

A summary of the first findings from the Whole System Demonstrator trial

# The impact of telehealth on use of hospital care and mortality

*Research summary*

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Health systems globally are exploring ways to increase the quality of care while achieving value for money, often with a focus on people with long-term health conditions. One approach involves installing technology (termed 'telehealth' devices) in patients' homes, to allow patients to measure items such as blood glucose and haemoglobin oxygenation levels on a daily basis, and to transmit this information to health care professionals working remotely. As the professionals are then alerted to early warning signs of deteriorations in patient health, they can provide appropriate responses. Advocates argue that telehealth has the potential to reduce emergency hospital admissions, but the evidence base has historically been mixed.

In 2006, the Department of Health announced three large pilots of telehealth, which became known as the 'Whole System Demonstrators'. The pilots were evaluated using a variety of methods including a randomised controlled trial (RCT), in which groups of patients either received the telehealth intervention or acted as controls by receiving their usual care. With over 3,000 patients participating in the trial, the evaluation was the largest and most complex trial of telehealth in the world. There were five strands of analysis. The Nuffield Trust examined the impact of telehealth on the trial participants' use of hospital care and on their mortality; the findings have been published in the *British Medical Journal (BMJ)* and are summarised here. Other strands of analysis – concerning the impact of telehealth on quality of life; the cost-effectiveness of telehealth; and patient, professional and carer views – have been conducted by partners, and are forthcoming.

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## Key Points

### *Main findings*

- Over the 12 months that they spent in the trial, patients allocated to receive the telehealth intervention had fewer emergency hospital admissions; they experienced an average of 0.54 emergency admissions per person, compared with 0.68 per person for control patients – a difference of around 20 per cent.
- Over the twelve months, 4.6 per cent of intervention patients died, compared with 8.3 per cent of controls.
- These differences in emergency admissions and mortality were statistically significant, so were unlikely to have been caused by chance.
- For intervention patients, the overall costs of hospital care (including emergency admissions, elective admissions and outpatient attendances) were £188 per patient less than those for controls. However, this cost difference was not statistically significant.
- Detailed estimates of the cost of the telehealth intervention have not yet been released, but will need to be offset against these cost estimates.

### *Reasons for caution*

- Although intervention patients experienced 20 per cent fewer emergency admissions than controls, these reductions were from a low base. Differences corresponded to 0.14 admissions per person over 12 months.
- The control group appeared to experience more emergency hospital admissions shortly after being recruited into the trial, compared with previously. The reasons for this increase are unclear but it is possible that trial recruitment processes affected admissions. Therefore, telehealth may have different impacts in routine practice than in this trial.
- Although this is the largest randomised trial of telehealth conducted globally, our findings relate to particular deployments of telehealth in three sites in England. The impact of telehealth depends on the type of technology and how it is used, as well as the nature of care that is subsequently provided.

### *Further considerations*

- Many local NHS efficiency plans assume financial savings from investment in telehealth plus related support. The trial did not conclude that there was a reduction in hospital costs due to telehealth. This does not mean that telehealth does not have an impact on costs, only that the differences observed in this trial could have been the effect of chance. So commissioners will need to look carefully at this trial and consider whether it is necessary to refine their approach.
- Decisions made about introducing telehealth should also take account of the overall cost of the intervention (telehealth technology, plus monitoring and related care); the impact on quality of life for patients; and carer outcomes, as well as the experiences of patients and professionals. Information from the other strands of evaluation is forthcoming.
- Telehealth is constantly developing and the findings from this study and other studies may help to improve its effectiveness. It would be worth considering a further, low-cost, evaluation, to assess if the impact in future is greater than now, as the effect of telehealth may change over time.



## Why is telehealth being considered in the NHS?

Budgetary pressures mean that health services around the world are actively exploring ways to deliver care that helps to prevent ill health and is cost-effective. There is a particular focus on management for people with long-term health conditions and the desire of people to receive care in their own homes. One intervention is ‘telehealth’, which involves the remote exchange of electronic information between patients and health care professionals. For example, blood glucose or haemoglobin oxygenation measurements might be taken by the patient in their own home most days of the week and the results transmitted to health care professionals over a telephone line. Professionals then use protocols to respond to worsening trends in measurements, for example by providing advice and, where appropriate, intervention.



Advocates argue that telehealth has the potential to prevent unnecessary hospital admissions

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Advocates claim that the use of telehealth devices can help to prompt earlier and more coordinated care from professionals or improve the ongoing self management by the patient. Thus, it is argued, telehealth has the potential to prevent unnecessary hospital admissions and deliver efficiency savings for the NHS. As yet there has been little robust evidence to support this claim, partly because of the difficulties of recruiting the large numbers of patients needed for robust evaluation and the associated costs of such studies. Assessment has typically been based on aggregated findings from a large number of diverse small pilot schemes, making findings difficult to generalise (Chaudhry and others, 2011). In addition, many previous studies had not conformed to robust evaluation criteria (Bergmo, 2009).

In 2006, the Department of Health in England published a White Paper *Our Health, Our Care, Our Say*, which included a focus on integrated care supported by advanced assistive technologies such as telehealth (Department of Health, 2006). A system of remote, automatic and passive monitoring was also tested for people with social care needs (‘telecare’). Pilot projects – termed Whole System Demonstrators (WSDs) – were established in three areas of England (Cornwall, Kent and Newham). In recognition of the need for evidence, the Department of Health commissioned an evaluation of the impact of telehealth and telecare as deployed in the WSDs. The result included the largest randomised controlled trial of telehealth conducted to date, with over 3,000 participants. This paper discusses the first set of results from the WSD evaluation, which have been published in the *BMJ* (Stevenson and others, 2012). These concern the impact of telehealth on hospital use and mortality.

## Background to the Whole System Demonstrator pilot and evaluation

### Selection of patients

In the WSD sites, telehealth (including technology, monitoring systems and related preventive or supportive care) was provided to people with chronic obstructive pulmonary disease, diabetes or heart failure. Broad inclusion criteria were used to determine which patients were eligible to participate in the trial, requiring only a diagnosis of at least one of these conditions and being aged over 18. The patient’s home also had to be suitable for the installation of telehealth devices. More sophisticated criteria, for example those related to the predicted risk of future hospitalisation, were not used.

### The interventions trialled in the three sites

The three sites defined and procured the telehealth devices, related monitoring systems and associated preventive/supportive care. There was no attempt to standardise these across the sites and the evaluation aimed to assess the impact of the interventions overall rather than to compare specific devices and systems. However, there were similarities in the approaches that were chosen. Across all sites, the key telehealth devices used were:

- pulse oximeters for chronic obstructive pulmonary disease
- glucometers for diabetes
- weighing scales for heart failure.

Telehealth participants were asked to take clinical readings up to five days per week at the same time each day. In addition to the telemonitoring aspect of the intervention, questions about symptoms and educational messages were transmitted via a special telehealth unit or a 'set-top' box connected to a television. At the end of each session, information from clinical readings and responses to the questions about symptoms were transmitted to monitoring centres via a secure server. These centres were staffed by specialist nurses or community matrons from local health organisations who used protocols to respond to the information.

### Evaluation strands and teams

The WSD evaluation was multi-dimensional and included assessment of the impact of telehealth (the technology and associated preventive/supportive care) on the use of a range of health and social care services, mortality, quality-of-life outcomes for carers, and cost-effectiveness. Qualitative strands of the evaluation explored views from patients and professionals as well as the organisational factors associated with implementing the intervention. The Nuffield Trust led the analysis of the impact of telehealth on service use and mortality. Research teams covering other strands came from City University, the London School of Economics, the University of Manchester, Imperial College London and Oxford University, University of East Anglia and University of Surrey.

## Methods

### Randomisation and consent

The study was designed to compare telehealth with usual care, within the context of the wider service redesign that was ongoing in the sites. When the study was designed, local professionals working in the sites advised that randomisation of individual patients into telehealth and usual care groups was unlikely to be acceptable. Instead, the study used a pragmatic approach whereby general practices were randomised. After general practices had been recruited, potentially eligible participants were identified from routine data sources and asked whether information about them could be shared with the evaluation team. Once this letter had been returned, patients were visited by members of the project team and clinical staff. During these visits, patients were provided with information regarding the trial and consent forms for participation. The patient's home was also assessed for suitability for telehealth. Only after patients had consented to participate in the trial were they told whether they would receive telehealth or usual care. Participants not immediately offered telehealth were offered telehealth after twelve months of the trial, if they were still eligible at that point. The sites aimed to recruit 3,000 patients in total.

Even though this study was randomised, there may still have been differences in the characteristics of intervention and control patients. Case-mix adjustment was therefore performed using both a set of baseline characteristics (age, sex, ethnicity, area-based

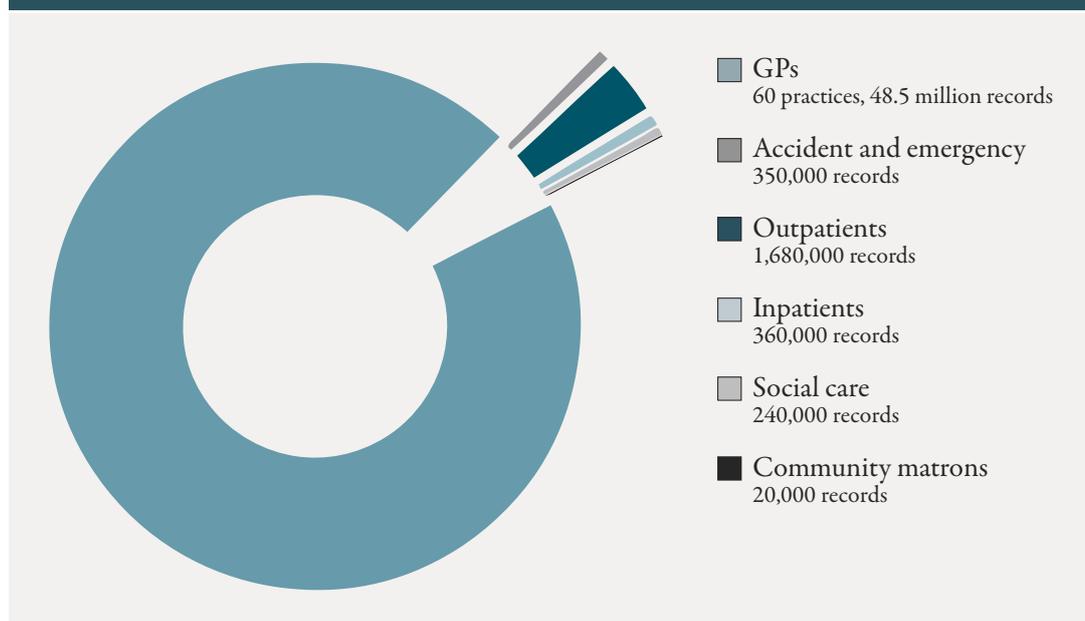
socioeconomic deprivation score, site, principal condition, number of chronic conditions and prior hospital use) and the results of a predictive risk model. The model chosen was the Combined Predictive Model, which uses linked hospital and primary care data to estimate the probability that a patient will experience an emergency hospital admission in the following twelve months (Wennberg and others, 2006).

#### Analysis of service use and mortality

The Nuffield Trust analysis relied on electronic data extracted from administrative systems. Person-level data on hospital use were collected from four NHS primary care trusts (Newham, Cornwall, Eastern and Coastal Kent, and West Kent) and from the National Hospital Episode Statistics (HES) database, while person-level data on use of primary care were collected from general practices across the three sites. Data about social care use have also been collected. All data sets were anonymised at source to protect patient confidentiality, and then linked to show use of care in individuals. Over a billion rows of data were cleaned and linked (see Figure 1).

More of the detail about how data sets were assembled and the case-mix adjustment implemented is available in the *BMJ* article (Steventon and others, 2012).

Figure 1: An illustration of the data sets collected for one WSD area (Newham)



## Results

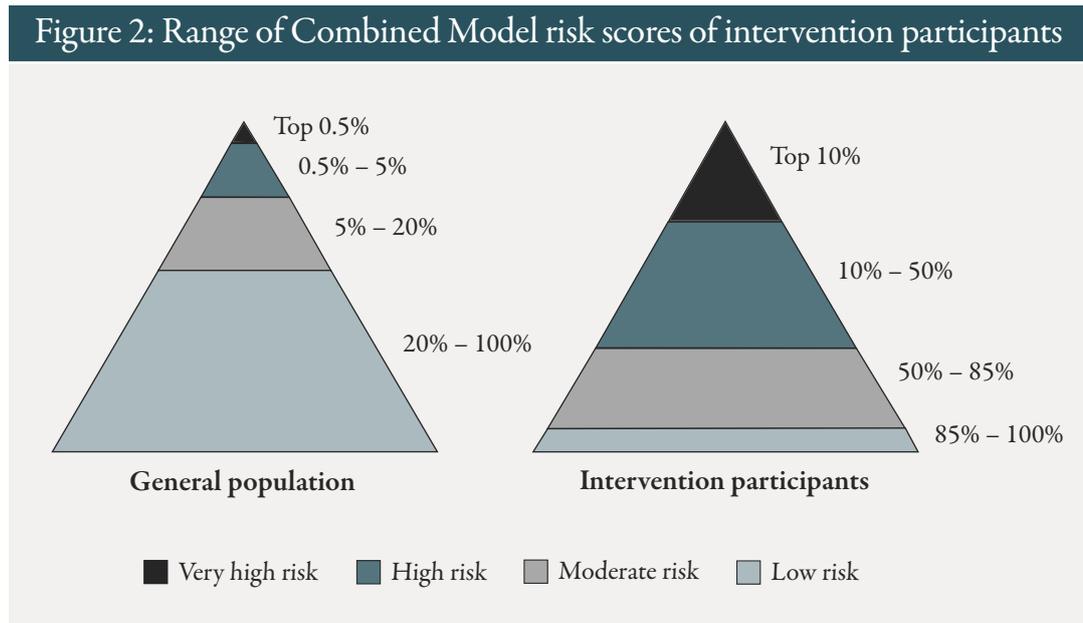
### Characteristics of people recruited

Across the three sites, 238 general practices agreed to participate in the trial. Of these practices, 179 provided participants and ultimately a total of 3,154 patients (1,584 control and 1,570 intervention) were enrolled into the trial and subsequently analysed. No large differences in baseline characteristics were detected between patients assigned to intervention and control.

Recruited patients tended to have more than one long-term condition (1.8 on average, according to inpatient data). For the purposes of analysis, patients were assigned a

‘principal’ condition: this was chronic obstructive pulmonary disease for 47.1 per cent of intervention patients, heart failure for 27.1 per cent and diabetes for 25.9 per cent.

The participants reflected a range of Combined Predictive Model risk scores. While very high-risk patients are often considered to be the top 0.5 per cent of the general population in terms of risk of emergency admission, they made up approximately 10 per cent of intervention participants. As the trial was not targeted on the highest-risk patients, around half of intervention participants were at low or moderate levels of risk, so were expected to have low levels of future emergency hospital use, even without intervention (see Figure 2).



### Impact on hospital use and mortality

Figures 3 to 8 show trends in hospital activity for the intervention and control groups. The breaks in the chart correspond to the start date; the charts summarise activity over a series of calendar quarters before and after this date. Rates of emergency hospital admission had peaked for both intervention and control groups around six quarters before the start of the trial. Following the start of the trial, emergency admissions increased for the control group, from 0.13 per head in the quarter immediately before to 0.18 per head in the quarter immediately after. After the initial increase in activity for the control group, rates of emergency admission for the two groups began to converge, although a difference in favour of the intervention group appears to have persisted for the whole of the 12 months of the trial. The aim of the statistical analysis was to test whether these differences between intervention and control patients were not the result of chance.

Of the intervention participants, 42.9 per cent experienced a hospital admission in the 12 months of the trial, compared with 48.2 per cent of controls. The analysis revealed that this difference was statistically significant, even after case-mix adjustment.

The emergency admission rate observed for control patients was low, reflecting the preponderance of low or moderate predictive risk scores. Control patients experienced 0.68 emergency admissions per head over the twelve months of the trial. In comparison, intervention participants experienced 0.54. Therefore intervention patients experienced

0.14 less admissions per person than controls, around 20 per cent fewer emergency admissions. This difference was significant in the unadjusted analysis and when adjusting for the predictive risk score. However, it was not quite statistically significant at conventional levels when adjusting for baseline characteristics.

Of the intervention participants, 4.6 per cent died within the 12 months, compared with 8.3 per cent of controls. This difference remained significant after adjustment for the predictive risk score, though adjustment for baseline characteristics could not be undertaken. Differences were detected in the number of days spent in hospital (4.87 days per person for intervention patients, compared with 5.68 for controls), perhaps because of the lower number of emergency admissions among the telehealth intervention group. Other aspects of hospital care such as elective admissions, outpatient attendances, and accident and emergency visits, did not in general produce statistically significant findings.

Cost-effectiveness is being addressed in a separate strand of the evaluation. Here, we considered notional costs of hospital care to NHS commissioners as a way of summarising overall levels of hospital use across inpatient and outpatient categories. Notional costs were £188 per head lower for intervention participants than controls. However, as costs per head tend to vary widely, this difference was not statistically significant, so could have been the result of chance. (The costs of the telehealth intervention are not included in these figures.)

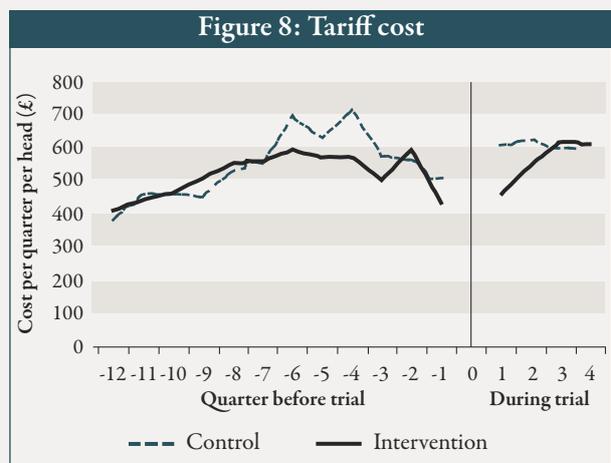
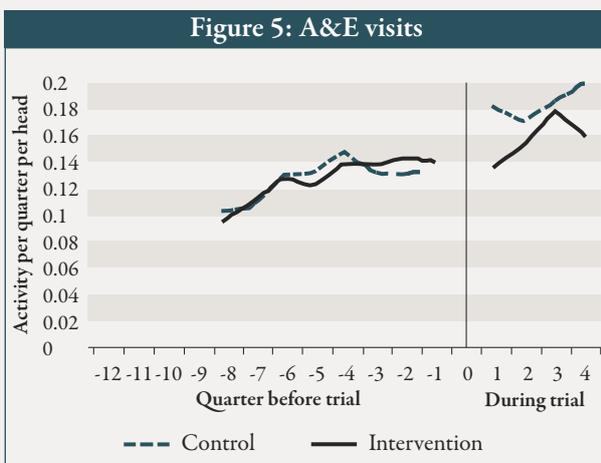
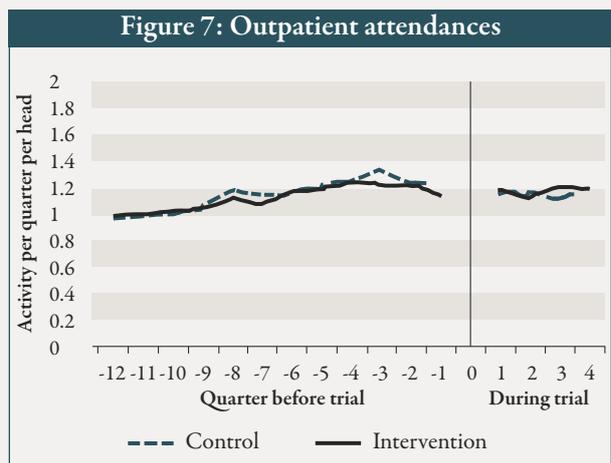
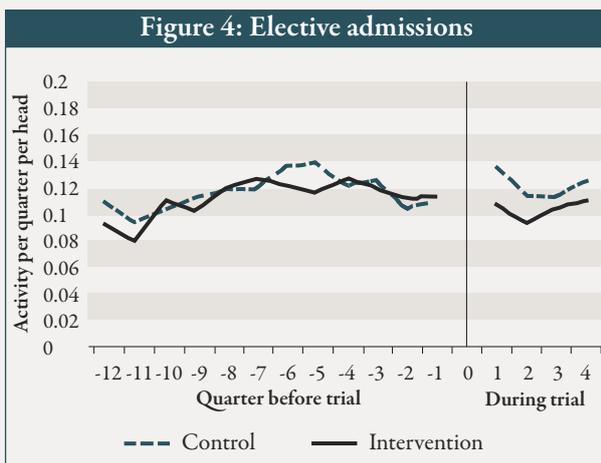
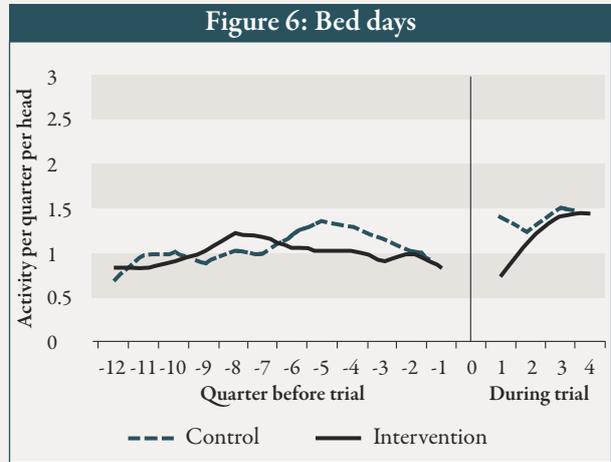
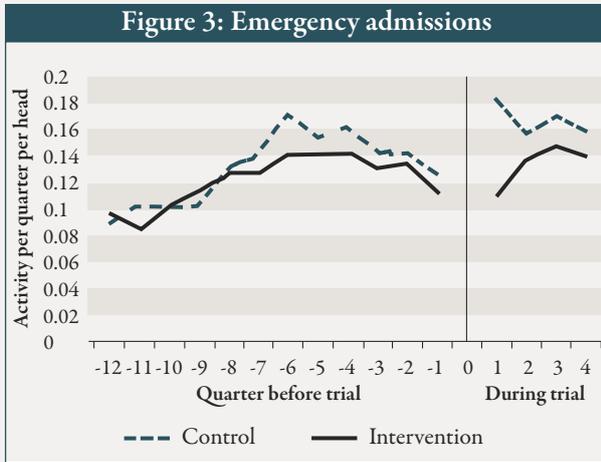
More detailed analysis is available in the *BMJ* article (Steventon and others, 2012).

## Discussion

This was the largest randomised controlled trial of telehealth conducted to date, with over 3,000 participants recruited from three areas of England. There were statistically significant differences in rates of emergency hospital admission and mortality during the twelve months of the trial between control and intervention groups. However, the numbers of emergency admissions experienced were relatively low, reflecting the low or moderate predictive risk scores of many of the patients recruited. Our best estimate of differences in the tariff cost of providing secondary care was therefore around £188 per person per year. Moreover, differences in secondary care costs were most likely due to chance, as they were not statistically significant. Similar interventions have cost more than our best estimate of the amount that was saved through reduced hospital care use (Giordano and others, 2009), so the full cost-effectiveness data are needed to understand the overall effect of telehealth on cost. These data are forthcoming.

Differences in emergency hospital admissions were most marked at the beginning of the trial, when they increased sharply in the control group. The timing of this increase suggests it is unlikely to be the result of usual care, so it may have been caused by the recruitment processes used in the trial. Therefore, telehealth may have different impacts in routine practice than in this trial. Differences detected in emergency hospital admissions may be considered attributable to telehealth, assuming that the factors that led to the increase among controls were equally likely to apply to the telehealth intervention patients. One theory for the increase is that some patients felt anxious after learning that their health condition warranted recruitment into the trial. This may have been particularly the case for patients allocated to usual care, as telehealth may have provided some reassurance to other patients. Alternatively, some of the clinicians who visited patients at the beginning of the trial may have detected additional health problems

Figures 3 to 8: Crude trends in hospital activity for patients recruited into the telehealth study



that later required hospitalisation among the control group, but could be managed through telehealth for other patients.

This was a large randomised trial, designed to evaluate the impact of telehealth over a twelve-month period. However, the findings relate to particular telehealth deployments in three sites in England, within the context of a Department of Health-funded pilot of integrated care supported by advanced assistive technologies. Telehealth may have different impacts in other settings. For example, another recent study found higher levels of mortality among telehealth patients than controls (Takahashi and others, 2012). Impacts may also vary according to the design of telehealth technology and monitoring systems, and the nature of preventive/supportive care received. Further, there could have been impacts over longer time periods than examined in this study, or on other services besides NHS hospitals.

### Further considerations

Although this trial found indications of an impact on emergency admissions, it did not conclude that there was a reduction in hospital costs due to telehealth. This does not mean that telehealth does not have an impact on costs, only that the differences observed in this trial could have been the effect of chance. However, many NHS QIPP (Quality, Innovation, Productivity and Prevention) efficiency plans assume financial savings from investment in telehealth. Commissioners, providers and policy-makers keen on introducing similar telehealth technologies should look carefully at this trial, both at the intervention and at how it was targeted, and consider whether it is necessary to refine the approach. Decisions made about introducing telehealth should also consider:

- the overall cost of the intervention
- impacts on quality of life and overall cost-effectiveness
- patient, carer and professional views
- organisational factors associated with implementation.

Detailed information from the other evaluation themes is forthcoming.

Opportunities may exist to improve the effectiveness of telehealth at reducing hospital admissions, beyond that reported here. Since the demonstrators were established, telehealth equipment, monitoring systems and cost models have all developed. Telehealth may demonstrate larger effects if targeted on patients with certain characteristics, such as those at higher risk of emergency hospital admission, though further work is necessary to determine whether this would be beneficial. It may be that new incentives can be designed, to improve the quality of preventive care offered.

To move forward appropriately there is a need to design interventions carefully, learning from this trial, and monitor the impact. Given that the funding for another large randomised controlled trial is unlikely in the near future, thought should be given as to:

- how to advise local commissioners on low-cost local evaluations that are good enough to show the impact of telehealth if implemented
- the desirability of low-cost, near-real-time surveillance of the impact on service use and cost, using nationally available data.

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