STRATEGIES TO PREVENT UNINTENTIONAL INJURY IN CHILDREN

Economic modelling of legislation/regulations and related national strategies to promote the wider use of:

20mph zones in residential areas, and

TMVs in social housing for families

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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 Appraisal and Centre for Public Health Excellence) and systematic reviews as part of the Cochrane Collaboration Heart Group, as well as 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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Declaration of authors' competing interests

No authors have competing interests.

List of abbreviations

Abbreviation	Meaning
CBA	Cost-benefit analysis
CEA	Cost-effectiveness analysis
CSA	Cost-savings analysis
CUA	Cost-utility analysis*
DfT	Department for Transport
EQ-5D	EuroQol instrument (5 dimensions)*
GB	Great Britain
ICER	Incremental Cost-Effectiveness Ratio*
LRE	Jurisdiction-wide strategic policies such as legislation, regulations, standards together with activities for their enforcement or promotion (see Guidance Scope for fuller definition)
mph	Miles per hour
NPV	Net Present Value*
ONS	Office for National Statistics
PenTAG	Peninsula Technology Assessment Group (Peninsula Medical School, Exeter)
PHIAC	Public Health Interventions Advisory Committee (of NICE)
PSA	Probabilistic Sensitivity Analysis*
QALY	Quality-adjusted life-year*
STATS19	A standard form used by police in the UK for recording details of road accidents
TMV	Thermostatic Mixing Valve
UK	United Kingdom
USA	United States of America
WTP	Willingness to pay*

*These terms are defined in the Glossary on the following page

Glossary

Term	Definition
20mph zone	An area of road network with both a mandatory 20mph speed limit and physical traffic calming measures with signage to lower speeds to this level
Cost-utility analysis	An analysis comparing the incremental resources used by 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))
EQ-5D	A preference-based instrument for measurement of non-disease-specific health-related quality of life. Sometimes called the EuroQol instrument.
'high casualty areas'	In this report, this denotes the type of residential areas defined by Grundy et al. 2008 in their evaluation of 20mph zones in London, as having approximately > 1 (mean = 1.66) casualties per km per year. Their evaluation of the effectiveness of 20mph zones showed greater effectiveness (more injuries prevented) in these areas, and we use these evaluation results in the analyses of legislation/regulation presented here.
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 present value (or net benefit)	The total monetary benefit of an intervention less its costs (compared with an alternative intervention) when discounted to its present value.
Probabilistic Sensitivity Analysis	Sensitivity analysis in which many of the input variables in a model are varied simultaneously by repeated random sampling from pre-specified distributions of potential values for each uncertain input variable, and then aggregating the results from many (usually 1000 or more) such separate simulations based on the sampled values.
Quality-adjusted life year	Year of life adjusted for quality of life, usually using a preference weight for different generic health states obtained from the general population

Term	Definition
Registered Social Landlords	Social landlords that are registered with the Tenant Services Authority (previously the Housing Corporation until December 2008) - most are housing associations, but there are also trusts, co-operatives and companies. They provide housing for the employees of associated industrial and other undertakings, for special groups such as the aged, disabled people or single persons, or housing on a mutual and self-build basis.
Social housing	Flats or houses rented from and owned/managed by either Local Authorities or Registered Social Landlords (e.g. housing associations).
Thermostatic Mixing Valve	A valve that blends hot water with cold water to ensure constant, safe outlet temperatures in order to prevent scalding (Wikipedia; accessed 16 February 2010)
Utility	Preferences groups or individuals have for a particular set of health states. Health states generally given a utility value of between 1 (for perfect or full health) and 0 (for a health state which is as bad as being dead), although some states may judged to be worse than death (and therefore have a negative utility weight)
Willingness to pay	The amount a provider 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 jurisdiction-wide strategic approaches for promoting the wider and earlier uptake of effective interventions for preventing unintentional injuries in children (aged under 15 years). The exploratory analyses are conducted from a UK public sector perspective.

It last of seven reports to support the development of NICE public health programme guidance about strategies for preventing unintentional injuries to children and young people (aged under 15). Those reports, should be regarded as the context for this economic modelling exercise. However, as explained below, ultimately the various studies of the effectiveness of such strategic approaches did not provide a strong evidence base on which to build an economic modelling exercise. Also, the review of economic evaluations of strategic approaches provided few insights into how to conduct such analyses.

In order to build a sound and informative economic evaluation of a particular strategic approach to injury prevention, favourable answers are needed to the following questions:

- Is there good quality evidence of the effectiveness of the strategy or programme?
- Is there sufficient information about the types and quantities of different resources required (to develop and implement the strategy)?
- Is there sufficient information about the resource (or cost) impacts associated with the main effectiveness outcomes of interest?

The choice of strategic approaches to be assessed by the economic modelling attempted to reflect four other considerations: the potential to use/adapt previously developed models for the suite of work on preventing unintentional injuries to children; the emerging draft recommendations of the programme development group; the published examples of cost-effectiveness analysis of the strategic approach, and; the published evidence of the effectiveness of the intervention which the strategy aims to promote.

It was decided, in discussion with NICE, to compare two different strategic policies, one to reduce unintentional injuries to children and adults in the road setting, and one to reduce unintentional injuries to children at home:

1. Legislation or regulations supported by enforcement, promotion and monitoring activities to promote the wider and earlier implementation of **mandatory 20mph zones in high casualty residential areas**.
2. Regulations supported by enforcement, promotion and monitoring activities to promote the wider and earlier installation of **thermostatic mixer valves in family social housing where there are children aged less that 5 years**.

1.2. Aim

The aims of the economic modelling were:

To develop a generic model for evaluating strategic approaches for promoting the uptake of effective interventions for preventing injuries in children.

To use the model to explore the potential cost-effectiveness of a selection of strategic approaches to child injury prevention (e.g. legislation, regulation, standards, and/or mass media and other approaches to promote or enforce compliance) in a variety of settings in the UK.

1.3. Methods

A generic model for evaluating strategic policies

We developed a generic model for evaluating strategic approaches to preventing unintentional injuries based upon the following core assumptions.

1. The primary purpose of a strategic policy or piece of legislation/regulation is to promote a specific intervention of known effectiveness (and cost-effectiveness).

2. The main dimensions of the effectiveness of the strategic policy or legislation/regulation are (i) higher eventual uptake or coverage of eligible areas/households (etc.) and (ii) earlier achievement of the eventual uptake or coverage (within the jurisdiction of interest).

3. In order to exist and be effective, the strategic policy or legislation/regulation requires both (i) initial 'development' resources to draft, develop and pass the legislation/regulation or new policy, and (ii) ongoing (annual) expenditure on activities to enforce and/or promote awareness and compliance with it.

The model was built in Microsoft Excel and presumed a maximum time horizon for the effective lifetime of the legislation/regulation or policy of 30 years.

The analyses were conducted from a public sector perspective, and used a base year of 2009. For each of the two examples, the legislation or regulation was compared with the absence of the legislation or regulation.

1.4. Findings

Legislation/regulations to promote the earlier and wider implementation of 20mph zones

This exploratory modelling exercise has shown that the following factors are important in determining the cost-effectiveness of legislation/regulations to promote the earlier and wider implementation of 20mph zones:

- The cost, effectiveness and therefore the cost-effectiveness of implementing 20mph zones themselves

Interestingly, the cost of either introducing the legislation/regulation, or of enforcing and monitoring compliance by Local Authorities with it, is much less significant. This is mainly because the expected incremental cost of implementing 20mph zones (around £55,000 for each new zone) multiplied by the difference in the expected eventual number that would be implemented with and without the regulations (2,000) is very large relative to the overall cost of introducing the legislation/regulation and enforcing it (£110 million over 30 years, compared with our initial estimate of the cost of introducing the legislation/regulation of only £3.5 million).

Legislation/regulations/other strategies to promote the earlier and wider installation of TMVs in social housing for families with young children

This exploratory modelling exercise has shown that the following factors are important in determining the cost-effectiveness of legislation/regulations to promote the earlier and wider installation of TMVs in social housing:

- The expected eventual level of take-up/installation of TMVs in social housing following the introduction of regulations
- The number of years within which the eventual level of take-up/installation of TMVs in social housing would be reached following the introduction of regulations.
- The cost of enforcing and monitoring compliance with the regulations
- The number of eligible social housing households that would be eligible to have a TMV offered and fitted under the regulations.

The reasons that this evaluated regulation is sensitive to different model assumptions (compared with the 20mph zone analysis) is due to the scale of use of the intervention in combination with its per-household cost, which is not very large compared with the assumed cost of introducing and enforcing the regulation.

Discussion

The main limitation of the economic modelling is that most of the assumptions or variables used in the modelling are based on very limited or no published data. In particular, there is considerable uncertainty regarding:

- the extent to which the strategic policies will achieve greater coverage or uptake of the interventions, and over what time period this would be achieved;
- the initial cost of both developing and introducing the new legislation or regulations, and the ongoing costs of enforcing them or promoting them;

- the total number of eligible households, areas or communities in the jurisdiction which would be targetted by the relevant intervention or programme (i.e. that the strategic policy aims to promote)

Given this, the results should all be regarded as exploratory.

In addition, the model has not been specifically designed to reflect the possibility that the effectiveness (greater take-up or coverage) that is attributable to any legislation, regulation or other strategic policy might diminish over time – either because it is superseded by subsequent policies, or because societal behaviours and broader contexts to the interventions will change in the long term (e.g. driving behaviours and street layouts in residential areas, or the propensity to fit showers rather than baths, or baths with mixer taps as standard). However, the effect of discounting is such that by 20 years and 30 years post-policy introduction any effectiveness due to the policy or legislation is reduced by 50% and 64% respectively. Conversely, it is conceivable that some types of legislation, regulation or other strategic policies may have a cumulative impact over time,

This economic modelling has also been limited to extending the incremental cost-effectiveness analyses of the underlying public health or transport safety interventions. Apart from the cost-benefit (net present value) estimates for the 20mph zones and associated regulations, it therefore mainly produces ratio measures of cost-effectiveness. This has a number of limitations compared with taking a broader cost-benefit approach. It gives no value to the absolute level of coverage or increased uptake of the intervention achieved. Secondly, there may be additional value to society, not captured in this modelling, in achieving close to complete coverage or uptake of an intervention across the country. Lastly, some types of intervention and policy have aims - and associated costs and benefits – which go beyond health and health care and therefore cannot or should not be assessed in terms of their cost per QALY alone.

Research recommendations

Therefore, more valid, reliable and in particular longer term research is required are in order to establish:

- the extent to which the specific strategic policies will achieve greater coverage or uptake of the interventions, and over what time period this would be achieved;

- the initial cost of both developing and introducing the new legislation or regulations, and the ongoing costs of enforcing them or promoting them;
- the total number of eligible households, areas or communities in the jurisdiction which would be targetted by the relevant intervention or programme (i.e. that the strategic policy aims to promote)
- More valid and reliable estimates of the effectiveness and cost-effectiveness of the public health interventions which the strategic policies are promoting.

2. Introduction

2.1. Introduction

This report describes the economic modelling which has been undertaken to assess the cost-effectiveness of strategic approaches for promoting the wider and earlier uptake of effective interventions for preventing unintentional injuries in children (aged under 15 years). The exploratory analyses are conducted from a UK public sector perspective.

It is the last of seven reports to support the development of NICE public health programme guidance about strategies for preventing unintentional injuries to children and young people (aged under 15). Those reports should be regarded as the context for this economic modelling exercise. However, as explained below, the various studies of the effectiveness of such strategic approaches did not provide a strong evidence base on which to build an economic modelling exercise. Also, the review of economic evaluations of strategic approaches provided few insights into how to conduct such analyses.

2.2. Review of published economic studies

Table 1 below shows the previously published economic evaluations of legislative and other strategic approaches to preventing unintentional injuries to children on the road and in the home. These eight studies were found as part of the preparatory work for this model-based analysis, but gave few insights into how our model-based analysis should be designed (Anderson & Moxham 2009). (The summary of that review is presented in Appendix 1.)

Of particular note, only one of the five studies which evaluated new legislation or regulations estimated the cost of activities to enforce or promote the new legislation or regulation, and only one study (Hatziandreu et al. 1995) apparently estimated the "initial cost" of developing and passing the new legislation, regulation or policy (see Table 2). However, they gave few details of what was included in these costs. A more recently published economic study from Canada on the cost-effectiveness of introducing a law to make the use of mobile phones while driving illegal, has also omitted the 'start-up' cost of developing and passing the legislation (Sperber et al. 2009).

Table 1. Economic evaluations of legislation, regulation standards and associated strategies for enforcing or promoting them

Author & year	Type of strategy	Design	Empirical or model	Country
	Legislation:			
Taylor & Scuffham 2002	Compulsory wearing of bicycle helmets	CBA & CEA	Model	New Zealand
Hansen & Scuffham 1995	Compulsory wearing of bicycle helmets	CEA	Calculation*	New Zealand
Hatziandreu et al 1995	Compulsory wearing of bicycle helmets (vs community-wide and school-based promotion)	CEA	Model	USA
Han et al 2007	Thermostat settings to reduce water scalds	CSA	Model	Canada
Jensen et al 1989	Smoke detector laws	CEA	Model	USA
	Enforcement strategies:			
Chen 2005	Photo radar speed enforcement program	CBA	Model	BC, Canada
Hooke et al 1996	Speed cameras (and traffic light cameras)	CBA	Calculation*	UK

CBA = Cost-Benefit Analysis; CEA = Cost-Effectiveness Analysis; CSA = Cost-Savings Analysis
* Note that the distinction between model-based evaluations and ones based on more straightforward calculations is somewhat arbitrary. However, an analysis was called model-based if there was a clear model structure (e.g. decision tree) reflecting different participant pathways or the conditional probability of different events or states.

Table 2. Published economic evaluations: inclusion of the costs of (i) developing and passing legislation/regulations or (ii) related enforcement and monitoring activities

Author & year	Type of strategy	Were the costs of developing passing and promoting awareness of the legislation or regulation included?	Were the costs of enforcement or monitoring activities included?
	Legislation or regulation:		
Taylor & Scuffham 2002	Compulsory wearing of bicycle helmets	NO	NO
Hansen & Scuffham 1995	Compulsory wearing of bicycle helmets	NO	NO
Hatziandreu et al 1995	Compulsory wearing of bicycle helmets (vs community-wide and school-based promotion)	YES – some assessment of the cost of initiating the legislation & programme ($12,444), but method of estimation or data source not described.	NO
Han et al 2007	Thermostat settings to reduce water scalds	NO	NO – cost of disseminating educational notices to households only included
Jensen et al 1989	Smoke detector laws	NO	YES - but apparently very crudely ($0.50 per household, but method of estimation or data source not described)
	Enforcement strategies:		
Chen 2005	Photo radar program	NO	YES – Start-up costs, police costs, photo & ticket processing, equipment maintenance costs, court costs
Hooke et al 1996	Speed cameras (and traffic light cameras)	NO	YES – Annualised fixed costs and recurrent costs

* method of estimation or data source not described.

2.3. Feasibility assessment of economic modelling

In order to build a sound and informative economic evaluation of a particular strategic approach to injury prevention, favourable answers are needed to the following questions:

- Is there good quality evidence of the effectiveness of the strategy or programme?
- Is there sufficient information about the types and quantities of different resources required (to develop and implement the strategy)?
- Is there sufficient information about the resource (or cost) impacts associated with the main effectiveness outcomes of interest?

The choice of strategic approaches to be assessed by the economic modelling attempted to reflect four considerations:

- Potential to use/adapt previously developed models for the suite of work on preventing unintentional injuries to children
- Emerging draft recommendations of the programme development group
- Published examples of cost-effectiveness analysis of the strategic approach
- Published evidence of the effectiveness of the intervention which the strategy aims to promote

Ideally, we had also hoped to have the relevant research evidence and modeller time to be able to model the cost-effectiveness of a variety of different types of strategic policy, and hopefully with an example in each of the main environmental contexts in which unintentional injuries can be experienced by children; in the road environment, in the home, and in non-road outdoor environments. However, after weighing up these various considerations, and following the suggestion of CPHE analysts, it was decided that we should attempt to model the cost-effectiveness of:

1. Legislation or regulations supported by enforcement, promotion and monitoring activities to promote the wider and earlier implementation of **mandatory 20mph zones in 'high casualty' residential areas**.
2. Regulations supported by enforcement, promotion and monitoring activities to promote the wider and earlier installation of **thermostatic mixer valves in family social housing where there are children aged less that 5 years**.

3. Aims

The aims of the economic modelling were:

To develop a generic model for evaluating strategic approaches for promoting the uptake of effective interventions for preventing injuries in children.

To use the model to explore the potential cost-effectiveness of a selection of strategic approaches to child injury prevention (e.g. legislation, regulation, standards, and/or mass media and other approaches to promote or enforce compliance) in a variety of settings in the UK.

The design of the generic cost-effectiveness model is described in the next section.

4. Methods

4.1. The generic strategic policy model

Given the lack of existing good quality economic evaluations in a UK setting, or good quality effectiveness studies which provide adequate information about resource requirements to permit an economic analysis, it was decided (after discussion and agreement with CPHE analysts) that a more generic strategic policy evaluation model might be useful.

The simple model that we devised reflects the following three core assumptions:

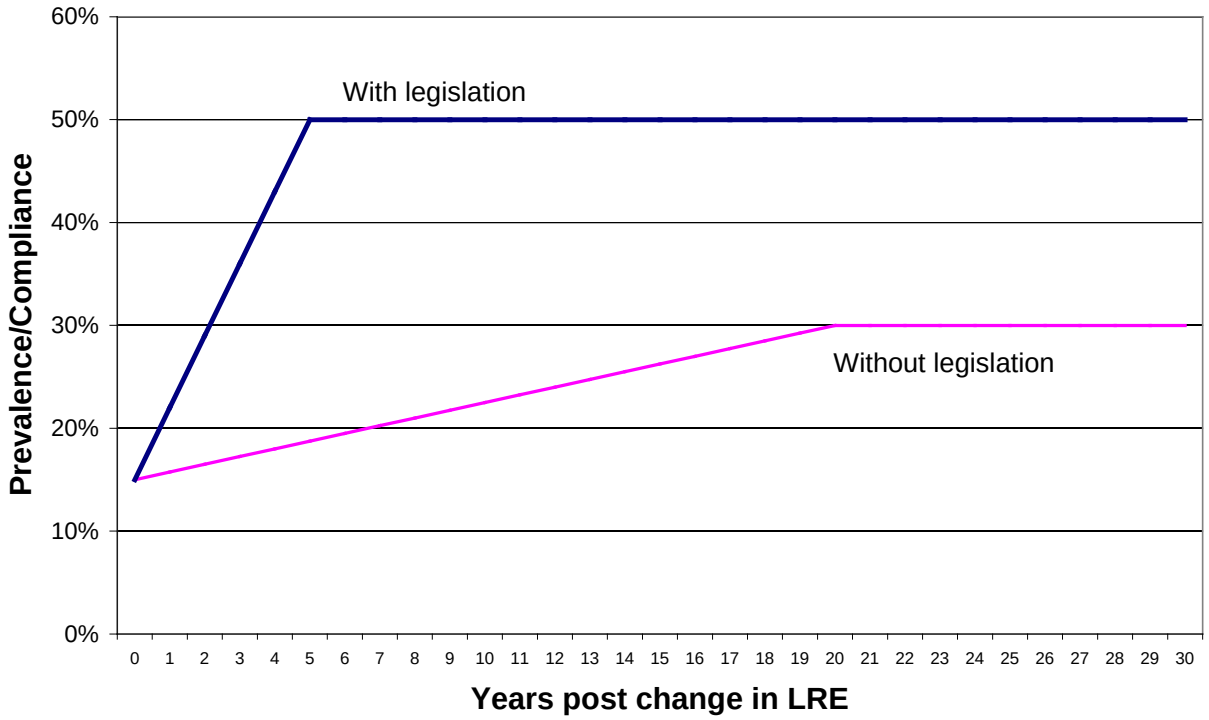
4. The primary purpose of a strategic policy or piece of legislation/regulation is to promote a specific intervention of known effectiveness (and cost-effectiveness).

5. The main dimensions of the effectiveness of the strategic policy or legislation/regulation are (i) higher eventual uptake or coverage of eligible areas/households (etc.) and (ii) earlier achievement of the eventual uptake or coverage (within the jurisdiction of interest).

6. In order to exist and be effective, the strategic policy or legislation/regulation requires both (i) initial 'development' resources to draft, develop and pass the legislation/regulation or policy, and (ii) ongoing (annual) expenditure on activities to enforce and/or promote awareness and compliance with it.

Figure 1 below shows how the impact of such a strategic policy is simulated, showing the degree of uptake or coverage of the effective intervention over time, in those areas which are eligible/suitable. The model was constructed in Microsoft Excel.

Figure 1. A generic model for evaluating strategic policy

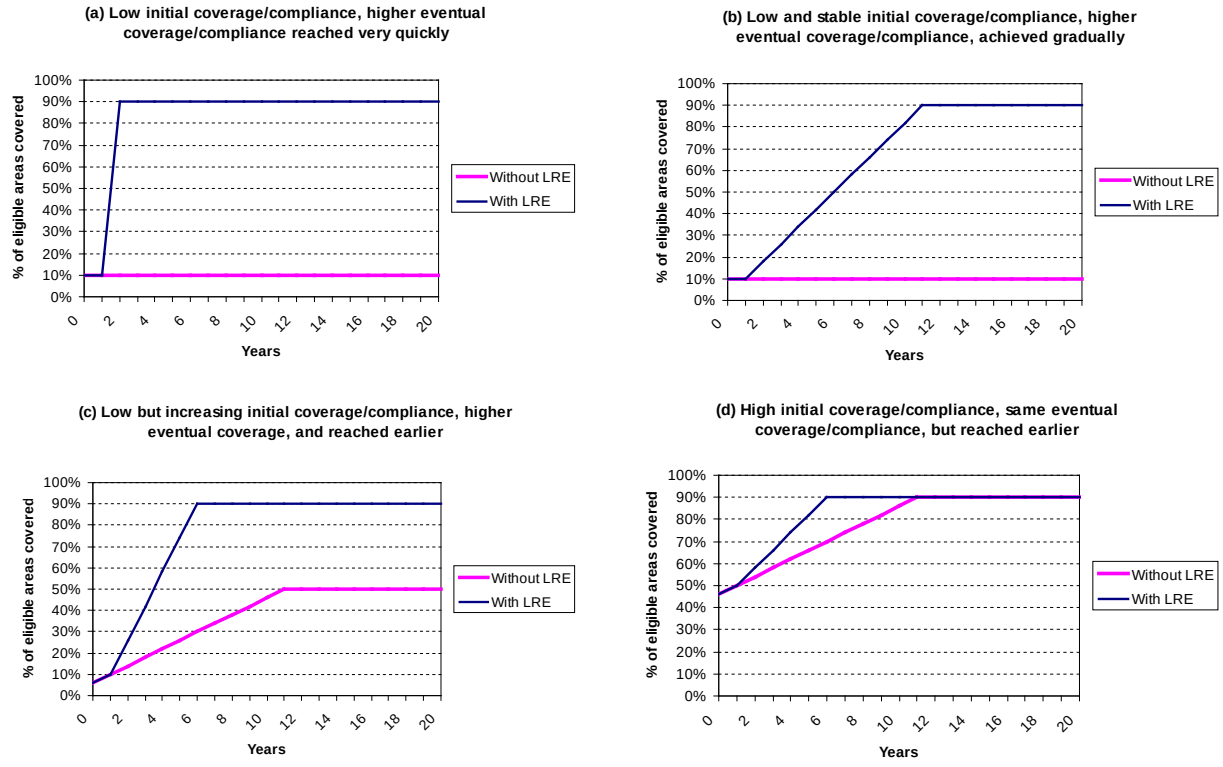


LRE = Legislation, regulation, enforcement or other jurisdiction-wide strategic policy.

Although quite simple, this model can be used to explore a variety of circumstances in which strategic policies or new legislation/regulations might be introduced. For example, it can evaluate situations where there will be no change in the coverage or uptake of the intervention in the absence of the strategic policy, all the way through to situations where the eventual uptake/coverage achieved by the strategic policy will be the same, but it will be achieved some years earlier.

Figure 2, (a) to (d), on the following pages illustrates some of the alternative scenarios which could be evaluated. It can be seen that the benefit of the strategic policy over time, in terms of the combined effect of greater and earlier intervention coverage, can vary enormously from scenario to scenario.

Figure 2. Different scenarios of increasing intervention coverage with or without a strategic policy

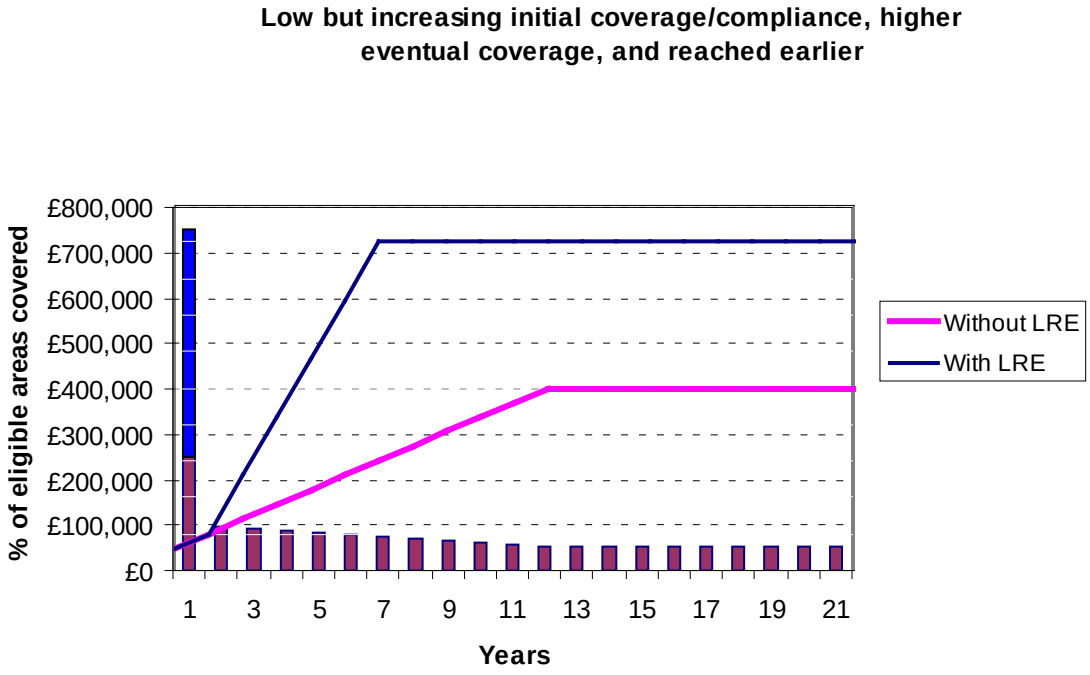


LRE = Legislation, regulation, enforcement or other jurisdiction-wide strategic policy.

The model can also allow things like enforcement costs to vary according to the proportion of areas, people or households that are not complying with a policy or law (

Figure 3 shows the estimated costs associated with a law or regulation which has £500,000 initial costs of development and passing into law, and annual initial enforcement costs of £250,000).

Figure 3. Illustration of the cost profile associated with a piece of legislation or strategic policy



LRE = Legislation, regulation, enforcement or other jurisdiction-wide strategic policy.

4.2. Interventions and comparators

The model was developed to compare two different strategic policies, one to reduce unintentional injuries to children and adults in the road setting, and one to reduce unintentional injuries to children at home:

3. Legislation or regulations supported by enforcement, promotion and monitoring activities to promote the wider and earlier implementation of **mandatory 20mph zones in high casualty residential areas**.
4. Regulations supported by enforcement, promotion and monitoring activities to promote the wider and earlier installation of **thermostatic mixer valves in family social housing where there are children aged less that 5 years**.

Both are compared with the absence of the new legislation/regulation or strategic policy.

4.3. Road: 20mph zones in residential areas

This modelling exercise simulates the cost-effectiveness of legislation or regulations to promote the earlier and wider implementation of 20mph zones in eligible 'high casualty' residential areas.

4.3.1. Incremental cost-effectiveness of 20mph zones

The cost-effectiveness of 20mph zones, from a public sector perspective, is obtained from the base case analysis of the economic model produced by PenTAG for the NICE Guidance on road and street design-based interventions for preventing unintentional injuries to children on the road (Peters et al. 2009). The PenTAG model-based analysis of 20mph zones by Peters et al, in turn built directly upon the recent published evaluation of 20mph zones in London (Grundy et al. 2008).

Twenty mph zones are legally defined areas where there is both a mandatory 20mph maximum speed limit on all the roads in the area and physical traffic calming measures with signage to lower speeds to below this level.

Table 3 below shows the base case results of our economic modelling in high casualty areas, which the Grundy et al (2008) study in London had defined as those areas having injury rates greater than 1 (mean = 1.658) casualties per km per year. Table 4 shows the breakdown of the incremental costs in terms of intervention costs, medical care savings and police cost savings. Also, Table 5 shows how varying the assumed level of underreporting alters the expected numbers of the different types of injury which were simulated in the Peters et al (2009) intervention model, alongside the expected QALY gains associated with them.

Adjusting for under-reporting of true casualty rates

It has been known for some years that the data on casualties from road accidents recorded by police (STATS19 data) probably underestimate the true casualty levels – particularly for non-fatal accidents (UK Statistics Authority 2009;Ward et al. 2006). It is estimated that the number of serious casualties recorded by the police using the STATS19 form should be increased by a factor of 2.76, and the number of slight

casualties by a factor of 1.7, although under-reporting for some types of casualty or road user – such as children - may be lower (Ward et al. 2006). A more recent DfT report provides a "current best approximation" of underreporting in STATS19 reports by a factor of between 2.8 and 3.8 (central estimate: 3.3) (Department for Transport, 2009). In our modelling below we have therefore adjusted the baseline (i.e. background) high casualty rates from the analysis for the PUIC on the Road Intervention modelling (Peters et al. 2009) by increasing them by 33% (i.e. assuming that one quarter of casualties are not reported in STATS19 data) 100% (half of casualties not reported) and 200% (two-thirds of casualties not reported) and 300% (three-quarters of casualties not reported. This alters both the incremental cost and the incremental effectiveness of 20mph zones compared with our original report for PHIAC.

Table 3. Incremental cost-effectiveness and net benefit of 20mph zones in 'high casualty' residential areas

Intervention	Cost-Benefit	Cost-Utility		
	NPV	ICER in £/QALY	Incremental Cost	Incremental Benefit in QALYs
As per original base case in PUIC Road modelling (for public health Intervention Guidance):				
20mph zones	90,625	89,700	62,708	0.70
Assuming that STATS19 data only records 3/4 of casualties (baseline casualty rate multiplied by 1.33):				
20mph zones	146,100	64,600	60,180	0.93
Assuming that STATS19 data only records 1/2 of casualties (baseline casualty rate multiplied by 2):				
20mph zones	257,000	39,400	55,125	1.4
Assuming that STATS19 data only records 1/3 of casualties (baseline casualty rate multiplied by 3):				
20mph zones	423,400	22,700	47,542	2.1
Assuming that STATS19 data only records 1/4 of casualties (baseline casualty rate multiplied by 4):				
20mph zones	590,000	14,300	39,959	2.8

Source: Peters et al. 2009. Plus additional analyses to adjust for potential under-estimation of casualty numbers in STATS19 data.

Table 4. Incremental costs of mandatory 20 mph zones in 'high casualty' areas

	Total incremental costs of intervention (£)	Medical costs saved (£)	Police costs saved (£)	Incremental cost (£)
Under original base case casualty rate assumptions	70,291	6,779	804	62,708
Increasing baseline casualty rates by 33% (i.e. were underestimated by 25%)	70,291	9,039	1,072	60,180
Doubling baseline casualty rates*	70,291	13,558	1,608	55,125
Tripling baseline casualty rates*	70,291	20,337	2,412	47,542

* baseline casualty rates increased according to possible underestimation of casualty rates in STATS19 data. Source data is the analysis by Peters et al 2009, based on Grundy et al. 2008.

Table 5. Estimated injuries saved by implementing a single 20mph zone in a 'high casualty' area (discounted injuries)

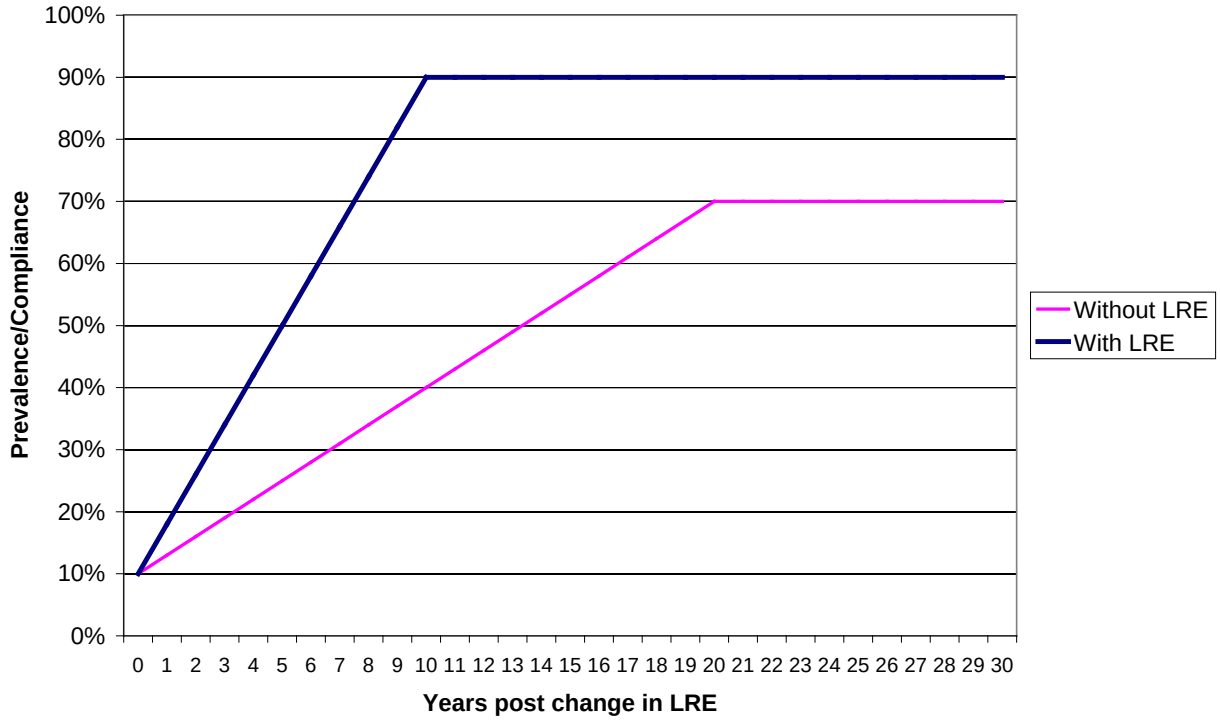
	QALYs	Fatal injuries	Serious permanent injuries	Serious short-term injuries	Slight injuries
Under original base case casualty rate assumptions	0.7	0.0451	0.0076	0.3692	2.3705
		(0.0393)	(0.0066)	(0.3242)	(2.0694)
Increasing baseline casualty rates by 33% (i.e. underestimated by 25%)	0.93	0.0601	0.0101	0.4922	3.1607
		(0.0523)	(0.0088)	(0.4322)	(2.7592)
Doubling baseline casualty rates*	1.4	0.0901	0.0151	0.7383	4.7410
		(0.0785)	(0.0132)	(0.6483)	(4.1388)
Tripling baseline casualty rates*	2.1	0.1352	0.0227	1.1075	7.115
		(0.1178)	(0.0198)	(0.9725)	(6.2082)

* baseline casualty rates increased according to possible underestimation of casualty rates in STATS19 data. Source data is the analysis by Peters et al 2009, based on Grundy et al. 2008.
Numbers in brackets are the discounted numbers of injuries (at 3.5% per year).

4.3.2. Speed and level of take-up with and without legislation or regulation

Figure 4 below shows the initially modelled level of adoption of 20mph zones both with and without legislation, regulations and their enforcement to promote of their wider use in relevant localities.

Figure 4. Speed and level of take-up of 20mph zones with and without legislation/regulation and enforcement



4.3.3. Cost of the legislation/regulation and its enforcement

In the absence of any other published estimates, we have initially assumed that it would cost £500,000 to develop, draft and pass the relevant legislation or regulations to

promote the wider and earlier implementation of mandatory 20mph zones. [A proposed estimate of £250,000 was presented to the Programme Development Group as part of a presentation of interim findings, and was thought by some to be too low a starting estimate]. This could also be seen as including the cost of any pre-publicity to maximise the impact of the legislation/regulations.

In terms of 'enforcement costs' there is a similar lack of evidence and we have crudely initially assumed that the costs of monitoring how quickly and where Local Authorities are implementing 20mph zones is £250,000 per year. [A proposed estimate of £100,000 was presented to the Programme Development Group as part of a presentation of interim findings, and was thought by some to be too low a starting estimate]. However, this cost is also gradually reduced over time according to the number of eligible residential localities which remain 'untreated' (as a proportion of those that will ultimately have 20mph zones implemented in the absence of the legislation/regulation).

Note that these ongoing costs are *not the costs of enforcing the 20mph speed limits within the zones* – these costs would or should already be included as part of the cost-effectiveness of the intervention (Peters et al. 2009) - but should be the costs of monitoring and promoting the implementation of 20mph zones at the level of each Local Authority. In other words, the compliance sought be the *regulation* is not the compliance of drivers in the 20mph zones, but the compliance of local government organisations who are in control of implementing them in eligible localities. For example, therefore, the present analysis would also include the presumed cost of applying any sanctions on Local Authorities which do not implement the use of 20mph zones fast enough or in appropriately defined localities.

Given the considerable uncertainty, both the supposed cost of developing and passing the legislation/regulation, and the cost of its enforcement will be varied widely in sensitivity analysis.

4.3.4. Summary of initial assumptions: 20mph zones

Table 6. Summary: parameters and starting assumptions in the 20mph zone economic model

Input parameter	Initial value/assumption	Source and justfication
Incremental cost of implementing a 20mph zone	£55,125	Cost-utility analysis for NICE by PenTAG (Peters et al. 2009) assuming underreporting by half mainly based on effectiveness and cost data from Grundy et al. 2008
Incremental QALYs of implementing a 20mph zone	1.4 QALYs	
Net Present Value per 20mph zone implemented	£257,000	
Total number of residential areas that are amenable to 'treatment' by 20mph zones	10,000 areas	ASSUMPTION*
Current % of eligible areas turned into 20mph zones	10%	ASSUMPTION* & See note **
Eventual % that would become 20mph zones *in the absence of specific legislation/regulation*	70%	ASSUMPTION*
Number of years in which this maximum coverage/uptake would be achieved *in the absence of specific legislation/regulation*	20 years	ASSUMPTION*
Eventual % that would become 20mph zones *with specific legislation/regulation to promote them in eligible areas*	90%	ASSUMPTION*
Number of years in which this maximum coverage/uptake would be achieved *with specific legislation/regulation to promote them in eligible areas*	10 years	ASSUMPTION*
Discount rate for costs and effects	3.5% per year	As per NICE methods guidance for public health guidance development (NICE 2009)
Time horizon	30 years	ASSUMPTION – covers assumed time periods for intervention coverage increase

* no available evidence – will be varied in sensitivity analysis

** NB. Searching of the DfT website for this data only yielded two DfT reports which stated that: in 1999 there were estimated to be 300 20 mph zones in Great Britain. Another DfT publication (on Bus Priorities) claimed that in 2004 Hull had approximately 100 20 mph zones.. DfT (1999), Sustainable Distribution: A Strategy. DfT (2004), Bus priority: The way ahead [Resource pack – edition 2].

4.4. Home: TMVs in social housing for families

Thermostatic mixing valves (TMVs) are water valves that blend hot water with cold water to ensure constant, safe outlet temperatures in order to prevent scalding (Wikipedia; accessed 16 February 2010).

The cost-effectiveness study and intervention

There is a recently completed randomised controlled trial of installing TMVs in social housing in Glasgow, which has a parallel economic evaluation as a submitted paper (Phillips et al. 2010). [redacted].

The trial reported [redacted] between the two trial arms, which was used to estimate the reduction in the number of scalds leading to specialist burns centre treatment, the number leading to hospitalisation and the number requiring emergency department attendance.

The cost-effectiveness analysis based on the RCT evaluated the cost-effectiveness of TMVs [redacted].

4.4.1. Incremental cost-effectiveness of installing TMVs

Table 7 below shows the base case results of the cost-effectiveness analysis of installing TMVs in social housing (Phillips et al. 2010). It is based upon the trial-based

estimate that for every 1,000 family households with a TMV offered and fitted [redacted] would be prevented, combined with the key assumption that on average each hot water scald in a child leads to the loss of [redacted] discounted quality-adjusted life-years (QALYs) (Phillips et al. 2010). (NB. [redacted]).

Table 7. Cost-effectiveness of installing TMVs to reduce bath water scalds (per 1,000 households targetted)

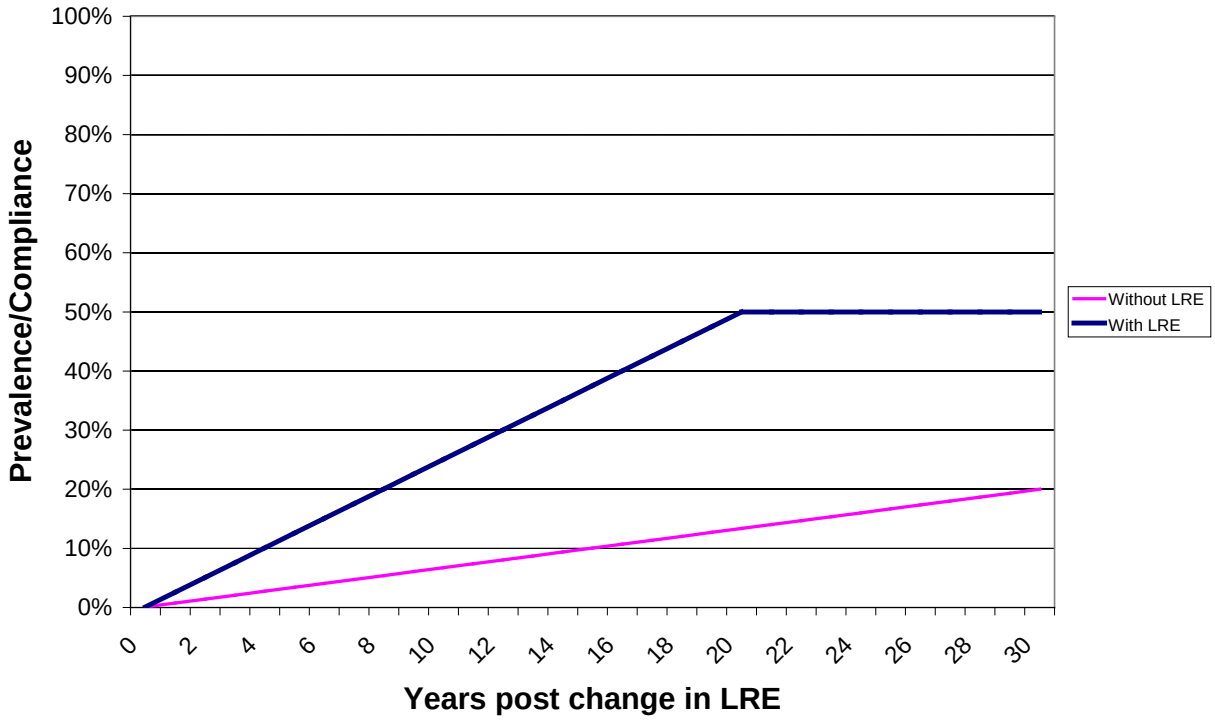
Intervention	Cost-Utility		
	ICER in £/QALY	Incremental Cost	Incremental Benefit in QALYs
Base case	[redacted]	[redacted]	[redacted]

Source: 'Scenario 3' analysis from Phillips et al. 2010. (*submitted for publication*)

4.4.2. Speed and level of take-up with and without legislation or regulation

Figure 5 below shows the initially modelled level of take-up of installing TMVs in social housing with children, both with and without the legislation/regulations to promote their earlier and wider usage. These basic assumptions are varied in the sensitivity analysis.

Figure 5. Assumed speed and level of eventual take-up of TMVs in social housing with and without new regulations



LRE = Legislation, regulation and enforcement or related promotional activity.

4.4.3. Cost of the legislation/regulation and its enforcement

As with 20mph zones, in the absence of any other published estimates, we have initially assumed that it would cost £500,000 to develop, draft and pass the relevant legislation or regulations to promote the wider and earlier installation of TMVs. [A proposed estimate of £250,000 was presented to the Programme Development Group as part of a presentation of interim findings, and was thought by some to be too low an estimate] This could also include any pre-publicity to maximise the impact of the legislation/regulations.

In terms of 'enforcement costs' there is a similar lack of evidence, and we have crudely initially assumed that the costs of monitoring how quickly and where Local Authorities, Housing Associations and other social renting landlords are installing and maintaining TMVs is £250,000 per year. [A proposed estimate of £100,000 was presented to the

Programme Development Group as pert of a presentation of interim findings, and was thought by some to be too low an estimate]. However, this cost is gradually reduced over time according to the number of households which are non-compliant, as a proportion of those that will ultimately comply in the absence the regulation. This reduction in enforcement and monitoring costs could be regarded as reflecting reduced the costs as the installation of TMVs in social housing becomes accepted standard practice for social renting landlords.

Again, as with the 20pmh zones, note that these ongoing enforcement costs are *not the costs of maintaining and repairing the TMVs themselves* – these costs have already been included in the cost-effectiveness of the intervention (see Table 1 in Phillips et al., 2010). Instead, it would include the cost of applying any sanctions on any social renting landlords which do not install the TMVs quickly enough or in appropriately identified family households, or the recurrent cost of periodically inspecting hot water systems in social housing for the presence of a functioning TMV.

Given the considerable uncertainty, both the cost of developing and passing the regulation, and the cost of its enforcement will be varied widely in sensitivity analysis.

4.4.4. Summary of initial assumptions: TMVs in social housing

Table 8. Summary: Parameters and starting assumptions in the TMV economic model

Input parameter	Initial value/assumption	Source and justfication
Incremental cost of installing a TMV in a social housing household	[redacted]	Phillips, Kendrick et al. (Academic in Confidence, submitted paper, plus additional data kindly supplied by Prof. Ceri Phillips)
Incremental QALYs of installing a TMV in a social housing household	[redacted]	
Total number of social housing households with children under 5 years old, that are amenable to fitting with TMVs	400,000 households	= approximately one third (*ASSUMPTION*) of the number of social rented households in England with dependent children (= 1,217,000; source Table 804, Household type by tenure; Department of Communities and Local Government's live tables on household characteristics (at: www.communities.gov.uk)
Current % of eligible households with a TMV	0.1%	ASSUMPTION*
Eventual % of eligible households that would have a TMV fitted *in the absence of specific regulation*	20%	ASSUMPTION*
Number of years in which this maximum uptake would be achieved *in the absence of specific regulation*	30 years	ASSUMPTION*
Eventual % of eligible households that would have a TMV fitted *with specific legislation/regulation to promote them in eligible areas*	50%	ASSUMPTION*
Number of years in which this maximum uptake would be achieved *with specific regulation to promote them in eligible areas*	20 years	ASSUMPTION*
Discount rate for costs and effects	3.5% per year	As per NICE methods guidance for public health guidance development (NICE 2009)
Time horizon	30 years	ASSUMPTION – covers assumed time periods for wider intervention take-up

* no available evidence – will be varied in sensitivity analysis

4.5. Perspective and analysis base year

For both types of strategic policy change evaluated, the cost-utility analysis was conducted from a public sector perspective.

In practice, for the evaluation of 20mph zones, this means that the analysis includes the cost to Local Authorities of implementing 20mph zones (planning, consultation, new signage and physical changes to the road and street e.g. speed humps). It also captures estimates of the NHS and social care costs of treating road casualties, and police costs of dealing with accidents.

For the evaluation of the TMV programme, the original cost-effectiveness study was conducted from a public sector perspective, so captured costs regardless of whether they fell upon Local Authorities or Housing Associations (e.g. the cost of installing, maintaining and repairing TMVs) as well as the cost to the NHS (e.g. education materials, and savings due to scalds avoided). In line with this, and NICE methods guidance for developing public health guidance, our model-based analysis of regulations to promote the installation of TMVs in social housing is therefore also conducted from a public sector perspective.

The base year of both our analyses is 2009.

4.6. Time horizon

The time horizon of the analysis is initially 30 years. This relatively long time horizon is specified in order to allow for the possible longer time (e.g. 20 years) for achieving eventual intervention take-up or coverage in the absence of legislation/regulation or a given strategic policy.

This is varied in sensitivity analysis to reflect the possibility that the effectiveness of the legislation/regulation or other strategic policy may diminish earlier than this.

4.7. Discounting

Costs and benefits beyond the first year of the intervention are discounted at a rate of 3.5% per year (NICE 2009). In sensitivity analyses, the impact of assuming alternative discount rates is also assessed, where feasible (NB. this is constrained by the reporting of the sensitivity analyses with discount rates for the underlying interventions – 20mph zones and TMV installation programmes).

4.8. Sensitivity analyses

Since there is so little evidence to inform many of the parameters in this modelling exercise, the sensitivity analyses are the main analyses in this report. They are conducted to explore which factors have the strongest influence on the estimated cost-effectiveness of the strategic policies evaluated.

4.8.1. Deterministic sensitivity analyses

Simple deterministic sensitivity analysis were undertaken to assess the impact of changing particular pairs of assumptions on the results of the model. These include:

- The cost of introducing the legislation/regulation or strategy, and the annual cost of its enforcement or promotion
- Varying the number of years to final uptake and the eventual level of uptake/coverage with the legislation/regulation
- Varying the estimated number of eligible households or residential areas that would be the subject of the legislation or regulation.
- Factors reflecting uncertainty in the underlying incremental effectiveness or cost of the intervention which the legislation or regulation is promoting.

Even with a simple model like the one developed, the full range of pairs of possible parameters which may be varied in sensitivity analysis is quite large. We have been selective in choosing the main parameters varied, because many will alter the costs or effectiveness in equivalent ways. For example, while we have altered our assumptions regarding the eventual level and

speed of take-up/coverage of the intervention following legislation, we have not similarly varied the assumptions relating to take-up/compliance without legislation. This is because the cost-effectiveness estimates (whether cost-effectiveness ratios or net present values) are driven by the gap between the two levels of take-up, not their absolute levels.

4.8.2. Probabilistic sensitivity analyses

Because of the extreme uncertainty in the model structure and parameters, with most variables being crudely assumed in the absence of any available evidence – and also no uncertainty bounds for more than one or two model parameters – the results of a probabilistic sensitivity analysis would be self-fulfilling and uninformative. (Such an analysis would almost certainly produce a widely dispersed series of estimates showing the strategy to be either highly cost-effective or highly cost-ineffective to equal degree, but no clear indication of which is the most likely.)

In preference to conducting a probabilistic sensitivity analysis, therefore, we have invested more time in choosing and running deterministic sensitivity analyses.

5. Results

Given the considerable uncertainty in most of the model parameters, we mainly use two-way sensitivity analyses to explore how changing the values for selected pairs of parameters impacts on the incremental cost per QALY and other cost and effectiveness outputs. It is not possible to present these for all possible pairs of parameters which, if changed in combination, might make the programme more or less cost-effective, but some of the key combinations are presented.

These two-way sensitivity analyses may indicate which model parameters most require further research in order to reduce the uncertainty in our overall estimates of effectiveness and cost-effectiveness.

5.1. Legislation/regulations to promote the implementation of 20 mph zones

5.1.1. Speed and level of take-up with and without legislation or regulation

Table 9 below shows the cost-effectiveness and cost-benefit estimates (Net Present Value) for the legislation/regulations to promote the earlier and wider implementation of 20mph zones. The incremental cost-effectiveness estimates are remarkably insensitive to changes in either the faster speed of coverage of the zones (from 5 to 15 years earlier than without legislation/regulations), or their higher eventual coverage (between 80% and 100% coverage, compared with an assumed eventual coverage of 70% of eligible areas without additional legislation/regulations). In contrast, the estimates of Net Present Value vary more substantially according to the expected level of eventual coverage and the number of years for this level is reached – varying from £289 million to almost £1,000 million (for 100% coverage achieved within 5 years of introducing the legislation/regulation). This is because both the incremental costs and the incremental benefits of the legislation/regulation are both highly sensitive to the expected level of eventual coverage and the number of years for this level is reached (see Table 10 below).

Table 9. ICERs (£ per QALY) and Net Present Value (£ millions) of legislation/regulations promoting 20mph zones, by eventual coverage and years to eventual coverage

		Eventual uptake of 20mph zone coverage with legislation (as % of all eligible areas)		
		80%	90%	100%
Length of time to achieving eventual uptake	5 years	£40,600/QALY £532m	£40,200/QALY £764m	£40,000/QALY £996m
	10 years	£41,000/QALY £404m	£40,400/QALY £618m	£40,200/QALY £831m
	15 years	£41,700/QALY £289m	£40,700/QALY £486m	£40,300/QALY £684m

Table 10. Total incremental QALYs, and total incremental costs of legislation/regulations promoting 20mph zones, by eventual coverage and years to eventual coverage

Length of time to achieving eventual uptake		Eventual uptake of 20mph zone coverage with legislation (as % of all eligible areas)		
		80%	90%	100%
	5 years	2,880 QALYs £117.0m	4,145 QALYs £166.7m	5,409 QALYs £216.5m
	10 years	2,181 QALYs £89.4m	3,345 QALYs £135.3m	4,510 QALYs £181.1m
	15 years	1,555 QALYs £64.8m	2,630 QALYs £107.1m	3,705 QALYs £149.4m

5.1.2. Cost of the legislation/regulation and its enforcement

Table 11 below shows how the incremental cost-effectiveness (£ per QALY) and the incremental cost (£ millions) of the legislation/regulations for promoting the implementation of 20mph zones under different assumptions about introducing and enforcing the cost of the regulation. The cost-effectiveness of introducing such legislation/regulations is only slightly sensitive to the assumed annual cost of enforcing and monitoring compliance with the law/regulation, and it is hardly sensitive at all to the initial cost of developing and introducing the regulation.

Even increasing the initial cost of developing and introducing the legislation/regulation from £0 to £1 million, increases the cost per QALY by less than £300. Also, doubling the costs of enforcement and monitoring (from £250,000 to £500,000 per year) increases the cost per QALY by only about £1,500. In fact, at a national level the total incremental cost of *putting in* 20mph zones is so high relative to the cost of introducing and enforcing related legislation/regulations, that increasing the cost of introducing the legislation ten-fold (from £100,000 to £1 million) and the annual enforcement costs five-fold (from £100,000 to £500,000) only changes the incremental cost of the legislation/regulation by about 4% (from £133.2m to £138.8m; see Table 12.

Table 11. ICER (£ per QALY) and Net Present Value (£ millions) of legislation/regulations promoting 20mph zones, by cost of introducing and cost of enforcing the regulations

Cost of enforcing and monitoring the implementation of 20mph zones	Cost of developing and introducing the regulation for promoting the wider implementation of 20mph zones			
	£0	£250,000	£500,000	£1,000,000
£100,000	£39,739/QALY £615m	£39,813/QALY £616m	£39,888/QALY £616m	£40,038/QALY £616m
£250,000	£40,284/QALY £617m	£40,359/QALY £617m	40,434/QALY £618m	£40,583/QALY £618m
£500,000	£41,194/QALY £620m	£41,268/QALY £620m	41,343/QALY £621m	41,493/QALY £621m

Table 12. Total incremental costs (£ millions) of legislation/regulations promoting 20mph zones, by cost of introducing and cost of enforcing the regulations

Cost of enforcing and monitoring the implementation of 20mph zones	Cost of developing and introducing the regulation for promoting the wider implementation of 20mph zones			
	£0	£250,000	£500,000	£1,000,000
£100,000	£132.9m	£133.2m	£133.4m	£133.9m
£250,000	£134.8m	£135.0m	£135.3m	£135.8m
£500,000	£137.8m	£138.1m	£138.3m	£138.8m

5.1.3. Number of eligible residential areas in the jurisdiction

Table 13 below shows how sensitive the incremental cost-effectiveness estimates are to the number of eligible high casualty residential areas in the jurisdiction (the initial assumption was 10,000 eligible areas). If the number of eligible high casualty areas is half our original assumption (i.e. 5,000 rather than 10,000), then the cost-effectiveness ratio increases by only £1,000 to £41,500 per QALY. Conversely, if the number of eligible high casualty areas is twice our original assumption (i.e. 20,000 rather than 10,000), then the cost-effectiveness ratio for introducing and enforcing the legislation/regulation decreases by only about £600 to £39,900 per QALY. However, the absolute numbers of fatal and serious injuries avoided and the cost savings associated with all casualties avoided, would double with this change in assumptions.

Table 13. Cost-effectiveness by expected number of eligible 'high casualty' residential areas

Number of eligible residential areas meeting the criteria for mandatory implementation of a 20mph zone	ICER (£ per QALY)*	QALYs gained*	Fatal injuries avoided*	Serious injuries avoided*	Medical care cost savings* (£ million)	Police service cost savings* (£ million)	Total cost (£million)*
5,000 areas	41,500	1,673	94	790	16.2	1.9	69.4**
10,000 areas	40,500	3,345	188	1,580	32.4	3.8	135.3**
20,000 areas	39,900	6,691	375	3,160	64.8	7.7	267.0**

* With discounting of both costs and effects (QALYs, injuries) at 3.5% per year.

** Cost of introducing, enforcing and monitoring the legislation/regulation comprises only £3.5 million of these cost estimates.

Table 14 below shows how the estimated cost-effectiveness of introducing and enforcing regulations for 20mph zones would be sensitive the the cost-effectiveness of 20mph zones themselves. Here we have varied the cost-effectiveness of 20mph zones (as opposed to the regulations to promote their wider implementation) according to different assumptions about the level of underreporting of casualties in STATS19 data. It shows how very sensitive the cost-effectiveness estimates are to these assumptions.

Table 14. Cost-effectiveness by degree of casualty underreporting in STATS19 data

Proportion of all casualties recorded in STATS19 data	ICER (£ per QALY)* 20 mph zones	ICER (£ per QALY)* Regulations for 20mph zones	QALYs gained*	Cost (£ million)*
Three quarters	64,600	66,300	2,222	147.3
Half (base case assumption	39,400	40,400	3,345	135.3
Third	22,700	23,300	5,018	117.1
Quarter	14,300	14,800	6,691	99.0

* With discounting of both costs and effects (QALYs, scalds) at 3.5% per year.

5.2. Regulations to promote the installation of TMVs in social housing

5.2.1. Speed and level of take-up with and without regulations

Table 15 below shows how the incremental cost-effectiveness of new regulations to promote the wider installation of TMVs is expected to vary according to the eventual level of installation across households, and the length of time within which that uptake level is achieved (after introducing the regulation). Under the more favourable assumptions evaluated, with 70% take-up in eligible households achieved after 15 years, the cost-effectiveness of introducing the regulation is £67,000 per QALY gained (or £234,500 per scald averted). In contrast, if the regulation only achieves 30% uptake amongst eligible households, and this after a period of 25 years, then the cost-effectiveness ratio is almost three times higher (£189,800 per QALY gained, or £663,000 per scald averted). Table 16 below shows the how incremental costs and incremental effects (QALYs) which underlie these cost-effectiveness ratios vary.

Table 15. ICER (£ per QALY) of regulations promoting TMVs in social housing, by eventual take-up and years to eventual coverage

Length of time to achieving eventual uptake	Eventual uptake of TMV uptake with regulation (as % of all eligible social housing households)		
	30%	50%	70%
15 years	144,600	83,000	67,000
20 years	164,400	88,300	69,900
25 years	189,800	94,300	73,100

Table 16. Total incremental QALYs (£ per QALY), and total incremental costs (£ millions) of regulations promoting TMVs in social housing, by eventual take-up and years to eventual coverage

Length of time to achieving eventual uptake		Eventual uptake of TMV uptake with regulation (as % of all eligible social housing households)		
		30%	50%	70%
	15 years	47 6.8m	115 9.5m	182 12.2m
	20 years	40 6.5m	102 9.0m	165 11.5m
	25 years	33 6.3m	91 8.6m	149 10.9m

NB. The incremental number of scalds avoided is the QALYs divided by 3.5 (i.e. ranges from 13 to 43 scalds avoided due to introducing the legislation, after discounting).

5.2.2. Cost of the regulations and their enforcement

Table 17 below shows how the incremental cost-effectiveness (£ per QALY) and the incremental cost (£ millions) of the regulations for promoting TMV installation in social housing varies under different assumptions about introducing and enforcing the cost of the regulation. Whereas the cost-effectiveness of introducing such a regulation is quite sensitive to the assumed annual cost of enforcing and monitoring compliance with the regulation, it is relatively less sensitive to the initial cost of developing and introducing the regulation. Increasing the cost of developing introducing the regulation from £0 to £1 million increases the cost per QALY by about £10,000. In contrast, doubling the costs of enforcement and monitoring (from £250,000 to £500,000 per year) increases the cost per QALY by over £40,000.

Table 17. ICER (£ per QALY) and total incremental cost (£ millions) of legislation/regulations promoting TMVs in social housing, by cost of introducing and cost of enforcing the regulations

Cost of enforcing and monitoring the installation of TMVs		Cost of developing and introducing the regulation for promoting the installation of TMVs			
		£0	£250,000	£500,000	£1,000,000
	£100,000	£57,300/QALY £5.9m	£59,700/QALY £6.1m	£62,200/QALY £6.4m	£67,000/QALY £6.9m
	£250,000	£83,400/QALY £8.5m	£85,800/QALY £8.8m	£88,300/QALY £9.0m	£93,200/QALY £9.5m
	£500,000	£126,900/QALY £13.2m	£129,400/QALY £13.2m	£131,800/QALY £13.5m	£136,700/QALY £14.0m

5.2.3. Number of eligible households in the jurisdiction

Table 18 below shows how sensitive the incremental cost-effectiveness estimates are to the number of eligible social housing households to which the TMV installation regulations would apply. If the number of eligible households (those rented out by a Housing Association, Local Authority or other Registered Social Landlord, and with children under the age of 5 years) is half our original estimate (i.e. 200,000 rather than 400,000), then the cost-effectiveness ratio increases to £136,700 per QALY (or £478,000 per scald averted).

Table 18. Cost-effectiveness by expected number of eligible households

Number of eligible social housing households with children	ICER (£ per QALY)*	QALYs gained*	Scalds averted*	Cost (£ million)*
200,000	136,700	[redacted]	[redacted]	7.0**
400,000	88,300	[redacted]	[redacted]	9.0**
600,000	72,100	[redacted]	[redacted]	11.1**
1,000,000	59,200	[redacted]	[redacted]	15.1**

* With discounting of both costs and effects (QALYs, scalds) at 3.5% per year. ** Cost of introducing and enforcing and monitoring the regulation comprises £4.95 million of these estimates.

5.3. Summary of results

Legislation/regulations for 20 mph zones

This exploratory modelling exercise has shown that the main factor which is important in determining the cost-effectiveness of legislation/regulations to promote the earlier and wider implementation of 20mph zones is the cost, effectiveness and therefore the cost-effectiveness of implementing 20mph zones themselves. Interestingly, the cost of either introducing the legislation/regulation, or of enforcing and monitoring compliance by Local Authorities with it, is much less significant.

Legislation/regulations for TMVs in social housing

The sensitivity analyses suggest that the following factors are important in determining the cost-effectiveness of legislation/regulations to promote the earlier and wider installation of TMVs in social housing:

- The expected eventual level of take-up/installation of TMVs in social housing following the introduction of regulations
- The number of years within which the eventual level of take-up/installation of TMVs in social housing would be reached following the introduction of regulations.

- The cost of enforcing and monitoring compliance with the regulations
- The number of eligible social housing households that would be eligible to have a TMV offered and fitted under the regulations.

6. Discussion

This report has presented two analyses of the cost-effectiveness of jurisdiction-wide strategic policies – in this case, new legislation and/or regulations with associated enforcement activities – to promote the wider and earlier uptake or implementation of specific injury prevention interventions. By necessity, these analyses rely greatly on the validity and transferability of the cost-effectiveness and cost-benefit estimates for the underlying interventions being promoted.

6.1. Main findings

Legislation/regulations to promote the earlier and wider implementation of 20mph zones

This exploratory modelling exercise has shown that the following factors are important in determining the cost-effectiveness of legislation/regulations to promote the earlier and wider implementation of 20mph zones:

- The cost, effectiveness and therefore the cost-effectiveness of implementing 20mph zones themselves

Interestingly, in this case, the cost of either introducing the legislation/regulation, or of enforcing and monitoring compliance by Local Authorities with it, is much less significant. This is mainly because the expected incremental cost of implementing 20mph zones (around £55,000 for each new zone) multiplied by the difference in the expected eventual number that would be implemented with and without the regulations (2,000) is very large relative to the overall cost of introducing the legislation/regulation and enforcing it. The overall cost less expected savings of implementing 2,000 20mph zones would be £110 million over 30 years, compared with our initial estimate of the cost of introducing the legislation/regulation of only £3.5 million.

Legislation/regulations/other strategies to promote the earlier and wider installation of TMVs in social housing for families with young children

This exploratory modelling exercise has shown that the following factors are important in determining the cost-effectiveness of legislation/regulations to promote the earlier and wider installation of TMVs in social housing:

- The expected eventual level of take-up/installation of TMVs in social housing following the introduction of regulations
- The number of years within which the eventual level of take-up/installation of TMVs in social housing would be reached following the introduction of regulations.
- The cost of enforcing and monitoring compliance with the regulations
- The number of social housing households that would be eligible to have a TMV offered and fitted under the regulations.

The reasons that this evaluated regulation is sensitive to different model assumptions is due to the scale of use of the intervention in combination with its per-household cost is not very large compared with the assumed cost of introducing and enforcing the regulation. For example, if the incremental cost of offering and installing a TMV in one household is [redacted] (Phillips et al. *submitted for publication*), and the regulation after a number of years would achieve their successful installation in 120,000 additional family households (= 400,000 × 30%) then the incremental cost of offering, installing and maintaining/repairing the TMVs is a maximum of around £5.25 million. The discounted cost of introducing and enforcing the regulation (£4.95 million) is then much more significant relevant to the total incremental cost of the intervention itself.

The other, perhaps more obvious point relevant to both of the strategic and jurisdiction-wide policies modelled here, is that legislation, regulations or other strategic policies to promote the wider and earlier uptake of an effective intervention *can never be more cost-effective than the intervention that is being promoted*. This is simply because whereas there are additional

resources required to introduce and enforce the new legislation or regulations, the strategic policy only yields additional effectiveness via the wider or earlier uptake of the intervention promoted.

6.2. Limitations of the modelling

The main limitation of the model is that nearly all of the parameters used in the modelling are based on very limited or no published research data. In particular, there is considerable uncertainty regarding:

- the extent to which the strategic policies will achieve greater coverage or uptake of the interventions, and over what time period this would be achieved;
- the initial cost of both developing and introducing the new legislation or regulations, and the ongoing costs of enforcing them or promoting them;
- the total number of eligible households, areas or communities in the jurisdiction which would be targetted by the relevant intervention or programme (i.e. that the strategic policy aims to promote)

Given this, the results should all be regarded as exploratory.

The model has not been specifically designed to reflect the possibility that the effectiveness (greater take-up or coverage) that is attributable to any legislation, regulation or other strategic policy might diminish over time – either because it is superseded by subsequent policies, or because societal behaviours and broader contexts to the interventions will change in the long term (e.g. driving behaviours and street layouts in residential areas, or the propensity to fit showers rather than baths, or baths with mixer taps as standard). However, even though our model simulates the costs and effects of the strategic policies for a time horizon of 30 years, the effect of discounting is such that by 20 years and 30 years post-policy introduction any effectiveness due to the policy or legislation is reduced by 50% and 64% respectively.

Conversely, it is conceivable that some types of legislation, regulation or other strategic policies may have a cumulative impact over time, depending upon the policy context into which they are introduced, and for example the strength of countervailing social norms which may hinder compliance. There may thus be 'tipping points' in the complex systems which govern safety

behaviours, which create step changes in compliance with regulations or policies which our simple linear model cannot capture or predict (Shiell et al. 2008).

This economic modelling has also been limited to extending the incremental cost-effectiveness analyses of the underlying public health or transport safety interventions. Apart from the cost-benefit (net present value) estimates for the 20mph zones and associated regulations, it therefore mainly produces ratio measures of cost-effectiveness. This has a number of limitations compared with taking a broader cost-benefit approach. Firstly, it gives no value to the absolute level of coverage or increased uptake of the intervention achieved. This is illustrated by the two-way sensitivity analysis for 20mph zones in which shows little variation in the incremental cost-effectiveness ratio as these variables change, but substantial changes in the Net Present value of the policy under alternative assumptions (see Table 9, p.39). Secondly, there may be additional value to society in achieving close to complete coverage or uptake of an intervention across the country, separate from the value related to the incremental changes (in costs and QALYs) required to attain that level. And lastly, as noted in some of the previous economic modelling for the series of pieces of guidance on preventing unintentional injuries to children, some types of intervention and policy have aims - and associated costs and benefits – which go beyond health and health care. In the road environment in particular, many design-based interventions which come under the heading of "road safety interventions" will also have environmental improvement and economic development objectives (Peters et al, 2009).

For these reasons, an exclusive reliance on the estimated ratio of the incremental costs to the incremental QALYs gained from an intervention or a strategic policy, should be avoided if possible. This is why we have tried to take a more disaggregated 'balance sheet' or cost-consequence approach to presenting the results of some of our results.

6.3. Strengths of the modelling

This modelling exercise has been conducted for the specific purpose of exploring the cost-effectiveness of strategic, and typically national, approaches to promoting the wider uptake of effective injury prevention interventions. Because of the considerable uncertainty surrounding many of the model inputs it should not be relied upon, as some economic models are, for producing definitive cost-effectiveness estimates on which to base decisions. Rather, the

deterministic sensitivity analyses should be used to gain a provisional understanding of which factors are most likely to determine the cost-effectiveness of such strategic approaches.

A strength of this economic modelling - certainly relative to almost all other economic studies in the field of safety and injury prevention - is that we have included the costs (crudely estimated though they may be) of developing, implementing and enforcing and/or monitoring legislation or regulations (Anderson & Moxham 2009). The only other examples of economic analyses which we have found which appear to have attempted to do this (in the child injury prevention field), are the study by Hatziandreu et al (1995) of legislation and other strategies to make cycle helmet wearing compulsory, a study by on introducing new product standards to prevent baby-walkers from falling down stairs (Rodgers & Leland 2008), and a study by Miller et al of the costs and outcomes of introducing a law to promote the use of booster seats in cars (Miller et al. 2006). The study by Miller et al, used estimates from a 1981 paper by Downing to estimate that "the cost of approving mandates" (i.e. laws) in the USA was on average between 2.9% and 7.1% "of the direct costs imposed on the public, with public implementation and administration [of the mandate] costing another 4.2% to 4.6%" (p.1995). However, it is unclear how these percentages are derived, and also doubtful whether they would be transferable to the UK policy making setting some 30 years later.

6.4. Research recommendations

The research recommendations are derived directly from the types of parameter uncertainty which seem to determine the cost-effectiveness of the modelled strategic policies most strongly. Therefore, more valid, reliable and in particular longer term research is required are in order to establish:

- the extent to which the specific strategic policies will achieve greater coverage or uptake of the interventions, and over what time period this would be achieved;
- the initial cost of both developing and introducing the new legislation or regulations, and the ongoing costs of enforcing them or promoting them;
- the total number of eligible households, areas or communities in the jurisdiction which would be targetted by the relevant intervention or programme (i.e. that the strategic policy aims to promote)

- More valid and reliable estimates of the effectiveness and cost-effectiveness of the public health interventions which the strategic policies are promoting.

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Appendix 1 Review of published economic studies

The review Questions

a. What is the cost-effectiveness of legislation, regulations, standards, intended to prevent unintentional injuries in children, and/or of strategies to enforce them, or to promote them using mass media?

b. What methods have been used in the past to conduct economic evaluations of such strategies for preventing injuries to children?

These two questions were addressed where they related to the types of legislation or strategy etc. covered by the review protocols of the effectiveness reviews already conducted as part of the PUIC programme development process.

Methods

We sought to identify and review full economic evaluations of the legislation/regulation or other strategic approaches of interest published since 1990. Full economic evaluations compare both the costs and the effects/benefits of two or more policy or intervention comparators; they could be cost-benefit analyses, cost-effectiveness analyses, cost-utility analyses, cost-offset analyses, or cost consequence analyses.

Search strategy

See full final report available at www.nice.org.uk: Preventing unintentional injuries in children [programme guidance]. Systematic review to provide an overview of published economic evaluations of relevant legislation, regulations, standards, and/or their enforcement and promotion by mass media, by: Anderson R & Moxham, T.

Findings

The searches within the previously generated RefMan databases for the two public health intervention reviews (road interventions, and home-based interventions and injuries) produced a database of 225 titles and abstracts. The searches within the previously generated RefMan databases for the five public health programme reviews (i.e. the search hits for the reviews for

PDG meetings 1,2,3,4 and 6) produced a database of 272 titles and abstracts. Finally, the new searches conducted for this review in EconLit and NHSEED produced 405 hits.

Seven studies met our inclusion criteria of being full economic evaluations of the relevant interventions. Three were economic evaluations of legislation to increase use of bicycle helmets in New Zealand (Hansen & Scuffham 1995;Hatziandreu et al. 1995;Taylor & Scuffham 2002), and in the United States (Hansen & Scuffham 1995;Hatziandreu et al. 1995;Taylor & Scuffham 2002). There was one cost-savings analysis from Canada of the introduction of laws to set temperatures on the thermostats of hot water systems (Han et al. 2007), and another from the USA on laws to increase the use of smoke detectors (Jensen et al. 1989). There were also two economic evaluations (one from Canada, one from the UK) of road speed enforcement programmes (Chen 2005;Hooke et al. 1996).

Compulsory wearing of bicycle helmets

The three economic evaluations of legislation about bicycle helmets all compared costs with different measures of effectiveness or societal benefit (e.g. net benefit, cost per life saved, cost per life-year saved, cost per hospitalisation prevented, cost per injury avoided) (Taylor & Scuffham, 2002; Hansen & Scuffham, 1995; Hatziandreu et al, 1995). Partly as a result of this there is inconsistent evidence from New Zealand and the USA that national laws to make the wearing of bicycle helmets compulsory would be cost-effective from a societal perspective. However, from a *public sector* perspective – critically, omitting the cost to individuals or families of purchasing bicycle helmets – the measure is likely to by highly cost-effective. The two New Zealand studies suggested that bicycle helmet laws would be more cost-effective in younger (age 5-12 years) than older children (age 13-18), and one of them estimated that costs would probably exceed benefits in older children and adults (again, from a societal perspective) (Taylor & Scuffham, 2002; Hansen & Scuffham, 1995).

The USA study also estimated the cost-effectiveness of community-wide and school-based strategies for promoting the wearing of bicycle helmets did not directly compare these strategies with the legislative approach (Hatziandreu et al, 1995). However, when compared with 'no programme' the legislative approach was the most cost-effective of the three strategies (but still with an estimated cost per life-year saved of over US$900,000 – which, from a health care perspective, would not normally be judged as cost-effective).

Water heater thermostat settings

One model-based cost-effectiveness analysis from Ontario, Canada, estimated that legislation to restrict the thermostat temperature on (newly manufactured) hot water systems would be both cost-saving and more effective in terms of tap-water scalds prevented, compared with no legislation (Han et al 2007). In fact, the health care cost savings from injuries avoided were estimated as almost ten times the cost of implementing the legislation (C$480,000 vs C$51,000). However, note than only the educational component of the programme (educational notices about the risks of tap-water scalds sent with utility bills) was included as a 'cost of the legislation'.

Compulsory smoke detectors

The model-based economic analysis of smoke detector legislation in the USA estimated that implementing this legislation to make the fitting of detectors compulsory in all US states would produce net savings (i.e. enforcement plus detector costs, less injury-related savings) of between $150,000 and $250,000 per year, alongside saving over 800 lives per year across the USA (Jensen et al. 1989). If the health care cost savings due to injuries averted are excluded from the analysis, the cost-effectiveness would be approximately $65,000 per life saved.

Camera or radar speed enforcement programmes

There were two cost-benefit analyses which assessed the impact of speed enforcement programmes. The photo radar programme in British Columbia was estimated to produce net benefits to society of about C$114 million (in 2001 C$), and still produced substantial net savings of C$38 million if only considered from the provincial insurance corporation's perspective (Chen, 2002).

Similarly, the 420 automated speed camera sites in the UK in 1995/6 (Hooke et al. 1996) were estimated to have a positive Net Present Value of over £26 million, even after one year, rising to £241 million after ten years. This is because annualised fixed costs of £5.3 million plus annual recurrent costs of £3.6 million, would be offset not just by the £6.7 million in fine income, but also the over £30 million in the estimated annual value to society of accidents avoided. In all ten police force areas there was a positive net present value (i.e. benefits exceeded costs) within a year of the programme starting.

Appendix 2 Base case assumptions in PUIC Road Economic modelling of 20mph zones

In our PUIC Road (Intervention) model, all road casualties are categorised into one of four levels of severity: fatal, serious permanent injuries, serious short-term injuries and slight injuries. The cost-utility analysis is from the perspective of the public sector and accounts for all quality-adjusted life-years (QALYs) and medical, police, local authority and DfT costs invested or saved from the prevention of casualties due to the intervention.

The cost-benefit analysis is from a broader societal perspective and accounts for medical and human costs saved and lost output saved, from the prevention of casualties due to the intervention. Other potential benefits, such as changes in health and well-being due to physical activity and/or those associated with reduced congestion or pollution, which may be a consequence of the road interventions are not considered in this evaluation.

All costs associated with the construction, planning, design and maintenance of an intervention were estimated. One-way deterministic sensitivity analysis and probabilistic sensitivity analyses were undertaken to explore parameter uncertainty in the model. Results from the cost-benefit analysis were presented in terms of Net Present Value (NPV) (and First Year Rate of Return, for camparison with previous studies), while the incremental cost per QALY is reported from the cost-utility analyses (this is the Incremental Cost-Effectiveness Ratio, or 'ICER').

In the base case analyses, all results from both types of analysis are presented for an assumed 10 years from the construction/installation of the intervention, to cover the assumed effective life of the intervention. In the CUA, all lifetime health costs and benefits (QALYs) associated with casualties saved due to the intervention are estimated.

See the following tables for the main parameter values used in relation to 20mph zones.

Table 19. Base case parameter values and source details

Parameter	Value (standard error)	Justification/Source
Effective lifetime of intervention	10 years	Personal communication, Heather Ward, June 2009
Discount rate:		
Costs	3.5%	As specified in NICE methods guidance (2006)
Benefits	3.5%	
Effectiveness outcomes		
Number of casualties without intervention	See Table 20	Specific to intervention
% reduction in casualties due to intervention	See Table 20	Specific to intervention
Background reduction in casualties	Fatal: 4.3% (1.4%) Serious permanent: 7.9% (3.5%) Serious short-term: 7.9% (3.5%) Slight: 6.2% (3.0%)	Means and standard errors from Grundy et al (2008)
Utilities (CUA only)		
Utility decrement for individuals with serious permanent injuries until death	4.0% (1.2%)	Mean from Nyman et al (2008). Standard error of 30% of mean assumed for PSA
Loss in utility for individuals with serious short-term injuries (1 year only)	2.4% (0.7%)	Mean from Nyman et al (2008). Standard error of 30% of mean assumed for PSA
First year loss in utility for individuals with slight injuries (1 year only)	1.5% (0.5%)	Mean from Nyman et al (2008). Standard error of 30% of mean assumed for PSA
% of serious casualties with permanent injury	2%	Hopkin & Simpson (1995)
Health utilities (by age)	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). Standard error calculated from standard deviation reported in Kind et al.
Age-specific survival rates	UK Interim Life Tables (Office for National Statistics 2009b)	
Time horizon of model	95 years	UK Interim Life Tables (Office for National Statistics 2009b)
Costs		
Lifetime societal costs associated with injury prevented (CBA only)	Fatal: £1,710,479 (£513,144) Serious: £193,370 (£58,011) Slight: £14,908 (£4,473)	Uprated to 2009 costs from DfT 2007 costs (Department for Transport 2009) using nominal gross domestic product growth of 4.4% from June 2007 to June 2009 (Office for National Statistics 2009a). Standard error of 30% of mean assumed for PSA

Parameter	Value (standard error)		Justification/Source
Lifetime medical costs (CUA only)	Fatal: Serious permanent: Serious short-term: Slight:	£1,013 (£304) £113,723 (£34,117) £11,537 (£3,462) £1,023 (£307)	Uprated to 2009 costs from DfT 2007 costs (Department for Transport 2009) using nominal gross domestic product growth of 4.4% from June 2007 to June 2009 (Office for National Statistics 2009a). See Section **Error! Reference source not found.** in Peters et al. 2009, for details on calculation of serious permanent and serious short-term costs.
Police costs (CUA only)	Fatal: Serious permanent: Serious short-term: Slight:	£1,017 (£974) £382 (£366) £382 (£366) £305 (£91)	Calculated as weighted averages from DfT costs for prevention of accidents (see Peters et al 2009, Section **Error! Reference source not found.** for further details).

For sources cited in Justification/Source column see Peters et al 2009 report Reference list.

6.4.1. Effectiveness outcomes

The effectiveness parameters are i) the number of casualties in the comparator area and ii) the percentage reduction in casualties due to the intervention. The base case effectiveness values for each intervention are given in Table 20.

Table 20. Base case effectiveness outcomes used in the PUIC Road intervention economic model

Intervention	Severity	Number casualties (per km per year) without intervention	% reduction in casualties due to intervention	Source
Mandatory 20 mph zones – low casualty	Fatal	0.002	57%	From Grundy et al. (2008). 2% of serious casualties are considered permanent.
	Serious – permanent	0.002	26%	
	Serious – short-term	0.074	26%	
	Slight	0.547	22%	
Mandatory 20 mph zones – high casualty	Fatal	0.010	57%	From Grundy et al. (2008). 2% of serious casualties are considered permanent.
	Serious – permanent	0.004	26%	
	Serious – short-term	0.201	26%	
	Slight	1.443	22%	

NB. these are the base case effectiveness assumptions prior to any adjustment for underreporting of casualties in STATS19 records.