PREVENTING UNINTENTIONAL INJURIES AMONG UNDER-15s IN THE HOME

Report 3:

Cost-effectiveness modelling

of home based interventions aimed at reducing unintentional injuries in children

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About the Peninsula Technology Assessment Group (PenTAG)

The Peninsula Technology Assessment Group is part of the Institute of Health Service Research at the Peninsula Medical School. PenTAG was established in 2000 and carries out independent Health Technology Assessments for the UK HTA Programme, systematic reviews and economic analyses for NICE (Technology Appraisals and for the Centre for Public Health Excellence) and systematic reviews as part of the Cochrane Collaboration Heart Group, as well as work for other local and national decision-makers. The group is multi-disciplinary and draws on individuals' backgrounds in public health, health services research, computing and decision analysis, systematic reviewing, statistics and health economics. The Peninsula Medical School is a school within the Universities of Plymouth and Exeter. The Institute of Health Services Research is made up of discrete but methodologically related research groups, among which Health Technology Assessment is a strong and recurring theme.

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Collaborations

Up until the end of June 2009, our work for the NICE Centre for Public Heath Excellence was carried out in close collaboration with the West Midlands Health Technology Assessment Centre (WMHTAC) at the University of Birmingham. They were not, however, directly involved in producing this report.

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Declaration of authors' competing interests

No authors have competing interests.

List of abbreviations

Abbreviation	**Meaning**
AIC	Academic in Confidence (applied to data)
CAPT	Child Accident Prevention Trust
CBA	Cost-benefit analysis
CEAC	Cost-effectiveness acceptability curve
CI	Confidence Interval
CUA	Cost-utility analysis
GAD	Government Actuary's Department
GB	Great Britain
GDP	Gross domestic product
HASS	Home Accident Surveillance System
NB	Net benefit
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NPV	Net present value
ONS	Office for National Statistics
PenTAG	Peninsula Technology Assessment Group
PSA	Probabilistic Sensitivity Analysis
QALY	Quality-adjusted life-year
RoSPA	Royal Society for the Prevention of Accidents
UK	United Kingdom
USA	United States of America
WMHTAC	West Midlands Health Technology Assessment Collaboration

Glossary

Term	Definition
Base case analysis	The main analysis based on using the 'best' or most likely values for all relevant model assumptions and input parameter values
Cost-benefit analysis	An analysis comparing the incremental resources used as a result of an intervention to the incremental benefits gained, valued in monetary terms, over another intervention
Cost of illness study	A type of economic study which estimates the overall burden to society, in cost terms, of a disease or condition. It does not involve estimating either the costs or effectiveness of specific interventions or programmes to prevent or treat those diseases or conditions.
Cost-utility analysis	An analysis comparing the incremental resources used as a result of an intervention to the incremental health benefits gained as expressed in quality-adjusted life-years, over another intervention (and where the quality of life weighting for added/lost years of life is based on people's preferences for those health states relative to full health (=1) or being dead (=0))
Deterministic analysis	An analysis based on point estimates for each input parameter (in contrast to probabilistic sensitivity analysis, where parameter values are specified as distributions of possible values)
EQ-5D	A preference-based patient-reported instrument for the measurement of generic (i.e. non-disease-specific) health-related quality of life.
Incremental cost-effectiveness ratio	The incremental cost of an intervention divided by the incremental benefit of that intervention compared to an alternative intervention
Incremental benefit	The difference in benefits between two interventions
Incremental cost	The difference in cost between two interventions
Net benefit or net present value	The total monetary benefit of an intervention less its costs (compared with an alternative intervention) when discounted to its present value.
Probabilistic Sensitivity Analysis	An analysis conducted to quantify the decision uncertainty which arises from the uncertainty of all the parameter estimates used as model inputs. Involves defining a distribution of possible values for each uncertain input parameter and then sampling from those values for a large number of simulated individuals.
Quality-adjusted life-year	Year of life adjusted for quality of life (usually using population preferences)
Rate of return	The total benefits of an intervention as a percentage of the total costs of the intervention in a given time period
Utility	Preferences groups or individuals have for a particular set of health states
Willingness to pay	The amount that a government department or society is willing to pay to obtain the specified benefits

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1. Summary

1.1. Introduction

This report describes economic modelling which explores the cost-effectiveness of selected home based interventions which have a primary or significant purpose of reducing injuries in the home. It is the third of three reports to support the development of NICE public health intervention guidance on preventing unintentional injuries to children and young people (aged less than 15) in the home.

1. Report 1: presents the systematic review of effectiveness studies and a systematic review of economic evaluations and UK-based costing studies
2. Report 2: presents a systematic review of qualitative research studies relevant to understanding to barriers to and facilitators of successful and effective programme implementation
3. Report 3: This report, describing some economic modelling of selected types of programme and aspects of them.

There are very few previous economic evaluations of the types of programme of interest: only two of safety device supply and installation programmes (Ginnelly et al. 2005;Haddix et al. 2001), and one of a home risk assessment visit with the provision of discount vouchers for purchasing safety equipment (King et al. 2001). While the economic evaluation of a smoke alarm give-away scheme in the UK (provided in central London in the late 1990s) uses a simple decision model, it appears that the model was primarily to facilitate a probabilistic sensitivity analysis around the main trial-based estimates of cost and effectiveness (Ginnelly et al. 2005). This study therefore gives few insights into the key trade-offs between resources and outcomes within such programmes, which might have informed the development of our decision model.

A note on the purpose of our decision modelling

In our view, the development and use of a decision model within the context of the development of public health guidance has multiple purposes. First, depending on the amount and quality of cost and effectiveness data available about a specific type of past interventions, a model can be used to produce a more accurate estimate of the relative costs and effects of an intervention in the longer term and for the ultimate outcomes of interest (i.e. extrapolating beyond the time-horizon of the trial data, and converting data on injury severity into quality of life impacts and QALYs). This, in some cases, is effectively re-estimating the cost-effectiveness of a past programme as it was implemented at the time and in the locality it was actually implemented.

However, to inform policy making (i.e. public health guidance development) this is less useful than using models to predict the cost-effectiveness of *similar or the same programmes* and if they were to be implemented *in other communities and localities, tomorrow*. This is subtly but importantly different, because it requires that a decision model combines some supposedly transferrable information from the original study or studies, with new data on the setting, existing policies or population where the policy or programme may be implemented. A further feature of decision modelling to inform policy making is that, in the absence of sufficient information to produce reliable cost-effectiveness estimates the focus of the analysis generally shifts away from producing a single main estimate. Instead, it is often more useful in such circumstances to use the model as an exploratory tool, to identify the probable key factors which alter cost-effectiveness estimates. Due to the absence of good or any research data on many key variables, we believe the following analyses are best viewed as adopting this latter approach.

1.2. Aim

The aim of the economic modelling was to conduct a cost-utility analysis of the lifetime costs and effectiveness of relevant home safety interventions. The following comparisons, based on recent economic evaluations in the UK (so that there are relevant in terms of costs, effects and benefits to NICE) were evaluated:

- Supply and Installation of Free Smoke Alarms vs. no intervention
- General home safety consultation and equipment provision* vs. no intervention

*General home safety programme includes measures such as: home safety consultation visits, provision of educational materials and advice, as well as the free supply and installation of a range of home safety equipment (including smoke alarms, stair gates, cupboard and window locks etc).

1.3. Methods

In our analysis we used a two-stage model. Firstly, the effectiveness of a home safety intervention in improving the adoption level of a safety feature in the population is analysed using a decision tree structure. This accounts for existing prevalence of installed equipment and acceptance rate for the intervention amongst those in the modelled population who do not have the installed feature. This decision tree, referred to below as the *Intervention Model*, is also used to estimate the costs of implementing the intervention.

The second stage of our model, referred to as the *Outcomes Model,* uses a simple Markov state-transition structure to estimate the marginal cost-utility of intervention outcomes over time. The Outcomes model uses the levels of installed safety equipment in the population derived from the Intervention Model as its primary inputs. It then models the outcomes in terms of injuries and fatalities for the lifetime of the population cohort. The cost-utility analysis is undertaken from the perspective of the UK NHS and personal social services.

The important effectiveness parameters within the intervention decision tree are: existing prevalence of an intervention (i.e. the percentage of households with the safety equipment already installed), the acceptance of the intervention amongst those households lacking the safety equipment, and the proportion of successful implementation of the equipment amongst accepting households.

Within the Markov model, three levels of injury severity are modelled: fatal, permanent, and minor. Death from other causes is also modelled. In addition, a decay function is included in the model to account for the loss of function of an intervention over time. For example, the loss of smoke alarm function over time due to removal or non-replacement of batteries or poor maintenance. In the model where child-specific safety equipment is provided (eg. Stair gates, cupboard latches) this decay function can also be used to reflect the reduction in use of a safety feature as children become older.

All costs associated with the implementation of a home safety intervention were estimated in our decision tree model, these are broken down into fixed and variable costs according to the targeted population. Costs associated with the outcomes due to injuries, fire service and property damage between compared arms were derived from the Markov outcomes model.

One-way deterministic sensitivity analysis and probabilistic sensitivity analyses were undertaken to explore parameter uncertainty. Results from the cost-utility analyses are presented in terms of the incremental cost per QALY (i.e the Incremental Cost-Effectiveness Ratio, or 'ICER'). In the base case analyses, all results are presented for a time horizon of a hundred years from the application of an intervention to encompass all potential outcomes. In the CUA, lifetime health costs and benefits (QALYs) associated with casualties saved due to the intervention are estimated.

1.4. Findings

Table 1 below shows the base case results for smoke alarm comparison intervention and a series of three outputs from general home safety programme based on three differing levels of assumed relative risk of injury (for homes with vs without the child home safety devices). In the latter case we were unable to assign a base case value to the relative risk since no reliable data could be found for this crucial model parameter.

Given all the various assumptions and input parameters in the model, the smoke alarm give-away scheme would be judged as probably cost-effective according to the decision rules used by NICE for approving new technologies. However, there are a great many uncertain parameters in this model, and it should be noted that the empirical evidence of the effectiveness of such schemes is inconsistent.

The cost-effectiveness of the home safety assessment with safety equipment is highly sensitive to the relative injury risk reduction (or efficacy) of the various child safety devices, which again we have no reliable estimates for from the research literature (the ICER varies from £187,000 to £20,000 even when the risk reduction for these devices changes from 1.0 to 0.95). NB the scheme is still effective with a risk ratio of 1.0 because these schemes also included smopke alarms, with a base case risk reduction of 0.5)

Table 1 : Main cost-benefit and cost-utility results (with discounting)

ARM	TOTAL Prog. Costs	TOTAL Outcome Costs	Total Costs /household	Total QALYs / household	Incremental Cost Eff'ness Ratio (£s/QALY)	Net Benefit £20K/QALY / household	Net Benefit £30K/QALY /household
FREE SMOKE ALARM SCHEME							
Control	£0	£1,793,732	**22.42**	**51.7817**			
Intervention	£232,982	£1,776,979	**25.12**	**51.7818**			
Difference	£232,982	-£16,753	**£2.70**	**0.0001**	**£23,046**	-£0.36	£0.82
GENERAL HOME CHILD SAFETY PROGRAMME							
Relative Risk of injury in households with vs without safety devices (non-smoke alarm components) = 1							
Control	0	£2,095,349	1222.49	77.4799			
Intervention	£38,702	£2,095,087	1244.92	77.4800			
Difference	£38,702	-£262	22.43	0.0001	**£187,154**	-£20.03	-£18.83
Relative Risk of injury in households with vs without safety devices (non-smoke alarm components) = 0.99							
Control	0	£2,093,553	1221.44	77.4802			
Intervention	£38,702	£,2092,290	1243.29	77.4805			
Difference	£38,702	-£1,262	21.84	0.0003	**£75,718**	-£16.07	-£13.19
Relative Risk of injury in households with vs without safety devices (non-smoke alarm components) = 0.95							
Control	£0	£2,086,318	£1,217.22	77.4812			
Intervention	£38,702	£2,081,039	£1,236.72	77.4821			
Difference	£38,702	-£5,279	£19.50	0.0010	**£20,207**	-£0.20	£9.45

Sensitivity analyses

Our economic modelling serves mostly to demonstrate that "it all depends": the cost-effectiveness of the types of child injury prevention programme which are the focus of this NICE Guidance depend critically on a number of factors for which there will be no consistent average value for. Our sensitivity analyses show the following factors to be the most important:

- The discount rate applied to QALYs, together with the time horizon – this is because the incremental benefits due to permanent or fatal injuries avoided are accrued over the time horizon of the model (up to 100 years) and hence the rate at which these are discounted impacts on the ICER.

- Population targetted and household sizes – significant changes to the underlying population included in the intervention will affect the ICER since the fixed costs of the programme remain the same. Smoke alarms confer benefit on all members of a household, so an increase in the average size of households in the intervention population will increase the number of people who benefit. Families with, or which go on to have, more children will also gain more ‘child-years’ of benefit from those safety devices or advice which targets child injuries.
- Programme costs – the overall costs of implementing a give-away or home safety assessment scheme is central to determining its overall cost-effectiveness.
- Existing prevalence – The level at which the population already has a smoke alarms installed greatly affects the impact of the smoke alarm programme in increasing usage and impacts the ICER accordingly.
- Uptake – the effectiveness of a free smoke alarm programme in gaining acceptance amongst the target population is critical in determining the extra number of alarms installed and the cost-effectiveness of the programme.
- Functional decay – key to determining the overall benefits gained from extra installed smoke alarms is the longevity of function those extra alarms.
- Relative risk of permanent and fatal injuries – because the QALY impact of both permanent and fatal injuries persist for the lifetime of the people in the model, change to the relative risk between those households with and without alarms for these types of injury has a significant impact on the ICER.
- Utility decrement applied to the years with a permanent injury – this decrement is applied to all but the first year of patients experiencing permanent injury in the model. Changing the level of decrement applied to this type of injury therefore has a considerable impact on the ICER.

The cost-effectiveness estimates were relatively insensitive to the following input parameter changes:

- Relative risk of minor injuries – changes to the relative risk of minor injuries for households with versus those without the safety features has little effect on the ICER. This is because the effect of minor injuries is short-lived relative to permanent and fatal injuries.

- Discount rate applied to costs – the largest component of incremental cost between arms in our model is due to the programme cost. This is applied in the first cycle of the model so is unaffected by discounting. Changes to the discount rate for costs in the model therefore has little effect on the ICER.

- Outcome costs – changes to costs relating to the treatment of injury and fire attendance and property damage cost have little impact on the ICER. This is because they are applied only once per incident in the model.

The relative importance of these different factors was almost identical for either the smoke alarm give-away scheme or the general home safety assessment scheme modelled.

1.5. Conclusion

Given both the paucity of good data to inform this economic modelling, and the wide possible variety of programme designs (and therefore varying programme costs and effectiveness), the economic modelling presented in this report primarily serves to explore the relative importance of different factors in determining their cost-effectiveness. The cost-effectiveness modelling of the general home safety assessment programme has been especially speculative in nature, as there was no good quality and well described economic evaluation of such a programme on which to base our modelling.

Nevertheless, in contrast to the few published economic evaluations, we have estimated the effects of such programmes over the full time horizon that their impacts might be expected, and incorporating the impact of injuries prevented on both mortality and morbidity (i.e. Quality-Adjusted Life-Years). By creating a model with a structure which incorporates some of the main determinants of programme success, we have been able to show that the cost-utility of such programmes from a public sector perspective is likely to be highly dependent on:

- The main determinants of 'programme reach', such as the existing prevalence of use of safety devices, the proportion of households that choose to participate in a programme, and the proportion that correctly install or use any devices provided.
- The duration of the effectiveness of the device (or other changes in the household) – what we modelled as 'functional decay'.
- The fixed or overhead costs of programmes relative to the number of households targeted
- The number of people in a household and their age
- The relative risk reduction due to properly fitting and using a safety device (or, equivalently, adopting safer behaviour in the home)

We have not been able to explore the potential additional effects of alternative programme components such as: free device supply of home safety devices vs supply *and installation*; free device supply vs *tailored* device supply and advice (e.g. after home risk assessment); discounted devices vs *free* devices; or different amounts of safety education and information alongside the safety device-based programme components. This is mainly because empirical studies have not sought to isolate the additional effectiveness (or cost) of such components within interventions (e.g. through using factorial trial designs).

2. Introduction

This report describes an economic modelling analysis which explores the cost-effectiveness of selected home safety interventions which have a primary purpose of reducing unintentional injuries in the home for children under 15 years old. It is the third of three reports to support the development of NICE public health intervention guidance of preventing unintentional injuries to children and young people (aged less than 15) in the home. The other two reports for consideration by NICE's Public Health Intervention Advisory Committee are:

- Report 1: Systematic reviews of effectiveness and cost-effectiveness of home safety equipment and risk assessment schemes
- Report 2: Barriers to, and facilitators of the prevention of unintentional injury in children in the home: a systematic review of qualitative research.

As described in Report 1 there are currently only three published economic evaluations of interventions for the prevention of unintentional injuries to children in the home which focus on the free (or discounted) supply of safety equipment (two studies), or on home risk assessments (one study).

Decision modelling is increasingly regarded as the best method for estimating the cost-effectiveness of alternative policies or programmes because it allows the estimation of longer term outcomes, the extrapolation from intermediate outcomes (e.g. injury severity) to final outcomes of interest (e.g. deaths and quality of life impacts), and it permits full exploration (and quantification) of different types of uncertainty. Modelling also allows the exploration of the impact of specific factors such as prior prevalence of safety practices, acceptance/participation rates, installation rates and device obsolescence/service failure – all of which can in theory be investigated in advance of choosing where to implement a child home safety scheme.

3. Aims

3.1. Objectives and Rationale

The aim of the economic modelling is to conduct a cost-utility analysis (using recommended NICE methods) of the relevant costs and effectiveness of selected home safety interventions for which good quality economic evaluations have been found (i.e. those identified and quality assessed in the systematic review of economic evaluations; see Report 1).

The following comparisons, based on economic evaluations of interventions in the UK, are evaluated:

1. Free Smoke Alarm programmes vs. no intervention
2. General home child safety assessment and equipment provision scheme vs. no intervention

The first of these comparisons was chosen because it was possible to base the analysis on a recent good quality UK study which reports both effectiveness and cost/resource use data. The economic modelling of the more general home child safety scheme was based on a high quality recent UK study, but the cost of the scheme had to be estimated from a variety of sources.

The economic modelling presented in this report is focused primarily on preventable injuries to children. However, because some types of safety device, such as smoke alarms, have benefits to all members of a household, adults are also included in the outcomes analysis. Therefore the extra costs of programmes which include the give-away of smoke alarms are compared with the quality of life and mortality outcome changes to both adults and children in households.

4. Methods

4.1. Interventions and comparators

In our analyses we evaluate the following two separate interventions and compare them to no intervention; a free smoke alarm programme and a more general home safety intervention. These are considered independently below. For each analysis the same model structure is used although differing data parameters and assumptions are made as outlined in the following sections.

4.1.1. Provision of Free Smoke Alarms

In this analysis we model the impact of a specific programme design to increase the prevalence of smoke alarm use within a targeted population of households. The base case for this analysis is based on data drawn from the 'Let's Get alarmed' initiative which targeted deprived households in inner city London (DiGuiseppi et al. 1999b).

4.1.2. Home Safety Consultation and Equipment Provision Schemes

In this analysis we model the impact of a general home safety intervention programme which incorporates a range of safety measures. The base case effectiveness data for this analysis is based on an RCT trial in which the intervention group received a home safety package including a standardised safety consultation and the provision of free and fitted stair gates, smoke alarms and cupboard and window locks (Watson et al. 2005).

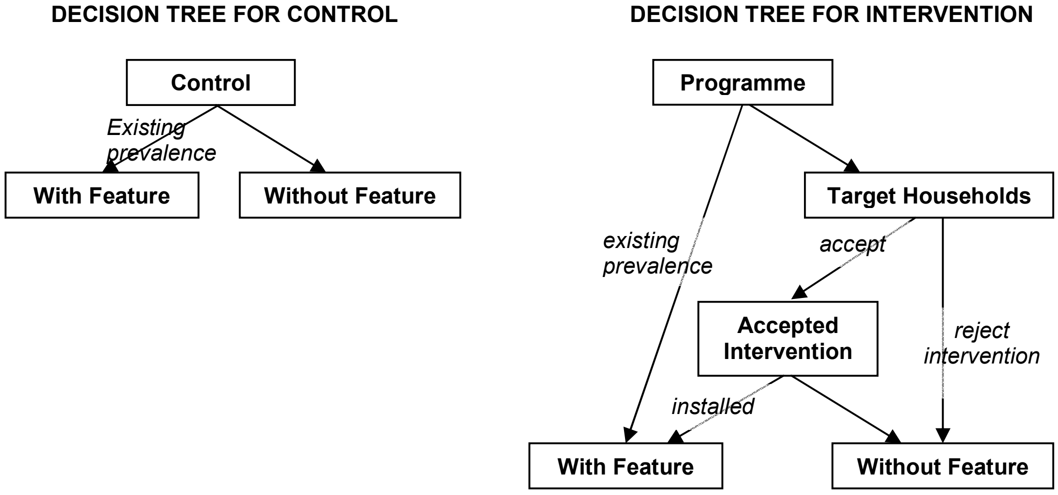
4.2. Model structure

For each of the interventions above the same two-staged modelling approach is used to assess costs and utility. Firstly an **Intervention Model**, structured as a decision tree, is used to analyse the costs and effects of a home safety programme in terms of its impact on the levels of adoption of the specified safety feature within the modelled population. In this part of the model, households are the unit of analysis. Secondly, an **Outcomes Model** uses the adoption levels from the Intervention Model to estimate cost-utility outcomes over time for the lifetime of the modelled population cohort. This part of the model also simulates households, but estimates outcomes according to the number of children and adults assumed to live in each house. These two models are described in more detail below.

4.2.1. Intervention Model - decision tree

In order to assess the cost-effectiveness of a child home safety intervention programme, it is first necessary to assess its impact in terms of changing the underlying adoption of a safety feature within the modelled population (for example the proportion of households with a smoke alarm). It is also necessary to model the separate components of cost inherent in the programme implementation. To do this we use a simple decision tree shown in Figure 1 below. This model incorporates the existing prevalence of use of the safety feature in the modelled population and the subsequent levels of acceptance and implementation of the safety feature for those in the population who do not have the installed equipment. At each stage of the decision tree appropriate costs can be assigned dependant on the uptake of a programme. The primary outputs from the Intervention Model are, firstly, the resultant *levels of adoption* of a safety feature (or group of features) within the modelled population respectively for both control and intervention arms and, secondly, the *cost* of the intervention programme.

Figure 1. Diagram of the 'Intervention Model' showing structure for Control and Intervention arms



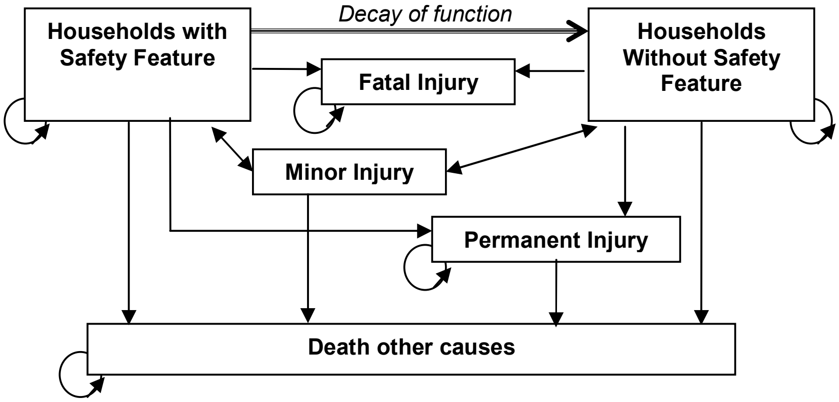
4.2.2. Outcomes Model – Markov state transition model

In order to model the outcomes over time for differing levels of adoption for an analysed safety feature (eg. smoke alarm) a simple state-transition model was used. This is shown in Figure 2 below. In this model, the initial levels of safety feature adoption derived from the Intervention Model tree are used to parameterise each compared arm in the analysis (i.e. control versus intervention). This model measures injury outcome and hence the unit of analysis is people. Household numbers are therefore weighted in the Outcomes Model to represent the average number of members of each household.

Given the lack of detailed injury outcomes in most studies, but a need to estimate quality-adjusted life-years, we adopted a simple three-level injury classification. A **fatal injury** is simply an injury which results in the death of the injury victim (usually defined as within 30 days of the injury incident). A **permanent injury** is pragmatically defined as an injury which results in a life-long impact on health-related quality of life (and related life-long additional health and social care costs). A **minor injury** is an injury which results in an attendance at a hospital A&E department, but is ultimately neither fatal nor permanent.

Note that in theory a person in the model may incur a minor injury more than once. In contrast, once a person has sustained a permanent injury they remain in the 'permanent injury' health state until death from other causes, and it is assumed they cannot incur any further injuries (other than those reflected in the death rates due to other causes). Both of the death states in the model ('Fatal injury', and 'Death other causes') are, of course, 'absorbing states', which means people do not leave once they have entered these states.

Figure 2. Diagram of 'Outcomes' model



SUMMARY DESCRIPTION OF A MARKOV STATE-TRANISTION MODEL
Within a Markov state transition model, patients reside in one of a number of discrete health states (represented by rectangles in the model diagram above). At regular time intervals (the model cycle) patients make at most one transition between states based on the arrows between states. Where states are shown with circular arrows re-cycling within the state is supported. In the Outcomes model (above) a one year cycle was deemed appropriate to accurately capture the main clinical pathways and events. During each cycle, all patients must be in one of the health states in the model. The number of patients transferring between states at the end of each cycle is based on the probabilities attached to each transition between model states. These probabilities are based, where possible, on published data. By using evidence to assign a cost and utility to each state and measuring the population of individual states at each cycle, it is possible to assess the overall cost and utility for the modelled population for each cycle. The aggregate of the cycle costs and utilities for the complete time horizon of the model (ie. the total number of cycles for which the model is run) then gives and output of overall costs and utilities for the modelled population over the time horizon of the model.

4.3. General assumptions of cost-utility analysis

The cost-utility analysis was conducted from a UK public sector perspective, incorporating all injury-related health costs, fire service fire extinction costs, police attendance costs and any property damage costs assumed to be borne by local authorities (National Institute for Health and Clinical Excellence 2006). The incremental cost of implementing an intervention is calculated as well as the incremental cost and utility impacts from preventable injuries in the two compared arms.

The Quality-Adjusted Life-Years (QALYs) saved over a lifetime by the prevention of injuries due to the intervention are calculated to obtain the incremental QALYs of the intervention compared with the comparator. For fatalities, the number of QALYs saved is based on the assumed age of the individual at the time of the fatality. Life expectancy tables (Office for National Statistics 2009a) are used to calculate the number of lost life years, which are then adjusted by the quality of life at each age. Calculation of QALYs lost due to non-fatal injuries depends not only on the age of the individual and their quality of life at the time of the injury, but also on the severity of the injury (the quality of life decrement) and the duration of the impact of the injury. In our model we model both minor injuries that sustain just one year of quality of life decrement and permanent injuries which sustain both an initial quality of life decrement in the first year and also a sustained quality of life decrement for all subsequent years of life.

4.3.1. Economic outcomes

For the cost-utility analysis the incremental cost (£) per quality-adjusted life year (QALY) gained, also known as the incremental cost-effectiveness ratio (ICER), is reported.

The time horizon is informed by the effective survival of the population cohort in order to encompass all potential outcomes of an intervention over time. A time horizon of a hundred years from implementation of an intervention is assumed in the model after which virtually all the original population cohort is dead. The impact of assuming an alternative, ten-year, model time horizon is assessed in sensitivity analyses.

4.3.2. Discounting

Costs and benefits beyond the first year of the intervention are discounted at a rate of 3.5% per year (National Institute for Health and Clinical Excellence 2006). In sensitivity analyses, the impact of assuming zero discount rates is assessed, as is the impact of differential discounting: 6% for costs and 1.5% for benefits and vice versa.

4.4. Model parameters: Free Smoke Alarms Programme

The input parameters (ie numerical model inputs) relating to the costs and effectiveness for the modelled home safety interventions as well as the costs and utilities associated with modelled outcomes are described below.

For the Free Smoke Alarm analysis, the base case parameter values and data sources for the Intervention Model are summarised below in Table 2 and for the Outcomes Model in Table 3. A more detailed description of these data and sources is then given in the following sections.

The primary data source for this analysis is the ‘Let’s Get Alarmed’ study (DiGuiseppi et al. 1999b) and the linked cost-effectiveness analysis of the same programme (Ginnelly et al. 2005). These have been used to parameterise the population and cost variable for the base case model as far as possible. Costs taken from these studies have been inflated to represent current 2009 values.

Table 2 : Free Smoke Alarms Scheme - Intervention Model : Base case parameter values and source

INTERVENTION MODEL

Parameter	**Value**	**Source and Rationale**
Population (households)	80,000	Based on population in DiGuiseppi et al 2002
Household composition	1 child (age 8 years) 1.22 Other household members (age 27 years)	Based on reported household composition DiGuiseppi et al 2002
Decision tree probabilities:		
Pre-existing prevalence of use	47%	As reported in Ginelly et al 2005
Acceptance Rate (those without smoke alarms who participated in intervention)	47.3%	Based on acceptance rate (20,050 out of 73,399 approached) reported in Ginelly et al 2005
Implementation Rate (ie. the proportion of smoke alarms received which are correctly installed)	51%	Based on a speculated rate of installation reported in DiGuiseppi et al which references a another study (Mallonee et al. 1996)
Costs		
Fixed costs of Intervention (set-up, administration etc)	£64,387	Composite value derived from cost analysis (Table 2) presented in DiGuiseppi et al 1999
Survey and other costs relevant to entire modelled population	£0.65 per household	Composite value derived from cost analysis (Table 2) presented in DiGuiseppi et al 1999
Variable costs for those accepting Intervention in targeted population	£5.01 per household	Derived from cost analysis (Table 2) presented in DiGuiseppi et al 1999
Variable costs for those successfully implementing fire alarm	£1.60 per household	Derived from cost analysis (Table 2) presented in DiGuiseppi et al 1999

Table 3: Free Fire Alarms Scheme - Outcomes Model : Base case parameter values and source

OUTCOMES MODEL

Parameter	**Value**	**Justification/Source**
Time Horizon	100 years	Until pop. all dead to account for all outcomes
Discount Rate:	Costs:3.5%, Benefits:3.5%	NICE Reference Case
Effectiveness outcomes		
Annual Probability of Fatality		Injury rate values for household without smoke alarms is based on data for injuries from (DiGuiseppi et al. 2002) see Section 4.4.1.4 below. The injury rate values for households with alarms is based on a relative risk ratio of 2 quoted by CAPT (2009). see Section 4.4.1.5 below.
Without smoke alarm fitted	7.88 per million person years	
With Smoke Alarm fitted	3.94 per million person years	
Annual Prob. of Permanent Injury		
Without smoke alarm fitted	22.17 per million person years	
With Smoke Alarm fitted	11.08 per million person years	
Annual Probability of Minor Injury		
Without smoke alarm fitted	348.30 per million person years	
With Smoke Alarm fitted	174.15 per million person years	
Functional Decay : Rate at which safety function is reduced per year**.**	30.1% per year of installed alarms	(Rowland et al. 2002)
Utilities		
Utility decrement for individuals with serious permanent injuries until death	First year of Injury: [redacted] (AIC) Subsequent years: [redacted] (AIC)	Assumed double effect of subsequent years (Nicholl et al. 2009).
Utility decrement for individuals with minor injuries (1 year only)	[redacted] (AIC)	Assumed 10% of permanent injury effect in first year.
General Background utilities for non-injured population	Under 25 yrs: 0.94 (0.007) 25-34: 0.93 (0.005) 35-44: 0.91 (0.007) 45-54: 0.85 (0.011) 55-64: 0.80 (0.012) 65-74: 0.78 (0.012) Over 74 yrs: 0.73 (0.015)	UK Population Norms (Kind et al. 1999).
Costs		
Treatment Costs (first year)	minor injury : £105 permanent injury : £3,585	Cost component analysis based on DoH National Schedule of Reference costs (Department of Health 2008)
Treatment Costs Subsequent years	permanent injury :: [redacted] (AIC)	(Nicholl et al. 2009)
Costs of Fire attendance etc	£523	From analysis in Ginelly et al 2005
Costs of property damage	£607	From analysis in Ginelly et al 2005 assuming 50% of affected houses are council supported or owned.

4.4.1.1. Population

The modelled population used in our analysis, based on the DiGuiseppi et al (1999) trial consists of a total of 80,000 households. This study targeted households in deprived areas of London with an existing prevalence of smoke alarm use of 47% (compared with the National UK average of 72%). The prevalence level of 47% has therefore been adopted in our base case analysis.

In order to assess all benefits and costs in our model it was essential to consider outcomes in terms of all the family members of each household. Each household was therefore modelled according to an assumed average composition. This was based on figures presented in diGuiseppi et al { (2002) which shows the average household in the study population consisted of 2.22 people. In our model we have therefore assumed each household to consist of one children with a median age of 8, and 1.22 other household members with a mean age 27 (the average age of the UK population as a whole). These assumptions have been explored in the sensitivity analysis.

4.4.1.2. Intervention Programme Effectiveness

Intervention effectiveness describes the impact of the free smoke alarms programme in changing the levels of adoption of functioning smoke alarms amongst the modelled population. Data from DiGuiseppi et al (1999) trial were used to assess the acceptance level of the free smoke alarms amongst those households (i.e. the target households) who did not possess a smoke alarm in advance of the scheme. A total of 20,050 alarms were distributed amongst the a total of 42,400 target households, which suggests an acceptance rate of 47.3% assuming that one smoke alarm was distributed to each household.

In addition, it is important to estimate the proportion of distributed alarms which were correctly installed within households. Although this is not measured directly in the DiGuiseppi et al trial, the study does cite an estimate of 51% for correctly installed alarms based on the study conducted in Oklahoma City and we have adopted this figure as our base case estimate in the model {Mallonee, 1996 2832 /id}.

4.4.1.3. Cost Values

The two principle elements of cost incorporated in our economic analysis are:

1. Cost associated with implementation of the intervention programme
2. Cost associated with outcomes (eg injury costs, fire event costs, property damage etc.)

Implementation costs for the smoke alarm programme have been taken from the DiGuiseppi et al (1999) trial and inflated using the UK Retail Price Index to represent 2009 prices. These costs have been broken down into separate components to account for the different aspects of expenditure. Hence, fixed costs, which are applicable to the scheme as a whole regardless of uptake, are distinguished from variable costs, which depend of the level of adoption and uptake amongst the population.

Outcome costs refer to those overheads associated with fire events in the outcomes model and can be divided into the following elements:

- Injury treatment costs for minor and permanent injuries resulting from fires
- Fire event costs (eg fire and police service costs)
- Property Damage costs (eg. damage to council property)

Importantly, the first of these listed costs, treatment costs, applies to individuals whereas the other two cost elements apply to each household. It was important therefore for each cost element to be treated separately within the model to avoid double counting of costs.

Injury costs in the model were calculated based on a number of sources. Minor injuries incur a one-off treatment cost which is based on the average cost of an A&E visit, this value was derived from an analysis based on the National Schedule of Reference Costs in the NHS (Department of Health 2008). Permanent injuries are modelled according with two values, firstly the treatment costs which are applied during the first cycle of permanent injury state and secondly the costs applied to subsequent years of injury (after the first year). For the first year of injury an aggregated cost was calculated for this using the National Schedule of reference costs. For the estimate of the maintenance cost applied to permanently injured people for all subsequent cycles after the first cycle of injury in the model we used a value derived from the study by Nicholl et al (Nicholl et al. 2009).

Fire event costs are derived from the analysis given in Ginnelly et al, 2005 which itemises key components of cost associated with fire attendance and impact. These have been inflated to 2009 levels to derive a cost estimate for our model.

For property damage costs we have again use values given in Ginnelly et al, 2005 and inflated these to 2009 levels. For the purposes of our base case we have assumed that 50% of the households in our model are council owned properties. This assumption was explored in the sensitivity analyses.

4.4.1.4. Safety Effectiveness outcome values

A key element in our model are the data which represent the relative probabilities of incurring fire related injuries which are either minor, permanent, or fatal during each year. A baseline risk level for each type of injury for households *without* a smoke alarm was estimated from the data supplied in the DiGuiseppi et al (2002) trial. We used the pooled data from both groups in this study to derive values for the risk of injury for households without smoke alarm. This assumption is based on the fact that the general level of functioning alarms for all groups was very small. To obtain values for our three modelled injury types, we assumed that 25% of non-fatal injuries requiring hospitalisation resulted in permanent injury (i.e. life-long quality of life and cost impacts). These data then gave the risks of fatal, permanent, and minor injuries from household fires amongst the study population respectively as 7.88, 22.17 and 348.30 per million person years. Injury risk for households *with* smoke alarms was then estimated using the relative risk parameter as discussed below.

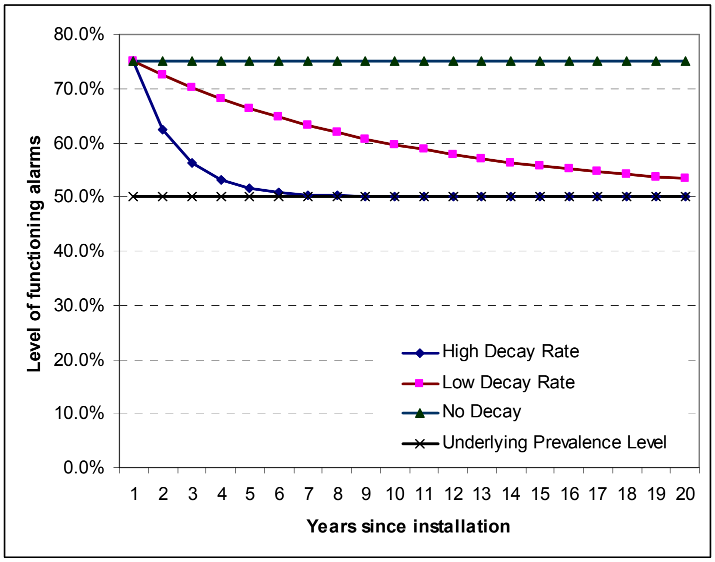
4.4.1.5. Relative Risk of injury with and without smoke alarm

The relative risk of suffering injury from home fire events for those households *without* a smoke alarm versus those *with* a functioning alarm is the key discriminating variable in our Outcomes Model since it determines both the marginal cost and utility output by the model. For this parameter we used an estimate of double the risk quoted on the Child Accident Prevention Trust website (2009). This value is considerably lower than the odds ratio of 3.4 quoted in an American study (Runyan et al. 1992) and the value of 3.2 given in another (LeBlanc et al. 2006). We chose however to adopt the value of double the risk because of the different cultural contexts of the Runyan and LeBlanc studies. Extensive sensitivity analysis was conducted to explore the effects of varying this relative risk value in the model.

4.4.1.6. Functional decay of working smoke alarms over time

A number of studies (DiGuiseppi et al. 1999a;Ginnelly et al. 2005;Mallonee et al. 1996;Rowland et al. 2002) outline observed levels at which installed smoke alarms fail to function over time due to non-maintenance, battery exhaustion etc. The study by Mallonee et al in 1996 showed a reduction in functioning smoke alarms in study population from 61% after three months, to 51% after a year and 45% after two years. Observations from a UK based study showed in a random inspection, that nearly half of installed battery operated smoke alarms were not functioning when test 15 months after installation (Rowland et al. 2002). From this study we calculated the probability of functional loss of working alarms as 30.1% per year. In our model, it is assumed that functional decay applies only to the extra alarms installed as a result of the intervention and occurs at a constant rate, no further decline in the proportion of functioning smoke alarms takes place once decline has reached the initial level of prevalence of smoke alarms. Figure 3 below shows graphically the hypothetical effect of the functional decay for three differing scenarios on the overall level of smoke alarm prevalence in the population over time. Different scenarios of functional decay are explored in our sensitivity analyses.

Figure 3 : Alternative scenarios of functional decay of working smoke alarms after initial installation. Control represents background prevalence in household population.



4.4.1.7. Utility values

Utility values are assigned to all the states within our Markov Outcomes Model in order to assess the health quality of life impact of different levels of injuries experienced by the population. Background levels of utility are related to age and derived from population norms values (Kind et al. 1999). The utility level for permanent injuries was derived from a recent study (Nicholl et al. 2009). This investigated long term health outcomes and quality of life for patients who had sustained serious injury from accident. This study showed a mean reduction of [redacted] (concealed because is 'Academic in Confidence' - AIC) in EQ-5D score from a population norm of [redacted](AIC) for patients monitored for up to 11 years after an accident. This suggests a sustained reduction in utility of around [redacted](AIC) for patients who suffer a permanent injury. For the first year of a permanent injury, our model assumes that this decrement is doubled to [redacted](AIC) to account for the initial severe disutility reduction suffered in a fire related accident. For minor injuries a scaled decrement to utility was applied only to the first year after injury was sustained. An assumed decrement for minor injury was set at [redacted](AIC) (10% the level for the first year of permanent injury).

4.5. Model Parameters: The General Home Safety Assessment and provision scheme

From our review of the cost-effectiveness literature we found no good quality studies that provided evidence for the cost-effectiveness for general home safety interventions (see Report 1). In view of this, we chose to use our economic model to conduct an exploratory analysis to determine the trade-off between costs and benefits for this form of intervention. Given its highly speculative nature we do not presented a single base case for this comparison.

For the General home safety assessment and equipment provision scheme, parameter values and data sources for Intervention model are listed in Table 4 and for the Outcomes model in Table 5 below. These values represent the parameters for the model for all aspects of the intervention except smoke alarms. A separate model was used to analyse the cost-effectiveness of the smoke alarm component of the intervention. The outputs from both these models (ie. that model without smoke alarms, and the smoke alarm model) were aggregated to provide the final outputs.

The primary data source for this analysis is the randomised control study outlined by Watson et al (Watson et al. 2005) which investigated the effects of providing a package of home safety measures including a free safety consultation, free stair gates, smoke alarms and cupboard and window locks. The data from this study have been used where possible to calibrate the base case model for our analysis.

Importantly, no significant evidence of effectiveness between control and intervention was recorded in the trial outputs from the Watson study which was chosen to calibrate the model.

The model was therefore used to explore the thresholds of cost and effectiveness that would be required to attain overall cost effectiveness at normal willingness-to-pay thresholds.

Table 4 : General Home Safety Assessment Scheme : Intervention Model Base case parameter values and sources (Model without smoke alarm component)

INTERVENTION MODEL

Parameter	Value	Justification/Source
Population (households)	1714	Based on population in Watson et al(Watson et al. 2005)
Household composition	2.2	Assumed 2.2 people per household for smoke alarm outcomes. Other outcomes applied only to one child
Decision tree probabilities:		
Pre-existing prevalence of use	10%	Assumption (see below)
Acceptance Rates in target population	68%	Based on acceptance rate reported in Watson et al study (Watson et al. 2005)
Successful Installation	100%	Acceptance rate above incorporates rate of installation and adoption.
Costs		
Fixed costs of Intervention (set-up etc)	£ 32,193 total	Assumed half the fixed costs of Free smoke alarms scheme (due to smaller scale see below)
Survey and other costs relevant to entire modelled population	£0.65 per household	Assumed equivalent costs per household as Free Smoke Alarm scheme
Variable costs for those accepting Intervention in targeted population	£79.79 per household	Composite value derived from cost analysis of components of intervention.

Intervention model values for the smoke alarm component of our analysis were taken from the separate study (see Table 2 above) with the following changes:

- The assumed population of households is 1,714 based on Watson et al. 2005 study data.
- The fixed overheads of the intervention are set to zero (to avoid double counting) since these are already included in the non-smoke alarm component.

Table 5 : General Home Safety Assessment Scheme : Base case parameter values and source

OUTCOMES MODEL : General Home Safety Intervention (without Smoke Alarms)

Parameter	**Value**	**Source/Rationale**
Time Horizon	100 years	Until pop. all dead to account for all outcomes
Discount Rate:	Costs:3.5%, Benefits:3.5%	As specified in NICE methods guidance(National Institute for Health and Clinical Excellence 2006)
Effectiveness outcomes		
Annual Probability of Fatality		Based on ONS data(Office for National Statistics 2009b) for mortality by accident data
Without Safety Features	0.000005	
Relative Risk with vs without Features	different values used	Exploratory assumption
Annual Prob. of Permanent Injury		Estimates based on HASS 2002 data for UK population of children aged 0-4 (see below). Assumed risk ratio of 0.95 for with vs without safety equipment. Risk Ratio of 0.95 is an exploratory assumption
Without Safety features	0.003837	
Relative Risk with vs without Features	different values used	
Annual Probability of Minor Injury		
Without Safety Features	0.0665	
Relative Risk with vs without Features	different values used	
Functional Decay :		
Rate at which safety function is reduced per year**.**	40 % per year of installed alarms	Based on an assumption of 90% obsolescence after 4 years of use.
Costs		
Treatment Costs (first year)	minor injury : £105 permanent injury : £3,585	Cost component analysis based on DoH National Schedule of Reference costs(Department of Health 2008)
Treatment Costs Subsequent years	permanent injury :: [redacted](AIC)	From (Nicholl et al. 2009)
Utilities		
Utility decrement for individuals with serious permanent injuries until death	First year of Injury: [redacted](AIC) Subsequent years: [redacted] (AIC)	Assumed double effect of subsequent years Based on (Nicholl et al. 2009).
Utility decrement for individuals with minor injuries (1 year only)	[redacted](AIC)	Assumed 10% of permanent injury effect in first year.
General Background utilities for non-injured population	Under 25 yrs: 0.94 (0.007) 25-34: 0.93 (0.005) 35-44: 0.91 (0.007) 45-54: 0.85 (0.011) 55-64: 0.80 (0.012) 65-74: 0.78 (0.012) Over 74 yrs: 0.73 (0.015)	UK Population Norms – Kind et al, 1999.

Note: Outcome models for the smoke alarm component of the model are shown in Table 3 above

Population

The modelled population used in our analysis is based on the Watson et al (Watson et al. 2005) RCT study which consisted of 3,428 households in Nottingham each with a child under five years old. These families were divided into two approximately equal groups for the study, hence we have used a base case population of 1,714 households. Since the intervention consisted of a wide-range of home safety measures it was assumed that the existing prevalence of use amongst the population was very low (10%) in our model. This assumption was made since the probability of all of the interventions already being adopted amongst the population was estimated to be relatively small. Sensitivity analysis was performed to test the impact of this assumption on the outputs.

With the exception of smoke alarms, the safety interventions offered in this study were focused exclusively on the young child member of each family and so these outcomes were measured in terms of single individuals. A mean age of 2 years old was assumed for this population. For the modelled smoke alarm component, the costs and benefits of the safety assessment programme were assessed for a wider population of the all households in the study. For this we assumed each household to consist of one child with a median age of 2, plus 1.2 adults with median age 40 based on the population analysis provided in Watson et al (Watson et al. 2005). These assumptions have been explored in the sensitivity analysis.

4.5.1.1. Intervention Programme Effectiveness

Intervention effectiveness describes the impact of a home safety programme in changing the levels of adoption of safety equipment amongst the modelled population. Data from Watson et al (Watson et al. 2005) were used to determine the levels of uptake of the intervention amongst the population. This report that only 68% of the intervention group accepted any aspect of the safety measures provided.

4.5.1.2. Cost Values

The two principal elements of cost incorporated in our economic analysis are:

1. Cost associated with implementation of the intervention programme
2. Cost associated with outcomes (eg injury costs, event costs, property damage etc.)

Implementation costs for the General home safety programme were divided into fixed and variable costs. Since no data could be obtained for the fixed overheads of the study from which the base case data were based, we assumed that these costs were half the costs experienced in the Free Smoke Alarms scheme (see Table 2 above). This assumption was made based on the fact that although the intervention itself was more complex, the size of the study population was much smaller for this comparison than that of the DiGuiseepi study(DiGuiseppi et al. 1999b). For estimation of the variable costs, the individual costs of the separate items included in the intervention were used to arrive at an aggregated average cost for each family which accepted the intervention. Weighted averages were used in the cost analysis to account for the varying levels of uptake for each type of safety equipment and advice that was offered. Table

Table 6 : Itemised costs used to parameterise variable costs of equipment and advice provided in the home safety intervention.

Safety Item	Cost per household (£s)	%age of intervention group who receive item	%age uptake in families accepting intervention	Mean Cost per intervention accepting household
Health visitor cons. (home visits)	**33.67**	68%	100%	**33.67**
Stair gate	**32.5**	36.2	53.2	**17.29**
Fireguards	**16.45**	36.2	53.2	**8.75**
cupboard locks (Pack)	**1.25**	37.7	55.4	**0.69**
window locks (pack)	**35.00**	37.7	55.4	**19.39**

Outcome costs refer to those overheads associated with accidents in the outcomes model and consist mainly of the injury treatment costs for minor and permanent injuries resulting from home accidents. For these values we have used the same sources as for the free smoke alarm study report above (see Table 3 above). For the smoke alarm component of our analysis we have also included the following cost components, again we have used the equivalent values from the free smoke alarm study.

- Event costs (eg fire and police service costs)
- Property Damage costs (eg. damage to council property)

4.5.1.3. Safety Effectiveness outcome values

In order to assess the risk of home accidents for our population we used data contained in the HASS (Home Accident Surveillance Survey) Report.(Department for Trade and Industry 2003) This records an annual rate of 477,486 home accidents per year in the UK population of 0-4 year olds. We have assumed in our model that 50% of these accidents are preventable as a result of adoption of the safety features installed as a result of the safety intervention. Using ONS data for the total UK population of 0-4 year olds, it is then possible to calculate an annual risk of about 7% for preventable accidents in the home for this age group. To calculate the proportion of accidents resulting in permanent injury we used the proportion of hospitalisations resulting in inpatient stays of greater than 10 days (around 5%). To calculate the risk of fatal injuries from home accidents ONS data were used. For our exploratory analysis we made an assumption of a relative risk of all types of injury (minor, permanent and fatal) of 0.95 for those households who received the safety intervention versus those who did not. It should be emphasised that as far as we know this assumption is not supported by study evidence. Differing levels of relative risk of injury were explored in the sensitivity analyses.

4.5.1.4. Functional decay of safety features over time

Safety equipment installed for children is likely to become obsolescent over time as a child grows older. We have assumed in our model a functional decay rate of 30% to reflect this growing redundancy of equipment over time.

4.5.1.5. Utility values

For utility decrement for minor and permanent injuries sustained in the model we used the equivalent values as for the free smoke alarm comparison (see Section 4.4.1.7 p.21 above).

4.6. Sensitivity analyses

Given the exploratory nature of this investigation the sensitivity analyses are central. One-way deterministic sensitivity analyses (where the value of just one parameter is changed) and probabilistic sensitivity analyses (where parameter values are changed simultaneously) were carried out and their findings are reported by intervention type in Section 5. Deterministic sensitivity analyses allow investigation of the impact of a particular parameter, by changing only one parameter at a time. PSA allows the total uncertainty in the model parameters, characterised in distributions, to be propagated through the model, where results can be interpreted in light of the overall uncertainty in the model's numerical inputs.

4.6.1. Deterministic sensitivity analyses

Simple deterministic sensitivity analysis were undertaken to assess the impact of particular assumptions on the results of the model.

5. Results

The results section is divided into two sections: Section 5.1 presents the cost-utility estimates produced by the model for a smoke alarm give-away scheme closely based upon the London-based scheme evaluated by Di Guiseppi and colleagues, and for which we also found the highest quality economic evaluation study supported by a separate costing study (DiGuiseppi et al. 1999b;DiGuiseppi et al. 2000;Ginnelly et al. 2005); Section 5.2 (page 40) presents a much more speculative cost-utility analysis for what we have called a 'general home safety assessment' scheme. This includes both a face-to-face home safety assessment and the free provision of a range of home safety devices relevant to preventing injuries to young children in the home. While this analysis is based, in broad terms, on the programme that was provided by health visitors in Nottingham in the early 1990s (Watson et al. 2005) many of the critical variables in this analysis either had to be assumed, or were drawn from a variety of other studies and data sources.

Therefore, **the modelling analysis of the general home safety assessment scheme presented in Section 5.2 should be treated as an exploratory analysis, primarily to explore the relative influence of different factors on estimated cost-effectiveness**. In particular, the analysts believe that the base case results for that analysis should be treated with great caution, and not relied upon for directly informing policy choices.

Note that in addition to presenting the incremental cost-effectiveness ratio (ICER), as a cost per QALY, we have presented the estimated per household Net Benefit. This is calculated by valuing the estimated QALYs gained per household at an assumed rate of willingness to pay for a QALY (here, either £20,000 or £30,000 per QALY), and then deducting the per household incremental cost. A positive Net Benefit indicates that, if QALYs are valued at the given rate, benefits are estimated to exceed costs (and *vice versa*).

5.1. RESULTS : Free Smoke Alarms

The base case cost-effectiveness results from our model are shown below in Table 7.

Table 7 : Base case cost-effectiveness results for free smoke alarm scheme

ARM	TOTAL Prog. Costs	TOTAL Outcome Costs	Total Costs per household	Total QALYs per household	Incremental Cost Eff'ness Ratio (£s/QALY)	Net Benefit £20K/QALY per household	Net Benefit £30K/QALY per household
Control	£0	£1,793,732	**22.42**	**51.7817**			
Intervention	£232,982	£1,776,979	**25.12**	**51.7818**			
Difference	£232,982	-£16,753	**£2.70**	**0.0001**	**£23,046**	-£0.36	£0.82

Note: Costs and QALYs are discounted at 3.5% per year

For our model base case assumptions we were able to calculate the effective years of household cover for each arm. This represents the number of households multiplied by the years during which they have a working smoke alarm. We calculated these values as 2,675,377 (1,001,824 discounted at 3.5%) for the control arm and 2,698,933 (1,023,800 discounted at 3.5%) for the intervention arm. Our model therefore showed that in the intervention arm an extra 23,556 additional household-years of smoke alarm cover (21,975 years discounted at 3.5%) were created by the free smoke alarm programme.

It was also possible to count the effective number of fire-related injuries in each arm of our model. These outputs are shown in Table 8. This shows a small reduction in the incidence of all forms of fire related injury in the intervention arm due to the additional smoke alarms present in this arm. The event counts over the first 10 years modelled demonstrate that the great majority of injuries averted in the intervention arm of our model occur in the first 10 years, this is due to the functional decay of installed alarms over time, which entails that after 10 years there is very little difference in the level of installed and working smoke alarms between the control and intervention arms. However, it should be noted, that although almost all of the incremental *injuries* occur in the first ten years, the quality of life benefits sustain throughout the time horizon of the model (eg a permanent injury sustained early in the model is assumed to incur an ongoing utility decrement).

Table 8 : Model Base Case Event counts for population of 80,000 households with mean of 2.2 people per household (for lifetime horizon and after 10 years)

Lifetime horizon	**Control Arm**	**Intervention Arm**	**Difference**
Fire Related Minor Injuries	3379.95	3367.05	***-12.90***
Fire Related Permanent Injuries	215.04	214.22	***-0.82***
Fire Related Fatalities	76.55	76.26	***-0.29***
10 Year horizon			
Fire Related Minor Injuries	468.52	455.87	***-12.64***
Fire Related Permanent Injuries	29.81	29.00	***-0.80***
Fire Related Fatalities	10.60	10.32	***-0.29***

5.1.1. Deterministic sensitivity analysis results

A wide range of one-way deterministic sensitivity analyses were undertaken to assess the impact of certain assumptions on the cost-effectiveness. These are discussed below under a number of sectional headings.

5.1.1.1. General model variables

We examined the effect on our model of varying the discount rates for costs and QALYS and in reducing the modelled time horizon to 10 years. Outputs from these analyses are shown in Table 9 below.

Table 9 : One-way sensitivity analysis for discount rates and time horizon

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
Discount rates	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Base Case	22.42	51.782	25.12	51.782	23,046	-0.357	0.816
Costs=0% QALYs=0%	74.75	131.466	77.27	131.467	8,013	3.770	6.915
Costs=1.5% QALYs=1.5%	41.51	82.689	44.14	82.689	13,622	1.232	3.164
Costs=6% QALYs=6%	12.91	34.212	15.66	34.212	36,744	-1.251	-0.504
Costs=0% QALYs=3.5%	74.75	51.782	77.27	51.782	21,488	-0.175	0.998
Costs=3.5% QALYs=0%	22.42	131.466	25.12	131.467	8,594	3.588	6.733
Ten Year Time horizon	5.07	17.650	7.85	17.650	80,981	-2.091	-1.748

Amongst these variables the biggest effect on model outputs due to discount rate changes is caused by changes to the QALY discount rate. This is because most of the incremental cost in the model is sustained at the outset (i.e. the intervention programme costs, and initial injury treatment and fire incident costs) and is therefore not affected by discount rate changes, whereas the QALY benefits are gained over the full time horizon of the model.

The output for the ten year time horizon is interesting in that it demonstrates that much of the utility gained in the model occurs after the first ten years. If a ten year horizon is assumed it can be seen that the modelled ICER increases to nearly £81,000 (i.e. worse cost-effectiveness) whereas the for the full time horizon it is £23,046

5.1.1.2. Population variables

We changed a number of key parameters relating to the number of households targeted by the give-away programme: the mean age of children; the number of children and the number of adults in a household. The outputs from these analyses are shown in Table 10 below.

Table 10 : One-way sensitivity analysis for population parameters

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
Population Parameter	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Base Case	22.42	51.782	25.12	51.782	23,046	-0.357	0.816
Total Pop = 20,000 households (base =80,000)	22.42	51.782	27.54	51.782	43,633	-2.772	-1.599
Total Pop = 140,000 households (base =80,000)	22.42	51.782	24.78	51.782	20,105	-0.012	1.161
Initial Age of Child = 4	22.95	52.551	25.65	52.551	22,691	-0.320	0.870
Initial Age of Child = 12	21.83	50.896	24.54	50.896	23,469	-0.400	0.753
Extra Child in each household	28.65	76.002	31.29	76.002	9,130	3.147	6.041
Extra Adult in each household	28.65	74.750	31.29	74.750	15,600	0.745	2.437
Extra Adult and Extra child in each household	34.88	98.970	37.46	98.970	7,557	4.248	7.663

As expected these model outputs show that the intervention becomes less cost-effective (i.e. the ICER increases) as the population size is reduced since the number of households who benefit from the intervention decreases relative to the fixed costs of the programme. Increasing the assumed size of a household increases the cost-effectiveness of the intervention (i.e reduces the ICER) since more people benefit from the extra years of safety cover given by the intervention. Also a younger mean age of householders will reduce the ICER since a greater number of QALYs are gained through the avoidance of fatalities and permanent injuries.

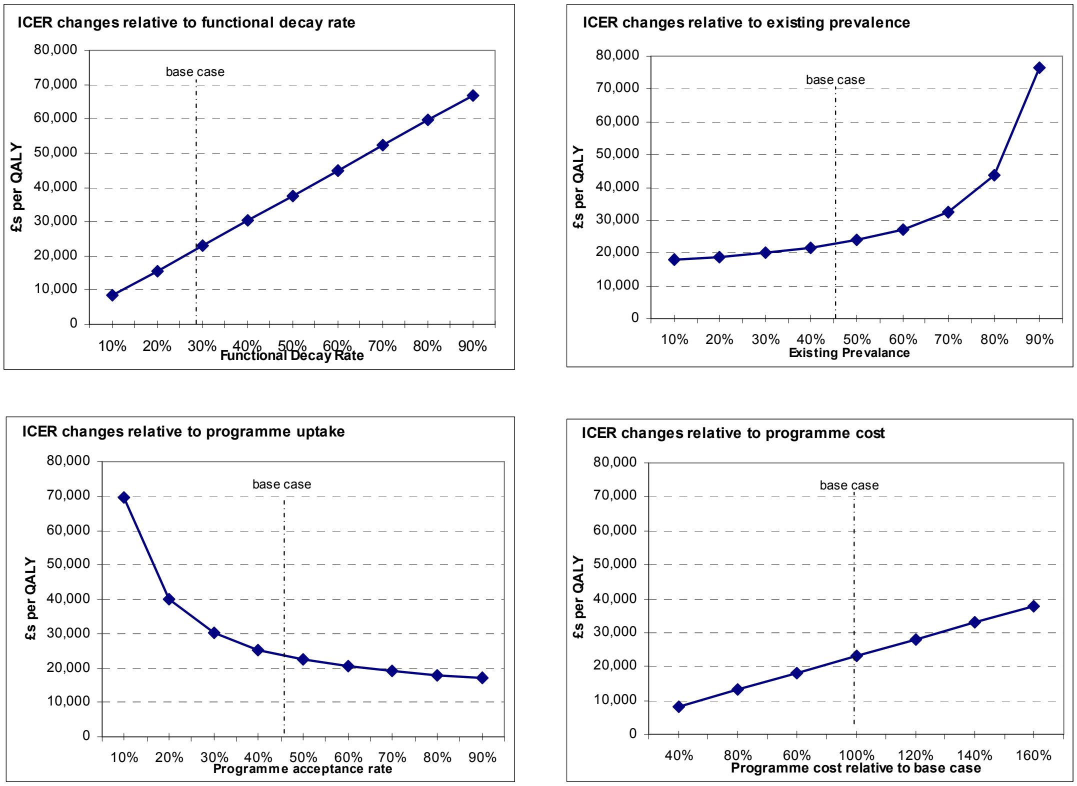
5.1.1.3. Programme costs and effectiveness

Table 11 : One-way sensitivity analysis for programme cost and effectiveness parameters

Parameter change	Control per household		Intervention per household		ICER	Net Benefit per household	
PROGRAMME COSTS	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Base Case (£233K)	22.42	51.782	25.12	51.782	23,046	-0.357	0.816
Total cost of programme doubled (£466K)	22.42	51.782	28.04	51.782	47,877	-3.270	-2.097
Total cost of programme halved (£116K)	22.42	51.782	23.67	51.782	10,630	1.099	2.272
EFFECTIVENESS	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Existing Prevalence level increased to 75%	18.32	51.784	20.36	51.784	36,957	-0.938	-0.385
Existing Prevalence level decreased to 25%	25.64	51.780	28.86	51.780	19,399	0.100	1.760
Programme acceptance level increased to 75%	22.42	51.782	25.86	51.782	18,458	0.287	2.147
Programme acceptance decreased to 25%	22.42	51.782	24.54	51.782	34,138	-0.876	-0.256
Successful Implementation increased to 75%	22.42	51.782	25.03	51.782	15,095	0.846	2.571
Successful Implementation decreased to 25%	22.42	51.782	25.23	51.782	48,915	-1.661	-1.087
Functional Decay rate doubled	22.42	51.782	25.23	51.782	45,081	-1.565	-0.941
Functional Decay rate halved	22.42	51.782	24.94	51.782	12,058	1.658	3.745

Table 11 shows the effect of changing a number of the key variables relating to the effectiveness of the modelled intervention programme. These include the overall programme costs as well as parameters relating to the extent of implementation within the target households. These effects - of varying the assumed functional decay rate, prior prevalence of smoke alarm use, rates of programme uptake and the cost of providing the programme - are further explored in the threshold analyses shown below in Figure 4. All these parameters have a substantial effect on the estimated cost-effectiveness, and therefore the uncertainty associated with these key inputs should lead us to be cautious when interpreting the outputs from the model. Their combined uncertainty (see probabilistic sensitivity analysis) will of course magnify the need for such caution.

Figure 4 : Threshold graphs showing relationship between key input parameters relating to the intervention cost and effectiveness and the output model ICER.



5.1.1.4. Safety outcomes

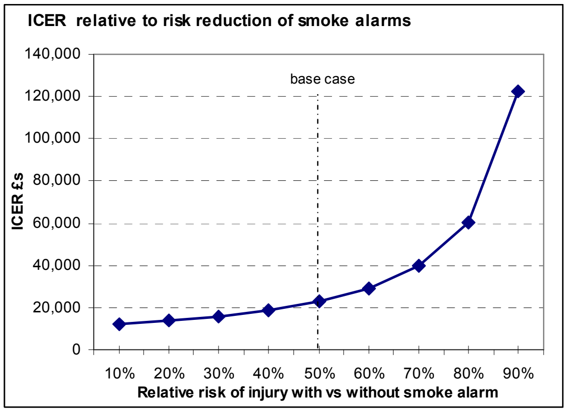
To examine the effects of changes to the relative risk of injury between household with versus those without smoke alarms we varied the base case value of 0.5. The outputs from this analysis is shown in Table 12.

Table 12 : One-way sensitivity analysis for effectiveness of smoke alarms in preventing injuries

Parameter change	Control per household		Intervention per household		ICER	Net Benefit per household	
Relative Risk	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Base Case	22.42	51.782	25.12	51.782	23,046	-0.357	0.816
Rel Risk all injuries =0.25	18.98	51.783	21.58	51.783	14,774	0.919	2.678
Rel Risk all injuries =0.75	25.86	51.780	28.67	51.780	47,862	-1.634	-1.048
Rel Risk of minor inj. = 0.25	20.94	51.782	23.60	51.782	22,293	-0.274	0.921
Rel Risk of minor inj = 0.75	23.91	51.782	26.65	51.782	23,828	-0.441	0.710
Rel Risk of perm inj = 0.25	20.49	51.782	23.13	51.782	19,551	0.061	1.410
Rel Risk of perm. inj = 0.75	24.35	51.781	27.12	51.781	27,779	-0.775	0.221
Rel Risk of fatal inj = 0.25	22.39	51.783	25.10	51.783	17,320	0.418	1.978
Rel Risk of fatal inj = 0.75	22.45	51.781	25.15	51.781	34,432	-1.133	-0.348

The relative risk of fire related injury for people in a household with smoke alarms versus those without smoke alarms is a central parameter in our model. If there is no difference in risk between these two groups can be demonstrated (ie. relative risk = 1) then no incremental QALY difference would be estimated by the model and the intervention could never be cost-effective. Our base case analysis assumes a relative risk of 0.5 across all three levels of injury severity. It can be seen from these outputs (Table 12) that the QALY differences created by changes to this parameter are very small but because the model is driven by very small QALY differences these small changes have a significant impact on the ICER. Figure 5 below shows how the level of ICER output by the model varies as this value is changed in the model.

Figure 5 : Threshold graph showing the effect on the ICER for different levels of relative risk of injury between household with versus households without smoke alarms



5.1.1.5. Outcome-related costs

To examine the impact of changes to the outcome costs of injury we varied these values in the model. The resultant outputs are shown in Table 13. These show that in general the model is not very sensitive to the level of these model parameters.

Table 13 : One-way sensitivity analysis for costs of injury, fire and property costs

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
Cost Parameter	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Base Case	22.42	51.782	25.12	51.782	23,046	-0.357	0.816
Treatment costs of minor injury doubled	24.06	51.782	26.75	51.782	22,932	-0.344	0.829
Treatment costs of minor injury halved	21.60	51.7817	24.31	51.7818	23,103	-0.364	0.809
Treatment costs of permanent injury doubled	25.99	51.7817	28.66	51.7818	22,798	-0.328	0.845
Treatment costs of permanent injury halved	20.64	51.7817	23.36	51.7818	23,170	-0.372	0.801
Maintenance costs of permanent injury doubled	30.91	51.7817	33.52	51.7818	22,230	-0.262	0.911
Maintenance costs of permanent injury halved	18.18	51.7817	20.93	51.7818	23,454	-0.405	0.768
Incident costs doubled	26.46	51.7817	29.13	51.7818	22,765	-0.324	0.849
Incident costs halved	20.40	51.7817	23.12	51.7818	23,186	-0.374	0.799
Property Damage costs doubled	27.11	51.7817	29.77	51.7818	22,720	-0.319	0.854
Property Damage costs halved	20.08	51.7817	22.80	51.7818	23,209	-0.376	0.796

5.1.1.6. Utility levels

Model outputs when changes to the level of utility decrement applied to injuries sustained in each arm of the model are shown below in Table 14. These show that changes to the decrement applied for the first year of injury for both minor and permanent injury have virtually no affect on the ICER. Changes to the level of decrement applied to the years of sustained permanent injury do have an impact, although the ICER still remains below the £30,000 level even when this decrement is halved.

Table 14 : One-way sensitivity analysis for utility decrement applied to injuries

Parameter change	Control per household		Intervention per household		ICER	Net Benefit per household	
Utility Parameter	Total Costs	Total QALYs	Total Costs	Total QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Base Case	22.42	51.782	25.12	51.782	23,046	-0.357	0.816
Scaled decrement for minor injuries doubled	22.42	51.781289	25.12	51.781410	22,213	-0.269	0.947
Scaled decrement for minor injuries halved	22.42	51.781935	25.12	51.782051	23,486	-0.401	0.750
Scaled dec for permanent injuries Yr1 doubled	22.42	51.781720	25.12	51.781837	23,045	-0.357	0.816
Scaled dec for permanent injuries Yr1 halved	22.42	51.781720	25.12	51.781837	23,046	-0.357	0.816
Scaled dec for perm. Inj. after Yr1 doubled	22.42	51.778802	25.12	51.778954	17,803	0.334	1.852
Scaled dec for perm. Inj. after Yr1 halved	22.42	51.783178	25.12	51.783278	27,026	-0.703	0.297

5.1.2. Probabilistic sensitivity analysis (PSA)

Probabilistic sensitivity analyses were undertaken to investigate the joint uncertainty in the model parameter values. Parameter uncertainty was propagated through the base case economic analysis using Model Carlo simulation (1000 samples). A full description of the distributions used and their parameter values are given in 63Appendix 1.

5.1.2.1. Mean outputs from the PSA

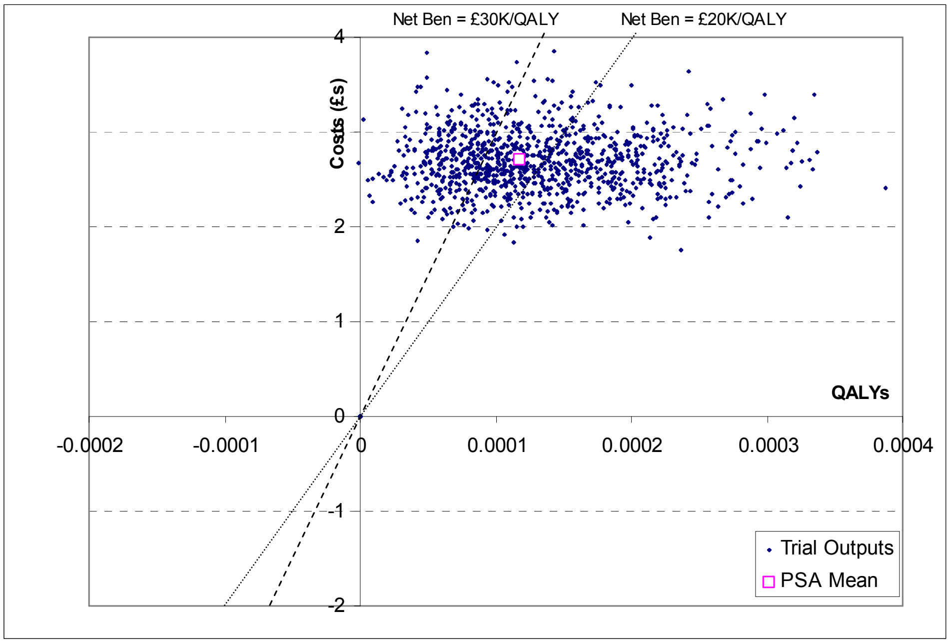
The mean average of the 1000 simulation trials conducted with our model is shown below in Table 15. These closely mirror the outputs from the deterministic model.

Table 15 : Mean outputs from PSA simulation

Control per household		Intervention per household		Differences (Interventn – Control)		ICER
Costs	QALYs	Costs	QALYs	Costs	QALYs	(£s/QALY)
£22.42	51.78172	£25.12	51.78184	£2.70	0.000117	£23,046

Figure 6 below shows the cost-effectiveness outputs from the simulation on the cost-effectiveness plain where each small dot represents an output from a simulation trial.

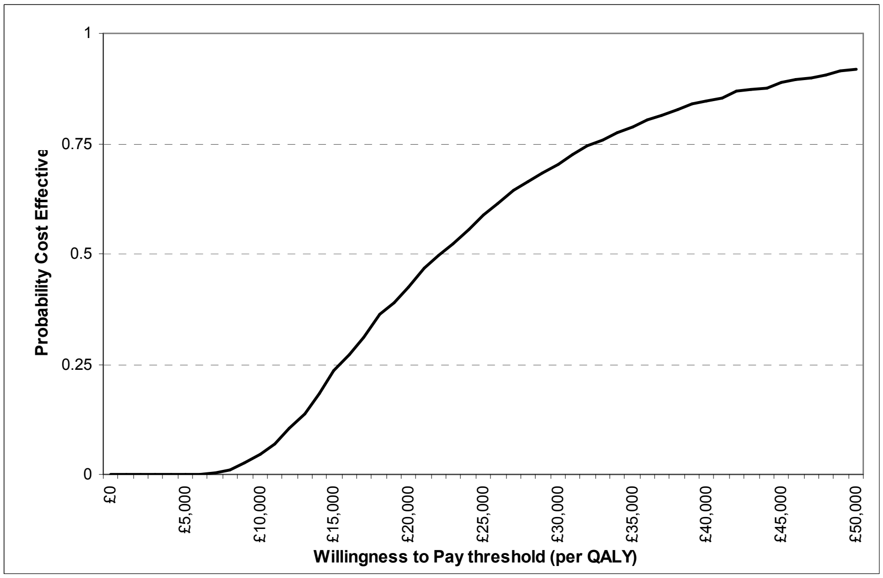
Figure 6 : Incremental cost-effectiveness ratio outputs from simulation



5.1.2.2. Cost-effectiveness acceptability curve (CEAC)

The CEAC from our PSA is shown below (Figure 7). This predicts that at a willingness-to-pay threshold of £20,000 per QALY gained there is a 43% probability that the intervention modelled is cost-effective. At a willingness-to-pay threshold of £30,000 per QALY gained there is a 70% probability that the intervention is cost-effective. There is a 50% probability of that the intervention is cost-effective at a willingness-to-pay threshold of approx £22,000 per QALY gained.

Figure 7 : Cost Effectiveness Acceptability curve (CEAC) for Free Smoke Alarm scheme model.



5.2. RESULTS – General Home Safety Assessment

As previously highlighted, **the modelling analysis of the general home safety assessment scheme (presented below) should be treated as an exploratory analysis, primarily to explore the relative influence of different factors on estimated cost-effectiveness**. Due to considerable uncertainty in many of the key factors which determine the cost-effectiveness of such schemes, the analysts believe that the results for this analysis should be treated with great caution, and not relied upon for directly informing policy choices.

5.2.1. Base case and probabilistic sensitivity analysis results

Because no reliable estimate could be found for the key model parameter for the relative risk of injury in those households who receive an intervention versus those who do not, we were unable to report a single base case output from our model. Instead, we report three alternative outputs from the model in Table 16. These are based on three alternative values for the relative risk of injury of 1, 0.99 and 0.95. These relative risks have been applied respectively to the non-smoke alarm components of the intervention. For the smoke alarm component in the model a relative risk of 0.5 has been applied in all this cases (the same value used in the free smoke alarm comparison presented separately in Section 5.1).

Table 16. Cost-effectiveness results for general home safety assessment scheme, by assumed injury relative risk reduction due to child safety devices

ARM	TOTAL Prog. Costs	TOTAL Outcome Costs	Total Costs per househd	Total QALYs per househd	IICER (£s/QALY)	Net Benefit £20K/QALY per househd	Net Benefit £30K/QALY per houshd
Relative Risk of injury in households with vs without safety devices (non-smoke alarm components) = 1							
Control	0	£2,095,349	1222.49	77.4799			
Intervention	£38,702	£2,095,087	1244.92	77.4800			
Difference	£38,702	-£262	22.43	0.0001	**£187,154**	-£20.03	-£18.83
Relative Risk of injury in households with vs without safety devices (non-smoke alarm components) = 0.99							
Control	0	£2,093,553	1221.44	77.4802			
Intervention	£38,702	£,2092,290	1243.29	77.4805			
Difference	£38,702	-£1,262	21.84	0.0003	**£75,718**	-£16.07	-£13.19
Relative Risk of injury in households with vs without safety devices (non-smoke alarm components) = 0.95							
Control	£0	£2,086,318	£1,217.22	77.4812			
Intervention	£38,702	£2,081,039	£1,236.72	77.4821			
Difference	£38,702	-£5,279	£19.50	0.0010	**£20,207**	-£0.20	£9.45

NB. Costs and QALYs both discounted at 3.5% per year

From Table 16 it can be seen that the cost-effectiveness of the general home safety intervention is largely a function of the relative risk of injury between household receiving the intervention versus those who do not (as described above). The residual level of QALY gain shown when the relative risk is set to 1 is due solely to the injury reduction resulting from the smoke alarm component of the model (where the relative risk of injury for households with alarms versus those without is set to 0.5).

5.2.2. Deterministic one-way sensitivity analysis results

A series of one-way sensitivity analyses were conducted using our model. For these analyses we chose to use the variant of the model with a relative risk value (households with versus without the intervention) of 0.95 for injury for the non-smoke alarm component of the model. This is referred to as the 'Reference' in the tables below (it should not be regarded as a base case)..

5.2.2.1. General model variables

Table 17 : One-way sensitivity analysis for discount rates and time horizon

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
Discount rates	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Reference (3.5% both)	1217.22	77.481	1236.72	77.482	20,207	-0.199	9.451
Costs=0% QALYs=0%	4809.42	208.302	4825.51	208.305	6,333	34.718	60.121
Costs=1.5% QALYs=1.5%	2465.09	126.808	2483.28	126.810	11,617	13.119	28.770
Costs=6% QALYs=6%	645.16	50.493	665.42	50.493	32,266	-7.701	-1.423
Costs=0% QALYs=3.5%	4809.42	77.481	4825.51	77.482	16,670	3.214	12.864
Costs=3.5% QALYs=0%	1217.22	208.302	1236.72	208.305	7,676	31.305	56.708
Ten Year Time horizon	209.19	25.717	230.11	25.717	67,359	-14.706	-11.601

5.2.2.2. Population variables

Table 18 : One way sensitivity analysis for population parameters

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
Population Parameter	Costs	QALYs	Costs	QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Reference	1217.22	77.481	1236.72	77.482	20,207	-0.199	9.451
Total Pop = 800 households (base =1714)	1217.22	77.481	1258.18	77.482	42,444	-21.659	-12.008
Total Pop = 5,000 households (base =1714)	1217.22	77.481	1224.38	77.482	7,415	12.145	21.795
Initial Age of Child = 1	1224.22	77.718	1243.72	77.719	20,151	-0.146	9.528
Initial Age of Child = 3	1209.84	77.223	1229.35	77.224	20,268	-0.258	9.365
Extra Child in each household	1222.58	102.096	1242.04	102.097	19,065	0.955	11.163
Extra Adult in each household	1222.58	100.831	1242.04	100.832	19,121	0.894	11.073
Extra Adult and Extra child in each household	1227.94	125.446	1247.37	125.448	18,092	2.048	12.785

5.2.2.3. Programme Costs and Effectiveness

Table 19 : One way sensitivity analysis for Programme Cost and Effectiveness

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
PROGRAMME COSTS	Total Costs	Total QALYs	Total Costs	Total QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Reference	1217.22	77.481	1236.72	77.482	20,207	-0.199	9.451
Total cost of programme doubled	1217.22	77.481	1257.29	77.482	41,517	-20.765	-11.114
Total cost of programme halved	1217.22	77.481	1226.44	77.482	9,551	10.083	19.734
EFFECTIVENESS	Total Costs	Total QALYs	Total Costs	Total QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Prevalence level increased to 75%	1180.06	77.491	1199.55	77.492	67,809	-13.738	-10.865
Prevalence level decreased to 0%	1227.38	77.477	1247.70	77.478	16,663	4.069	16.264
Programme acceptance level increased to 75%	1217.22	77.481	1237.39	77.482	17,960	2.291	13.520
Programme acceptance decreased to 25%	1217.22	77.481	1236.69	77.482	52,360	-12.033	-8.315
Successful Implementation increased to 75%	1217.22	77.481	1237.27	77.482	24,781	-3.867	4.222
Successful Implementation decreased to 25%	1217.22	77.481	1238.64	77.481	79,927	-16.061	-13.381
Functional Decay rate doubled	1217.22	77.481	1238.38	77.482	41,152	-10.875	-5.734
Functional Decay rate halved	1217.22	77.481	1233.80	77.483	9,477	18.412	35.910

5.2.2.4. Safety outcomes

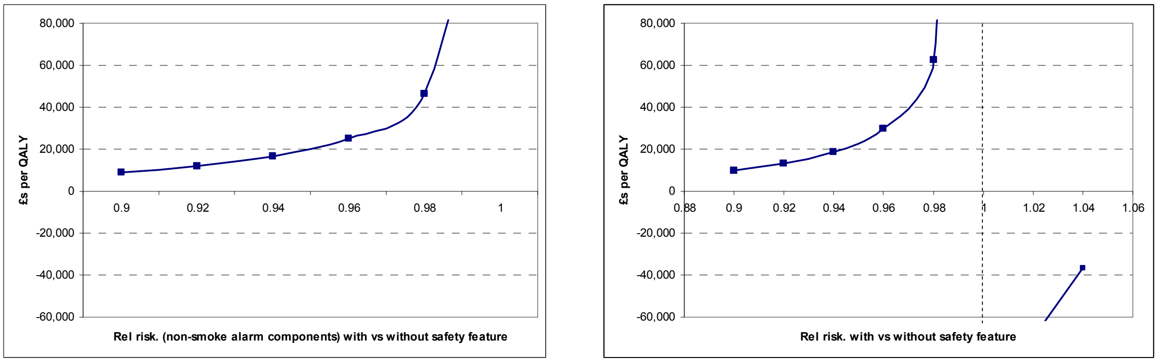
To examine the effect of changes to the assumed relative risk of injury between those households which receive the safety intervention and those which do not receive it, we varied the relative risk parameter in our model for all injury types (fatal, permanent and minor). Two different analyses were conducted, firstly we varied only the relative risk for the non-smoke alarm components of the intervention, and secondly we varied the relative risk for both smoke alarm and the non-smoke alarm components of our general home safety intervention model. These outputs are shown in Table 20 and

Figure 8 below and demonstrate clearly the importance of the relative risk parameter in determining cost-effectiveness in our model. Model outputs are seen to be extremely sensitive to this parameter with small changes in relative risk resulting in large ICER changes. These results show very clearly why, in the absence of any study data providing clear evidence of an effect of home safety interventions in reducing injury, the outputs from our model can only be treated as exploratory and speculative.

Table 20 : One-way sensitivity analysis for effectiveness of safety programme in preventing injuries

Parameter change	Control per household		Intervention per household		ICER	Net Benefit per household	
Relative Risk	Total Costs	Total QALYs	Total Costs	Total QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Reference	1217.22	77.481	1236.72	77.482	20,207	-0.199	9.451
Applied to non-smoke alarm components of the model only							
Rel. Risk all injuries =0.9	1211.88	77.482	1228.43	77.484	9,117	19.754	37.905
Rel. Risk all injuries =0.94	1216.16	77.481	1235.07	77.483	16,667	3.781	15.128
Rel. Risk all injuries =0.98	1220.39	77.480	1241.65	77.481	46,485	-12.112	-7.539
Rel. Risk all injuries =1	1222.49	77.480	1244.92	77.480	187,154	-20.030	-18.832
Rel. Risk all injuries =1.04	1226.66	77.479	1251.41	77.478	-44,766	-35.808	-41.337
Applied to both smoke alarm and non-smoke alarm components of the model							
Rel. Risk all injuries =0.9	1217.58	77.480	1234.30	77.482	9,724	17.668	34.861
Rel. Risk all injuries =0.94	1222.43	77.479	1241.52	77.480	18,556	1.486	11.778
Rel. Risk all injuries =0.98	1227.23	77.477	1248.69	77.478	62,700	-14.616	-11.193
Rel. Risk all injuries =1	1229.61	77.477	1252.25	77.477	Div. by zero	-22.638	-22.638
Rel. Risk all injuries =1.04	1234.35	77.475	1259.32	77.475	-36,609	-38.625	-45.448

Figure 8 : Threshold analysis of ICER changes relative to the relative risk of injury for household with and without the safety intervention.



Relative risk of injury varied for non-smoke alarm components only

Relative risk of injury varied for all components

5.2.2.5. Outcome Costs

Table 21 shows the impact of changes to the outcome costs in out model. This shows that in general the model was insensitive to changes in these values.

Table 21 : One-way sensitivity analysis for costs of injury, fire and property costs

Parameter change	**Control per household**		**Intervention per household**		**ICER**	**Net Benefit per household**	
Cost Parameter	Total Costs	Total QALYs	Total Costs	Total QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Reference	1217.22	77.481	1236.72	77.482	20,207	-0.199	9.451
Treatment costs of minor injury doubled	1383.07	77.481	1402.26	77.482	19,885	0.111	9.762
Treatment costs of minor injury halved	1134.30	77.4812	1153.95	77.4821	20,368	-0.355	9.295
Treatment costs of permanent injury doubled	1512.26	77.4812	1531.26	77.4821	19,685	0.304	9.954
Treatment costs of permanent injury halved	1069.70	77.4812	1089.45	77.4821	20,467	-0.451	9.199
Maintenance costs of permanent injury doubled	1964.67	77.4812	1981.97	77.4821	17,933	1.995	11.645
Maintenance costs of permanent injury halved	843.50	77.4812	864.10	77.4821	21,344	-1.297	8.354
Incident costs doubled	1221.33	77.4812	1240.80	77.4821	20,173	-0.166	9.484
Incident costs halved	1215.17	77.4812	1234.68	77.4821	20,224	-0.216	9.434
Property Damage costs doubled	1222.00	77.4812	1241.46	77.4821	20,167	-0.161	9.489
Property Damage costs halved	1214.83	77.4812	1234.35	77.4821	20,226	-0.219	9.432

5.2.2.6. Utility levels

Table 22 below shows the effect on model outputs when the levels of utility decrement applied to the three types of injury in our model are varied. From these results it can be seen that only changes to the decrement applied to the years of permanent injury following the first year significantly affect the ICER.

Table 22 : One-way sensitivity analysis for costs of injury, fire and property costs

Parameter change	Control per household		Intervention per household		ICER	Net Benefit per household	
Utility Parameter	Total Costs	Total QALYs	Total Costs	Total QALYs	(£s/QALY)	£20K/QALY	£30K/QALY
Reference	1217.22	77.481	1236.72	77.482	20,207	-0.199	9.451
Scaled decrement for minor injuries doubled	1217.22	77.4812	1236.72	77.4821	20,207	-0.199	9.451
Scaled decrement for minor injuries halved	1217.22	77.4812	1236.72	77.4821	20,207	-0.199	9.451
Scaled dec for permanent injuries Yr1 doubled	1217.22	77.4812	1236.72	77.4821	20,207	-0.199	9.451
Scaled dec for permanent injuries Yr1 halved	1217.22	77.4812	1236.72	77.4821	20,207	-0.199	9.451
Scaled dec for permanent injuries after Yr1 doubled	1217.22	77.1381	1236.72	77.1401	9,890	19.936	39.654
Scaled dec for permanent injuries after Yr1 halved	1217.22	77.6527	1236.72	77.6532	42,240	-10.267	-5.651

5.2.3. Probabilistic sensitivity analysis PSA

For the PSA analysis we used the reference case example of our model where the relative risk of injury for the non-smoke alarm components of the intervention is set to 0.95 for household with versus those without the intervention.

5.2.3.1. Mean outputs from the PSA

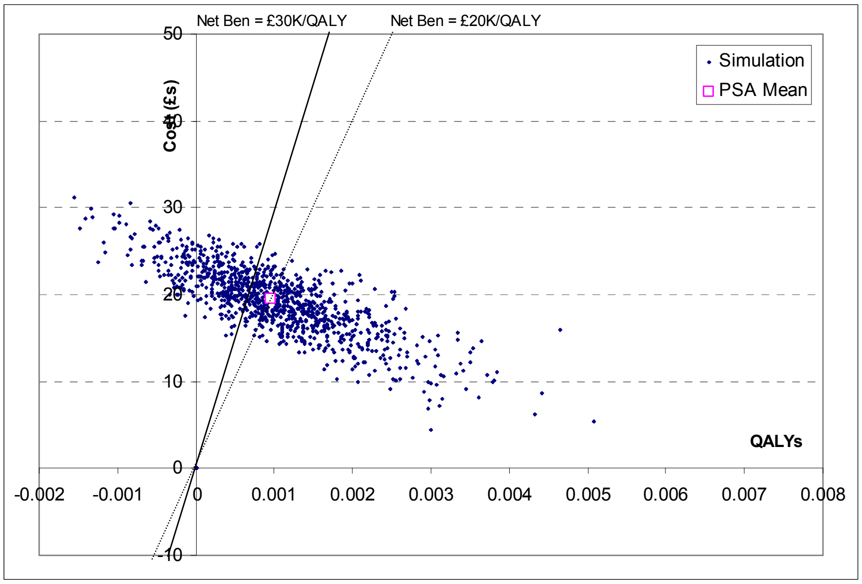
The mean average of the 1000 simulation trials conducted with our model is shown below in Table 23.

Table 23 : Mean outputs from the PSA simulation for the General Home Programme

Control per household		Intervention per household		Differences per household		ICER
Costs	QALYs	Costs	QALYs	Costs	QALYs	(£s/QALY)
£1,217.22	77.48117	£1,236.72	77.48214	£19.5	0.000965	£20,206.65

5.2.3.2. Incremental cost-effectiveness ratio

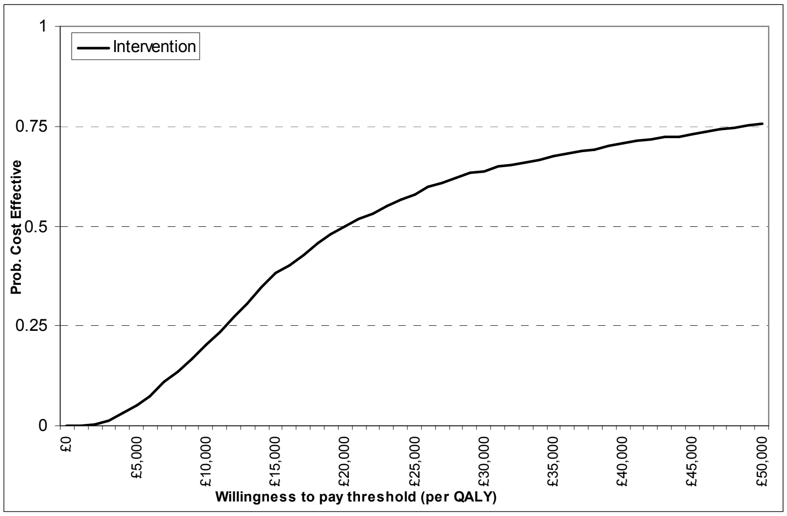
Figure 9 : Incremental cost-effectiveness ratio outputs from simulation



5.2.3.3. Cost-effectiveness acceptability curve (CEAC)

The CEAC from our PSA is shown below (Figure 7). This predicts that at a willingness-to-pay threshold of £20,000 per QALY gained there is a 50% probability that the intervention modelled is cost-effective. At a willingness-to-pay threshold of £30,000 per QALY gained there is a 64% probability that the intervention is cost-effective.

Figure 10. Cost-Effectiveness Acceptability curve (CEAC) for general home safety scheme



6. Discussion

In this section we first discuss our general findings arising from our economic analysis. We then turn to look specifically at the results relating to the two specific modelled programmes.

From our one-way sensitivity analysis a number of key variables in the model are shown to be important in determining the cost effectiveness of a home safety programme. One simple and general characterisation of this analysis is to separate a home safety programme into the following two components:

1. **Programme reach**: The impact of a scheme in increasing the number of household years of adoption of a safety measure gained set against the associated costs of the scheme.
2. **Safety Measure Effectiveness**: The general effectiveness of a safety measure in reducing accidental injuries and damage in the home (and hence increasing quality of life and reducing costs). That this to say the effective advantage accrued to those household with installation of a safety measure against those who do not have the safety measure.

The overall cost-effectiveness of a scheme can be seen to be the combined effect of these two components. There may of course also be safety impacts from educational components of community child safety programmes, but we have not explicitly modelled these.

6.1.1. Programme reach

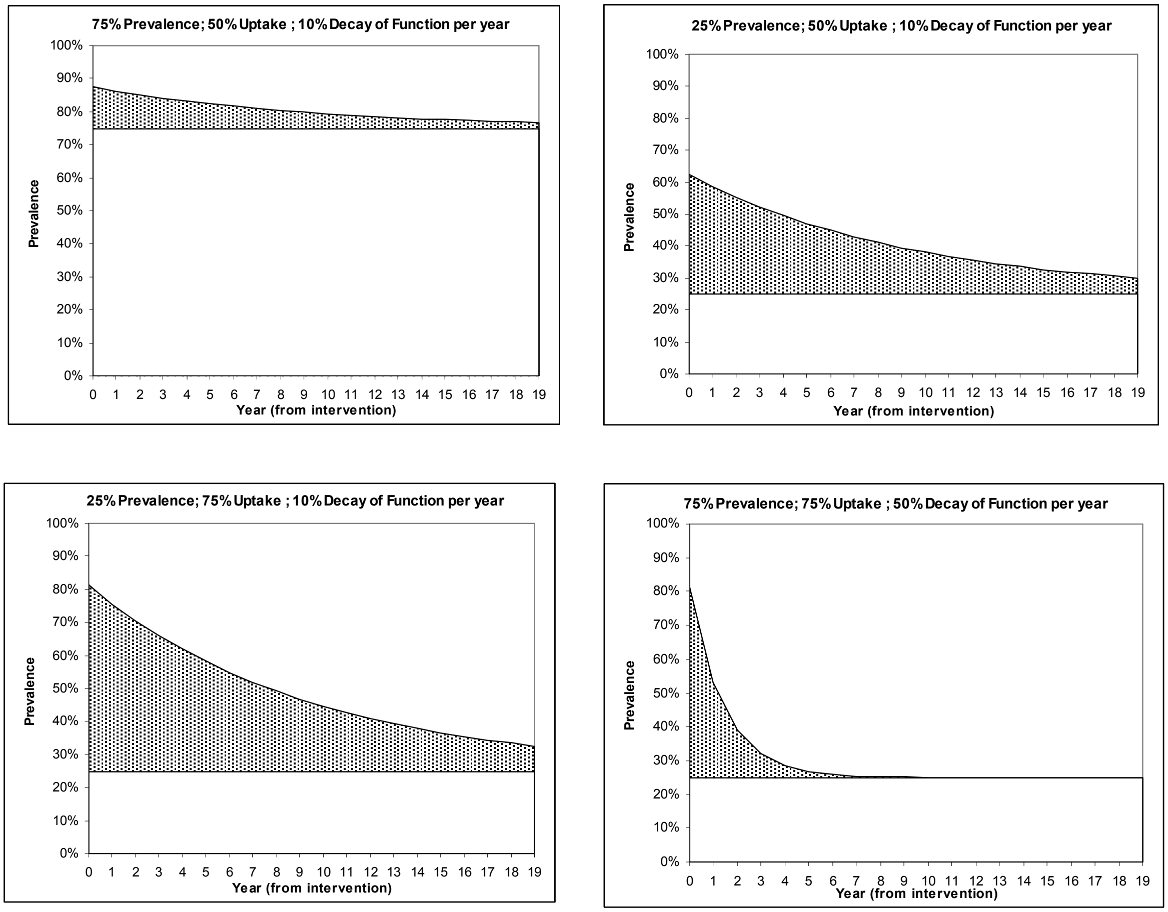
When we examined programme reach (the first of the components above) there are three key parameters which together determine the overall increase in 'household years' of adoption of a safety measure as a result of a home safety programme intervention (eg the extra households with functioning smoke alarms multiplied by the average duration of their continued operation). These three are described below:

- **Prevalence** – the existing level of adoption of safety measure amongst the population included with the home safety intervention scheme. Low levels of prevalence entails a greater number of 'target households' (i.e. those without the safety measure already) and hence is likely to increase the effectiveness of a scheme in increasing levels of adoption.

- **Uptake** – the level at which the target group in the population (ie. those without a safety measure) respond to the intervention by accepting *and* properly implementing the offered feature. Uptake level encompassed in our Intervention model as the product of both acceptance rate and implementation rate.
- **Functional Decay Rate**– the rate at which the additional safety measures adopted by the targeted households as a result of an intervention programme become ineffective over time. In the case of smoke alarms, for example, this would correspond to the rate at which installed smoke alarms become non-operational due to battery non-replacement or other causes. In the case of safety equipment targeted at children, functional decay could be due to children in a household becoming older and the associated progressive inapplicability of the safety equipment.

The way in which these three factors, prevalence, uptake, and functional decay, combine to create differing levels of intervention is shown graphically below in Figure 11. In these diagrams the overall number of extra ‘household years’ of adoption of a safety measure is represented by the shaded area of each graph. From these graphs it can be seen how each of the three factors are critically important in determining the extra ‘household years’ gained through implementation of a safety scheme.

Figure 11 : Graphs showing levels of impact in terms of 'household years' gained over time given different combinations of prevalence, uptake and functional decay for a home safety intervention.



Using our model it was possible to calculate the overall household years of exposure gained for a range of different levels of these three variables. These outputs are shown below in Table 24, and demonstrate the strong effect of these parameters in determining the potential impact of an effective home safety device. (It is important to note that even in past effectiveness and cost-effectiveness studies, the extent to which these factors are accurately known, particularly the rate of functional decay, is often disappointing).

Table 24 : Intervention impact in terms of increased 'household years' of adoption of a safety measure per 1000 households for differing levels of existing prevalence of use, uptake, and functional decay over time.

Functional Decay Rate per year		**Low Prevalence = 25%**			**Medium Prevalence = 50%**			**High Prevalence = 75%**		
		High Uptake = 75%	Medium Uptake = 50%	Low Uptake = 25%	High Uptake = 75%	Medium Uptake = 50%	Low Uptake = 25%	High Uptake = 75%	Medium Uptake = 50%	Low Uptake = 25%
0%	Undiscounted	40024	26683	13341	26683	17788	8894	13341	8894	4447
	Discounted	14987	9992	4996	9992	6661	3331	4996	3331	1665
10%	Undiscounted	5040	3359	1679	3359	2239	1118	1679	1119	559
	Discounted	3873	2582	1291	2582	1721	860	1291	860	430
30%	Undiscounted	1310	873	436	872	581	289	436	290	144
	Discounted	1216	810	405	810	540	270	405	270	135
50%	Undiscounted	561	373	186	373	248	123	186	123	61
	Discounted	544	362	181	362	241	120	181	120	60
70%	Undiscounted	239	159	78	158	105	51	78	52	25
	Discounted	237	158	79	158	105	52	79	52	26

In terms of the policy implications, it is clear that different approaches such as those listed below could be used to improve the impact against each of the three factors listed:

Prevalence: Identifying and targeting home safety schemes at low prevalence populations (eg deprived areas) is likely to improve impact levels. Also, the development of cheap but reliable surveys for identifying homes with and without specific safety features or equipment may be worthwhile.

Uptake: Measures to improve the levels of acceptance and successful implementation amongst those households in the population. The effectiveness review (Report 1) was equivocal about the value of schemes involving the offer of free and/or professional installation of safety devices (like smoke alarms) which require proper fitting for optimal effectiveness. However, design features of the device itself which make it easier to fit may be important.

Functional decay: Measures to ensure the prolonged functionality of installed equipment and safety provisions for example through the use of long life smoke alarms (Rowland et al. 2002) or through follow up visits and procedures.

6.1.2. Safety Measure Effectiveness

In our model, evidence from just two case-controlled studies was used to estimate the reduction in fire related injuries resulting from the installation of smoke alarms. Evidence of effect from the presence of other home safety measures was harder to obtain from the literature and hence our analysis focussed on exploring the threshold of effectiveness required to delivery cost-effective outcomes for such interventions.

Furthermore, risk ratios from such studies may over-estimate the effectiveness of such devices when provided as part of give-away schemes, since it is likely that householders who have chosen to buy and install particular safety devices themselves are more safety conscious in general. Therefore, a part of the ‘effect’ of the safety device from case-control studies is actually due to the characteristics and typical behaviours of the householders who choose to have them. The implication of this is that more evaluations of home safety programmes should endeavour to produce subgroup analyses of household-level data according to the existing presence, newly acquired or absence of the specific safety features, and the rates of the specific types of injuries that those features are designed to prevent.

6.2. Limitations of the modelling

Many of the assumptions used in the modelling are based on very limited data, and so conclusions about the overall cost-effectiveness of interventions must be made with full acknowledgement of these uncertainties; in general the analyses should therefore be regarded as exploratory. In particular:

There was **no reliable research evidence** on UK costs relating to programme implementation for general home safety assessment schemes (the only previous cost-effectiveness or costing study of this type of programme was in Canada (King et al. 2001)). Also, critical evidence relating to the safety impact of an installed safety feature in reducing injuries is essential to the analysis of benefits from home safety interventions as analysed in this report. Such data are very limited or non-existent. In the absence of good evidence on this, intermediate measures such as the rates of safety feature adoption amongst a study population are unlikely to be adequate (see Report 1 Discussion).

There was **limited research evidence** on: background rates of injury in the target population; relative risk ratio for households with and without safety feature; costs relating to programme implementation (only one UK-based cost and cost-effectiveness study of a smoke alarm give-away scheme (DiGuiseppi et al. 1999b;Ginnelly et al. 2005)); the household structure of target households (i.e. especially the number and ages of occupants); costs related to both the short-term treatment and the longer term health and social care costs of different types and different severity of injury; the duration of effective function of the different safety devices (denoted 'functional decay rate' in our model). Evidence of effectiveness alongside costs was particularly lacking for general risk assessment/consultation with equipment provision schemes. More evidence is available for the free smoke alarm schemes.

Another problem with the data in this field is the injuries which determine the bulk of the incremental benefit, that is permanent and fatal injuries, are relatively rare. This implies that study sizes need to be very large to significantly measure any outcomes of importance in terms of longer term cost or health outcomes. Low incidence of many of the key outcomes means that many of the relevant trials are underpowered to detect effects of an intervention (see Report 1).

Other key limitations

Apart from the prevention of fire-related injuries due to the provision of smoke alarms, we have not separately modelled the impact of specific types of safety device (or advice/education) on the types of injury that they are aimed at preventing. Instead we have created an aggregate model which only defines injuries fairly crudely in terms of their severity (minor, permanent, fatal) and does not distinguish, for example, that some types of injury (e.g. falls down stairs) may be more or less likely to be fatal or permanent, and may also incur different treatments costs. A model which aimed to separately estimate the cost and QALY impacts of the various types of unintentional injury which children may experience in the home would require a great deal of data which is simply not available. We have instead modelled the whole 'bundle' of home safety devices offered and only assessed differential take-up of devices in terms of their cost to the programme.

Related to the point just made, arguably there should be an incremental approach to deciding what the optimum combination of components within such a home safety programme should be. This would start with a fairly minimalist (and cheap) programme which, for example, simply gives households with children free devices (with safety advice leaflets) - where reliable evidence suggests that the device would prevent the greatest loss of QALYs (relative to their cost). Then, the additional provision of other intervention components – such as the supply of other safety devices, or giving face-to-face visits to assess risks and provide verbal child safety advice – should be assessed as part of a model's incremental cost-effectiveness analysis, each time using the model to estimate the additional costs and additional benefits of adding the extra programme component. However, such an ambitious cost-effectiveness modelling exercise would, at some point, need to identify empirical studies (preferably RCTs) which have evaluated the cost and effectiveness of these differing combinations of programme components.

In the absence of alternative data, the levels of relative risk reduction from for the two types of non-fatal injuries were assumed to be the same as the relative risk for fatal injuries. In reality, the effectiveness of more households having or using home safety devices, or of altering safety behaviours within the home, is likely to differentially impact the different levels of injury.

Also in our model, we have assumed that the background levels of risk amongst the population who are targetted with programmes reflects population norms. This is questionable since it is likely that the characteristics of households in areas likely to be targeted, and who do not have the specified safety devices, are likely to be different from estimates based on the whole population (e.g. more deprivation, more children, single parent families etc).

Because the structure of our model is based primarily on the simulated effects of having and correctly using various types of home safety device, we have departed from using the aggregate effectiveness results of existing effectiveness studies. Although the effectiveness studies identified by our systematic review (see Report 1) revealed a very mixed picture of their findings, such studies would still have the advantage of capturing any effect of both the presence of newly used/installed safety devices *and* any changes in safety behaviours (due, for example, to the educational and awareness-raising components of the programme). Our model has not separately modelled the possible effectiveness of such educational and information- or advice-giving components, largely because data relating to the additional effectiveness produced by these components is lacking. While this is an omission from our modelling, it seems relatively less significant given the severe lack of data regarding even the injury risk reductions which the presence of safety devices is supposed to achieve.

6.3. Strengths of the modelling

We believe that our model provides a relatively simple and coherent framework which encompasses key elements of the potential ‘reach’ of intervention programme in promoting adoption of safety equipment etc. as well as investigating the outcomes related to differing adoption or exposure levels. Furthermore:

- Despite the data limitations listed in the previous section, developing an economic model which more closely adhered to the data available from previous economic evaluations might have, effectively, led to the replication of the trial results, but using simulation methods. This, in our view, would defeat the main purpose of performing a model-based analysis: that is to explore key trade-offs which exist within a programme, and between programmes with different components, and the nature of the populations in which they are implemented, and the impact of these trade-offs on costs and effectiveness.

- In contrast to the published trial-based cost-effectiveness analyses available, our model both incorporates the estimation of the health-related quality of life impacts of non-fatal injuries, and also the longer term QALY gains due to fatal and non-fatal injuries prevented (even though the data on which to base such longer term gains is highly uncertain).

- The modelling allows for the exploration of different factors through sensitivity and threshold analysis to examine the likely impact of key variables on longer-term cost and effectiveness outcomes. We have done this through both one-way and probabilistic sensitivity analysis.

So overall, our economic modelling serves mostly to demonstrate that “it all depends”: the cost-effectiveness of the types of child injury prevention programme which are the focus of this NICE Guidance depend critically on a number of factors for which there will be no consistent average value for. Our sensitivity and threshold analyses have revealed the following:

6.3.1. Free smoke alarms – key factors

High impact parameters:

Changes to the following parameter values have a substantial impact on the estimated cost-effectiveness:

- The discount rate applied to QALYs – this is because the incremental benefits due to permanent or fatal injuries avoided are accrued over the time horizon of the model (up to 100 years) and hence the rate at which these are discounted impacts on the ICER.

- Time horizon – a short time horizon does not capture the long term incremental benefits so measuring the model output after only 10 years was found to greatly increase the ICER.

- Population – significant changes to the underlying population included in the intervention will affect the ICER since the fixed costs of the programme remain the same. Increasing the population addressed will lower the ICER of the programme.

- Household size – because smoke alarms confer benefit on all members of a household, an increase in the average size of households in the intervention population will increase the number of people affected by the intervention and therefore reduce the ICER significantly (for similar reasons to the affect of increasing the population).

- Programme costs – the overall costs of implementing a free smoke alarm scheme is central to determining its overall cost-effectiveness.

- Existing prevalence – The level at which the population already has a smoke alarms installed greatly affects the impact of the smoke alarm programme in increasing usage and impacts the ICER accordingly.

- Uptake – the effectiveness of a free smoke alarm programme in gaining acceptance amongst the target population is critical in determining the extra number of alarms installed and the cost-effectiveness of the programme.

- Functional decay – key to determining the overall benefits gained from extra installed smoke alarms is the longevity of function those extra alarms.

- Relative risk of permanent and fatal injuries – because the QALY impact of both permanent and fatal injuries persist for the lifetime of the people in the model, change to the relative risk between those households with and without alarms for these types of injury has a significant impact on the ICER.

- Utility decrement applied to the years with a permanent injury – this decrement is applied to all but the first year of patients experiencing permanent injury in the model. Changing the level of decrement applied to this type of injury therefore has a considerable impact on the ICER.

Low impact parameters

The cost-effectiveness estimates were relatively insensitive to the following input parameter changes:

- Relative risk of minor injuries – changes to the relative risk of minor injuries for households with versus those without smoke alarms has little effect on the ICER. This is because the effect of minor injuries is short-lived relative to permanent and fatal injuries.

- Discount rate applied to costs – the largest component of incremental cost between arms in our model is due to the programme cost. This is applied in the first cycle of the model so is unaffected by discounting. Changes to the discount rate for costs in the model therefore has little effect on the ICER.

- Outcome costs – changes to costs relating to the treatment of injury and fire attendance and property damage cost have little impact on the ICER. This is because they are applied only once per incident in the model.

PSA findings

The PSA revealed a very large amount of uncertainty given our assumptions about the uncertainty inherent in the inputs. The analysis predicts a 50% probability of that the simulated intervention is cost-effective at a willingness-to-pay threshold of approx £22,000 per QALY gained.

6.3.2. General home safety intervention – key factors

High impact parameters:

The parameter changes to which the model was most sensitive in our general home safety intervention are largely the same as for this comparison as for the free smoke alarm analysis as listed above. In particular the model was highly sensitive to changes to the relative risk value for the likelihood of injuries between those houses who receive and do not receive the various child home safety devices.

PSA findings

The PSA again revealed a very large amount of uncertainty given our assumptions about the uncertainty inherent in the inputs. The analysis predicts a 50% probability of that the intervention is cost-effective at a willingness-to-pay threshold of approx £20,000 per QALY gained.

6.4. Research recommendations

A variety of different types of research could better inform the estimation of the cost-effectiveness of such home-based child safety programmes in the future, for example:

Evaluations of the effectiveness of safety device give-away schemes, or home risk assessment schemes (with or without the free or discounted supply or installation of home safety equipment) should include a comprehensive assessment of the cost of providing the programme and the short- and longer-term cost impacts of injury and other outcomes

Evaluations of home safety programmes should endeavour to produce subgroup analyses of household-level data which examines *whether the presence or absence of the specific safety features* (or exposure to education or advice about specific risks or behaviours), is related to reduced rates *of the specific types of injuries* that those features (or the tailored advice) was designed to prevent.

Studies to map high risk areas/households against prevalence of safety device use/ownership to determine priority areas for targetting of interventions (i.e. areas of high fire risk and low prevalence of smoke alarms likely to be more cost-effective providing that uptake can be attained).

More research is needed to determine the precise level of injury reduction associated with smoke alarm use in the UK. What is the basis for the commonly quoted relative risk of 2 for fire-related deaths? (i.e. that people are twice as likely to die from a house fire in a house without than one with a smoke alarm)

Studies to investigate why freely provided smoke alarms remain uninstalled, and how the offer of free installation affects this? i.e. is there a trade-off whereby fewer people want others to come into their home to install them, but the rate of correct instalment is higher with professional instalment?

Study to determine whether smoke alarms with greater longevity (e.g. with better long-life batteries and more tamper-proof) are more cost-effective despite the increased cost.

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Appendix 1

Table 25 : Parameters used for Deterministic and Probabilistic Analysis of Cost-effectiveness of Free Smoke Alarm Scheme

PARAMETER	BASE CASE Values	Source/Rationale	PSA Variation		Source/ Rationale of variation
			Range	Dist.	
GENERAL					
Discount Rate – Costs	3.5%	NICE Reference Case	Not varied		
Discount Rate - Utilities	3.5%	NICE Reference Case	Not varied		
Time Horizon (years)	100	Pop Lifetime outcomes	Not varied		
Cycle Length (years)	1	Model Assumption	Not varied		
POPULATION					
No of Households	80,000	Based on population in DiGuiseppi et al 2002 (DiGuiseppi et al. 2002)	Not varied		
Initial Age of Main Pop	8	Mean age of children 1 to 15 years	1.02 Std Err	Normal	Assumed 95% CI from 6-10 years
No of Extras A per hshold	1.2	Reported household composition population in DiGuiseppi et al 2002 (DiGuiseppi et al. 2002)	1-2 Range	Uniform	Assumption
Initial Age of Extras A	27	Mean Age of UK Population	3.57 Std Err.	Normal	Assumed 95% confidence limits from 20-34 years
No of Extras B per hshold	0	scenario anlysis only	unused		
Initial Age of Extras B	0	scenario anlysis only	unused		
PROGRAMME EFFECTIVENESS					
Existing Prevalence	47.0%	As reported in Ginnelly et al 2005(Ginnelly et al. 2005)	10.5% Std Err	Normal	95% CI set from 30%-71% (upper limit – UK Avg prevalence)
Programme Acceptance	47.3%	Based on acceptance rate reported (20,050 out of 73,399) (Ginnelly et al. 2005)	2.4% Std Err	Normal	95% CIs set using interval reported in (Ginnelly et al. 2005)
Successful Installation	51.0%	Based on a speculated rate of installation reported in DiGuiseppi et al 1999(DiGuiseppi et al. 1999b) which references an study by Mallonee et al 1996(Mallonee et al. 1996)	3.06% Std Err	Normal	Based on 95% CIs reported in Mallonee et al 1996(Mallonee et al. 1996)
Functional Decay per year	30.1%	Based on study by Rowland et al(Rowland et al. 2002)	2.9% Std Err	Normal	Based on Rowland et al taking difference between best and worst groups in study as 95% CI.(Rowland et al. 2002)
SAFETY EFFECTIVENESS					
Prob. of minor injury per year without alarm	0.0003483	From DiGuiseppi et al.(DiGuiseppi et al. 2002)	0.00005	Normal	Assessed from DiGuiseppi et al. 2002 (DiGuiseppi et al. 2002)

Relative risk minor injury with alarm/without alarm	0.5	Based on a relative risk ratio quoted by CAPT (2009)	0.153	Normal	Using 95% CI of 0.8 to 0.2 based on studies by Runyan et al(Runyan et al. 1992)
Probability of permanent injury per year without alarm	0.00002216	From DiGuiseppi et al.(DiGuiseppi et al. 2002)	0.000007	Normal	Assessed from DiGuiseppi et al.(DiGuiseppi et al. 2002)
Relative risk permanent injury with alarm/without alarm	0.5	Based on a relative risk ratio quoted by CAPT (2009)	0.153	Normal	Using 95% CI of 0.8 to 0.2 based on studies by Runyan et al(Runyan et al. 1992)
Probability of fatal injury per year without alarm	0.00000788	Base data from DiGuiseppi et al(DiGuiseppi et al. 2002)	0.000003	Normal	Assessed from DiGuiseppi et al. Based on differences between
Relative risk fatal injury with alarm/without alarm	0.5	Based on a relative risk ratio quoted by CAPT (2009)	0.153	Normal	Using 95% CI of 0.8 to 0.2 based on studies by Runyan et al(Runyan et al. 1992)
COSTS OF INTERVENTION					
Fixed costs of Intervention	£64387.45	Composite value derived from cost analysis presented in DiGuiseppi et al(DiGuiseppi et al. 1999b)	6570.15	Normal	Assumption Std. Error set to 10% of mean
Survey costs per household	£0.65	Composite value derived from cost analysis presented in DiGuiseppi et al(DiGuiseppi et al. 1999b)	0.07	Normal	Assumption Std. Error set to 10% of mean
Acceptance costs / hshld	£5.01	Value taken from cost analysis presented in DiGuiseppi et al(DiGuiseppi et al. 1999b)	0.51	Normal	Assumption Std. Error set to 10% of mean
Add'l Installation cost / hshld	£1.57	Value taken from cost analysis presented in DiGuiseppi et al{DiGuiseppi, 1999 2553 /id	0.16	Normal	Assumption Std. Error set to 10% of mean
OUTCOME COSTS					
Cost of Minor Injury/year	£105.00	Cost component analysis based on National Schedule of Reference costs	25.2	Normal	Cost component analysis based on National Schedule of Reference costs
Cost of Major Injury/first year	£3,585.00	Cost component analysis based on National Schedule of Reference costs	956.3	Normal	Cost component analysis based on National Schedule of Reference costs
Major Injury/Subsqt years	[redacted](AIC)	Based on (Nicholl et al. 2009)	[redacted](AIC)	Normal	Based on 95% CI reported in (Nicholl et al. 2009)
Incident (Fire Service etc)	£522.64	Ginelly et al	77.1	Normal	Based on 95% CIs reported in Ginelly et al.
Cost of Property Damage	£607.00	(Ginelly et al) assuming 50% of affected houses are council supported or owned.	155	Normal	Based on 95% Confidence Limits of 25-70% council ownership
UTILITIES					
Scaled Decrement for Minor Injury - Year1 only	[redacted](AIC)	A tenth of permanent injury decrmt.	See below		Varied as factor (20%) of perm. injury decrement (below)
Scaled Decrement for Permanent Injury -	[redacted](AIC)	Assumed double effect of subsequent years	See below		Varied as factor (200%) of perm. injury

Year 1 only					decremnt (below)
Scaled Decrement for Perm. Injury - All Subsequent Years	[redacted](AIC)	Based on (Nicholl et al. 2009)	[redacted](AIC)	Normal	Based on confidence interval reported in Nicholl et al(Nicholl et al. 2009)
General Background utilities for non-injured population	Under 25: 0.94 25-34: 0.93 35-44: 0.91 45-54: 0.85 55-64: 0.80 65-74: 0.78 Over 74 : 0.73	UK Population utility norms published in Kind et al 1999 (Cuny & Fredekind 196)	0.015 0.007 0.005 0.007 0.011 0.012 0.012	Normal	Standard error calculated from standard deviation reported in Kind et al(Kind et al. 1999)

Table 26 : Parameters used for Deterministic and Probabilistic Analysis of Cost-effectiveness of General Home Safety Assessment Scheme

PARAMETER	BASECASE Values	Source/Rationale	PSA Variation		Source/ Rationale of variation
			Range	Dist.	
GENERAL					
Discount Rate – Costs	3.5%	NICE Reference Case	Not varied		
Discount Rate - Utilities	3.5%	NICE Reference Case	Not varied		
Time Horizon (years)	100	Pop Lifetime outcomes	Not varied		
Cycle Length (years)	1	Model Assumption	Not varied		
POPULATION					
No of Households	1,714	Based on population in Watson et al(Watson et al. 2005)	Not varied		
Initial Age of Main Pop	2	Mean age of children 1 to 4 years	1.02 Std Err	Normal	Assumed 95% CI from 6-10 years
No of Extras A per hshold	1.2 (Used for smoke alarm component of model only.)	Reported household composition population in DiGuiseppi et al 2002 (DiGuiseppi et al. 2002)	1-2 Range	Uniform	Assumption
Initial Age of Extras A	27 (smoke alarm component only.)	Mean Age of UK Population	3.57 Std Err.	Normal	Assumed 95% confidence limits from 20-34 years
No of Extras B per hshold	0	scenario anlysis only	unused		
Initial Age of Extras B	0	scenario anlysis only	unused		
PROGRAMME EFFECTIVENESS					
Existing Prevalence	General Prog. 10 %	assumption			
	Smoke Alarm 47.0%	As reported in Ginnelly et al 2005(Ginnelly et al. 2005)	10.5% Std Err	Normal	95% CI set from 30%-71% (upper limit – UK Avg prevalence)
Programme Acceptance	General Prog. 68%	Reported in Watson et al study (Watson et al. 2005)	10.2 Std err.	Normal	95% CIs set from high and low acceptance levels reported in (Watson et al. 2005)
	Smoke Alarm 47.3%	Reported in Ginnelly et al 2005(Ginnelly et al. 2005)	2.4% Std Err	Normal	95% CIs set using interval reported in (Ginnelly et al. 2005)
Successful Installation	General Prog. 100%	Installation rate incorporated in acceptance rate above	Not varied		
	Smoke Alarm 51%	See Table 25 above	3.06% Std Err	Normal	See Table 25 above
Functional Decay per year	General Prog. 40%	Based on an assumption of 90% obsolescence after 4 years of use.	5.1%	Normal	95% CIS based on 3 and 5 years obsolescence.
	Smoke Alarm 30.1%	See Table 25 above	2.9% Std Err	Normal	See Table 25 above
SAFETY EFFECTIVENESS					
Prob. of minor injury per year without feature	General Prog. 0.0665	HASS 2002 data for UK population of children aged 0-4(Department for Trade and Industry 2003)	0.0136	Normal	95% CIs set using assumption about proportion of all injuries preventable by safety intervention
	Smoke Alarm	See Table 25 above	0.00005	Normal	See Table 25 above

	0.0003483				
Probability of permanent injury per year without alarm	General Prog. 0.003837	HASS 2002 data for UK population of children aged 0-4(Department for Trade and Industry 2003)	0.00051	Normal	95% CIs set using assumption about proportion of all injuries preventable by safety intervention
	0.00002216	See Table 25 above	0.000007	Normal	See Table 25 above
Probability of fatal injury per year without alarm	General Prog. 0.000005	ONS mortality data(Office for National Statistics 2009b) for mortality by accident data	0.0000005	Normal	95% CIs set using assumption about proportion of all injuries preventable by safety intervention
	Smoke Alarm 0.00000788	See Table 25 above	0.000003	Normal	See Table 25 above
Relative risk of injury (all types) with feature vs. without alarm	General Prog. 0.95	Varied assumption	0.9-1 Range	Uniform	assumption
	Smoke Alarm 0.5	See Table 25 above	0.153	Normal	See Table 25 above
COSTS OF INTERVENTION					
Fixed costs of Intervention	£64387.45	Composite value derived from cost analysis presented in DiGuiseppi et al(DiGuiseppi et al. 1999b)	6570.15	Normal	Assumption Std. Error set to 10% of mean
Survey costs per household	£0.65	Composite value derived from cost analysis presented in DiGuiseppi et al(DiGuiseppi et al. 1999b)	0.07	Normal	Assumption Std. Error set to 10% of mean
Acceptance costs / hshld	£5.01	Value taken from cost analysis presented in DiGuiseppi et al(DiGuiseppi et al. 1999b)	0.51	Normal	Assumption Std. Error set to 10% of mean
Add'l Installation cost / hshld	£1.57	Value taken from cost analysis presented in DiGuiseppi et al{DiGuiseppi, 1999 2553 /id	0.16	Normal	Assumption Std. Error set to 10% of mean
OUTCOME COSTS					
Cost of Minor Injury/year	£105.00	Cost component analysis based on National Schedule of Reference costs	25.2	Normal	Cost component analysis based on National Schedule of Reference costs
Cost of Major Injury/first year	£3,585.00	Cost component analysis based on National Schedule of Reference costs	956.3	Normal	Cost component analysis based on National Schedule of Reference costs
Major Injury/Subsqt years	[redacted](AIC)	Based on (Nicholl et al. 2009)	[redacted](AIC)	Normal	Based on 95% CI reported in (Nicholl et al. 2009)
Incident (Fire Service etc)	£522.64	Ginelly et al	77.1	Normal	Based on 95% CIs reported in Ginelly et al.
Cost of Property Damage	£607.00	(Ginelly et al) assuming 50% of affected houses are council supported or owned.	155	Normal	Based on 95% Confidence Limits of 25-70% council ownership
UTILITIES					
Scaled Decrement for Minor Injury - Year1 only	[redacted](AIC)	A tenth of permanent injury decrmt.	See below		Varied as factor (20%) of perm. injury decrement (below)
Scaled Decrement for Permanent Injury - Year 1 only	[redacted] (AIC)	Assumed double effect of subsequent years	See below		Varied as factor (200%) of perm. injury decremnt (below)

Scaled Decrement for Perm. Injury - All Subsequent Years	[redacted] (AIC)	Based on (Nicholl et al. 2009)	[redacted] (AIC)	Normal	Based on confidence interval reported in (Nicholl et al. 2009)
General Background utilities for non-injured population	Under 25: 0.94 25-34: 0.93 35-44: 0.91 45-54: 0.85 55-64: 0.80 65-74: 0.78 Over 74 : 0.73	UK Population utility norms published in Kind et al 1999 (Cuny & Fredekind 196)	0.015 0.007 0.005 0.007 0.011 0.012 0.012	Normal	Standard error calculated from standard deviation reported in Kind et al(Kind et al. 1999)