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Cost-Effectiveness Analysis in Telehealth: A Comparison between Home Telemonitoring, Nurse Telephone Support, and Usual Care in Chronic Heart Failure Management

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ABSTRACT

Objectives: To assess the cost effectiveness of home telemonitoring (HTM) and nurse telephone support (NTS) compared with usual care (UC) in the management of patients with chronic heart failure, from a third-party payer's perspective. **Methods:** We developed a Markov model with a 20-year time horizon to analyze the cost effectiveness using the original study (Trans-European Network–Home-Care Management System) and various data sources. A probabilistic sensitivity analysis was performed to assess the decision uncertainty in our model. **Results:** In the original scenario (which concerned the cost inputs at the time of the original study), HTM and NTS interventions yielded a difference in quality-adjusted life-years (QALYs) gained compared with UC: 2.93 and 3.07, respectively, versus 1.91. An incremental net monetary benefit analysis showed €7,697 and €13,589 in HTM and NTS versus UC at a willingness-to-pay (WTP) threshold of €20,000, and €69,100 and €83,100 at a WTP threshold of €80,000, respectively. The incremental cost-effectiveness ratios were €12,479 for HTM versus UC and €8,270 for NTS versus UC. The current scenario (including telenurse cost inputs in NTS) yielded results that were slightly different from those for the original scenario, when comparing all New York Heart Association (NYHA) classes of severity. NTS dominated HTM, compared with UC, in all NYHA classes except NYHA IV. **Conclusions:** This modeling study demonstrated that HTM and NTS are viable solutions to support patients with chronic heart failure. NTS is cost-effective in comparison with UC at a WTP of €9000/QALY or higher. Like NTS, HTM improves the survival of patients in all NYHA classes and is cost-effective in comparison with UC at a WTP of €14,000/QALY or higher.

Keywords: CEA, CHF, Markov model, telehealth.

Introduction

Cardiovascular disease (CVD) is the number one cause of death in the world—in 2012, 17.5 million people died from CVD, representing 31% of all global deaths [1]. Age-related changes in the cardiovascular system—particularly hypertension, coronary artery disease, and valvular heart disease—result in a high prevalence of heart failure [2]. As a result, chronic heart failure (CHF) is becoming an increasing problem globally, imposing "direct costs to healthcare systems and indirect costs on society through morbidity, unpaid care costs, premature mortality and lost productivity" [3].

In the European Union (EU), the rate of mortality from CVD has been declining since the early 1980s, but recently, deaths caused by CVD have plateaued in 15 countries [4]. CVD causes 1.9 million deaths in the EU and is estimated to cost the EU economy almost €196 billion a year [5]. Out of the total cost of CVD in the EU, about 54% is accounted for by direct health care costs, 24% by productivity losses, and 22% by informal care [5].

People live longer in the EU [6], and although mortality from CVD is in decline, there will be an increasing number of patients with heart disease in the future, and this will place a significant burden on the health care systems [7]. The use of information communication technologies in the provision of care for patients with heart disease could prove to be a useful strategy for tackling this problem. It is believed that successful management of patients with CHF is dependent on telemonitoring, adherence to treatment, provision of guidelines, and daily communication with patients [8,9]. There have been a number of studies on the clinical effectiveness of telemonitoring systems [10,11], but few full analyses of the cost effectiveness of telemonitoring systems for patients with CHF [12,13].

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The biggest telemonitoring trial to date—the Whole System Demonstrator (WSD)—aimed to "examine the costs and cost-effectiveness of telehealth in addition to standard support and treatment, compared with standard support and treatment" in heart failure in the United Kingdom [12]. Participants received telehealth equipment and a monitoring service for 12 months, whereas the control group received usual care (UC) and social care. The authors found that telehealth is associated with lower mortality and reduced emergency admission rates [14], but "the QALY gain by patients using telehealth in addition to usual care was similar to that for patients receiving usual care only, and total costs associated with the telehealth intervention were higher" [12].

The Trans-European Network–Home-Care Management System (TEN-HMS), another study from the United Kingdom, the Netherlands, and Germany, found the "number of admissions and mortality similar among patients assigned to home telemonitoring (HTM) or nurse telephone support (NTS), but the mean duration of hospital admissions reduced by 6 days (95% confidence interval 1 to 11) with HTM" [8]. The interventions were similar to the WSD: HTM consisted of twice-daily patient self-measurement of weight, blood pressure, and heart rate and rhythm with automated devices linked to a cardiology center; NTS consisted of specialist nurses being available to patients by telephone; and UC consisted of care delivered by primary care physicians [8]. Patients assigned to receive UC had "higher one-year mortality (45%) than patients assigned to receive NTS (27%) or HTM (29%) ($p = 0.032$)" [8].

Both the WSD and TEN-HMS trials used versions of a Philips telemonitoring system. The aim of this study was to provide insights into the cost effectiveness of a telehealth (i.e., telemonitoring) system in the Netherlands. We were interested in knowing whether HTM and NTS are cost-effective strategies in the management of CHF, compared with UC, and whether there is a subgroup of patients with CHF who can benefit the most from telemonitoring.

Methods

We developed a Markov cohort model to analyze the cost effectiveness of HTM and NTS for managing patients with CHF, compared with UC. We secured access to original data from the TEN-HMS study. Modeling was necessary for two reasons: 1) the original trial used a short follow-up interval of 240 to 450 days, and so there was a need to extrapolate beyond the end points of the trial because CHF is a chronic condition, and 2) the intervention is expected to have an effect on the costs and quality-adjusted life-years (QALYs) after the trial [15]. Besides the TEN-HMS, we concentrated on clinical results and it was necessary to include Dutch health care costs to study the cost effectiveness.

Framing the Model

Target population

In this modeling study we deal with a hypothetical cohort of 1000 people with CHF aged 70 years and older, in all New York Heart Association (NYHA) classes of severity [16]. Our chosen population reflects the TEN-HMS study database population, that is, patients with CHF older than 70 years of age, of both sexes, and in all four NYHA stages. In the clinical trial, random permuted blocks for each hospital were used to allocate 426 patients to treatment groups by an independent statistical group (Institute for Medical Informatics and Biostatistics, Basel, Switzerland). Patients were assigned randomly to HTM, NTS, and UC in a 2:2:1 ratio. The TEN-HMS study included patients who had recently been admitted to a hospital with worsening heart failure (left ventricular ejection fraction <40%), and we used the characteristics of that population to model our own. A detailed description and the results of the TEN-HMS trial are published elsewhere [8].

Setting and location

Our model reflects the health care situation in the Netherlands, because we were using the EuroQol five-dimensional questionnaire (EQ-5D) weights and costs from the Netherlands.

Study perspective

Because in the Netherlands it is probably the health care insurers who will decide on the availability of monitoring support to patients with CHF, in this study we performed the analysis on the basis of the third-party payer's perspective.

Comparators

We were interested in the cost effectiveness of two interventions, compared with one comparator, in the management of CHF: HTM and NTS compared with UC. We give an outline of how each intervention is commonly delivered.

UC comprises a patient management plan [17] which, upon discharge from hospital, is usually sent by a nurse to the patient's primary care physician, who is asked to implement it. The protocol follows the clinical guidelines. When the usual organization of care involves the titration of drugs by a specialist nurse, this is encouraged. The patient's status is usually evaluated at a clinic every 4 months to assess intervention history, symptoms and signs, renal function, and serum electrolytes.

NTS is managed as described for UC except that patients are contacted by telephone each month by a specialist heart failure nurse to assess their symptoms and current medication. The nurse can offer advice to the patient at this time and provide feedback to the primary care provider. Patients can contact the nurse by telephone at any time, either directly or by leaving a message on a telephone-answering machine. Nevertheless, in the event of an out-of-hours emergency, they are expected to contact their primary care doctor or the ambulance service.

Patients on HTM receive the telemonitoring equipment and written instructions on how to use it. A service engineer visits the patient's home to install the equipment, which usually consists of low-profile, electronic weighing scales, an automated sphygmomanometer, and a single-lead electrocardiogram using wristband electrodes. Each device contains a short-range radio transmitter that allows it to communicate automatically with a hub connected to the patient's conventional telephone line. The signal is sent automatically to a central Web server and then via secure Intranet connections to a workstation at each clinical site. Data are encrypted during transmission to ensure patient confidentiality. Patients are asked to take a set of measurements every day before breakfast and before their evening meal, after emptying their bladder, while wearing light clothing, no shoes, and before taking their next dose of medication. The patient's weight, blood pressure, and heart rate and rhythm are therefore monitored twice daily.

Utilization data

Data gathered in the TEN-HMS study were used for the purposes of cost-effectiveness analysis. We were interested in health care resources utilization and tracked time-dependent (per 4 months) and time-independent (average) utilization of the following in each treatment arm: number of telephone calls with the