hospital-at-home label, leading to difficulties in evaluating their effectiveness, for example key features of the Johns Hopkins “hospital-at-home” model are defined as follows:

* A substitutive model providing hospital-level care for patients living in a specified geographic catchment area delineated by 30-minute travel time.
* Eligible patients are those with certain acute illnesses that require hospital-level care who also meet previously validated medical eligibility criteria.
* Robust input from physicians (at least daily visits and 24-hour coverage) and nurses (initial continuous nursing care following by intermittent visits and 24 hour coverage).
* Patient retains inpatient status and the hospital or health system retains responsibility for the acute care episode.
* Care is provided in a coordinated manner similar to that in an inpatient ward.

.

## 1.4 Methods

This evidence review was developed using the methods and process described in [Developing NICE guidelines: the manual](https://www.nice.org.uk/process/pmg20/chapter/introduction). Methods specific to this review question are described in the review protocol in Appendix A. The search strategy used to identify published economic evidence of relevance to this review is outlined in Appendix B.

As this is a review of the economic evidence, we have focused on the outcomes used in the economic evidence reviews in NG94, namely quality of life and resource use. Other outcomes were only extracted and reported narratively in the study tables. These are: mortality, avoidable adverse events, patient and carer quality of life, patient and carer satisfaction, number of admissions to hospital, resource use and costs, outcomes are length of hospital stay, length of stay in programme, number of presentations to emergency department, number of GP presentations, and readmission up to 30 days since admission.

## 1.5 Results

This search retrieved 1,493 results. After deduplication this resulted in 1,058 unique studies. Based on title and abstract screening, 1,036 of the studies were excluded for this question. Thirty-one of the identified studies were systematic reviews of virtual wards that were published within the past 10 years. After reviewing these reviews and the articles included in them, we included an additional 11 studies in the full text review, resulting in 33 studies for full text review. Following the full-text review we excluded a further 18 studies. Thus, the review for this question includes 15 studies.

Overall, the included evidence ranged from being directly applicable with minor limitations to partially applicable with potentially serious limitations. Characteristics and key findings of the included studies are summarised in Tables 2 to 5.

As detailed in Appendix A, studies were excluded if they were more than 10 years old or if they were not conducted in an Organisation for Economic Co-operation and Development (OECD) country (US studies were also excluded as their health system is different enough to a UK perspective that the costs reported therein are of limited value). See Appendix E for a list of excluded studies with reasons for exclusion.

The included studies were grouped into two categories based on the definitions provided in section 1.2.2 and they were further stratified based on the key objective of the intervention (admission avoidance or early discharge):

1. Hospital at home:
	1. admission avoidance (n=8)
	2. early discharge (n=5)
2. Virtual wards
	1. admission avoidance (n=1)
	2. early discharge (n=1)

The majority of the included studies used the term “hospital at home”, while a smaller number of studies referred to “virtual wards”. Examples of intervention definitions in the included studies were as follows for each category:

1. Hospital at home for admission avoidance (Shepperd et al. 2022): “*The intervention was geriatrician-led multidisciplinary admission avoidance HAH with CGA (otherwise known as hospital in the home) as an alternative to admission to hospital.”*
2. Hospital at home for early discharge (Echevarria et al. 2018) : “*Patients were admitted to hospital, identified as low risk by dyspnoea, eosinopenia, consolidation, acidaemia, and atrial fibrillation (DECAF) score, and then returned home under the care of the hospital respiratory team, usually within 24 hours of admission. Patients received once or twice daily visits from an respiratory specialist nurse (RSN), under remote supervision from a respiratory consultant. An emergency contact number allowed patients to contact the team 24 hours a day, 7 days a week. Physiological parameters were monitored daily and blood sampling (including arterial blood gas analysis) taken as required. Oral and intravenous therapies, acute controlled oxygen therapy, physiotherapy, psychology, occupational therapy and formal social care were available at home.”*
3. Virtual wards for admission avoidance (Miron et al. 2018): “*During the stable phase, the nurse in charge revised the data collected in the web platform every working day, carried out a structured phone interview with every patient once a week and visited the patients in their home once a month.*“
4. *Virtual wards for early discharge (Swift et al. 2022): "Patients discharged from UHL who had been admitted with Covid respiratory disease and were discharged into the virtual ward to either aid with oxygen weaning in their own home or discharged early to recover more fully at home and free up beds.”*

Of the included studies four were UK based, while four were in Spain, three in Australia, and one each in the Netherlands, Germany, Italy and France. In terms of clinical areas, respiratory conditions were the most frequently considered (n=5 studies). Other areas were geriatrics/frailty, heart failure, mental health, infections and surgery.

Table 2: Economic evidence profile: Hospital at home for admission avoidance compared to hospital care

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Condition** | **Population** | **Intervention and comparator** | **Cost difference** | **Outcomes difference**  | **Cost difference per additional QALY** | **Uncertainty around key findings\*** | **Applicability & limitations** |
| Hernandez et al. (2023) Location: Spain Perspective: Healthcare provider Cost year: Not reported Time horizon: 30 daysStudy design: Cost Consequences Analysis (CCA) | Any medical condition | Adults (aged 18 and older) presenting to ER with any medical condition who lived in their house within thecatchment area, had a formal or informal caretaker (including relatives) available 24 hours per day | Intervention: Hospital at Home (HAH) as admission avoidanceComparator: Hospitalisation | The average cost per episode was €1,093 lower in the HAH group. | Patients at HAH had lower mortality during the episode (0 vs. 19 (4.3%); p < 0.001). | Not applicable | Not reported | Partially applicable with potentially serious limitations |
| Shepperd et al. (2022) Location: UK Perspective: Health care and societal Cost year: 2017 Time horizon:12 monthsStudy design: Cost Utility Analysis (CUA) alongside clinical trial | Geriatric conditions | Patients considered for unplanned admission and aged 65 years and older | Intervention: Comprehensive geriatric assessment with admission avoidance hospital at home (CGAHAH) Comparator: Hospitalisation | CGAHAH cost per patient was £2,547 less (95% CI, –£5,059 to –£34) from a health care perspective and £3,017 less (95% CI, –£5,765 to –£269) from a societal perspective.  | CGAHAH produced fewer QALYs than the comparator by 0.002 (95% CI, –0.013 to 0.010).  | CGAHAH saved £113,250\* per QALY lost. | Low level of uncertainty around cost-effectiveness (Note high uncertainty around the changes in QALY gains) | Directly applicable with minor limitations |
| Yu et al. (2020) Location: Australia Perspective: Not reported (probably health care) Cost year: 2017 Time horizon: Not reported Study Design:Cost consequences analysis (CCA) | Congestive cardiac failure (CCF) | Patients 65 years or older with a congestive cardiac failure (CCF) diagnosis-related group code | Intervention: Hospital in the home (HITH) Comparator: Hospitalisation | HITH costs $708 less than UC per patient.  | No difference between the cohorts in mortality within 60 days of discharge, time to death, 30-day and 60-day readmissions, time to readmission and complication rate.  | Not applicable | Not reported | Partially applicable with potentially serious limitations |
| Tsiachristas et al. (2019) Location: UK Perspective: Not reported (probably health care) Cost year: Not reported Time horizon: 6 monthsStudy Design:Cost Consequences analysis (CCA) alongside observational study  | Geriatric conditions | Patients aged 64 years and older admittedto hospital-at-home or hospital | Intervention: Geriatrician-led admission avoidance hospital-at-home (HAH) services at three different sites.Comparator: Hospitalisation | HAH cost more per patient in all three configurations by 27%, 9% and 70% over six months. | Being admitted to HAHwas associated with an increased risk of death by 1.55 fold (1.29 to 1.86) (28% vs 21% in site 1, 32% vs 22% in site 2, and 27% vs 17% in site 3). | Not applicable | Low level of uncertainty | Directly applicable with potentially serious limitations |
| Kilian et al. (2016) Location: Germany Perspective: Not reported (probably German health care system) Cost year: Not reported (analyses covered 2006-2010) Time horizon: Not reported (probably less than a year)Study Design:Cost Effectiveness Analysis (CEA) alongside prospective observational study | Acute mental illness | Patients with acute mental illness | Intervention: Hospital at Home (HAH) Comparator: Hospitalisation | HAH costs €1,621 lower than in-hospital treatment per admission, although this was not statistically significant. | HAH improved depression symptoms compared to in-hospital treatment. | The net monetary benefit was €7,515 when one unit improvement in the HoNOS score was valued at €0 (i.e. cost effectiveness threshold =€0) | Not reported | Partially applicable with potentially serious limitations |
| Kameshwar et al. (2015) Location: Australia Perspective: Single hospital Cost year: 2012 Time horizon: 12 monthsStudy Design:comparative cost analysis alongside retrospective cohort study | Lower-limb cellulitis | Patients on parenteral therapy for lower-limb cellulitis | Intervention: Hospital in the home (HITH) which included nurse visits up to twice daily.Comparator: Hospitalisation | HITH costs AU$677 more per admission. | Not applicable | Not applicable | Not reported | Partially applicable with minor limitations |
| Pugh et al. (2015) Location: Australia Perspective: Not stated (probably health care) Cost year: 2011 Time horizon: Trial of first void plus 30 days follow-upStudy Design:Cost effectiveness analysis (CEA) of observational study | Acute urinary retention | Low-risk patients having trial of void | Intervention: Hospital-In-The-Home (HITH) trial of voidComparator: Hospitalisation | HITH costs AU$396 less per patient. | No statistically significant difference between successful first trial of void between DPU and HITH.  | Not applicable | Not reported | Partially applicable with potentially serious limitations |
| Vianello et al. (2013) Location: Italy Perspective: Not reported (probably health care) Cost year: Not reported Time horizon: Not reported (probably 3 months in addition to treatment time)Study Design:Cost Consequences Analysis (CCA) alongside a randomised clinical trial | Respiratory tract infections | Adult motor neurone disease patients with respiratorytract infection requiringhospital admission | Intervention: Hospital at home delivered primarily by a district nurse with follow-up from a pulmonologist and respiratory therapist.Comparator: Hospitalisation | HAH cost €8,348 less than UC per patient. | No statistically significant difference was observed between two groups in terms of treatment failure, time to recovery and death 3-month follow-up. | Not applicable | Not reported | Partially applicable with potentially serious limitations |
| \*If the study included a probabilistic sensitivity analysis (Shepperd et al. 2023), low level of uncertainty was defined as probability of cost-effectiveness more than 90%. If the study included deterministic sensitivity analysis (Tsiachristas et al. (2019), low level of uncertainty was defined as no change in the overall cost-effectiveness results. |

Table 3: Economic evidence profile: Hospital at home for early discharge compared to hospital care

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Condition** | **Population** | **Intervention and comparator**  | **Cost difference** | **Outcomes difference**  | **Cost difference per additional QALY** | **Uncertainty around key findings\*** | **Applicability & limitations** |
| Echevarria et al. (2017) Location: UK Perspective: Health care Cost year: 2017 Time horizon: 90 days Study Design:Cost Utility Analysis (CUA) alongside randomised clinical trial | Chronic obstructive pulmonary disease (COPD) exacerbation | Patients with low mortality risk (DECAF score 0 to 1) and aged 35 years and older | Intervention: Hospital at Home (HAH). Patients received once or twice daily visits from an RSN, underremote supervision by a respiratory consultant. Physiological Comparator: Usual care (in hospital) | HaH cost £1,016 lower than usual care (UC) (inpatient admission) per admission. | HAH produced 0.03 more QALYs gained than UC. | HAH was dominant over UC because it produced more QALYs at a lower cost. | Low level of uncertainty  | Directly applicable with minor limitations |
| González-Ramallo et al. (2017) Location: Spain Perspective: Health care Cost year: 2012 Time horizon: 30 daysStudy Design: Comparative Cost Analysis  | Any medical condition that requires antimicrobials | Patients with diagnostic certainty of infection requiring i.v. antimicrobials | Intervention: Outpatient parenteral antimicrobial therapy (OPAT) administered by Hospital at Home (HaH)Comparator: Inpatient OPAT administration | The cost of OPAT by HaH plus the cost of re-admissions (€2,350) was lower than the cost of inpatient care (€4,357). | Although not reported in greater detail, the authors state the ‘results on clinical effectiveness and safety are consistent with other reports’. | Not applicable | Not reported | Partially applicable with potentially serious limitations |
| Pajarón et al. (2017a) Location: Spain Perspective: Not reported Cost year: 2013 Time horizon: Not reported (average stay was 49 days)Study Design: Trial-based Comparative Cost Analysis | Infective endocarditis (IE)  | Patients admitted to University Hospital in Spain with infective endocarditis (IE) between 1998 and 2014 | Intervention: Self-administeredOutpatient Parenteral Antimicrobial Therapy (S-OPAT) supported by a hospitalization-at-home unit (HAH).Comparator: In hospital treatment of infective endocarditis. | HAH saved €17,908 per IE episode. | Not applicable | Not applicable | Not applicable | Partially applicable with minor limitations |
| Pajarón-Guerrero et al. (2017b) Location: Spain Perspective: Not reported (probably a hospital’s perspective) Cost year: Not reported (probably 2014) Time horizon: 12 monthsStudy Design: Comparative Cost Analysis | LaparoscopicColorectal Surgery | Patients over 18, with a favourable clinical course 72 h after colorectal surgery | Intervention: Hospital at Home (HAH) 72 hours after surgeryComparator: Post-surgery care continued in a hospital ward  | HAH cost €3,171 less per episode. | Not reported | Not applicable | Not reported | Partially applicable with potentially serious limitations |
| Goossens et al. (2013) Location: Netherlands Perspective: Healthcare and societal Cost year: 2009 Time horizon: 3 months and 7 daysStudy Design: Cost-utility analysis (CUA) | COPD exacerbation | Patients aged 40 years or older  | Intervention: Three days of usual hospital treatment and treated at home by community nurses for 4 days.Comparator: Seven days of inpatient hospital care. | Early discharge cost less than UC by €168 (95% CI, -€1,253 to €922) from a healthcare perspective while it cost more from a societal perspective €880 (95% CI -€580 to €2,268), including initial assessment and follow-up costs. | Early discharge produced fewer QALYs compared with UC -0.005 (95% CI, -0.021 to 0.0095). | Early discharge saved €31,111 per QALY lost compared to UC from a healthcare perspective while the opposite was true from a societal perspective. | High level of uncertainty | Partially applicable with minor limitations |
| \*If the study included a probabilistic sensitivity analysis, high level of uncertainty was defined as probability of cost-effectiveness less than 70% (Goossens et al. 2013) while low level of uncertainty was defined as probability of cost-effectiveness more than 90% (Echevarria et al. 2017).  |

Table 4: Economic evidence profile: Virtual wards for admission avoidance compared to hospital care

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Condition** | **Population** | **Intervention and comparator** | **Cost difference** | **Outcomes difference**  | **Cost difference per additional QALY** | **Uncertainty around key findings\*** | **Applicability & limitations** |
| Mirón et al (2018) Location: France Perspective: Not stated (probably Spanish health care) Cost year: Not reported (probably 2013) Time horizon: 6 monthsStudy Design: Cost-consequences analysis (CCA) | COPD | Patients with spirometry-confirmed COPD | Intervention: Telemonitoring program consisting of follow-up and control by a nurse.Comparator: Standard hospital-based care for management of COPD patients. | Costs related to utilization of healthcare resources were reduced by €1,861 per patient per year. | 89% of patients experienced exacerbations in the study period vs 93% of patients in the control period. | Not applicable | Not reported | Partially applicable with potentially serious limitations |

Table 5: Economic evidence profile: Virtual wards for early discharge compared to hospital care

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Condition** | **Population** | **Intervention** | **Cost difference** | **Outcomes difference**  | **Cost difference per additional QALY** | **Uncertainty around key findings\*** | **Applicability & limitations** |
| Swift et al. (2022) Location: UK Perspective: Health care Cost year: 2020 Time horizon: 13 monthsStudy Design: Comparative Cost Analysis alongside service evaluation | COVID-19 | Patients admitted with COVID-19 and discharged.  | Intervention: Treatment at home (details not provided).Comparator: Hospital ward as per usual care. | Cost of an average virtual ward stay was (£184) lower than the comparator (£532), which went up to £191 when the potential reduction in the cost of re-admissions were also considered. | 30-day re-admission rate (2.9%) was reported to be lower than the expected figure estimated based on the literature (7.1%). | Not reported | Low level of uncertainty  | Directly applicable with minor limitations |
| \* The study included different regression models to estimate the length of stay, which were used in the economic evaluation as part of a deterministic sensitivity analysis, low level of uncertainty was defined as no change in the overall cost-effectiveness results. |

## 1.6 Discussion and interpretation

### 1.6.1 Benefits and harms

Although the benefits and harms of the studies included in this review are reported here, this review focused on economic evidence. Studies were only included if they were full economic evaluations or comparative cost analysis. Thus, it is very likely that additional studies reporting on benefits and harms of virtual wards exist and were not identified through this review.

Therefore, the results presented here represent a small subset of all studies evaluating the clinical effectiveness of virtual wards, meaning there is substantial uncertainty over the impact of using virtual wards on health outcomes. In order to gain a complete understanding of the clinical benefits and harms of virtual wards, a systematic review that is not limited to economic studies is needed. This would allow an accurate assessment of the impact of using virtual wards on other outcomes of interest such as mortality, morbidity and readmission.

### 1.6.2 Cost effectiveness

Overall, the majority of the studies (13 out of 15) reported that hospital at home and virtual wards provided a reduction in costs compared to traditional inpatient care.

It should be noted that most of these studies had a time horizon of less than one year and none used economic modelling to extrapolate beyond the study’s time horizon. This raises the potential that important long-term costs (and outcomes, where relevant) were not accounted for, increasing the uncertainty over the extent that these interventions are cost effective or cost saving in the long term.

Additionally, the majority of these studies did not undertake any sensitivity analysis, further increasing the uncertainty around their results. These points indicate the potential cost savings may be overestimated, which has also been reported on in a systematic review of hospital at home studies (Goossens et al. 2020). It is therefore important to view the potential cost savings with a degree of caution.

Additionally, some studies employed selective enrolment and chose patients who were in relatively better health for virtual wards. In this case, some of the difference in resource use can be attributable to patient selection rather than the clinical effectiveness of a specific care model, where this baseline difference has not been accounted for. In real practice, this selective enrolment, however, should be the norm as patients should be selected for admission/discharge to these alternative models of care based on set criteria that ensure the safety and effectiveness of their care. Developing adequate selection criteria is thus a key factor in realising the positive outcomes seen in these studies.

It was not possible to identify an explicit relationship between the cost-effectiveness findings and the intervention type or the condition under evaluation across the included studies, given the small number of studies in most included clinical areas. The clinical area that had the highest number of included studies was respiratory conditions (n=5), with three focussing on COPD, one on respiratory tract infections and one on COVID-19. These interventions were found to be dominant over hospitalisation in two studies (Echevarria et al. 2017; Mirón et al 2018). One study estimated that three days of usual hospital treatment followed by hospital at home treatment by community nurses for four days reduced costs, but it also resulted in non-significantly worse health outcomes (Goossens et al. 2013). Another study reported a virtual ward for early discharge intervention to be cost-saving for COVID-19 patients (Swift et al. 2022). Altogether, while these respiratory studies do seem to indicate these interventions may reduce costs, there is still uncertainty around impact on health outcomes which were either not assessed or found to be non-significantly different from the comparator.

Eight studies evaluated hospital at home interventions for admission avoidance. Among these, two were geriatric studies (Shepperd et al. 2022, Tsiachristas et al. 2019), one respiratory study (Vianello et al. 2013), one cardiology study (Yu et al. 2020), one dermatology study (Kameshwar et al. 2015), one mental health study (Kilian et al. 2016), one study in all medical conditions (Hernandez et al. 2023) and one study in medical and surgical conditions where people had a urinary catheter in place (Pugh et al. 2015).

Of the two geriatric studies, one was a cost utility analysis study that found hospital at home was cheaper and provided fewer QALYs (Shepperd et al. 2022), with estimated £113,250 saved per QALY lost. The other geriatric study was a cost consequence analysis that found hospital at home was both more expensive and resulted in worse health, specifically it was associated with an increase in mortality (Tsiachristas et al. 2019). Although this increase in morality is concerning, the authors of this paper acknowledge that there is a risk of residual confounding, therefore it is not possible to know if these results are legitimate or a by-product of failing to adjust for significant covariates (Tsiachristas et al. 2019).

Two studies were cost effectiveness analyses, with both showing hospital at home was cheaper and provided either the same or better health (Killian et al. 2016, Pugh et al. 2015). Of the remaining studies, one was a cost comparison (Kameshwar et al. 2015) which showed hospital at home was more expensive, and three were cost consequences analyses (Hernandez et al. 2023, Vianello et al. 2013, Yu et al. 2020) which showed hospital at home was cheaper with either equivalent or better health.

While the average clinical cost per-day of treatment with hospital at home for admission avoidance were cheaper than inpatient care, the length of stay for hospital at home was generally longer. Despite this difference, hospital at home usually remained cost savings. However, if there was a scenario where hospital at home no longer resulted in cost savings due to a longer length of stay, this increased cost might be acceptable if it frees up space within hospital for other people to be seen.

Of course, this suggests that trusts have staff available to not only staff hospital at home services but also hospital wards, which need to be taken in consideration. Whilst some technology platform providers also provide a comprehensive service including dedicated staff, this is likely to be associated with higher costs than the model reported in the included studies. Most NHS Virtual Ward services recruit additional dedicated clinical staff to provide the clinical supervision component. Given one goal of virtual wards is to increase hospital capacity by having people be seen at home to free up hospital beds to be used for other patients, thus reduce waiting times, the question around staffing is a significant one that needs to be taken into account when planning the implementation of this model to ensure the most cost-effective way to deploy a finite number of staff. Key outcomes to consider in this case include costs, number of people seen, and the impact on waiting lists.

Hospital at home interventions aimed at early discharge were evaluated in five studies. These were studies in surgical care (Pajaron-Guerrero et al. 2017), respiratory (Echevarria et al. 2018; Goossens et al. 2013), and infections (Gonzalez-Ramallo et al. 2017; Pajaron et al. 2017). Two of these studies were cost-utility studies: one reported hospital at home was both cheaper and provided better health (Echevarria et al. 2018), and the other study reported hospital at home was cheaper from a healthcare perspective but resulted in worse health outcomes (Goossens et al. 2013). However, in both of these cost-utility studies there was uncertainty around both costs and QALYs with the 95% confidence intervals for both crossing zero.

The other three studies were cost comparisons that showed hospital at home was cheaper (Pajaron-Guerrero et al. 2017, Gonzalez-Ramallo et al. 2017, Pajaron et al. 2017). These savings were observed as hospital at home stays were significantly cheaper than inpatient stays.

Only one study examined virtual wards for admission avoidance, which was a cost-consequences analysis assessing virtual wards that use telemonitoring in COPD management (Mirón Rubio et al. 2018). This study found that virtual wards cost less than hospital care. These results were driven principally by virtual wards having reduced hospital admissions and emergency room visits.

Only one study examined virtual wards for early discharge. The study found that using virtual wards for early discharge was cost-saving for COVID-19 patients, although long-term health impacts were not assessed (Swift et al. 2022). These results were driven principally by virtual wards reducing the number of bed days. It is this reduction in bed days that reduces costs.

### 1.6.3 Impact on carers

In six studies, having access to a carer was a requirement to be included in virtual wards (Gonzalez-Ramallo et al. 2017, Goossens et al. 2013, Mirón Rubio et al. 2018, Pajaron et al. 2017, Pajaron-Guerrero et al. 2017, Vianello et al. 2013). The findings of these studies were mixed. None of the economic evaluations included in this review incorporated the impact on carers’ quality of life although one study explored this in qualitative interviews (Shepherd et al. 2022). Two studies reported the cost-effectiveness findings from a healthcare and a wider perspective, which included the cost of carer’s time but not the impact on carer QALYs, and they reported conflicting results. These findings indicate determining what costs are included in the analysis has the potential to change not only the conclusion, but our confidence in the findings. It also raises significant social value questions, specifically around informal care and how this is valued.

One economic evaluation found that cost-savings of hospital at home increased when the caring costs were included while there was no impact on health benefits (Shepherd et al. 2022). As noted previously, one study found that early discharge was cheaper from a healthcare perspective (Goossens et al. 2013). However, when using a societal perspective that included the costs of community nursing, informal care, and production losses, hospital at home was more expensive (Goossens et al. 2013). This result is meaningful for two reasons. First, it shows there is conflicting evidence as to whether or not hospital at home is cost-effective from a societal perspective. Second, it highlights that using a different perspective may change the direction of the results from being cost-effective under a healthcare perspective to not cost-effective under a societal perspective.

### 1.6.4 Health inequalities

Virtual wards might not be suitable for certain people, and receiving hospital level care at home should always be a choice. Some people might lack home technology such as Wi-Fi which might prevent them from using a virtual ward. Similarly, some people might not feel comfortable using the technology required.

Often platform providers working within the NHS ensure that devices (such as tablets or smartphones), connectivity (via data enabled SIM cards or dongles) and ongoing customer training and support are provided to ensure people without technology provision at home, or high levels of digital confidence, can be supported.

Additionally, given that in six studies having access to a carer was a requirement to be eligible for the virtual wards, individuals who do not have access to a carer might not see the same results. It is important to consider whether this would exacerbate existing health inequalities in society. Notably, none of the studies included in this review assessed the potential impacts of virtual wards on health inequalities.

### 1.6.5 People’s preferences

While this was not a particular area of study, one evaluation measured preference and reported that people preferred treatment at home at a rate of 90% (Echevarria et al. 2018). It was clear that people’s preferences for using alternatives to hospital care varied. Some reported a number of benefits to being treated at home including feeling relaxed at home, saving money through not having to park at a hospital and saving time through not having to travel to hospital. Others however felt differently. Thus, careful considerations of people’s and carers preferences and circumstances should be a core part of the shared decision-making process.

Recent large surveys of public opinion on care at home completed by the Health Foundation and NHS Confederation in summer 2023 have found that the UK public is supportive of virtual wards in general with some evidence that older people and those living with long term conditions are more likely to be positive about using technology that keeps them out of hospital than younger people (The Health Foundation, 2023; NHS Confederation, 2023).

[NHS Confederation](https://www.nhsconfed.org/system/files/2023-06/Patient-empowerment-role-technology-transforming-care-FNL.pdf) also reported that “across all age groups, more than 7 out of 10 (72%) would use technology to avoid a hospital admission.” The highest category of responder to the question on being happy to use health monitoring technology to manage health if an NHS professional recommended it was those who are 75 years and over at 89% (all ages being 78%) (NHS Confederation, 2023).

Similarly, the [Health Foundation study](https://www.health.org.uk/news-and-comment/charts-and-infographics/how-do-the-public-and-nhs-staff-feel-about-virtual-wards) (n=7,100 July 2023) found 71% of the UK public surveyed were open to being treated in a virtual ward under the right circumstances. However, the survey also found that the concept of a virtual ward was not understood by many people, though hospital at home was better known. They also saw a difference in responses between socioeconomic groups. Those in socioeconomic groups D and E were on balance unsupportive of virtual wards, with some stating concerns about their home not being suitable for care at home as well as the lack of familiarity with the term virtual ward (The Health Foundation, 2023).

Future studies, therefore, ought to measure both health outcomes and people’s preferences to allow decision makers to better understand the impact on people’s health, as well as what people and their carers prefer. In one study, a carer said, ‘I’m worried if she falls…I don’t think I could lift her’ (Shepperd et al. 2022). Concerns like this are both valid and might not be possible to address, again highlighting the importance of ensuring the appropriate population is selected for these interventions. Not everyone may be suited for treatment out of hospital either due to the severity of their condition or not having the appropriate support in place for home treatment, and that shared decision making is at the heart of guiding the decision over which model of care to use.

### 1.6.6 Applicability and limitations

Although the majority of the studies reported favourable findings, the limitations should be taken into consideration when interpreting the outcomes. Regarding study applicability, the most common reasons for downgrading a study were that the perspective of costs and outcomes were not clearly reported and discounting was not performed, where relevant. In many papers, the perspective used for health outcomes and costs has not been explicitly stated. Additionally, most of the studies were not cost-utility analyses and therefore did not include quality-adjusted life-years (QALYs) as an outcome. So, their usefulness as a comparator for a UK NHS decision making context is limited, given this is what is typically used.

Regarding study limitations, the key limitations can be summarised into five key themes: study design, population, clinical impact assessment, economic impact assessment, assessment of impact on carers. The most common reasons for downgrading a study were that the time horizon was not sufficiently long enough, the exclusion of potentially relevant outcomes and costs, and the lack of appropriate sensitivity analysis.

As above, the risk of a short time horizon is the exclusion of costs and outcomes that may be relevant. Additionally, there is a wide degree of variation in the included studies with regards to the outcomes and costs they included.

In some studies, selective inclusion methods were used to define the intervention and comparator populations. As a result, the overall health of participants in virtual wards was better than those in hospitals. Thus, in those studies, the incremental health and cost benefits of virtual wards might not have been accurately estimated. However, appropriate selection of patients remains an important consideration for successfully implementing these models of care in practice. Additionally, the number of participants in some studies were relatively low and this might impact on the generalisability of and the confidence in their findings.

While most studies reported some kind of health outcome (n=11), only three evaluated the impacts on QALYs. In eight studies different outcomes were used, such as 30-day re-admissions or COPD exacerbations. The health benefits observed in some studies were not sufficient to reach a conclusion and whether they would be sustained over a long period. For example, one study reported 30-day re-admission rates for COVID-19 patients, and this would not capture the impacts of long COVID (Swift et al. 2022).

Most studies did not consider the implementation costs of virtual wards, such as training and staffing. Hence the incremental cost benefits might be overestimated in those studies. Additionally, a clear breakdown and description of the individual cost items included in the cost estimates was not provided in some studies. Thus, it was not possible to assess if the methods employed were consistent with NICE’s preferred methodology, as detailed in the [NICE reference case](https://www.nice.org.uk/process/pmg20/chapter/incorporating-economic-evaluation#the-reference-case).

One of the most significant limitations is the lack of appropriate sensitivity analysis. Most studies (10 out of 15) did not quantify uncertainties around the findings. The lack of sensitivity analysis is problematic as it presents the results as fixed, seemingly imparting greater confidence in them than there might be. The lack of any attempt to quantify the uncertainty undermines confidence in using the study results for decision making. It is for this reason all studies that did not attempt to explore uncertainty ought to be interpreted with some degree of caution.

## 1.7 Conclusion

Across the studies included in this review, hospital at home and virtual wards have most often been reported to be cheaper than the alternative inpatient provision, with this being the case in 13 of the 15 studies looked at in detail.

However, the uncertainty around the potential cost savings has not been adequately characterised and thus, it is possible that these cost savings may be overestimated.

Similarly, in relation to the impact on health outcomes - recognising that this was not the primary focus of our analysis - most of the studies that assessed health outcomes showed equivalence with a few suggesting either improvement or worsening but with high uncertainty around their results.

Additionally we need to recognise that the services evaluated in the included studies and the definitions used, may not completely align with how “virtual wards” are currently being defined and used in the NHS.

We believe that this calls for conducting further real-world evaluation on the use of this model across the NHS to answer these research questions and address these uncertainties. Future economic evaluations should also be undertaken and these should adhere to the NICE Reference Case and, in particular:

* clearly explain the model of delivery and how its use changes the current pathway.
* incorporate all relevant costs including the implementation costs (e.g., staff time, technology, set up and monitoring costs).
* include any potential adverse effects and re-admissions and incorporate the resource use associated with these.
* quantify the uncertainty by undertaking deterministic and probabilistic sensitivity analysis to estimate the confidence levels around the estimates.
* follow standard guidelines for reporting, e. g. CHEERS 2022.
	+ Explicitly state the perspective, price year, and how costs were estimated.
	+ Justify the time horizon chosen and discuss the potential implications on the findings

## 1.8 References

Echevarria C, Gray J, Hartley T, Steer J, Miller J, Simpson AJ, Gibson GJ, Bourke SC. Home treatment of COPD exacerbation selected by DECAF score: a non-inferiority, randomised controlled trial and economic evaluation. Thorax. 2018 Aug 1;73(8):713-22.

González-Ramallo VJ, Mirón-Rubio M, Mujal A, Estrada O, Forné C, Aragón B, Rivera AJ. Costs of outpatient parenteral antimicrobial therapy (OPAT) administered by Hospital at Home units in Spain. International journal of antimicrobial agents. 2017 Jul 1;50(1):114-8.

Goossens LM, Utens CM, Smeenk FW, van Schayck OC, van Vliet M, van Litsenburg W, Braken MW, Rutten-van Mölken MP. Cost-effectiveness of early assisted discharge for COPD exacerbations in the Netherlands. Value in health. 2013 Jun 1;16(4):517-28.

Goossens LM, Vemer P, Rutten-van Mölken MP. The risk of overestimating cost savings from hospital-at-home schemes: A literature review. International Journal of Nursing Studies. 2020 Sep 1;109:103652.

Hernandez C, Herranz C, Baltaxe E, Seijas N, Gonzalez-Colom R, Asenjo M, Coloma E, Fernandez-Sola J, Vela E, Carot-Sans G, Cano I. The value of Admission Avoidance: Cost-Consequence Analysis of one-year activity in a consolidated service. medRxiv. 2023:2023-01.

Kameshwar K, Karahalios A, Janus E, Karunajeewa H. False economies in home-based parenteral antibiotic treatment: a health-economic case study of management of lower-limb cellulitis in Australia. Journal of Antimicrobial Chemotherapy. 2016 Mar 1;71(3):830-5.

Kendall S, Wilson PM, Procter S, Brooks F, Bunn F, Gage H, McNeilly E. The nursing contribution to chronic disease management: a whole systems approach: Report for the National Institute for Health Research Service Delivery and Organisation programme SDO Project (08/1605/121). 2010.

Kilian R, Becker T, Frasch K. Effectiveness and cost-effectiveness of home treatment compared with inpatient care for patients with acute mental disorders in a rural catchment area in Germany. Neurology, Psychiatry and Brain Research. 2016 Jun 1;22(2):81-6.

Mirón Rubio M, Ceballos Fernández R, Parras Pastor I, Palomo Iloro A, Fernández Félix BM, Medina Miralles J, Zamudio López E, González Pastor J, Amador Lorente C, Mena Hortelano N, Domínguez Sánchez A. Telemonitoring and home hospitalization in patients with chronic obstructive pulmonary disease: study TELEPOC. Expert Review of Respiratory Medicine. 2018 Apr 3;12(4):335-43.

NHS Confederation. Patient empowerment: what is the role of technology in transforming care? [Patient-empowerment-role-technology-transforming-care-FNL.pdf (nhsconfed.org)](https://www.nhsconfed.org/system/files/2023-06/Patient-empowerment-role-technology-transforming-care-FNL.pdf). June 2023. Last Accessed 5 October 2023.

Pajarón M, Lisa M, Fernández-Miera MF, Dueñas JC, Allende I, Arnaiz AM, Sanroma-Mendizábal P, De Berrazueta JR, Fariñas MC. Efficiency of a self-administered outpatient parenteral antimicrobial therapy (s-opat) for infective endocarditis within the context of a shortened hospital admission based on hospital at home program. Hospital Practice. 2017a Oct 20;45(5):246-52.

Pajarón-Guerrero M, Fernández-Miera MF, Dueñas-Puebla JC, Cagigas-Fernández C, Allende-Mancisidor I, Cristóbal-Poch L, Gómez-Fleitas M, Manzano-Peral MA, Gonzalez-Fernandez CR, Aguilera-Zubizarreta A, Sanroma-Mendizabal P. Early discharge programme on hospital-at-home evaluation for patients with immediate postoperative course after laparoscopic colorectal surgery. European Surgical Research. 2017b; 58(5-6):263-73.

Pugh JD, Twigg DE, Giles M, Myers H, Gelder L, Davis SM, King M. Impact and costs of home‐based trial of void compared with the day care setting. Journal of Advanced Nursing. 2015; 71(3):559-69.

Shepperd, S., Cradduck-Bamford, A., Butler, C., Ellis, G., Godfrey, M., Gray, A., Hemsley, A., Khanna, P., Langhorne, P., Mäkelä, P. and Mort, S. Hospital at Home admission avoidance with comprehensive geriatric assessment to maintain living at home for people aged 65 years and over: a RCT. Health and Social Care Delivery Research, 2022; 10(2), pp.1-124.

Swift J, O'Kelly N, Barker C, Woodward A, Ghosh S. An Economic Evaluation of a virtual Covid Ward in Leicester, Leicestershire, and Rutland. medRxiv. 2022:2022-06.

The Health Foundation. [How do the public and NHS staff feel about virtual wards? (health.org.uk)](https://www.health.org.uk/news-and-comment/charts-and-infographics/how-do-the-public-and-nhs-staff-feel-about-virtual-wards). Accessed 5 October 2023.

Tsiachristas A, Ellis G, Buchanan S, Langhorne P, Stott DJ, Shepperd S. Should I stay or should I go? A retrospective propensity score-matched analysis using administrative data of hospital-at-home for older people in Scotland. BMJ open. 2019 May 1;9(5):e023350.

Vianello A, Savoia F, Pipitone E, Nordio B, Gallina G, Paladini L, Concas A, Arcaro G, Gallan F, Pegoraro E. “Hospital at home” for neuromuscular disease patients with respiratory tract infection: a pilot study. Respiratory care. 2013 Dec 1;58(12):2061-8.

Yu JJ, Sunderland Y. Outcomes of hospital in the home treatment of acute decompensated congestive cardiac failure compared to traditional in‐hospital treatment in older patients. Australasian Journal on Ageing. 2020 Mar;39(1):e77-85.

Appendices

1. – Review protocol

#### Review protocol for the cost-effectiveness of virtual wards compared with hospital care

| ID | Field | Content |
| --- | --- | --- |
| 1. | Review title | The cost-effectiveness of virtual wards compared with hospital care |
| 2. | Review question | How cost effective are virtual wards as alternatives to hospital care? |
| 3. | Objective | To assess the cost-effectiveness of virtual wards compared with hospital care and understand the drivers of their cost effectiveness. |
| 4. | Searches  | The following databases will be searched on population only:* Embase
* Medline (All)
* Econlit
* INAHTA

Searches will be restricted by:* Studies reported in English
* Applying [NICE’s sensitive cost utility filter](https://bmcmedresmethodol.biomedcentral.com/articles/10.1186/s12874-022-01796-2)
 |
| 5. | Condition or domain being studied | Virtual wards |
| 6. | Population | Inclusion:* Adults and young people (16 years and over) in need of medical care

Exclusion:* US Studies
 |
| 7. | Intervention | Alternatives to hospital care including the following:* Virtual wards
* Hospital at home including care at home led by:
	+ Secondary care physicians
	+ Primary care (GP and nurse)
	+ Both
* Step up/down care
* Rapid response schemes

For definitions of each intervention please refer to 1.1.3 DefinitionsStrata:* Early discharge
* Admission avoidance
 |
| 8. | Comparator | Hospital based care/services |
| 9. | Types of study to be included | * Cost-utility analysis (CUA)
* Cost-effectiveness analysis (CEA)
* Cost-benefit analysis (CBA)
* Cost comparisons
* Pre-prints were also included if relevant
 |
| 10. | Other exclusion criteria | * Abstracts, conference presentations and theses
* Non-human studies
* Non-English language studies
* Studies greater than 10 years old
 |
| 11. | Context | This is an update of existing NICE guidance (NG94) on alternatives to hospital care. The current update is being undertaken because NICE has been asked to produce a number of related products to support and inform the expansion of virtual ward provision and other intermediate care areas. |
| 12. | Primary Outcomes  | * Quality of life
* Mortality
* Resource use and cost
 |
| 14. | Data extraction (selection and coding) | All references identified by the searches and from other sources will be uploaded into EPPI reviewer and de-duplicated. 10% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer.The full text of potentially eligible studies will be retrieved and will be assessed in line with the criteria outlined above. A standardised form will be used to extract data from studies (see [Developing NICE guidelines: the manual](https://www.nice.org.uk/process/pmg20/chapter/introduction) section 6.4). Study investigators may be contacted for missing data where time and resources allow. |
| 15. | Quality assessment | Study quality will be assessed using NICE’s appraisal checklist for economic evaluations (see [Developing NICE guidelines: the manual – appendix H](https://www.nice.org.uk/process/pmg20/resources/appendix-h-appraisal-checklists-evidence-tables-grade-and-economic-profiles-pdf-8779777885)) |
| 16. | Strategy for data synthesis  | Results will be narratively summarised |
| 17. | Analysis of sub-groups | format of intervention (for example, hospital at home, virtual wards, etc.) |
| 18. | Type and method of review  | x | Intervention |
| ☐ | Diagnostic |
| ☐ | Prognostic |
| ☐ | Qualitative |
| ☐ | Epidemiologic |
| x | Service Delivery |
| ☐ | Other (please specify) |
| 19. | Language | English |
| 20. | Country | England |
| 21. | Anticipated or actual start date | 1 February 2023 |
| 22. | Anticipated completion date | 23 May 2023 |
| 23. | Stage of review at time of this submission | **Review stage** | **Started** | **Completed** |
| Preliminary searches |  | x |
| Piloting of the study selection process |  | x |
| Formal screening of search results against eligibility criteria |  | x |
| Data extraction |  | x |
| Quality and applicability assessment |  | x |
| Data analysis |  | x |
| 24. | Named contact | **5a. Named contact**HTA Lab, NICE.**5b Organisational affiliation of the review**National Institute for Health and Care Excellence (NICE) |
| 25. | Review team members | From the HTA Lab Team:* Dalia Dawoud, Associate Director, Science Policy and Research Programme
* Tuba Saygin Avsar, Scientific adviser, Science Policy and Research Programme
* Jeremy Dietz, Scientific Adviser, Science Policy and Research Programme

From Virtual Wards Working Group* Rachel Adams, Information Specialist
* Mark Sullivan, Head of Transformation
* Mark Salmon, Programme Director Information Resources
* Farhan Ismail, Associate Director Medtech Topic Intelligence and Office for Digital Health
* Angela Osei, Associate Director Implementation and Adoption
* Pall Jonsson, Programme Director Data and Analytics
* Elaine Cartwright, Associate Director Resource Impact Assessment
* David Hutchings, Pharmacy Clinical Fellow
* Robert Willans, Technical Adviser Data and Analytics
* Nick Crabb, Programme Director, Science Policy and Research
* Felix Greaves, Director, Science, Evidence and Analytics
 |
| 26. | Funding sources/sponsor | NICE HTA Lab Team |
| 27. | Conflicts of interest | All NICE employees must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any decisions to exclude a person from all or part of any meeting will be documented. Any changes to a member's declaration of interests will be recorded. Declarations of interests will be published with the final guideline. |
| 28. | Collaborators | Development of this systematic review will be overseen by NICE employees who are members of the Virtual Wards HTA Lab Working Group.  |
| 29. | Other registration details | None |
| 30. | Reference/URL for published protocol | None |
| 31. | Dissemination plans | NICE may use a range of different methods to raise awareness of this review. These include standard approaches such as:* notifying registered stakeholders of publication
* publicising the review through NICE's newsletter and alerts
* issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the review within NICE.
 |
| 32. | Keywords | Virtual wards; hospital at home; step-down care |
| 33. | Details of existing review of same topic by same authors | Not applicable |
| 34. | Current review status | ☒ | Ongoing |
| ☐ | Completed but not published |
| ☐ | Completed and published |
| ☐ | Completed, published and being updated |
| ☐ | Discontinued |
| 35. | Additional information | None |
| 36. | Details of final publication | [www.nice.org.uk](http://www.nice.org.uk) |

1. – Literature search strategies

***Are virtual wards cost effective as alternatives to hospital care?***

**Database: Ovid MEDLINE(R) ALL <1946 to March 02, 2023>**

Search Strategy:

--------------------------------------------------------------------------------

 1        home care services, hospital-based/        1978

2        (virtual adj3 ward\*).tw.        98

3        "hospital at home".tw.        588

4        hospital@home.tw.        3

5        "hospital in the home".tw.        205

6        "managed at home".tw.        401

7        "remote home monitoring".tw.        49

8        (("step down" or "step up") and (care or service\* or ward or approach)).tw.        2003

9        "healthcare services at home".tw.        7

10        telemanagement.tw.        75

11        "supported early discharge".tw.        4

12        "urgent community response".tw.        1

13        "secondary care led".tw.        8

14        "community care led".tw.        1

15        "virtual hospital\*".tw.        117

16        "virtual triage".tw.        17

17        "virtual inpatient".tw.        9

18        vward\*.tw.        1

19        "ward equivalent".tw.        9

20        or/1-19        5289

21        limit 20 to english language        4530

22        Cost-Benefit Analysis/        91826

23        Quality-Adjusted Life Years/        15456

24        Markov Chains/        15916

25        exp Models, Economic/        16183

26        cost\*.ti.        140896

27        (cost\* adj2 utilit\*).tw.        7403

28        (cost\* adj2 (effective\* or assess\* or evaluat\* or analys\* or model\* or benefit\* or threshold\* or quality or expens\* or saving\* or reduc\*)).tw.        264543

29        (economic\* adj2 (evaluat\* or assess\* or analys\* or model\* or outcome\* or benefit\* or threshold\* or expens\* or saving\* or reduc\*)).tw.        44748

30        (qualit\* adj2 adjust\* adj2 life\*).tw.        17014

31        QALY\*.tw.        13753

32        (incremental\* adj2 cost\*).tw.        16579

33        ICER.tw.        5691

34        utilities.tw.        9027

35        markov\*.tw.        30582

36        (dollar\* or USD or cents or pound or pounds or GBP or sterling\* or pence or euro or euros or yen or JPY).tw.        52494

37        ((utility or effective\*) adj2 analys\*).tw.        23927

38        (willing\* adj2 pay\*).tw.        9248

39        (EQ5D\* or EQ-5D\*).tw.        12562

40        ((euroqol or euro-qol or euroquol or euro-quol or eurocol or euro-col) adj3 ("5" or five)).tw.        3577

41        (european\* adj2 quality adj3 ("5" or five)).tw.        652

42        or/22-41        482225

43        21 and 42        657

**Database: Embase <1974 to 2023 March 02>**

Search Strategy:

--------------------------------------------------------------------------------

 1        (virtual adj3 ward\*).tw.        192

2        "hospital at home".tw.        896

3        hospital@home.tw.        9

4        "hospital in the home".tw.        341

5        "managed at home".tw.        734

6        "remote home monitoring".tw.        101

7        (("step down" or "step up") and (care or service\* or ward or approach)).tw.        3780

8        "healthcare services at home".tw.        8

9        telemanagement.tw.        105

10        "supported early discharge".tw.        11

11        "urgent community response".tw.        3

12        "secondary care led".tw.        16

13        "community care led".tw.        1

14        "virtual hospital\*".tw.        157

15        "virtual triage".tw.        33

16        "virtual inpatient".tw.        22

17        vward\*.tw.        0

18        "ward equivalent".tw.        12

19        or/1-18        6351

20        limit 19 to english language        6071

21        cost utility analysis/        12068

22        quality adjusted life year/        34683

23        cost\*.ti.        191485

24        (cost\* adj2 utilit\*).tw.        12455

25        (cost\* adj2 (effective\* or assess\* or evaluat\* or analys\* or model\* or benefit\* or threshold\* or quality or expens\* or saving\* or reduc\*)).tw.        373174

26        (economic\* adj2 (evaluat\* or assess\* or analys\* or model\* or outcome\* or benefit\* or threshold\* or expens\* or saving\* or reduc\*)).tw.        64213

27        (qualit\* adj2 adjust\* adj2 life\*).tw.        26722

28        QALY\*.tw.        26163

29        (incremental\* adj2 cost\*).tw.        28015

30        ICER.tw.        12599

31        utilities.tw.        14755

32        markov\*.tw.        38963

33        (dollar\* or USD or cents or pound or pounds or GBP or sterling\* or pence or euro or euros or yen or JPY).tw.        70234

34        ((utility or effective\*) adj2 analys\*).tw.        36700

35        (willing\* adj2 pay\*).tw.        14223

36        (EQ5D\* or EQ-5D\*).tw.        24916

37        ((euroqol or euro-qol or euroquol or euro-quol or eurocol or euro-col) adj3 ("5" or five)).tw.        4999

38        (european\* adj2 quality adj3 ("5" or five)).tw.        934

39        or/21-38        615109

40        20 and 39        762

**Database: Econlit <1886 to February 16, 2023>**

Search Strategy:

--------------------------------------------------------------------------------

 1        (virtual adj3 ward\*).tw.        0

2        "hospital at home".tw.        4

3        hospital@home.tw.        0

4        "hospital in the home".tw.        3

5        "managed at home".tw.        0

6        "remote home monitoring".tw.        0

7        (("step down" or "step up") and (care or service\* or ward or approach)).tw.        52

8        "healthcare services at home".tw.        0

9        telemanagement.tw.        0

10        "supported early discharge".tw.        0

11        "urgent community response".tw.        0

12        "secondary care led".tw.        0

13        "community care led".tw.        0

14        "virtual hospital\*".tw.        0

15        "virtual triage".tw.        0

16        "virtual inpatient".tw.        0

17        vward\*.tw.        0

18        "ward equivalent".tw.        0

19        or/1-18        58

**Database:** **INAHTA**

Search Strategy:

--------------------------------------------------------------------------------

20 #19 OR #18 OR #17 OR #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1 16

19 "ward equivalent" 0

18 vward\* 0

17 "virtual inpatient" 0

16 "virtual triage" 0

15 "virtual hospital\*" 0

14 "community care led" 0

13 "secondary care led" 0

12 "urgent community response" 0

11 "supported early discharge" 0

10 telemanagement 0

9 "healthcare services at home" 0

8 ("step down" or "step up") and (care or service\* or ward or approach) 4

7 "remote home monitoring" 1

6 "managed at home" 0

5 "hospital in the home" 1

4 hospital@home 0

3 "hospital at home" 7

2 virtual and ward\* 0

1 "Home Care Services, Hospital-Based"[mh] 6

1. – Economic evidence study selection

Additional records identified from systematic reviews of virtual wards (n=11)

Records identified through database searching
(n = 1493)

Total records included by title and abstract screening (n = 1058)

Full-text articles assessed for eligibility for review question
(n = 33)

Studies included
Primary studies

(n = 15)

Records excluded based on title and abstract (n=1036)

Full-text articles excluded:

Commentary only (1)

Not a peer-reviewed publication (1)

Not a cost-analysis (1)

Final results only described narratively and do not include summary figures (1)

No comparative cost analysis (2)

Does not compare a virtual ward with hospital care (9)

Is an additional publication on the same study (1)

Very serious limitations (2)

Records removed as duplicates

(n = 435)

1. – Economic evidence tables

 ***Hospital at home for admission avoidance***

|  |  |
| --- | --- |
| **Study**  | **Hernandez C, Herranz C, Baltaxe E, Seijas N, Gonzalez-Colom R, Asenjo M, Coloma E, Fernandez-Sola J, Vela E, Carot-Sans G, Cano I. The value of Admission Avoidance: Cost-Consequence Analysis of one-year activity in a consolidated service. medRxiv. 2023:2023-01.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost consequences analysis **Study design:** Trial-based evaluation **Approach to analysis:** Hospital at home (HaH) was compared to a propensity-score matched hospital patients. **Perspective:** Healthcare provider **Time horizon:** 30 days **Discounting:** Not applicable  | **Population:** Adults with any medical condition, living in the catchment area, had a formal or informal carer. **Intervention:** HaH – Usual care provided at home **Comparator:** Hospital wards relevant to the primary diagnosis    | **Cost difference:** The average cost per episode was €1,093 lower in the HaH group. **Currency and cost year:** EUR, year not provided **Costs included:** Direct costs, including medical care, overheads, travel costs.   | **Health difference:** Not reported.    | **Incremental analysis:** Not reported.  **Analysis of uncertainty:** Not reported.    |
| **Data sources**  |
| **Outcomes:** Data on length of hospital stay, 30-day mortality, and hospital admissions and ER visits within the 30 days following discharge were collected during the trial. **Quality of life:** Not measured. **Costs:** The SAP Health Information System at HCB and the Catalan Health Surveillance System (CHSS) were used to estimate the costs.   |
| **Comments**  |
| Source of funding: The study was funded by JADECARE project- HP-JA-2019 - Grant Agreement nº 951442 (2020-2023), a European Union’s Health Program 2014-2020  |
| **Overall applicability:** Partially Applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Shepperd, S., Cradduck-Bamford, A., Butler, C., Ellis, G., Godfrey, M., Gray, A., Hemsley, A., Khanna, P., Langhorne, P., Mäkelä, P. and Mort, S., 2022. Hospital at Home admission avoidance with comprehensive geriatric assessment to maintain living at home for people aged 65 years and over: a RCT. Health and Social Care Delivery Research, 10(2), pp.1-124.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost-utility analysis **Study design:** Randomised controlled trial-based evaluation **Approach to analysis:** Multi-level mixed-effects linear regression models were used to estimate differences in mean costs and QALYs **Perspective:** health and social care and societal perspectives **Time horizon:** 6 months **Discounting:** Not applicable  | **Population:** Patients considered for unplanned admission andaged 65 years and older Intervention: Comprehensive geriatric assessment with admission avoidance hospital at home (CGAHAH) with at least one virtual ward a day.  Comparator: Standard care at hospital ward.   | **Cost difference:** CGAHAH was less costly than the standard care by £2,265 (SE=£1,027) from a health and social care perspective and by £2,840(SE=£1,354) from a societal perspective. **Currency and cost year:** GBP 2017/18 **Costs included:** Direct costs, includingstaff costs, medicines, equipment, transport, and overheads.  | **Health difference:** CGAHAH produced fewer QALYs than the standard care by 0.002 (SE=0.006), although this was not statistically significant. There was no significant difference between groups in mortality at 12 months (RR 1.14, 95% CI 0.80 to 1.62), although with some uncertainty. There was no significant difference in the risk of readmission or transfer to hospital at 6 months (RR 0.95, 95% CI 0.86 to 1.06; p =0.40).   | **Incremental analysis:** CGAHAH saved £113,250\* per QALY lost.      **Analysis of uncertainty:** Probabilistic sensitivity showed significant uncertainty around the incremental QALY estimates. The probability of CGAHAH being cost-effective at the £20,000 threshold was 98%.    |
| **Data sources**  |
| **Outcomes:** Data on length of stay was collected during the trial. **Quality of life:** Health utilities were estimated based on EQ-5D-5L data collected as part of the trial. **Costs:** Resource use data was collected in the trial.  |
| **Comments**  |
| Source of funding: National Institute of Health Research (grant number 12/209/66)  |
| **Overall applicability:** Directly applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations (Table 6)  |
| **\***Estimated by the NICE team not reported by the authors.  |

|  |  |
| --- | --- |
| **Study**  | **Yu JJ, Sunderland Y. Outcomes of hospital in the home treatment of acute decompensated congestive cardiac failure compared to traditional in‐hospital treatment in older patients. Australasian Journal on Ageing. 2020 Mar;39(1):e77-85.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost consequences analysis **Study design:** Trial-based **Approach to analysis:** Economic evaluation of retrospective cohorts **Perspective:** Not explicitly stated (probably Australian Health System) **Time horizon:** Not reported (probably only covering the period in which patients were admitted to either hospital at home or a hospital) **Discounting:** Not reported (probably not done given the time horizon is likely to only cover a few weeks)  | **Population:** Patients 65 years or older with a congestive cardiac failure (CCF) diagnosis-related group code **Intervention:** Hospital in the home **Comparator:** Conventional hospitalization  | **Cost difference:** Hospital in the home was $708.16 cheaper than the cost of a patient treated in the hospital. **Currency and cost year:** Australian Dollars, 2016-2017 financial year. **Costs included:** Medical, nursing, and service type (either Hospital in the Home, intensive care or coronary care).  | **Health difference:** No difference between the cohorts in mortality within 60 days of discharge, time to death, 30-day and 60-day readmissions, time to readmission and complication rate. Hospital in the home patients had a longer length of stay (median length of stay 6 days for hospital in the home vs 4 days for hospital)    | **Incremental analysis:** Not reported.  **Analysis of uncertainty:** Not reported.     |
| **Data sources**  |
| **Outcomes:** Readmission, mortality and treatment-related complications obtained from patient medical records. **Quality of life:** Health utility was not measured. **Costs:** Cost data for the 2016-2017 financial year for relevant DRG codes were obtained through Northern Health’s finance department. Total costs divided by length of stay of each group to determine the cost per day of admission.  |
| **Comments**  |
| Source of funding: Not reported  |
| **Overall applicability:** Partially Applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Tsiachristas A, Ellis G, Buchanan S, Langhorne P, Stott DJ, Shepperd S. Should I stay or should I go? A retrospective propensity score-matched analysis using administrative data of hospital-at-home for older people in Scotland. BMJ open. 2019 May 1;9(5):e023350.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost Consequences analysis (CCA)**Study design:** Economic analysis alongside service evaluation **Approach to analysis:** Mean differences in resource utilisation costs (bootstrapping) and the relative risk of mortality were estimated. **Perspective:** UK NHS. **Time horizon:** 2 years before and 6 months after discharge. **Discounting:** Not applicable  | **Population:** Patients aged 65 years and older admitted to hospital-at-home or hospital. Intervention:  Three geriatrician-led admission avoidance hospital-at-home services in Scotland. **Comparator:** Hospital based acute health services.   | **Cost difference:** Hospital-at-home resulted with an increase in total costs by 27%, 9%, and 70% in the three study sites, during the 6 months after discharge. **Currency and cost year:** British Pound,Not stated. **Costs included:** Direct costs, includingemergency care,medication, and hospital stays.  | **Health difference:** Not measured but being admitted to hospital-at-home was associated with an increased risk of death during the whole study period in all three sites.  | **Incremental analysis:** Not applicable.  **Analysis of uncertainty:** When the intervention costs were assumed to be 50% lower, the total costs were still higher than the comparator in two sites while it was lower in one site over the whole study period.     |
| **Data sources**  |
| **Outcomes:** Hospital data on admissions and mortality were obtained during the study.  Quality of life: Not measured.  Costs: WHO Cost-It tool was used to collect data on the cost of the intervention. A top-down costing approach was followed to deduct the cost per patient.  |
| **Comments**  |
| Source of funding: NIHR, UK. (12/5003//01).  |
| **Overall applicability:** Directly applicable (Table 5)  |
| **Overall quality:** Potentially serious limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Kameshwar K, Karahalios A, Janus E, Karunajeewa H. False economies in home-based parenteral antibiotic treatment: a health-economic case study of management of lower-limb cellulitis in Australia. Journal of Antimicrobial Chemotherapy. 2016 Mar 1;71(3):830-5.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost comparison analysis **Study design:** Trial-based evaluation **Approach to analysis:** Univariable and multivariable generalized linear model was used to test the impact of intervention on costs. **Perspective:** Hospital perspective  Time horizon: 12 months **Discounting:** Not applicable  | **Population:** Patients on parenteral therapy for lower-limb cellulitis Intervention: Hospital in the home (HITH) – nurse visits up to twice daily **Comparator:** Medical management in general internal medical unit  | **Cost difference:** HITH cost AU$677 more per admission. **Currency and cost year:** AU$, 2012/13 **Costs included:** Direct costs,including medical care, overheads, administration, and information technology.  | **Health difference:**  Not reported.  | **Incremental analysis:** Not applicable as this was a cost-comparison study.  **Analysis of uncertainty:** Not reported.      |
| **Data sources**  |
| **Outcomes:** Length of stay data collected during the study. **Quality of life:** Not measured. **Costs:** Resource use data collected during the study.  |
| **Comments**  |
| Source of funding: None declared.  |
| **Overall applicability:** Partially applicable (Table 5)  |
| **Overall quality:** Minor limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Kilian R, Becker T, Frasch K. Effectiveness and cost-effectiveness of home treatment compared with inpatient care for patients with acute mental disorders in a rural catchment area in Germany. Neurology, Psychiatry and Brain Research. 2016 Jun 1;22(2):81-6.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost-effectiveness analysis **Study design:** Trial based   Approach to analysis: Prospective observation trial analysing mental health outcomes and costs.  Perspective: Not reported (probably German health care perspective) **Time horizon:** Authors report study duration varied between 7 and 321 days. It does not appear that there was any follow-up beyond this. **Discounting:** Not reported (given the time horizon is likely less than one year, it appears discounting was not performed)  | **Population:** Patients with acute mental illness **Intervention:** Home treatment **Comparator:** Acute inpatient treatment  | **Cost difference:** Home treatment was €1,620.92 cheaper compared with inpatient treatment, however this was not statistically significant. Cost regression model shows home treatment was on average €7,151 cheaper per treatment episode than inpatient treatment. The cost regression model differs from the absolute costs reported above in that it uses propensity scores to control for differences between treatment groups. **Currency and cost year:** Euros,Not provided – however analysis covers 2006-2010. **Costs included:** Medications, treatment costs (whether that be at home or inpatient),    | **Health difference:** Treatment duration in days was larger for home treatment compared with inpatient treatment and this was statistically significant. Home treatment resulted in a greater reduction in Hamilton Rating Scale for Depression (HAMD-21) and Health of the Nation Outcome Scale (HoNOS) scores. There was no difference between home treatment and inpatient treatment for the Positive and Negative Syndrome Scale (PANSS).    | **Incremental analysis:** If a one unit improvement of the HoNOS total score was valued at €0 the net benefit of home treatment compared to inpatient treatment was €7,515.69. This means even if no value was assigned to an improvement in HAMD home treatment still provided a monetary benefit compared to inpatient treatment.   When a one unit improvement of the HoNOS total score was valued at €1,000 the net benefit of home treatment compared to inpatient treatment was €7,742.37.   The net benefit of PANSS was also examined at a threshold of €0, €100 and €1,000 however p was always greater than 5%.  **Analysis of uncertainty:**  Not reported.  |
| **Data sources**  |
| **Outcomes:** Three different outcomes were measured: 1) Hamilton Rating Scale for Depresision (HAMD-21) 2) Health of the Nation Outcome Scale (HoNOS) 3) Positive and Negative Syndrome Scale (PANSS) **Quality of life:** Health utility was not measured. **Costs:** Treatment costs were provided by the hospital administration. Home treatment costs were calculated on a fee for service basis depending on the service use of each patient.   |
| **Comments**  |
| Source of funding: Not reported  |
| **Overall applicability:** Partially Applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations(Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Pugh JD, Twigg DE, Giles M, Myers H, Gelder L, Davis SM, King M. Impact and costs of home‐based trial of void compared with the day care setting. Journal of Advanced Nursing. 2015 Mar;71(3):559-69.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost-effectiveness analysis **Study design:** Trial-based **Approach to analysis:** Retrospective study **Perspective:** Not stated (probably that of a Health System) **Time horizon:** The time horizon covers the wait time, the trial of void (TOV) and the 30 days following a person’s first TOV attempt. **Discounting:** Not described in the paper (given the time horizon is less than one year, it appears discounting was not performed)  | **Population:** Patients with a urinary catheter in situ. **Intervention:** Hospital in the Home (HITH)-based TOV. **Comparator:** Day Procedure Unit (DPU).  | **Cost difference:** HITH was A$117 cheaper per patient than DPU. **Currency and cost year:** Australian Dollars, Not explicitly stated (probably 2011)  Costs included: HITH average ward-equivalent and DPU average ward costs as well as costs for additional Emergency Department (ED) visits required  | **Health difference:** DPU wait time was 27.15 days (SD 44.58) compared with 14.83 (13.63) for HITH which was statistically significant (P=0.007). No statistically significant difference between successful first TOV between DPU and HITH. Insufficient patients to test for a difference in ED presentations following successful TOV.  | **Incremental analysis:**  Not reported.  **Analysis of uncertainty:** Not reported.    |
| **Data sources**  |
| **Outcomes:** Gathered from coded patient discharge abstracts from a tertiary level, university-affiliated hospital in metropolitan western Australia. **Quality of life:** Health utility was not measured. **Costs:** Provided by the local finance department of the same hospital where outcomes were obtained from. ED visit costs taken from the Metropolitan Health Service 2009/2010 Annual Report and adjusted to 2011 prices.  |
| **Comments**  |
| Source of funding: ‘Funded by an Edith Cowan University Industry Collaboration Grant – 2012 Round in Collaboration with Sir Charles Gairdner Hospital (Grant Number G1000423 SUB/31447)’  |
| **Overall applicability:** Partially Applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Vianello A, Savoia F, Pipitone E, Nordio B, Gallina G, Paladini L, Concas A, Arcaro G, Gallan F, Pegoraro E. “Hospital at home” for neuromuscular disease patients with respiratory tract infection: a pilot study. Respiratory care. 2013 Dec 1;58(12):2061-8.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost consequences analysis**Study design:** RCT **Approach to analysis:** Within trial analysis of health outcomes and resource use. Unpaired t test was used to compare costs in both arms. **Perspective:** Not explicitly stated (probably Italian Health System) **Time horizon:** Not reported (appears to only account for the time on treatment at home or in hospital with a further 3-month follow-up). **Discounting:** Not reported (given the time horizon is likely only a few months, it appears discounting was not performed)  | **Population:** Adult neuromuscularpatients with respiratory tract infection requiring hospital admission **Intervention:** Hospital at home delivered primarily by a district nurse with follow-up from a pulmonologist and respiratory therapist. **Comparator:** Admission to hospital for inpatient treatment of respiratory tract infection.   | **Cost difference:** Hospital at home was €8,348 cheaper than hospital care. **Currency and cost year:** Euros, 2010 **Costs included:** Home visits by pulmonologist, district nurse and respiratory therapist. Daily rental costs for mechanical cough assist and portable ventilator, antibiotic prescriptions and telephone calls. Hospital stays.   | **Health difference:** Treatment failure, time to recovery and death 3-month follow-up were measured but none of these outcomes were statistically significant between the two groups.  | **Incremental analysis:** Not reported.  **Analysis of uncertainty:** Not reported.    |
| **Data sources**  |
| **Outcomes:** Within trial analysis with baseline data collected using clinical and functional measure. Data on mortality were collected at 3 months. **Quality of life:** Health utility was not measured. **Costs:** Both local and national unit cost sources were used.  |
| **Comments**  |
| Source of funding: Not reported  |
| **Overall applicability:** Partially Applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations (Table 6)  |

***Hospital at home for early discharge***

|  |  |
| --- | --- |
| **Study**  | **Echevarria C, Gray J, Hartley T, Steer J, Miller J, Simpson AJ, Gibson GJ, Bourke SC. Home treatment of COPD exacerbation selected by DECAF score: a non-inferiority, randomised controlled trial and economic evaluation. Thorax. 2018 Aug 1;73(8):713-22.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost-utility analysis **Study design:** Trial-based **Approach to analysis:** Mean difference in costs were calculated based on tariff costs. Bootstrapping was used to estimate 95% CIs. **Perspective:** UK NHS **Time horizon:** 90 days **Discounting:** Not applicable  | **Population:** Patients withlow mortality risk (DECAF 0–1), aged 35 years or older, 10 or more smoking pack-years, and pre-existing or admission obstructive spirometry **Intervention:** Hospital at Home (HAH) – typically 5 days **Comparator:** Usual care (UC) which included measures for quick discharge such as supported discharge by respiratory specialist nurse  | **Cost difference:** HaH cost £1,016 lower than UC per admission. **Currency and cost year:** British Pound, not provided **Costs included:** Bed stays,treatment costs, formal social care, home visits and A&E visits after discharge.  | **Health difference:** HAH produced 0.003 more QALY gains per patient.    | **Incremental analysis:** Incremental cost per additional QALY was £338.67\*  **Analysis of uncertainty:** Probabilistic sensitivity analysis showed a 90% probability of cost-effectiveness.     |
| **Data sources**  |
| **Outcomes:** Mortality and length of stay was identified in the randomised controlled trial. **Quality of life:** Health utility data was collected using EQ-5D-5L questionnaire. **Costs:** Resource use and costs were defined based onthe randomised controlled trial and trust tariffs.  |
| **Comments**  |
| Source of funding: Funded by the National Institute for Health Research (NIHR) under its Research for Patient Benefit (RfPB) Programme (Grant Reference Number PB-PG-0213-30105). Funding was also provided by the Northumbria Healthcare NHS Foundation Trust Teaching and Research Fellowship Programme.  |
| **Overall applicability:** Directly Applicable (Table 5)  |
| **Overall quality:** Minor limitations (Table 6)  |
| \*Estimated by the NICE team not the authors.  |

|  |  |
| --- | --- |
| **Study**  | **González-Ramallo VJ, Mirón-Rubio M, Mujal A, Estrada O, Forné C, Aragón B, Rivera AJ. Costs of outpatient parenteral antimicrobial therapy (OPAT) administered by Hospital at Home units in Spain. International journal of antimicrobial agents. 2017 Jul 1;50(1):114-8.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost comparison analysis **Study design:** Trial-based **Approach to analysis:** Economic evaluation of retrospective cohorts **Perspective:** Spanish National Health System **Time horizon:** The time horizon covers the infectious period and re-admissions within 30 days following discharge.  **Discounting:** Not reported (given the time horizon is less than one year, it appears discounting was not performed)  | **Population:** Patients with diagnostic certainty of infection requiring i.v. antimicrobials **Intervention:** Outpatient parenteral antimicrobial therapy (OPAT) administered by Hospital at Home (HaH) **Comparator:** Conventional hospitalisation   | **Cost difference:**  Outpatient stays (HaH) cost €3,001 (95% CI €2,700-€3,417) lower than Inpatient stays.  Inpatient stays cost €4,357 (95% CI €3,947-€4,977) compared to outpatient (HaH) stays which cost €1,356 (95% CI €1,247-€1,560) **Currency and cost year:** Euros, Not provided – however analysis covers 2012-2013 **Costs included:** The total cost of each infectious episode was calculated by adding the costs of inaptient stays (if any), the cost of outpatient stays (HaH) and re-admissions (if any) together.  | **Health difference:** Although not reported in greater detail, the authors state the ‘results on clinical effectiveness and safety are consistent with other reports’.    | **Incremental analysis:** Not applicable as this was a cost-comparison study.  **Analysis of uncertainty:** Not reported.     |
| **Data sources**  |
| **Outcomes:** Spanish Outpatient parenteral antimicrobial therapy (OPAT) registry **Quality of life:** Not estimated as this was not a cost-utility study. **Costs:** Resource use came from the Spanish OPAT registry. Cost accounting was done for each of the three centres in the study. Relative value units were estimated and these were then multiplied by the resource use per episode to obtain a specific weighting for each episode. This weight was ‘divided between the sum of the weighting of all the episodes. Multiplying by 100 these divisions, the percentages of the cost accounting corresponding to each episode were obtained’.  |
| **Comments**  |
| Source of funding: Economic analysis was sponsored by Merck & Co., Inc.   |
| **Overall applicability:** Partially applicable (Table 5)  |
| **Overall quality:** Potentially Serious Limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Goossens LM, Utens CM, Smeenk FW, van Schayck OC, van Vliet M, van Litsenburg W, Braken MW, Rutten-van Mölken MP. Cost-effectiveness of early assisted discharge for COPD exacerbations in the Netherlands. Value in health. 2013 Jun 1;16(4):517-28.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost-utility analysis **Study design:** Trial-based **Approach to analysis:** Economic evaluation alongside the multicentre randomized controlled Assessment of Going Home Under Early Assisted Discharge trial **Perspective:** Analyses for two perspectives performed, health care perspective and societal perspective **Time horizon:** 7 days of treatment and 3 months of follow-up **Discounting:** Not reported (given the time horizon is less than one year, it appears discounting was not performed)  | **Population:** Patients aged 40 years or older who were admitted to hospital because of an exacerbation of chronic obstructive pulmonary disease (COPD) **Intervention:** 3 days of usual hospital treatment and treated at home by community nurses for 4 days **Comparator:** 7 days inpatient hospital treatment  | **Cost difference:** Early assisted discharge was €-168 (negative to mean it was cheaper) than usual hospital care when using a health care perspective and including the cost of the initial episode plus follow-up (95% CI -€1,253; 922). Under a societal perspective early assisted discharge cost €880 more than usual hospital care again when including the cost of the initial episode plus follow-up (95% CI -€580; 2,268).  **Currency and cost year:** Euros, 2009 **Costs included:** GP consults, visits and phone calls, consults with various health and social workers, emergency room visits, ambulance transport, informal care, production loss by patient (in societal perspective only), inpatient hospital day standard price  | **Health difference:** Early assisted discharge produced fewer QALYs compared with usual hospital care -0.005 (95% CI -0.021; 0.0095)    | **Incremental analysis:** Early assisted discharge saves €31,111 per incremental QALY lost (because it was cheaper but provides fewer QALYs, although 95% CIs for both QALYs and costs included 0)   Usual hospital care was dominant using a societal perspective.  **Analysis of uncertainty:** Uncertainty around the estimates of costs and health outcomes was addressed by bootstrapping the data 1000 times. Mean values were used as the point estimates with 95% confidence intervals around this presented. Bootstrap replicates for outcomes and costs after 3 month were plotted in cost-effectiveness planes. Information from CE planes was summarized in cost-effectiveness acceptability curves.   Additional sensitivity analyses were performed including leaving out informal care costs, using a different unit cost per inpatient hospital day.  |
| **Data sources**  |
| **Outcomes:** 3 different outcomes were collected as part of the study: ‘1) incremental change from day of randomization in Clinical COPD questionnaire (CCQ) score at day 7 and 3 months; 2) the incremental proportion of patients with a clinically relevant improvement in the CCQ score (i.e., ≥ 0.4 units) on day 7 and at 3 months;…  **Quality of life:** ‘…and 3) the gain in quality-adjusted life-years (QALYs) after 3 months using utilities as measured by the EuroQol five-dimensional (EQ-5D) questionnaire using the Dutch tariff for the valuation of health states.’ **Costs:** Resource use recorded during the treatment phase, and during the follow-up phase resource use was recorded on a weekly basis in costs questionnaires that were distributed for each month of the trial.  |
| **Comments**  |
| Source of funding: The Netherlands Organisation for health Research and Development (ZonMw), grant number 945-50-773, and health insurers VGZ and CZ.  |
| **Overall applicability:** Partially Applicable (Table 5)  |
| **Overall quality:** Minor Limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Pajarón M, Lisa M, Fernández-Miera MF, Dueñas JC, Allende I, Arnaiz AM, Sanroma-Mendizábal P, De Berrazueta JR, Fariñas MC. Efficiency of a self-administered outpatient parenteral antimicrobial therapy (s-opat) for infective endocarditis within the context of a shortened hospital admission based on hospital at home program. Hospital Practice. 2017a Oct 20;45(5):246-52.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost Comparison Analysis **Study design:** Trial-based evaluation  **Approach to analysis:** Descriptive analysis of retrospective and prospective data was conducted. **Perspective:** Hospital perspective **Time horizon:** Not stated – the average stay per episode was 49 days **Discounting:** Not stated  | **Population:** Patients admitted to University Hospital in Spain with infective endocarditis (IE) between 1998 and 2014.**Intervention:** Hospital at Home (HaH) - Self administered Outpatient Parenteral Antimicrobial Therapy (S-OPAT) **Comparator**: In hospital treatment of infective endocarditis  | **Cost difference:** HaH saved €17,908 per IE episode. **Currency and cost year:** Euros,2013/14 **Costs included:** Direct costs, includingmedical care, overheads and transportation.  | **Health difference:** Not reported.    | **Incremental analysis:**  Not reported.  **Analysis of uncertainty:** Not reported.     |
| **Data sources**  |
| **Outcomes:** Data on mortality and length of stay were collected retrospectively (1998-2007) and prospectively (2008-2014).  Quality of life: Not measured.  Costs: The costs were calculated by the hospital’s analytical accounting unit based on DRG codes.  |
| **Comments**  |
| Source of funding: Medical writing support was paid for by Merck Sharp & Dohme (Spain).  |
| **Overall applicability:** Partially applicable (Table 5)  |
| **Overall quality:** Minor limitations (Table 6)  |

|  |  |
| --- | --- |
| **Study**  | **Pajarón-Guerrero M, Fernández-Miera MF, Dueñas-Puebla JC, Cagigas-Fernández C, Allende-Mancisidor I, Cristóbal-Poch L, Gómez-Fleitas M, Manzano-Peral MA, Gonzalez-Fernandez CR, Aguilera-Zubizarreta A, Sanroma-Mendizabal P. Early discharge programme on hospital-at-home evaluation for patients with immediate postoperative course after laparoscopic colorectal surgery. European Surgical Research. 2017b;58(5-6):263-73.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost Comparison Analysis**Study design:** Trial-based evaluation **Approach to analysis:** Descriptive analysis of retrospective data  **Perspective:** Not stated (probably a hospital’s perspective) **Time horizon:** 12 months **Discounting:** Not applicable  | **Population:** Patients over 18 a favourable clinical course 72 h after colorectal surgery **Intervention:** Hospital at Home (HAH) 72 days after surgery **Comparator:** Hospital ward care after surgery  | **Cost difference:** Average cost of bed day was €858 lower with HAH.  **Currency and cost year:** EUR, Not stated (probably 2014) **Costs included:** Direct costs, includingpersonnel, pharmacy, maintenance and depreciation costs  | **Health difference:** Not measured.    | **Incremental analysis:** HAH had a €3,171 lower cost per episode.  **Analysis of uncertainty:** Not reported.    |
| **Data sources**  |
| **Outcomes:** Retrospective patients’ data on mortality, complications and length of stay was obtained from a tertiary hospital in Spain. **Quality of life:** Health utility was not measured.  Costs: Not stated explicitly but probably hospital financial records were used.  |
| **Comments**  |
| Source of funding: Medical writing support was paid for by Merck Sharp and Dohme (Spain).  |
| **Overall applicability:** Partially applicable (Table 5)  |
| **Overall quality:** Potentially serious limitations (Table 6)  |

***Virtual wards for admission avoidance***

|  |  |
| --- | --- |
| **Study**  | **Mirón Rubio M, Ceballos Fernández R, Parras Pastor I, Palomo Iloro A, Fernández Félix BM, Medina Miralles J, Zamudio López E, González Pastor J, Amador Lorente C, Mena Hortelano N, Domínguez Sánchez A. Telemonitoring and home hospitalization in patients with chronic obstructive pulmonary disease: study TELEPOC. Expert Review of Respiratory Medicine. 2018 Apr 3;12(4):335-43.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:**  Cost-consequences analysis **Study design:** Non-randomised single-arm interventional study **Approach to analysis:** Outcomes from intervention compared to historical data of the same patients **Perspective:** Not stated but probably single hospital in Spain **Time horizon:** 6 months **Discounting:** Not applicable  | **Population:** Patients with spirometry-confirmed COPD **Intervention**: Telemonitoring program consisting of follow-up and control by a nurse during stable phase and intervention by home care unit during exacerbation **Comparator:** Standard hospital-based care for management of COPD patients  | **Cost difference:** €930.39 over 6 months.  **Currency and cost year:** Euros, Not stated (probably 2013) **Costs included:** Utilisation of healthcare resources including hospital admissions, emergency room visits, primary care visits, home hospitalisation and admission to ICU  | **Health difference:**   60% reduction of hospital admissions, 58% reduction in hospital days, and 38% reduction in emergency room visits.    | **Incremental analysis:** Not applicable.  **Analysis of uncertainty:** Not reported.    |
| **Data sources**  |
| **Outcomes:** Retrospective patients’ data collected from medical records compared with data collected during trial period. **Quality of life:** Health utility was not measured.  Costs: Reference prices for each resource. Date and setting not stated but probably Spain.  |
| **Comments**  |
| Source of funding: Cystelcom Sistemas S.A. assumed the costs of the technology. Funds from the University Hospital of Torrejón were used to finance the services of the medical writer.  |
| **Overall applicability:** Partially applicable (Table 5)  |
| **Overall quality:** Potentially serious limitations (Table 6)  |

***Virtual wards for early discharge***

|  |  |
| --- | --- |
| **Study**  | **Swift J, O'Kelly N, Barker C, Woodward A, Ghosh S. An Economic Evaluation of a virtual Covid Ward in Leicester, Leicestershire, and Rutland. medRxiv. 2022:2022-06.**  |
| **Study details**  | **Population & interventions**  | **Costs**  | **Outcomes**  | **Cost effectiveness**  |
| **Economic analysis:** Cost Comparison Analysis**Study design:** Economic analysis alongside service evaluation **Approach to analysis:** Observational data was used to conduct regression analysis and estimate the mean differences. **Perspective:** UK NHS  Time horizon: 13 months **Discounting:** Not applied since the time horizon was just over a year.  | **Population:** Patients admitted with COVID-19 and discharged.  **Intervention**: Treatment at home (details not provided). **Comparator:** Hospital ward as per usual care.   | **Cost difference:** Cost of an average virtual ward stay was (£184) lower than the comparator (£532). **Currency and cost year:** British Pound, 2020/2021 **Costs included:** Direct costs, including bed day, staff costs.  | **Health difference:** 30-day re-admission rate (2.9%) was reported to be lower than the expected figure estimated based on the literature (7.1%).    | **Incremental analysis:** Net saving with the intervention was £1,709 per patient, without including potential savings from reduced re-admission. **Analysis of uncertainty:** The mean difference in length of stay varied between 1.30 and 2.86, depending on the regression model chosen.     |
| **Data sources**  |
| **Outcomes:** Data on length of stay and 30-day re-admissions were obtained. No long-term impacts on health outcomes were expected. **Quality of life:** Not measured. **Costs:** Resource use and cost data on the comparator and intervention was obtained from the hospital, andPSSRU costs were used for estimating staff costs.  |
| **Comments**  |
| Source of funding: NHS Leicester City CCG, NHS East Leicestershire and Rutland CCG, NHS West Leicestershire CCG and Ageing Well funded the intervention.  |
| **Overall applicability:** Directly applicable (Table 5)  |
| **Overall quality:** Minor limitations (Table 6)  |

**Table 5: Applicability checklist**

| **Study**  | **1.1 Is the study population appropriate for the review question?**  | **1.2 Are the interventions appropriate for the review question?**  | **1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?**  | **1.4 Is the perspective for costs appropriate for the review question?**  | **1.5 Is the perspective for outcomes appropriate for the review question?**  | **1.6 Are all future costs and outcomes discounted appropriately?**  | **1.7 Are QALYs derived using NICE’s preferred methods, or an appropriate social care-related equivalent used as an outcome?**  | **1.8 Overall judgement**  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hernandez et al. (2023)  | Yes  | Yes  | Partly – Spain  | Partly – provider perspective  | Yes  | Not applicable  | Not applicable  | Partially Applicable  |
| Shepperd et al. (2022)  | Yes  | Yes  | Yes – UK   | Yes  | Yes  | Not applicable  | Yes  | Directly Applicable  |
| Yu et al. (2020)  | Yes  | Yes  | Partly – Australia  | Unclear  - perspective not reported (probably Australian Health System)  | Unclear – perspective not reported  | No – Discounting is not reported and does not appear to be done given the time horizon was likely less than one year.  | Partly - Not a cost-utility analysis therefore no QALYs. Outcomes included length of stay.  | Partially Applicable  |
| Tsiachristas et al. (2019)  | Yes  | Yes  | Yes – UK   | Yes  | Yes  | Yes  | Not applicable  | Directly Applicable  |
| Kameshwar et al. (2016)  | Yes  | Yes  | Partly – Australia  | Partly – provider perspective  | Yes  | Not applicable  | Not applicable  | Partially Applicable  |
| Kilian et al. (2016)  | Yes  | Yes  | Partly – Germany  | Unclear – Likely Health System Perspective  | Unclear – perspective not reported  | No – Discounting is not reported and does not appear to be done given the time horizon was likely less than one year.  | Partly - Not a cost-utility analysis therefore no QALYs. Outcomes included three other mental health measures.  | Partially Applicable  |
| Pugh et al. (2015)  | Yes  | Yes  | Partly – Australia  | Yes  | Unclear – perspective not reported  | No – Discounting is not reported and does not appear to be done given the time horizon was likely less than one year.  | Partly - Not a cost-utility analysis therefore no QALYs. Outcomes included wait time, successful first TOV and ED presentations following successful TOV.  | Partially Applicable  |
| Vianello et al. (2013)  | Yes  | Yes  | Partly – Italy  | Unclear  - perspective not reported (probably Italian Health System)  | Unclear – perspective not reported  | No – Discounting is not reported and does not appear to be done given the time horizon was likely less than one year.  | Partly - Not a cost-utility analysis therefore no QALYs. However patient mortality at 3 months was measured.  | Partially Applicable  |
| Echevarria et al. (2017)  | Yes  | Yes  | Yes – UK  | Yes – formal social care costs included  | Yes  | Not applicable  | Yes  | Directly Applicable  |
| Gonzalez-Ramallo et al. (2017)  | Yes  | Yes  | Partly – Spain  | Yes – National Health System Perspective  | Unclear – perspective not reported  | No – Discounting is not reported and does not appear to be done given the time horizon was less than one year.  | Partly - Not a cost-utility analysis therefore no QALYs. Other outcomes included safety and clinical effectiveness although these are not described in great detail beyond them being comparable with other studies.  | Partially Applicable  |
| Goossens et al. (2013)  | Yes  | Yes  | Partly – Netherlands  | Yes – Two perspectives calculated, health care perspective and societal perspective  | Yes  | No – Discounting is not reported and does not appear to be done given the time horizon was less than one year.  | Yes  | Partially Applicable  |
| Pajarón et al. (2017a)  | Yes  | Yes  | Partly – Spain  | Partly – provider perspective  | Unclear – perspective not reported  | Not applicable  | Not applicable  | Partially Applicable  |
| Pajarón et al. (2017b)  | Yes  | Yes  | Partly – Spain  | Unclear – perspective not reported  | Unclear – perspective not reported  | Not applicable  | Not applicable  | Partially Applicable  |
| Miron Rubio et al. (2018)  | Yes  | Yes  | Partly - Spain  | Unclear – perspective not reported  | Unclear – perspective not reported  | Not applicable  | Not applicable  | Partially Applicable  |
| Swift et al. (2022)  | Yes  | Yes  | Yes – UK   | Yes  | Yes  | Not applicable  | Not applicable  | Directly Applicable  |

**Table 6: Methodological Quality checklist**

| **Study**  | **2.1 Does the model\* structure adequately reflect the nature of the topic under evaluation?**  | **2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?**  | **2.3 Are all important and relevant outcomes included?**  | **2.4 2.4 2.4 Are the estimates of baseline outcomes from the best available source?**  | **2.5 Are the estimates of relative intervention effects from the best available source?**  | **2.6 Are all important and relevant costs included?**  | **2.7 Are the estimates of resource use from the best available source?**  | **2.8 Are the unit costs of resources from the best available source?**  | **2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?**  | **2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?**  | **2.11 Has no potential financial conflict of interest been declared?**  | **2.12 Overall assessment**  |   |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hernandez et al. (2023)  | Yes  | Partly – 30 days may not be enough for some conditions.  | No – quality of life was not considered.   | Yes  | Yes  | No – only direct costs were included. Carer’s time was not included although it was required for enrolment.   | Yes  | Yes  | No  | No  | Yes  | Potentially Serious Limitations  |  |
| Shepperd et al. (2022)  | Yes  | Partly – 6 months may not be enough to capture all the effects.  | No –  re-admission rates and adverse events were not compared across the two groups.  | Yes  | Yes  | Yes  | Yes  | Yes  | No – The reduction in QALYs was not statistically significant ICER was not estimated.   | Yes  | No  | Potentially Serious Limitations  |  |
| Yu et al. (2020)  | Yes  | Partly – Although costs only cover the period when a patient is admitted, the study follows patients to death so differences in mortality can be compared.  | Partly – Quality of life was not considered, however other outcomes of interest were including mortality, readmission, and complications.  | Yes  | Yes  | Yes  | Yes  | Yes  | Partly – Only a comparison of the cost of each intervention is reported. No reporting of the cost-effectiveness when using the other outcomes measured is done.  | No – No sensitivity analysis reported  | Yes  | Potentially Serious Limitations  |  |
| Tsiachristas et al. (2019)  | Partly - risk of residual confounding and lack of comparability between the two groups. | Yes  | No – quality of life was not considered.  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | No  – not conducted for mortality   | No  | Potentially serious limitations  |  |
| Kameshwar et al. (2016)  | Yes  | Partly – 12 months may not be enough to capture all the effects.  | No – quality of life was not considered.  | Yes  | Yes  | No – only direct costs were included.  | Yes  | Yes  | Yes  | No  | Yes  | Minor Limitations  |  |
| Kilian et al. (2016)  | Yes  | Unclear – Time horizon not reported but likely only covers the study duration which is reported as ranging between 7-321 days. Likely insufficient to measure long term differences between treatments.  | Partly – Quality of life was not considered, however three mental health measures were included.  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | No – No sensitivity analysis reported  | No  | Potentially Serious Limitations  |  |
| Pugh et al. (2015)  | Yes  | Partly – Time horizon includes wait time, TOV, and 30 days after first TOV attempt. This may not be sufficient.  | Partly – Quality of life was not considered, however other outcomes of interest were.  | Yes  | Yes  | Partly – Average costs for the intervention and comparator are provided although more detail on how these costs were calculated would be useful.  | Yes  | Yes  | Partly – Only a comparison of the cost savings per patient is reported. No reporting of the cost-effectiveness when using the other outcomes measured is done.  | No – No sensitivity analysis reported  | Yes  | Potentially Serious Limitations  |  |
| Vianello et al. (2013)  | Yes  | Unclear – Time horizon not reported but likely only covers the time a patient is treated and a follow-up period of 3 months.  | Partly – Quality of life was not considered, however other outcomes of interest were.  | Yes  | Yes  | Yes  | Yes  | Yes  | No – Only costs are compared, no other outcomes are reported.  | No – No sensitivity analysis reported  | Yes   | Potentially Serious Limitations  |  |
| Echevarria et al. (2017)  | Yes  | Partly – Follow-up period is 3 months. This may not be sufficient.  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | Partly – ICER per QALY not calculated  | Yes  | No  | Minor limitations  |   |
| Gonzalez-Ramallo et al. (2017)  | Partly – Analysis does compare inpatient and outpatient costs, however it does not disaggregate these. So some people will have had an inpatient stay, some will not, and this is not reported on.  | Partly – Time horizon includes infectious period and readmissions within 30 days. This may not be sufficient.  | Partly – Relevant outcomes are included but the results are not reported in great detail  | Yes  | Yes  | Yes  | Yes  | Yes  | No – Only costs are compared in great detail  | No – No sensitivity analysis reported  | No  | Potentially Serious Limitations  |   |
| Goossens et al. (2013)  | Yes  | Partly – Follow-up period is 3 months. This may not be sufficient.  | Yes  | Yes  | Yes  | Yes – Informal care costs are included (also are excluded in a scenario analysis)  | Yes  | Yes  | Yes  | Yes  | Yes  | Minor Limitations  |   |
| Pajarón et al. (2017a)  | Yes  | Partly – 49 days may not be enough.  | No – quality of life was not considered.  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | No  | No  | Minor Limitations  |  |
| Pajarón et al. (2017b)  | Partly –patients in the control group were those who did not meet the eligibility criteria for home recovery. Thus, they may not be an appropriate group of comparator.  | Yes  | No – quality of life was not considered.  | Yes  | Yes  | Yes  | Unclear – details not provided  | Unclear – details not provided  | Yes  | No  | Yes  | Potentially Serious Limitations  |  |
| Miron Rubio et al. (2018)  | Yes  | No – 6 months may not be sufficient.  | No – quality of life was not considered.  | Yes  | Yes  | Yes  | Yes  | Unclear – details not provided  | No  | No  | Yes  | Potentially Serious Limitations  |   |
| Swift et al. (2022)  | Partly – the comparator data for re-admission was taken from a Turkish study.  | Yes  | No – quality of life was not considered.  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | No  | Minor limitations  |    |
| \*Where studies do not include a model, the authors considered whether the evaluation design adequately reflected the nature of the topic under evaluation.  |    |

1. – Excluded Studies

| **Study**  | **Reason for exclusion**  |
| --- | --- |
| Nunan J, Clarke D, Malakouti A, Tannetta D, Calthrop A, Xu XH, Chan NB, Khalil R, Li W, Walden A. Triage Into the Community for COVID-19 (TICC-19) Patients Pathway-Service evaluation of the virtual monitoring of patients with COVID pneumonia. Acute Med. 2020 Jan 10;19(4):183-91.  | - Very serious limitations |
| Rodríguez-Cerrillo M, Poza-Montoro A, Fernandez-Diaz E, Matesanz-David M, Romero AI. Treatment of elderly patients with uncomplicated diverticulitis, even with comorbidity, at home. European journal of internal medicine. 2013 Jul 1;24(5):430-2. | - Very serious limitations |
| Achanta A, Velasquez DE, Grabowski DC. Hospital at Home: Paying for What It's Worth. American Journal of Managed Care. 2021 Sep 1;27(9).  | - Commentary only  |
| Jack K, Barnett J, Holiday A, Heard G, Thomson B. Hepatitis C therapy at home: a hospital and home care partnership. British Journal of Nursing. 2013 May 8;22(9):518-23.  | - No cost-analysis  |
| Samaranayake CB, Neill J, Bint M. Respiratory acute discharge service: a hospital in the home programme for chronic obstructive pulmonary disease exacerbations (RADS study). Internal Medicine Journal. 2020 Oct;50(10):1253-8.  | - Although costs are presented, a final summary figure is never given. Instead of a final costing figure (i.e. something like ‘the hospital program cost this much in total’) the authors only provide a description, stating the intervention was less costly than the hospital. How much less costly the intervention was is not reported. In the absence of more detail around the costs, this paper is of limited use  |
| Shah SS, Gvozdanovic A, Knight M, Gagnon J. Mobile App–Based remote patient monitoring in acute medical conditions: prospective feasibility study exploring digital health solutions on clinical workload during the COVID crisis. JMIR formative research. 2021 Jan 15;5(1):e23190.  | - Compares two virtual ward interventions not virtual ward versus hospital care  |
| Singh S, Gray A, Shepperd S, Stott DJ, Ellis G, Hemsley A, Khanna P, Ramsay S, Schiff R, Tsiachristas A, Wilkinson A. Is comprehensive geriatric assessment hospital at home a cost-effective alternative to hospital admission for older people?. Age and Ageing. 2022 Jan;51(1):afab220.  | - Initial publication of an included National Institute for Health Research (NIHR) report. This publication is substantially shorter, therefore we excluded it and instead only included the substantially more comprehensive NIHR report (Shepperd et al. 2022).  |
| Corrie PG, Moody AM, Armstrong G, Nolasco S, Lao-Sirieix SH, Bavister L, Prevost AT, Parker R, Sabes-Figuera R, of McCrone P, Balsdon H. Is community treatment best? a randomised trial comparing delivery of cancer treatment in the hospital, home and GP surgery. British Journal of Cancer. 2013 Sep;109(6):1549-55. | - It is not comparing a virtual ward with hospital care.  |
| Grustam AS, Severens JL, De Massari D, Buyukkaramikli N, Koymans R, Vrijhoef HJ. Cost-effectiveness analysis in telehealth: a comparison between home telemonitoring, nurse telephone support, and usual care in chronic heart failure management. Value in Health. 2018 Jul 1;21(7):772-82. | - It is not comparing a virtual ward with hospital care.  |
| Klarenbach S, Tonelli M, Pauly R, Walsh M, Culleton B, So H, Hemmelgarn B, Manns B. Economic evaluation of frequent home nocturnal hemodialysis based on a randomized controlled trial. Journal of the American Society of Nephrology. 2014 Mar 1;25(3):587-94. | - It is not comparing a virtual ward with hospital care. |
| Lassalle, A., Thomaré, P., Fronteau, C., Mahé, B., Jubé, C., Blin, N., Voldoire, M., Dubruille, V., Tessoulin, B., Touzeau, C. and Chauvin, C., 2016. Home administration of bortezomib in multiple myeloma is cost-effective and is preferred by patients compared with hospital administration: results of a prospective single-center study. Annals of Oncology, 27(2), pp.314-318. | - It is not comparing a virtual ward with hospital care. |
| Vindrola-Padros C, Sidhu MS, Georghiou T, Sherlaw-Johnson C, Singh KE, Tomini SM, Ellins J, Morris S, Fulop NJ. The implementation of remote home monitoring models during the COVID-19 pandemic in England. EClinicalMedicine. 2021 Apr 1;34:100799.  | - It is not comparing a virtual ward with hospital care. |
| Stoddart A, van der Pol M, Pinnock H, Hanley J, McCloughan L, Todd A, Krishan A, McKinstry B. Telemonitoring for chronic obstructive pulmonary disease: a cost and cost-utility analysis of a randomised controlled trial. Journal of telemedicine and telecare. 2015 Mar;21(2):108-18. | - It is not comparing a virtual ward with hospital care. |
| Tinelli M, Wittenberg R, Cornes M, Aldridge RW, Clark M, Byng R, Foster G, Fuller J, Hayward A, Hewett N, Kilmister A, Manthorpe J, Neale J, Biswell E, Whiteford M. The economic case for hospital discharge services for people experiencing homelessness in England: An indepth analysis with different service configurations providing specialist care. Health and Social Care in the Community. 2022; Nov;30(6):e6194-e6205. | - It is not comparing a virtual ward with hospital care. |
| Touati M, Lamarsalle L, Moreau S, Vergnenègre F, Lefort S, Brillat C, Jeannet L, Lagarde A, Daulange A, Jaccard A, Vergnenègre A. Cost savings of home bortezomib injection in patients with multiple myeloma treated by a combination care in Outpatient Hospital and Hospital care at Home. Supportive Care in Cancer. 2016 Dec;24:5007-14. | - It is not comparing a virtual ward with hospital care. |
| Walker PP, Pompilio PP, Zanaboni P, Bergmo TS, Prikk K, Malinovschi A, Montserrat JM, Middlemass J, Šonc S, Munaro G, Marušič D. Telemonitoring in chronic obstructive pulmonary disease (CHROMED). A randomized clinical trial. American journal of respiratory and critical care medicine. 2018 Sep 1;198(5):620-8. | - It is not comparing a virtual ward with hospital care. |
| Llorens, P., Moreno-Perez, O., Espinosa, B., García, T., Payá, A.B., Sola, S., Molina, F., Román, F., Jimenez, I., Guzman, S. and Gil-Rodrigo, A., 2021. An integrated emergency department/hospital at home model in mild COVID-19 pneumonia: feasibility and outcomes after discharge from the emergency department. Internal and Emergency Medicine, 16(6), pp.1673-1682. | - Does not conduct any comparative cost analysis  |
| Wong RC, Tan PT, Seow YH, Aziz S, Oo N, Seow SC, Seah A, Chai P. Home-based advance care programme is effective in reducing hospitalisations of advanced heart failure patients: a clinical and healthcare cost study. Ann Acad Med Singapore. 2013 Sep 1;42(9):466-71.  | - Does not conduct any comparative cost analysis   |