Building a business case for investing in adaptive technologies in England

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Summary

For thousands of dependent adults in England, equipment and adaptations play a vital role by allowing people to live independently in their own homes. Interventions vary from simple devices, such as grab rails, to major adaptations, such as stairlifts and bespoke bath and shower rooms.

The range of benefits that can be attributed to these interventions are well documented, both in terms of their impact on quality of life and – in some cases – the significant reduction in the demand for care that can be achieved through the avoidance, or delay in the onset, of the need for health and social care services. Few studies, however, have attempted to provide an *overall* picture of the benefits to the state and to the recipients of aids and adaptations in England.

The study described in this paper reviews and uses the evidence available in the literature to generate estimates of the overall costs and benefits associated with adaptive technologies. A quantitative model was constructed to provide a range of estimates, given a central, conservative and optimistic scenario.

Under the central scenario, the results suggest that equipment and adaptations lead to reductions in the demand for other health and social care services worth on average £579 per recipient per annum (including both state and private costs). In addition, the services lead to improvements in the quality of life of the dependent person worth £1,522 per annum. According to the conservative scenario (which incorporates more pessimistic assumptions about the outcomes achieved) reductions in the demand for health and social care equate to £261 per recipient per annum, with quality of life improvements valued at £1,379 per annum. According to the optimistic scenario, reductions in the demand for health and social care are estimated at £1,079 per recipient per year and quality of life gains at £1,723 per person per year. By comparison, in all scenarios the cost of providing the adaptations is estimated to be approximately £1,000 per individual per annum, taking into account the likely life expectancy of the equipment.

Based on the central scenario, a client base of 45,000 individuals receiving interventions (at a total cost of approximately £270 million, broadly equivalent to the total annual expenditure on Disabled Facilities Grants used to fund major adaptations), is likely to generate reductions in the demand for health and social care services worth £156 million over the estimated lifetime of the equipment, and to achieve quality of life gains of £411 million over the same period.

Low-level and preventative services are often an early target for budget cuts in times of fiscal austerity. However, as the present analysis demonstrates, reducing investment in these services can have significant implications for the demand for other health and social care resources. Taking into account the value of improvements in quality of life and reductions in the demand for care, the results in the study suggest that adaptive technologies generate important net social benefits in all of the scenarios explored. This is despite the fact that, due to the lack of appropriate evidence for use in a quantitative model, the analysis could not factor in other likely benefits, such as those for caregivers.

Executive summary

Background

For many dependent adults, the provision of adaptive technologies provides a means to independent living and a decrease in the reliance on support from family members or more costly social care services. At present, the two main sources of state funding for equipment and adaptations are through Community Equipment Services (for minor adaptations up to a value of £1,000, such as grab rails) and through Disabled Facilities Grants (DFGs) (for major adaptations up to a value of £30,000, such as stairlifts or bathroom modifications (Adams and Ellison 2009)). While costs of provision vary greatly by type of intervention, the majority of the research literature focuses on adaptations with an average value of approximately £6,000. Based on the average useful life of adaptations, these intervention costs equate to approximately £1,000 per year.

The research described in this report provides an evaluation of the outcomes associated with the provision of adaptive technologies at an economic level, and by extension the likely impact of increases or reductions in investment in the context of increasing constraints on social care budgets.

The analysis followed a three-stage process. The first stage was a systematic review of the literature in which the available evidence on the costs, effectiveness and outcomes associated with adaptive technologies was systematically collected and analysed. In the second stage, an analysis incorporating the findings gathered in the literature review was used to build a quantitative simulation model of the outcomes associated with aids and adaptations. At the final stage, the output of the literature review and model were used to inform a discussion around the policy implications.

Evidence from the literature

Much of the literature commonly cited in relation to adaptive technologies provides examples of the types of reductions in the demand for services – either at the individual level or locally through targeted pilot schemes – that can be achieved through equipment-based interventions. A review of the evidence on the costs and outcomes of housing adaptations, improvements and equipment conducted by Heywood and Turner (2007) on behalf of the Office for Disability Issues highlighted a number of examples of direct savings where the interventions led to substantial reductions in demand for other services. As an example, one London borough reported annual savings of £30,000 per client for two wheelchair users who were able to leave residential care due to the provision of adaptations in their homes. Another authority reported reductions in care costs of £1.98 million over five years as a result of an investment of £110,000 in 20 level-access showers.

Many of the costs that result from unmet equipment and adaptation needs are incurred through falls or as a result of the fear of suffering a fall. According to estimates provided by the Department of Health (DH 2009b), around one third of older people aged 65 and above will suffer a fall each year, with 2% of falls resulting in a hip fracture. Around half of those aged 80 and above will fall in a given year. The effectiveness of adaptations in averting falls varies between studies, although most of those identified suggested that adults lacking necessary adaptations were between 1.5 and 2.8 times more likely to suffer a fall than those where interventions were in place. Where incurred, a hip fracture is estimated to cost £10,170 in PbR tariff costs on average, with additional costs of £1,600 per community hospital admission (for around 20% of cases; each requiring an estimated stay of 8 days at £200 per day) and £400 per intermediate care referral (around 20% of cases, each requiring 20 hours of care at £20 per hour) (DH 2009b). Around one in ten cases will be discharged to a care home, and 60% will require additional home care.

In addition to the direct costs of falling, the fear of falling is in itself a strong predictor of institutionalisation. An unpublished 2005 report from Essex Learning and Social care reported in Heywood and Turner 2007 (Hill 2005 in Heywood and Turner 2007) claimed that 10 out of 183 people included in a study within the local authority of users of adaptations would otherwise have needed residential or nursing care, at an estimated average cost of £37,580 per person per annum.

Beyond the impact on the demand for health and social care services, the effects of unmet needs on mental health and independence is substantial. An evaluation of private sector housing improvement among adults in the UK reported in Heywood and Turner (2007) showed an average improvement of 6.2 points on the SF36 scale (an 8-scale profile of functional health and well-being) following heating, security and bathroom adaptations.

Modelled outcomes

The statistical model was built around a decision tree framework to simulate the distribution of effects encountered within a given population according to the likelihood of impacts such as falls, loss of independence and fear of falling.

The central scenario described by the model is based on what is perceived as the most likely set of pathways and outcomes, given the most reliable research literature and a conservative set of assumptions where strong evidence is not available. According to the central scenario, the benefits achieved through avoided health and social care contacts would equate to approximately £579 per older person in receipt of equipment and adaptations each year (see Table 1). Of this total, the reduced cost of healthcare (through both avoided falls and avoided delays in discharge) would amount to £120 per year (21%), the remaining £459 (79%) being accounted for by reductions in the demand for social care either following injury from falls, or due to fear off falls and reduced capacity to live independently.

In terms of QALYs, the combined effect of additional deaths, acute care episodes, increased levels of institutionalisation, disability, increased fear of falls and decreased independence in cases with unmet equipment and adaptation needs are estimated at -0.06 of a QALY per person per year on average (assuming an average QALY value of 0.75 for the corresponding population). At a value of £20,000 per QALY, this equates to a QALY gain of £1,522 per person per year in the base case scenario.

According to the low scenario, which assumes a more limited falls prevention effect and a smaller effect on the demand for social care services, the health and social care costs avoided would amount to £261 per person on average, with QALYs estimated at a value of £1,379. Under the high scenario, which assumes the highest effect on fall prevention suggested by the research literature, health and social care costs would equate to an average of £1,079 per person with unmet needs, with QALY gains of £1,723.

Table 1: Total gross modelled returns per older recipient of equipment and adaptations per year

	Scenario		
	Low	Central	High
Reduction in need for health and social care services			
Value to state	*£198*	*£394*	*£699*
Value to individuals	*£63*	*£185*	*£380*
Total value	£261	£579	£1,079
Value of Quality Adjusted Life Years (QALYs)			
	£1,379	£1,522	£1,723
Total combined value of reduction in need for services and QALYs			
	£1,640	£2,101	£2,802

Discussion

There are a number of caveats around the estimates provided given the limited availability of quantifiable evidence. Nonetheless, they provide an indication of the types of costs that are likely to be avoided through the appropriate provision of adaptive technologies according to a conservative range of estimates. In times of financial constraint, low-level and preventative services are often scaled back in favour of traditional care packages. The findings summarised in this report suggest that such moves would threaten not only to increase the burden on already-stretched services, but would also constitute a major step back in terms of the promotion of well-being and independent living cited in recent Green and White papers as being major drivers of improvements in social care delivery.

Background

The ageing of the population, reductions in the availability of informal care and increasing unit costs are placing significant added pressure on local councils' social care budgets. At a time of constrained public expenditure, this increase in demand for publicly funded care is resulting in marked changes in local patterns of support in terms of both preventative and 'traditional' care services. For many dependent adults, the provision of adaptive technologies provides a means to independent living and a decrease in the reliance on support from family members or more costly social care services.

The two main sources of state funding for equipment and adaptations are through Community Equipment Services (for minor adaptations up to a value of £1,000, such as grab rails) and through Disabled Facilities Grants (DFGs) (for major adaptations up to a value of £30,000, such as stairlifts or bathroom modifications (Adams and Ellison 2009)). Seventy per cent of recipients are older people, 25% are adults of working age and 5% are children and young people aged under 19 (Heywood *et al* 2005). The mean values of grants vary by significantly by age group and geographical region (Department for Communities and Local Government 2011).

According to Community Care Statistics data, the number of dependent adults receiving equipment and adaptations rose to a peak of 294,000 recipients in 2008/9; provisional data for 2010/11 suggest that this figure has now fallen to 2006/7 levels of around 242,000 recipients among all adult client groups. Total gross expenditure on equipment and adaptations as reported by the Information Centre has also fallen over this two-year period, from £240 million in 2008-9 to £236 million (according to provisional figures) in 2010/11.

By contrast, state investment in Disabled Facilities Grants has risen consistently since their introduction in 1990 – in January 2012 the Department of Health announced the allocation of an additional £20 million in DFG funding for 2011/12. Historically, central government has provided 60% of total DFG funding, the remainder being provided from local authority budgets; however, from 2008-9 local authorities were no longer specifically required to match this funding (Department for Communities and Local Government 2008). There are currently around 45,000 Disabled Facility Grants awarded each year (Communities and Local Government 2012).

Aside from these undulations in the overall level of provision, there are potentially substantial underlying levels of unmet need. Findings from the English House Condition Survey suggest that nearly one million households in England require some level of adaptation for one or more of their residents (Department for Communities and Local Government 2011). The estimated cost of meeting all eligible needs according to this figure was estimated at £1.9 billion in 2005; significantly more than the current total allocation for DFGs in England.

Scope and methodology

The purpose of this research is to evaluate the outcomes associated with the provision of adaptive technologies at an economic level, and hence to ascertain the likely impact of reductions in investment. Using available evidence, the analysis focuses on building a business case for aids and adaptations (rather than on calculating the net effect of changes in the use of resources by local authorities). It does this from a broad perspective, taking into account likely impacts on the health and social care systems and on the well-being of services users and their families. The findings provide the first estimate the outcomes of adaptive technologies at the national level.

Although the focus of this review is on the use of adaptive technologies by dependent adults in England, evidence is drawn from a wider range of countries and technologies. A number of terms are commonly used (mostly interchangeably) in the research literature, including ‘aids and equipment’, ‘aids and adaptations’ and ‘adaptive / assistive technologies’, and incorporate a range of technologies from minor adaptations such as grab rails, handrails and lever taps to major ones such as stairlifts, showers and ramps. Also included in some of the evidence base, although not central to the analysis, are certain *telecare* interventions such as fall sensors, flood alarms and other warning systems used to enable dependent people to live independently. The study did not consider the use or effectiveness of *telehealth* services, which involve the use of technology to deliver healthcare.

The analysis followed a three-stage process. The first stage was a systematic review of the literature in which the available evidence around the costs, effectiveness and outcomes associated with adaptive technologies was systematically collected and analysed. This review examined a wide range of possible costs and outcomes, such as impact on the well-being of users, the impact on carers and the impact on the use of other health and social care services.

A systematic search of the Thomson Reuters Web of Knowledge (including Web of Science), the Cochraine database, the Centre for Reviews and Dissemination (including the Database of Abstracts of Reviews of effects (DARE), and the NHS Economic Evaluation Database (NHS EED), Google and Google Scholar were searched using combinations of the keywords specified in Box 1. Lemmitisation (allowing for alternative permutations and spellings of words) was enabled where available to maximise the yield of positive results. Reference lists from relevant literature were then searched to identify any further publications missed through the systematic review.

Box 1: Search keywords

effectiveness	benefit	cost	economic	evaluation	prevention
aids	adaptations	equipment	assistive	adaptive	adaptations
stair lift	handrails	grab rails	lever taps	showers	ramps

In the second stage, the analysis incorporated the findings gathered in the literature review to build a quantitative simulation model of the outcomes associated with aids and adaptations. The model, based in Microsoft Excel, was structured around a decision tree framework to map the pathways and characteristics of individuals with unmet equipment needs, incorporating the probabilities, effects and costs of each of the quantifiable outcomes identified in the literature review. In keeping with the evidence available from research, the central assumptions of the model focus on the costs and outcomes associated with older people aged 65 and above who comprise the majority of users of equipment and adaptations.

Where no quantifiable information was directly available from research data, assumptions around likely effects have been made and additional sensitivity analyses conducted. Where conflicting evidence emerged from the literature review, alternative scenarios were incorporated into the model, allowing us to test the sensitivity of the results to alternative assumptions about the outcomes achieved.

Given the number of assumptions and permutations included in the model, it is not feasible to explore all combinations of estimates available from the literature. Instead, the results report three alternative scenarios: a central scenario, based upon the best-evidenced assumptions and a conservative estimate of potential benefits where sufficiently compelling evidence does not exist; a pessimistic scenario, based on evidence from studies that suggest the lowest levels of benefit from interventions; and an optimistic scenario, which incorporates evidence and assumptions that suggest the maximum level of benefit received.

As a final stage, the output of the literature review and model were used to inform a discussion around the policy implications. We examined the likely consequences of prospective reductions in the level of state investment in aids and adaptations in England, using the simulation model to quantify in monetary terms (as far as possible) the impact of shortfalls in the provision of aids and adaptations on a range of sectors of the economy (health, social care, etc.) with commentary around the key policy recommendations derived from the results.

Evidence from the literature

Case studies and success stories

A large volume of the literature commonly cited in relation to adaptive technologies provides examples of the types of reductions in the demand for services – either at the individual level or locally through targeted pilot schemes – that can be achieved through equipment-based interventions. Such evidence cannot always be translated into population-level projections since they tend to focus on selected individuals with a very unique set of circumstances. Nonetheless, they do provide a valid and informative illustration of the ways in which reductions in the demand for services are achieved in real-life scenarios.

A review of the evidence on the costs and outcomes of housing adaptations, improvements and equipment was conducted by Heywood and Turner (2007) on behalf of the Office for Disability Issues. This highlighted many of the ways in which adaptive technologies have been shown to result in direct savings to the state. In cases where institutionalisation is avoided or delayed, costs of adaptation tend to be recouped relatively quickly: two wheelchair users in a London borough who were able to leave residential care due to home adaptations each incurred a saving of £30,000 per year after the first year. Another authority was able to save a total of £4,900 in residential care costs per week following an investment of £37,000 in equipment, recouping the outlay in less than eight weeks. Net savings can also be achieved where the need for home care is either reduced or avoided outright: Heywood and Turner provide the example of one person requiring additional home care for 32 weeks at a total cost of £1,440 due to delays in the provision of a £300 adaptation.

In a submission addressing Comprehensive Spending Review questions, the Home Adaptations Consortium (2010) provided a list of illustrative efficiency savings, including reductions in the costs of assistance with bathing of £1.98 million over five years incurred by Newham Social Services as a result of installing 20 level access showers at a total cost of £110,000.

An evaluation of the cost implications of telecare provision in Scotland (Newhaven Research 2010) looked at the care packages of a sample of 'typical' users in Falkirk and Forth Valley and West Dunbartonshire as identified by care partnerships, who were then asked to specify the likely care arrangements if telecare were not in place. While some of the technologies included are not typical equipment and adaptations as is the focus of this paper, the study does include a number of users of equipment such as bath seats, grab rails and toilet raisers. Examples include an 89 year old male with dementia in receipt of a care package costing the local authority and NHS £6,527 per annum. In the absence of minor adaptations and a community alarm service, the care partnership estimates the alternative care package would instead cost around £32,850 due to the need for residential care.

The key benefits of aids and adaptations described in the research literature can be categorised in terms of: reductions in the need for social care services (either removing or delaying the need for care or reducing the amount of care required); reductions in the burden on health care services (in terms of avoiding injuries sustained either by clients or their carers) and improvements in wider outcomes such as quality of life and mental health. The latter is the most difficult to quantify in financial terms, but bears a well-documented correlation with positive financial outcomes.

Falls and injury prevention

Of the outcomes associated with adaptive technologies, the prevention of falls is the area most comprehensively covered by the research literature. In contrast with other outcomes considered in this study, a number of randomised control trials have been conducted to investigate the efficacy of various forms of intervention in preventing falls. There is also a good volume of quality information on the prognosis and care pathways associated with fall injuries, allowing us to map in detail the areas in which reductions in the demand for services can be achieved if injuries are avoided.

An economic evaluation of fracture prevention services published by the Department of Health (2009b) provides an estimate of the overall annual incidence of falls among older community residents (regardless of preventative interventions) and provides detailed approximations of the treatment pathways and diagnoses that follow falls. According to their estimates, 15,500 out of a population of 45,000 older people will fall in a given year. Of these, 2,200 will attend A&E and a similar number will call an ambulance. 360 older people are likely to have sustained a hip fracture and 890 will have sustained other types of fracture.

Estimates of the proportion of fall injuries that can be avoided through the provision of adaptive technologies vary somewhat. A recent review of fall prevention interventions conducted by the Cochrane Collaboration (Gillespie et al 2010) investigated the effectiveness of home hazard modification and personal mobility aids on the basis of six studies published between 1999 and 2001. The review found no statistically significant difference in the rate of falls as a result of home safety interventions (other than for those with a significant visual impairment) in the *overall* population; however, a subgroup analysis found that for those with either a history of falling or at a higher risk of falling, the number of falls sustained was significantly reduced where interventions were received.

A meta-analysis of eight trials that examined the effect of home hazard assessments conducted by the Centre for Health Economics Research and Evaluation in New South Wales (Church et al 2010) reported a lower overall rate of falling in intervention groups than control groups (RR= 0.70 (0.56, 0.88)).

The Healthy Communities Collaborative Pilot (HCCP), a scheme aimed at reducing the number of falls suffered by the elderly, found that the initiative (which included lighting improvements, installation of grab and stair rails, non-slip mats, exercise classes, improved footwear and eye tests) brought about a 32% reduction in falls in the older population (participants being 1.47 times more likely to fall without intervention) (Wanless 2004). This is broadly consistent with the results of a study of falls prevention among older people using a home intervention team that was reported by Nikolaus and Bach (2003; as summarised in Heywood and Turner 2007), which showed a control group to be 1.45 times more likely to suffer a fall than those receiving a suitable intervention.

A study of falls prevention in community- dwelling frail older people using a home intervention team (Mann and Ottenbacher et al (1999) as reported in Heywood and Turner (2007)) reported that 4 falls were observed in a treatment group, compared to 11 in a control group (the latter being 2.75 times more likely to suffer a fall requiring hospitalisation). Effects of a similar size were reported by Plautz et al (1996), which found members of a control group 2.78 times more likely to suffer a fall injury than those receiving an equipment-based intervention.

The likelihood of suffering fall injuries is also correlated with a number of other factors, the strongest predictor being past falls. A report published by the audit commission (2002) also found the probability of sustaining a hip fracture to be 1.5 to 2.4 times greater for those with reduced visibility. Heywood and Turner (2007) reported a 30% increased risk of fracture of the hip among older women if they are suffering from depression.

Where falls do occur, the costs incurred are determined largely by the diagnosis. Based upon 2009 costs, the Department of Health (2009b) estimates that each averted hip fracture yields healthcare average savings of £10,170 in PbR tariff costs, £1,600 per community hospital admission (for around 20% of cases; each requiring an estimated stay of 8 days at £200 per day) and £400 per intermediate care referral (around 20% of cases, each requiring 20 hours of care at £20 per hour). In addition to this, seven out of ten hip fracture patients are likely to require additional social care (see next section). Other common fall fractures – those of the humerus, spine and forearm – incur estimated mean PbR costs of £1,300, £3,246 and £1,082 respectively, in addition to social care needs. According to the Department of Health (2009), approximately half of those people who were previously independent become partly dependent following a hip fracture, while one-third become totally dependent.

Clearly, the provision of suitable aids and adaptations will not prevent all falls from occurring. However, it is important to note that additional reductions in the demand for services can still be accrued where equipment-based interventions are in place. Care and Repair Cymru (2006, in Heywood and Turner 2007) suggest that the average length of stay in hospital following a fall or critical incident may be reduced by up to a week when the necessary equipment is in place at home, potentially avoiding over £1,400 in extra costs due to delayed discharge.

Reducing the need for social care

A recent evaluation of fracture prevention interventions estimated that following hospitalisation, around one in ten hip fracture patients will be discharged directly to a care home on the basis of Hospital Episode Statistics data. This report estimated that the average placement will be for two years (Department of Health 2009c) at an average cost of £31,200 per year where received (this figure does not take into account how the care is funded, but the authors assume a 60:40 ratio of local authority funded places to self-funders . According to the same source, a further 60% of discharged patients are estimated to require additional home care as a result of injury, at an average intensity of four hours per day for six weeks. Approximately 20% of hip fractures die within 3 months and 30% within a year. It is assumed that the former will incur no social care costs.

As well as the increased short-term need for social care immediately following discharge from hospital, there is a wider correlation between fall risk and the demand for care. A history of falls and the fear of future falls occurring are commonly cited as strong predictors of institutionalisation, and are likely to lead to increases in the need for support within the home from both formal and informal care sources.

An American study investigating the link between falls and institutionalisation among older people (Dunn et al 2003) over a four-year period found a report of multiple falls at baseline to be associated with an increased risk of institutionalisation at both 2 years (odds ratio 3.1; 1.9-5.3) and at 4 years (odds ratio 2.6; 1.64.4) after baseline. This effect did not persist at a significant level once the number of difficulties with activities of daily living (ADLs) – a common measure of a person's physical dependency – was added to the model.

In a retrospective survey of 70 users of equipment and adaptations (Heywood 2001), one user had reportedly been brought out of residential care due to the provision of suitable home adaptations. A further four believed that institutionalisation would have been inevitable in the absence of equipment-based interventions, and one thought that entering residential care would have been a probability (although the timescales that these outcomes relate to cannot be derived). Based on PSS EX1 data, avoidance of one year's residential care fees will save on average £27,000 per older person aged 65 or over and £44,000 for an adult with physical disabilities (it is possible, however, that some of this would be offset if formal or informal support in the home is required).

An unpublished 2005 report from Essex Learning and Social care, reported in Heywood and Turner 2007 (Hill 2005), claimed that 10 out of 183 people included in a study of users of adaptations within the local authority would have needed residential or nursing care, at an estimated average cost of £37,580 per person per annum.

Where no fall injuries have been sustained, mobility problems that are not met through equipment and adaptations could also potentially lead to increases in the need for home care. In all likelihood this effect is likely to be small, particularly in the case of older people, since the small proportion of the population that are eligible to receive home care are likely to be of such a high level of dependency that they will continue to need personal assistance regardless of equipment being provided.

According to the most recent wave of the Personal Social Services (PSS) Survey of Adults receiving community equipment and minor adaptations (2009/10), 25% of a sample of 65,000 users of equipment and adaptations reported that they needed less help from others following receipt of their equipment or minor adaptation, and 18% that no help was needed from others. Just under half (49%) reported that the level of support required was unchanged, while 8% reported they now needed more help than they had before. Much of the reduction in the need for assistance is likely to be realised in terms of informal rather than professional care, however. A study by Adams and Gisbrook (1998, in Heywood and Turner 2007) found no evidence to suggest that the installation of level access showers led to any decrease in the need for formal care 12 months after provision.

Nonetheless, a number of studies investigated in Heywood and Turner (2007) do identify circumstances in which installation costs can be recouped through reductions in home care, with reported savings of up to £29,000 per year. However, since the unit costs involved are small in comparison to residential care (PSS EX1 figures for 2009/10 report an average cost of £17.60 per hour), the targeting of interventions is more critical to achieving a net economic benefit, particularly where life expectancy is likely to limit the total value received.

Wider outcomes

Beyond the immediate reductions in the demand for services available to funders of health and social care, adaptive technologies deliver the potential to achieve a wide range of benefits both to individuals and to society. While not all can easily be quantified in terms of financial return, to ignore these outcomes would be to misconstrue the key motivations for the provision of adaptive interventions. Even in cases where falls are not sustained, those with a fear of falling are at increased risk of suffering depression, mobility restrictions and social isolation (Boyd and Stevens (2009). According to the same study, 36% of older adults in the United States stated that they were moderately or very afraid of falling.

In addition to the increased risk of injury and demand for care, adults with unmet equipment and adaptive technology needs are likely to see a reduction in both quality of life and overall life expectancy. The avoidance of such outcomes is of substantial value from both a societal and a policy perspective, and requires a different method of quantification to the effects mentioned so far. Quality Adjusted Life Years (QALYs) provide a means of expressing the effect of interventions in terms of gains and losses in both the quality and quantity of life. According to this measure, each year lived in perfect health is assigned a value of 1, and death is assigned a value of 0. Where physical or mental health in negatively affected, the QALY is valued at a point between 0 and 1. The financial value of QALYs is usually evaluated through surveys in which people are asked how much they would be willing to pay for one additional year of survival in perfect health. The National Institute for Clinical Excellence (NICE) gives the example value of £20,000 per QALY (National Institute for Clinical Excellence 2008).

A study of the *health-related* quality of life (HRQoL) and cost implications of falls in older women (Iglesias et al 2009) found self-reported fear of falling to be the largest overall burden to morbidity, incurring an even greater negative effect on HRQoL than actual falls. Based on EQ-5D scores (a standardised measure of health outcomes), fear of falling was estimated to equate to a 6% decrement in a QALY per woman per year on average, whereas the QALY lost due to fractures was estimated at just a tenth of this amount. A report by the Centre for Health Economics Research and Evaluation, New South Wales (CHERE 2010) assumed a fear of falling decrement of 0.045, although this varied by age group.

According to the fracture prevention impact assessment conducted by the Department of Health (2009c), the QALY gains attributed to avoided hip fractures would equate to 0.75 on average. A separate study by Eastell *et al* (2001) estimated QALY losses through hip fractures to equate to 0.0833 for acute care, 0.6 for discharge to a nursing home for up to one year, and 0.3 for moderate disability. QALY losses for acute care resulting from wrist and vertebrae fractures are estimated at 0.04 and 0.03 respectively.

Self-reported feedback from equipment users suggests that adaptations provide an effective means of reducing fear of falls: according to the user survey described in Heywood (2001), 40% of recipients of major adaptations had fallen or had fear of falling. Nearly all recipients had this risk removed with adaptation. A survey of 54 recipients of adaptations (Baldwin 2003 in Heywood and Turner 2007) reported that 70% of respondents felt less at risk from accidents following intervention.

Heywood and Turner (2007) suggest that mental health improvements are the most consistent health outcome of housing interventions in small studies and in systematic reviews. An evaluation of private sector housing improvements among adults in the UK showed an average gain of 6.2 points on the SF36 scale (an 8-scale profile of functional health and well-being) following heating, security and bathroom adaptations. According to the findings of the 2009/10 PSS Survey of Adults receiving community equipment and minor adaptations, 70% of 48,961 older recipients reported that the equipment or adaptations received had made their quality of life much better, 26% reported it had made it a little better, 4% reported no effect, and the remaining 1% of respondents reported that their quality of life was worse. Among the 13,196 working-age respondents, 64% reported that the equipment/minor adaptation had made their quality of life much better, 30% reported it had made it a little better, 4% reported no effect, and the remaining 1% of respondents reported that their quality of life was worse.

The benefits associated with adaptive technologies are not all limited to immediate recipients of the intervention. Family and friends are likely to benefit to some degree, particularly if they provide informal care to the dependent person. As already noted, the 2009/10 PSS Survey reported that a quarter (25%) of recipients said they needed less help from others following receipt of their equipment or minor adaptation. Since the effects of adaptive technologies on home care receipt are (for older people at least) expected to be minimal, it is assumed that this figure relates mostly to informal care requirements.

Carers are also likely to benefit from reductions in rates of injury and quality of life improvements, either as the technology reduces the number of physical tasks with which they assist, or because the technology directly assists the caregiver as an additional user. A survey of carers conducted by Henwood (1998) found that 51% of carers had suffered a physical injury such as a strained back since they began to care. Nicholson, J (1999, in Heywood and Turner 2007) reported that 91% of carers of children that had to regularly assist with lifting and carrying reported musculoskeletal problems such as back pain (which was reported by 88%). Stairlifts, bathroom and toilet adaptations and ramps were among the most desired forms of assistance. Another questionnaire of carers of children cited in Heywood and Tuner found 21% of carers had problems due to insufficient equipment (Beresford and Oldman 2002).

Costs of provision

Adaptive technologies cover a number of interventions ranging from devices as simple as grab rails costing less than £100 on average, to bath/shower room adaptations with a mean cost of nearly £8,000. Even within technologies, major variations in costs are reported, mostly driven by differences in the scale of the individual projects undertaken. The cost of installing grab rails as published in the 2011 PSSRU Unit Costs of Social Care ranges from £4-£422, with a mean cost of £94. Costs of stair lifts range from £2,271 to £7,279 with a mean cost of £2,611, while new bathroom installations range from £3,785 to £34,063 with a mean cost of £7,774 (Curtis 2011). According to the annual costs summarised in Table 2, most modifications costing less than £500 are expected to last for around 6-7 years, although the cheapest items (grab rails) were expected to last for 16 years. Annual costs for more expensive items are expressed over a more variable time scale, ranging from 3 years to 9 years. Heywood and Turner (2007) estimate that typical major adaptations will last for at least 5 years.

Table 2: Costs of common types of adaptive technology

Equipment or adaptation	Mean	Median	Range		Median annual equipment cost
			Minimum	Maximum	3.5% discount
Additional heating	£429	£397	£144	£4,936	£48
Electrical modifications	£438	£512	£58	£3,908	£62
Joinery work (external door)	£507	£602	£261	£1,244	£72
Entry phones	£359	£487	£215	£3,051	£59
Individual alarm systems	£380	£445	£211	£958	£54
Grab rail	£94	£52	£4	£422	£6
Hoist	£934	2,608	£378	£8, 037	£310
Low level bath	£531	£665	£355	£1,441	£79
New bath/shower room	£7,774	£14,895	£3,785	£34,063	£1,771
Redesign bathroom	£1,423	£3,332	£473	£7,570	£396
Redesign kitchen	£2,873	£3,949	£694	£6,623	£470
Relocation of bath or shower	£1,059	£2,023	£178	£10,557	£241
Relocation of toilet	£864	£1,726	£169	£4,069	£205
Shower over bath	£945	£878	£209	£2,385	£104
Shower replacing bath	£2,582	£2,433	£467	£4,340	£289
Graduated shower floor	£2,395	£2,957	£1,227	£6,662	£352
Stair lift	£2,611	£3,293	£2,271	£7,279	£391
Simple concrete ramp	£646	£384	£66	£2,734	£46

Source: PSSRU Unit costs of Health and Social Care 2011

For the purposes of this study, the costs of the provision of aids and adaptations are based on the average annual costs of adaptation cited in the research literature in order to maximise the comparability between reported costs and benefits. While equipment costs are widely variable and outcomes can be achieved at a minimal cost in a number of cases, the majority of the research literature upon which the statistical model is based focuses on major interventions that would be provided through Disabled Facilities Grants. On this basis, it is assumed that interventions will cost approximately £6,000 on average and last for approximately six years, equating to an average annual cost of £1,000 including installation and maintenance.

Modelling outcomes

Using evidence from the literature and a range of informed assumptions, the quantitative model provides estimates of the likely outcomes associated with unmet equipment and adaptation needs. In light of the quality of evidence available, many of the outcomes – particularly when expressed in terms of cost – must be based on best estimates, with sensitivity analysis performed around various assumptions to take into account the level of uncertainty involved. Since there is very little evidence around the effectiveness of *individual* interventions, the model solely considers outcomes associated with a “package” of adaptive technology.

The majority of the evidence from the research literature relates to older people, although a number of the research findings suggest differences in the probability of certain outcomes according to age group. The need for home care receipt, for example, is more likely to be reduced among younger adults receiving aids and equipment than among older people, since the small minority of the latter who do receive home care are likely to be so frail as to continue requiring a similar level of formal support. Moreover, the unit costs involved vary according to age group, both in terms of the outlay on equipment and the unit costs of care where reductions in demand are achieved.

In order to model the range of outcomes consistent with a given population in need of equipment, a decision tree framework was constructed to simulate the distribution of clients according to the effects of non-receipt of interventions on their lives with regard to: whether or not falls occur; hospital attendances and types of injuries; and changes to lifestyle due to the perceived risk of injury. Each group represented in the decision tree was assigned to a separate ‘outcome group’, each of which assumed a unique set of costs and outcomes according to assumptions about the subgroups they represent.

Figure 1: Illustrative 12-month pathway based on 1,000 people with unmet equipment needs – central scenario

(illustrative numbers of people shown in red brackets)

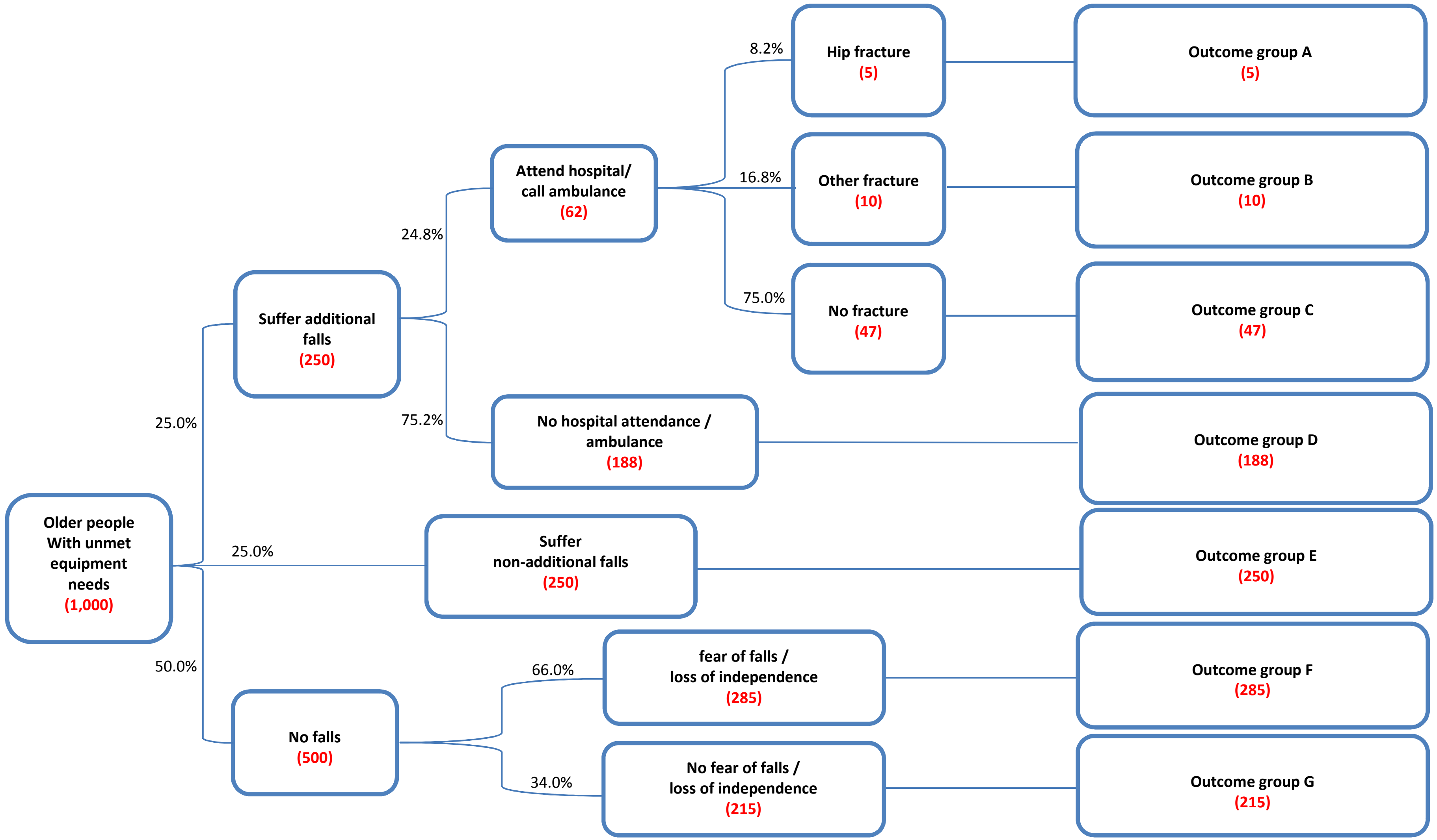

Figure 1 shows the estimated pathways associated with an illustrative 1,000 older people with unmet equipment needs in a given year, according to the central case of the model.

Based on the overall incidence of falls among older people, and the likely level of reduction achieved through intervention, we assume in the central case that 25.0% older people not receiving the necessary intervention will suffer *additional* falls (i.e. those that would not have occurred with equipment in place) in a given year. Fall prevention literature provides an estimate of the proportion of fall injuries that will be seen by an ambulance or attend a hospital (24.8%) and the subsequent distributions according to diagnosis (8.2% of hospitalised cases are assumed to be diagnosed as hip fractures, 16.8% as other fractures and 75% as non-fracture injuries). Since costs and outcomes involving hospitalisation are well documented, we can provide a reliable estimate of the immediate health and (short-term) social care costs.

More broadly, however, we can assume that fall injury will increase the likelihood of long-term institutionalisation due to an increase in the perceived risk of further falls, as well as increasing the probability of dependency on sources of informal care and incurring a negative impact on measures of mental health. Cases with *non-additional* falls (those that would have occurred even with equipment in place) will still incur an additional healthcare cost, since the lack of suitable adaptations at home are likely to results in prolonged hospital stays. Those who do not experience falls but experience a loss of independence and increased fear of falling due to unmet equipment needs are also assumed to have an increased likelihood of institutionalisation or requirement of alternative forms of care than those reporting no fear of falls or loss of independence, as suggested by user experience surveys (Heywood 2001).

Results

The central scenario described by the model is based on what is perceived as the most likely set of pathways and outcomes given the reliable research evidence and a conservative set of assumptions where strong evidence is not available. According to the central set of assumptions, older people with unmet needs will be twice as likely to suffer a fall in the absence of equipment or adaptations, meaning that *additional* falls will be suffered in approximately 25% of cases. Where hip fractures occur (in around 2% of falls), it is assumed that 10% of hospitalisations will be discharged to a care home and 60% will require additional home care. In addition, it is assumed that there will be a 2%

probability of institutionalisation among those who report fear of falling without equipment in place and 3% among those who have already suffered a fracture during the year. Where hospitalisation due to falls is likely to have occurred even with adaptations in place (estimated in the central scenario to be equivalent to the number of falls avoided), it is assumed that hospitalisations would involve an additional 7 bed days due to delayed discharge.

According to the central scenario, the outcomes achieved through avoided health and social care contacts would equate to approximately £579 per older person in receipt of equipment and adaptations each year (see Table 1). Of this total, the reduced cost of healthcare (through both avoided falls and avoided delays in discharge) amounts to £120 per year (21%), the remaining £459 (79%) being accounted for by reductions in the demand for social care either following injury from falls, or due to fear off falls and reduced capacity to live independently. Assuming a 60:40 ratio of state-to-private funding for residential care and 50:50 for home care (Department of Health 2009b), the total costs avoided by NHS and social care budgets would be £394 per person, in addition to £185 in annual social care costs on average.

At £579, the direct health and social care returns do not yield a net financial benefit on the basis of an average annual cost of around £1,000 for providing equipment and adaptations. However, the central scenario provides only a conservative estimate of the effect that the risk of falls and barriers to independence have on the rate of institutionalisation. Surveys and evaluations of service users reported in Hill (2005) and Heywood (2001) suggest that between 5.5% and 8.6% of users of equipment and adaptations would have otherwise needed residential care, whereas the central assumption of the model assumes that only 1.5% of all cases will require long-term residential care (including cases where no fear of falling is reported). In part this is due to the lack of reliability of self-reported data (although there are reasons why opinions may result in under-estimates as well as over-estimates). Since the only sources available looked at service users without comparison to a control group, assumptions as to the overall effect on institutionalisation have been treated with caution. Moreover, since the estimates uncovered in the literature review did not provide a timescale for their assumptions, we cannot assume that all cases would have resulted in institutionalisation within the 12-month timescale covered by the model.

The estimated returns accrued through reductions in demand for health and social care do not take into account the substantial gains in well-being achieved through increased independence and other mental-health related outcomes. In terms of QALYs, the combined effect of additional deaths, acute care episodes, increased levels of institutionalisation, disability, increased fear of falls and decreased independence in cases with unmet equipment and adaptation needs are estimated at -0.06 of a QALY per person per year on average (assuming an average QALY value of 0.75 for the corresponding population). At a value of £20,000 per QALY, this equates to a QALY gain of £1,522 per person per year in the base case scenario (Table 3).

Table 3: Total gross modelled returns per older recipient of equipment and adaptations per year

	Scenario		
	Low	Central	High
Reductions in need for health and social care services			
Value to state	*£198*	*£394*	*£699*
Value to individuals	*£63*	*£185*	*£380*
Total value	£261	£579	£1,079
Quality Adjusted Life Years (QALYs)			
	£1,379	£1,522	£1,723
Total combined value of reductions in demand for services and QALYs			
	£1,640	£2,101	£2,802

The low benefit scenario assumes that adaptive technologies have a far more limited effect on preventing falls, with falls only 1.5 times as likely to occur in the absence of an intervention. Furthermore, additional social care costs are only linked to cases where falls have occurred during the year, it being assumed that the fear of falling and losses to independence due to a lack of equipment to not directly lead to any increase in institutionalisation. At an average value of £261 per person per year this amounts to less than half the central estimate, mostly due to the limited effects on residential care that are assumed (accounting for only 60% of total costs at £158 per year, the remaining 40% (£103) being accounted for by health care costs. Taking into account the QALY gains estimated in the low-effect scenario, however, the total benefits accrued in the central scenario still exceed the annual costs of outlay: the estimated QALYs gained through provision equate to an annual average of £1,379 per person (Table 3).

The high-effect scenario incorporates the most optimistic fall-prevention effects implied by the research literature, and assumes that clients with unmet equipment needs are 2.78 times more likely to suffer a fall than those receiving equipment or adaptations. The rate of institutionalisation where recent falls have not taken place, but clients are likely to fear falls or report restrictions to mobility, is assumed to be 4% (equivalent to 3.2% of all clients with unmet equipment or adaptation needs). According to this scenario, the total annual health and social care costs avoided by addressing unmet needs for equipment and adaptation equate to £1,079 per person per annum, of which 12% (£135) are health costs and the remaining 88% (£945) social care costs. Under this scenario, the cost of QALYS where equipment needs are not met equals £1,723 per person (Table 3).

Assuming that the modelled benefits are achieved for a mean period of six years following the installation of adaptive technologies, the total value of reductions in demand for health and social care accrued by 45,000 recipients from adaptations costing £6,000 on average (i.e. a total outlay of £270 million[1]) would equate to £156 million over the lifetime of the adaptations and on the basis of the central assumptions of the model (see Table 4). The QALY gains yielded on the same basis would equate to £411 million (giving a combined value of £567 million in total). According to the low scenario, reduced demand for health and social care yielded by adaptive technologies would be worth £70 million with QALY gains of £372 million over the lifetime of the interventions. The high scenario assumptions imply a total benefit of £291 million in health and social care costs and QALY gains of £465 million, on the basis of 45,000 recipients of adaptations.

Assuming a consistent level of benefit is derived from interventions, increasing the client base by an additional 15,000 people (at an additional cost of £90 million) would provide reductions in demand for health and social care savings worth £52 million under the central scenario, compared to the base client level of 45,000 people, as well as additional QALY gains of £137 million over the lifetime of the adaptations provided (see Table 4).

[1] This figure is broadly comparable with total annual expenditure on Disabled Facilities Grants (DFGs), one of the main sources of funding for major adaptations. The quantitative model incorporates users of a wider range of equipment and adaptations than would be covered by DFG funds alone, however.

Table 4: Estimated costs and benefits over the lifetime of adaptations according to alternative levels of take-up and sensitivity scenarios

Number of clients	30,000	45,000	60,000
Total costs of adaptations (£)	£180,000,000	£270,000,000[1]	£360,000,000
Returns (low scenario)			
Reduction in health and social care demand (£)	£46,980,000	£70,470,000	£93,960,000
QALY returns (£)	£248,220,000	£372,330,000	£496,440,000
Return net of costs (£)	£115,200,000	£172,800,000	£230,400,000
Returns (central scenario)			
Reduction in health and social care demand (£)	£104,220,000	£156,330,000	£208,440,000
QALY returns (£)	£273,960,000	£410,940,000	£547,920,000
Return net of costs (£)	£198,180,000	£297,270,000	£396,360,000
Returns (high scenario)			
Reduction in health and social care demand (£)	£194,220,000	£291,330,000	£388,440,000
QALY returns (£)	£310,140,000	£465,210,000	£620,280,000
Return net of costs (£)	£324,360,000	£486,540,000	£648,720,000

Limitations and caveats

The biggest single limitation when modelling the economic benefits of investment in adaptive technologies is the dearth of quality *scalable* evidence. Evidence that adaptive technologies *can* pay their way is abundant; but while the evidence base around fall prevention is reasonably strong, indicators of wider benefits achieved with an average case are scarce at best.

In keeping with the evidence that *is* available from the research literature, the model investigates the outcomes associated with overall receipt compared to non-receipt of equipment and adaptations. The model does not attempt to differentiate between different types of intervention, although clearly there is likely to be significant variation in the costs and outcomes associated with different forms of equipment.

Since funding for equipment and adaptations can be derived from a range of sources, average costs of provision are calculated on the basis of the average reported costs of equipment and adaptations according to the research literature, and as such are not based on any single measure such as Disability Facilities Grant provision (although for much of the evidence base this is the main source of funding). While this constrains the ability to map results according to specific policy changes, it ensures that the costs and benefits achieved are modelled from a consistent set of sources.

The evidence used to inform the model is largely representative of people eligible for state-funded adaptations in terms of physical dependency, and can be used to estimate the effects of limited increases or decreases in state provision. It should not, however, be assumed to be indicative of the average effects likely to be observed if equipment and adaptations were provided to a *substantially* different proportion of the population, such as those with identified equipment needs as described by the Department for Communities and Local Government (2011), who are likely to have a different set of characteristics to the modelled population.

By far the bulk of the evidence around outcomes relates to older people. As such, the structure of the model is most directly applicable to this client group. For working age adults, some adjustments have been made to allow for likely differences in patterns of use, costs of interventions and other services and achievement of outcomes.

Costs of equipment and adaptations tend to be paid upfront and, while some will require on-going maintenance, expenditure differs from most traditional care services in that it involves irregular, one-off payments rather than an on-going package of care. Since the lifespan of technologies differs, the costs and benefits estimated by the model are based on an assumed average cost per year. Outcomes of the services (such as reduction in the demand for health and social care following a hip fracture) are reported on the basis of the first year of provision – and where a hospital stay is followed by residential care, we take into account a full year's residential care costs, assuming the average length of stay is no shorter.

The model only provides estimates of average effects rather than of the full range of scenarios covered in the literature. The range of benefits associated with adaptive technologies is also likely to go beyond those included in the model: cohabitants, in particular providers of informal care, are likely to benefit. Research literature suggests carer injuries to be common (Henwood 1998, Nicholson 1999, Beresford and Oldman 2002) and this risk may be alleviated by the intervention, although such effects have not been modelled since the evidence relates primarily to carers of children and does not provide a quantifiable estimate of the likely effect of equipment-based interventions.

Discussion

The outcomes of adaptive interventions can broadly be broken down into two categories: direct returns, where the need for health or social care services are avoided or delayed through intervention; and wider outcomes, where improvements in independence, well-being and mental health are achieved without necessarily impacting on interactions with traditional services.

Although less easily quantified in terms of financial returns, the importance of wider outcomes cannot not be downplayed when assessing the business case for adaptive technologies. According to a Department of Health report on fracture prevention services (Department of Health 2009), 80% of older women surveyed said they would rather be dead than experience the loss of independence and quality of life that results from a bad hip fracture and subsequent admission to a nursing home. In times of fiscal austerity, however, low-level and preventative services are often the first target for budget cuts. Yet as the estimates demonstrate, reductions in the provision of equipment and adaptations are likely to generate higher levels of demand for other health and social care services, as well as lead to significant reductions in the well-being and independence of dependent people.

The quantitative model provides a range of estimates of the costs and benefits of adaptive technologies, rather than a comparison of their cost effectiveness relative to other forms of intervention or service. The results suggest that adaptive technologies provide a good return on investment according to all three of the scenarios described. The value of reductions in demand for health and social care equates to more than half of the cost of provision according to the central and optimistic scenarios, and the total value of benefits including quality of life gains far exceed provision costs in all sensitivity scenarios included in the model.

Needless to say, costs and outcomes will vary significantly at the individual level, and the extent to which an adaptation can be justified in purely economic terms is largely dependent on the type and cost of adaptation. The costs of installing grab rails, which can equate to as little as £6 per year, are easily recouped if they are effective in avoiding even a small fraction of falls. From a financial perspective, more costly interventions such as bathroom adaptations invariably require more careful targeting to ensure that they provide a means of delaying, reducing or avoiding reliance on traditional care services, and that they are likely to be used for a sufficiently long period of time to offset the initial outlay.

As already mentioned, the assumptions of the model are based on the characteristics of typical users of adaptations, and the outcomes achieved will vary according to levels of dependency of the targeted individuals. Assuming services are targeted on users with similar characteristics to current recipients, the central scenario (summarised in Table 5) suggests that for each pound invested in adaptive technologies, a return of 58 pence is achieved through reduced demand for health and social care services, and quality of life gains with a value of £1.52.

Table 5: Estimated returns per pound invested in adaptive technologies

	Scenario		
	Low	Central	High
Health and social care returns (£)	£0.26	£0.58	£1.08
QALY returns (£)	£1.38	£1.52	£1.72
Total value of returns (£)	£1.64	£2.10	£2.80
Total return net of cost (£)	£0.64	£1.10	£1.80

The total current expenditure on equipment and adaptations from all services is difficult to estimate. On the basis of approximately 45,000 clients receiving adaptive technologies each year at an average cost of £6,000 (broadly comparable to the volumes and costs associated with DFGs), an annual outlay of £270 million would be likely to generate reductions in the demand for health and social care services worth £156 million over the estimated lifetime of the equipment, and to achieve quality of life gains with a value of £411 million over the same period, assuming the central modelled scenario (as summarised in Table 4). Increasing the client base to 60,000 at an additional cost of £90 million would yield additional reductions in demand for health and social care worth £52 million as well as additional QALY gains of £137 million over the lifetime of the adaptations provided.

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