Cost-effectiveness of digital health interventions (remote monitoring) for the management of heart failure in the United Kingdom

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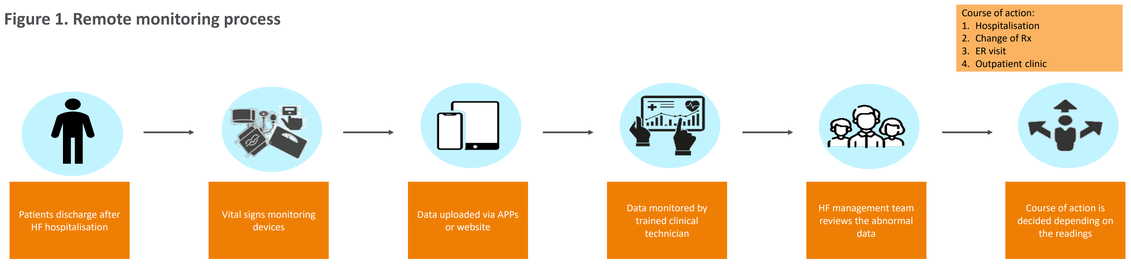
Introduction

- Heart failure (HF) poses significant challenges due to its high morbidity, mortality, and healthcare burden. Despite advancements in treatment, recurrent hospitalizations remain a concern, contributing to worsening symptoms and increased mortality risk for HF patients once discharged from hospital.[1]
- Digital health technologies (DHT), particularly remote monitoring (RM), offer promise in improving HF management by enabling timely detection of clinical changes and reducing hospital readmissions.[1, 2]
- However, while studies have shown clinical benefits, there remains a lack of robust economic evaluations to support the cost-effectiveness of RM.[3] Addressing this gap is essential for informing the adoption and implementation of RM as a routine HF management strategy.
- The objective of the study is to assess the long-term cost-effectiveness of RM when compared to the usual care (UC) for patients with HF aged ≥ 65 and recently discharged from hospital in the UK:
  - The RM intervention facilitates timely detection of any abnormality that can occur between the discharge and follow-up visits (**Figure 1**). RM was assumed to be conducted for a 12-month duration followed by UC.
  - For UC, patients receive a comprehensive post-discharge plan outlining follow-up visits every 2-4 weeks depending on the severity.

Figure 1. Remote monitoring process



Methods

- A Markov cohort model, with a lifetime horizon (50 years) and from the NHS and personal social service (PSS) perspective, was developed consisting of two health states: 'Alive' and 'Death'. During each monthly cycle, patients within the Alive state are at risk of re-hospitalization (due to HF or other causes) and can transition to the Death state (**Figure 2**).

Figure 2. Markov model structure

- Efficacy data were based on risk ratio (RR) of DHT vs UC from a 2022 meta-analysis[4], applied to monthly mortality and hospitalisation probability for UC from a HTA Report[1,5] (**Table 1**).
- Utilities were obtained from REACH-HF cost-effectiveness study for the UK[6] (**Table 2**).
- Costs on RM, healthcare resource use (HCRU), and hospitalization readmission were considered, and data sourced from literature[3,7,8,9,10] (**Table 3**). To calculate the cost for RM per patient, one time cost of £8500 for setup and implementation of RM and monthly telemonitoring services licence fee of £2500 were assumed to cover 250 HF patients discharged from a hospital.[9,10]

Table 1. Efficacy data

Time since discharge (months)		Monthly probability for UC	RR (95% CI) (RM vs UC)
Mortality	0-1	0.0462	0.80 (0.66-0.96)
	>1-3	0.0331	
	>3-6	0.0267	
	>6-12	0.0235	
	>12-24	0.0187	
	>24	0.0147	
HF related hospitalisation		0.0350	0.82 (0.66-1.02)
All cause hospitalisation		0.0875	0.89 (0.77-1.03)
Sources		1, 5	4

Table 2. Utility values

Health states	Utility values	Source
Stable HF	0.736	6
HFrH	0.652	
OCH	0.704	
Dead	0.00	

Table 3. Cost and healthcare resource use parameters

Hospital readmission cost	Cost (£)	Mean frequency per year		Sources
		RM	UC	
HFrH	£2,429.02	NA	NA	7
OCH	£3,685.08			
Medical and home care	**Unit cost (£)**			
Nurse visits	£46.00	2.00	1.40	8,7
GP visits	£42.00	7.80	6.20	3,7
Specialist visits	£113.00	6.50	6.40	
Nurse specialist visits	£57.00	7.30	6.40	
Emergency room visits	£418.00	0.57	0.60	
Home care funded by government (per day)	£24.84*	0.34	0.33	11, 12
Remote monitoring per patient	**Total cost (£)**			
Remote monitoring setup	£34.00	One time cost for setup and implementation		9,10
Remote monitoring services licences	£10.00	Per month		
Measurement tools	£122.36	One time cost		
*Derived by deducting 82% of home care cost per day of £138 being self-funded.				

- Costs and health outcomes were discounted at 3.5% annually.
- Life years gained (LY), quality-adjusted life years (QALYs) and total cost were estimated for both RM+UC and UC alone. Incremental outcomes, incremental cost, and incremental cost-effectiveness ratio (ICER) were calculated.
- Deterministic sensitivity analysis (DSA) and probabilistic sensitivity analysis (PSA) were conducted to assess model robustness and address uncertainties in input parameters. Scenario analyses were conducted, including a societal perspective, variations in patients' starting age, and RM duration to account for model variability.

Results

- In the base case, RM cost £1,586 per patient more than UC but yielded 0.13 additional QALYs per patient, producing an ICER of £12,588 per QALY (**Table 4**).
- Using 95% CI for RR from the meta-analysis[4] or varying other parameter values by ±20%, DSA found the main cost driver to be HCRU for RM and UC (**Figure 3**).
- PSA results were consistent (mean ICER of £13,139), although there was some uncertainty (**Figure 4**). RM demonstrated, at a willingness-to-pay (WTP) threshold of £20,000/QALY, an 86% probability of being cost-effective compared to UC (**Figure 5**).
- The scenario analyses showed that all scenarios explored generated an ICER less than the WTP of £20,000/QALY. The ICER improved when the duration of RM was extended to 5 years or patients started RM at a younger age. When considering the societal perspective, ICER increased by 27% but was still below the WTP threshold.

Table 4. Base case results

	RM	UC	Incremental (RM vs UC)
Discounted outcomes			
LYs	3.94	3.72	0.22
QALYs (patients)	2.25	2.12	0.13
Discounted costs			
Hospitalisation costs	£12,835	£12,392	£442
Medical care cost	£6,743	£5,962	£781
Remote Monitoring costs	£269	£0	£269
Home care cost government funded	£936	£844	£93
Total costs	**£20,784**	**£19,198**	**£1,586**
ICER (Cost/LY)	—	—	**£7,175**
ICER (Cost/QALY)	—	—	**£12,588**

Figure 3. Tornado diagram on DSA results

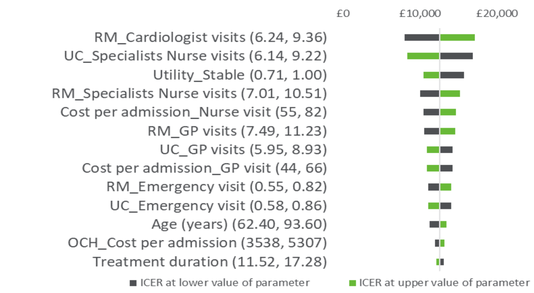


Table 5. Scenario analysis results

Scenario	ICER(£)	% change from base case
Base case	£12,588	-
Societal perspective	£15,933	27%
Time horizon: 1 year	£15,044	19.51%
Time horizon: 5 years	£12,668	0.64%
Time horizon: 10 years	£12,544	-0.35%
Time horizon: 20 years	£12,586	-0.02%
Time horizon: 30 years	£12,588	0.00%
Discounting QALY: 0%	£10,917	-13.28%
Discounting QALY: 6%	£13,746	9.20%
Discounting costs: 0%	£14,536	15.47%
Discounting costs: 6%	£11,520	-8.48%
Duration of treatment: 60 months	£10,734	-14.73%
Cost of RM: £432 (Includes telekit, development and cost of running the programme)	£11,360	-9.75%
Cost of RM: £95.69 as cost of developing and £ 6.85 as monthly maintenance charge and telekit charge as base case	£11,426	-9.23%
Age: 50	£11,066	-12.09%
Age: 75	£13,418	6.60%

Figure 4. Cost-effectiveness plane

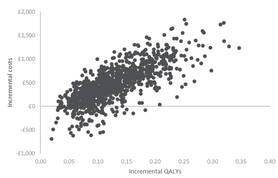
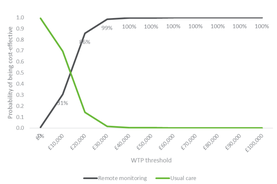


Figure 5. Cost-effectiveness acceptability curve



Discussion and Conclusion

- RM is a cost-effective strategy at a WTP of £20,000/QALY. DSA and PSA showed the result is robust, with uncertainty due to HCRU rather than relative efficacy for RM vs UC.
- Scenario analysis affirmed RM's cost-effectiveness and potential to enhance patient quality of life even when treatment duration is increased and age for patient population is lowered.
- These findings emphasize the potential advantages of incorporating RM as a standard strategy in managing HF, which can lead to improved clinical outcomes and quality of life over the long term. Comparative studies in the UK and Europe supported RM's cost-effectiveness.[1,13]
- Strengths of the study included efficacy based on a recent meta-analysis and a thorough sensitivity analysis. However, limitations such as short-term data reliance, patient compliance assumptions, and parameter uncertainty should be considered. The results need to be interpreted with caution as they are based on the assumption of a 100% uptake of the RM programme.

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