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Review

Design of telehealth trials – Introducing adaptive approaches

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ABSTRACT

Background: The field of telehealth and telemedicine is expanding as the need to improve efficiency of health care becomes more pressing. The decision to implement a telehealth system is generally an expensive undertaking that impacts a large number of patients and other stakeholders. It is therefore extremely important that the decision is fully supported by accurate evaluation of telehealth interventions.

Objective: Numerous reviews of telehealth have described the evidence base as inconsistent. In response they call for larger, more rigorously controlled trials, and trials which go beyond evaluation of clinical effectiveness alone. The aim of this paper is to discuss various ways in which evaluation of telehealth could be improved by the use of adaptive trial designs.

Results: We discuss various adaptive design options, such as sample size reviews and changing the study hypothesis to address uncertain parameters, group sequential trials and multi-arm multi-stage trials to improve efficiency, and enrichment designs to maximise the chances of obtaining clear evidence about the telehealth intervention.

Conclusion: There is potential to address the flaws discussed in the telehealth literature through the adoption of adaptive approaches to trial design. Such designs could lead to improvements in efficiency, allow the evaluation of multiple telehealth interventions in a cost-effective way, or accurately assess a range of endpoints that are important in the overall success of a telehealth programme.

Contents

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1. Introduction

Telehealth is the use of technology to allow communication of information between patient and care-provider whilst the patient is outside the clinical environment, e.g. in their own home. The range of telehealth is broad, from the monitoring of blood glucose levels in diabetics who provide measurements from home, to patients of mental illness receiving therapy treatment online. It can allow low-cost monitoring of the patient's condition, which reduces demands on hospital resources and staff. Implementation of an effective telehealth intervention therefore has the potential to lead to improved patient care and improved efficiency in health care, which has been demonstrated in various studies [1–4]. However, widespread implementation of telehealth faces barriers due to a lack of strong, valid evidence of its benefits. This lack of evidence is discussed in Ekeland et al's systematic review of reviews, which examined up to 80 telehealth reviews in two separate papers [5,6]. According to their findings, telehealth literature suffers from several flaws. Firstly, many of the trials carried out are too small, lacking the power to find a benefit over standard care. Second, a lack of consistency in endpoints in the literature makes it difficult to consolidate evidence. Further, there is a belief that clinical effectiveness alone is not sufficient evidence for implementing a telehealth system. Some reviews call for studies to include technical, ethical and organisational effects, including direct and indirect costs to patients and care-providers. Lastly, several reviews discuss the heterogeneity that can exist in patient responses to the same telehealth intervention, contributing to inconsistency in the evidence base. There is a lack of knowledge about why some people respond or comply well with a telehealth programme but others do not. Suggested explanations can be as objective as the patient's specific type of illness, or as subjective as the patient's personal sense of motivation. Reviews recommend exploring reasons for varying response and compliance if the telehealth intervention is to be successful.

It may be possible to address the criticisms and issues discussed in reviews of telehealth through appropriate trial design. Ekeland et al. [6] discuss methodology used in telehealth studies, and recommend standard randomised controlled trials as the most rigorous option of trial design. In this paper we argue that the evaluation of telehealth interventions could benefit from expanding this usual approach to include adaptive trial designs. The potential advantages of adaptive designs in drug trials have been examined in several places in the literature [7,8]. The aim of this paper is to introduce adaptive designs in the context of telehealth, taking into account the specific challenges that may arise when evaluating telehealth interventions.

2. Adaptive designs

An adaptive design is one in which new decisions can be made about the design or progress of the trial, once the trial is already underway. This is in contrast to standard, non-adaptive designs, in which all aspects of the trial are fixed beforehand and remain fixed throughout. The changes made in an adaptive trial are based on interim analyses of the data observed so far. Examples of changes that may be made are: stopping the trial early if efficacy or futility has already been demonstrated; changing the endpoint or objective of the study, and; re-estimating the sample size. Potential changes are usually considered beforehand and incorporated into the design stage of the study, so that if these changes do need to be made, any increase in resources required is known in advance. At the end of the trial, the final analysis includes all patients recruited since the beginning of the trial. Thus the