

Known Knowns, Known Unknowns, Unknown Unknowns: The predicament of evidence-based policy.

"There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we now know we don't know. But there are also unknown unknowns. These are things we do not know we don't know". [Donald Rumsfeld, Former United States Secretary of Defence, 2002.]

Abstract

The paper presents a case study examining the potential for policies to be 'evidence-based'. To what extent is it possible to say that a decision to implement a complex social intervention is warranted on the basis of available empirical data? The case chosen is a contemporary conundrum about whether there is sufficient evidence to justify a ban smoking in cars carrying children. The numerous assumptions underlying such a proposal are elicited. The weight and validity of evidence for each is appraised. A mixed picture emerges. Certain propositions seem well supported; others are not yet proven and possibly unknowable. The paper argues that this is the standard predicament of evidence-based policy and that studying it will help to develop our understanding of research utilisation. Evidence does not come in finite chunks offering certainty and security to policy decisions. Rather, evidence based policy is an accumulative process in which the data pursues but never quite captures unfolding policy problems. The whole point is the steady conversion of 'unknowns' to 'knows'.

Key words: evidence-based policy, realist synthesis, uncertainty, legislative interventions, smoking bans

Introduction

Rumsfeld's circuitous and circumspect statement on the fallible basis for forward planning won the 2003 '*Foot in Mouth*' award from the Plain English Campaign. Given his confident and certain pronouncements on weapons of mass destruction, many commentators might have preferred conferral under a '*Please Practice What You Preach*' award. This paper, however, comes in praise of Rumsfeld's Dictum. It is a profound distillation of the predicament of evidence-based policy. We live in the 'evidence age'. We seek to justify policy decisions on the basis of 'known knowns'. The real problem is what to make of the 'known unknowns' and the even more troubling 'unknown unknowns'. The paper seeks to explore the limits of evidence-based policy when, as always happens, the knowledge base falls short of absolute, indubitable truth.

Let us begin with the basic premise of the evidence movement - the 'what works?' agenda and its mission to trade on the benefits of hindsight. Research into the effectiveness of programmes and policies is by now quite middle-aged. Interventions have been tried and tried again and researched and researched again. The best way to underpin policy by evidence, the argument goes, is to assemble all previous empirical findings in a particular policy domain in order to synthesise the available lessons on which initiatives and measures are the most fruitful. In its original and still most influential guise, namely evidence-based medicine, this philosophy led the creation of an accredited method of systematic review, namely meta-analysis, and an authoritative agency, namely the Cochrane Collaboration, all based on that best

know and most trustworthy of knowns, namely evidence culled from randomised controlled trials (Sackett et al, 1996).

From this hub in the world of clinical treatments ambitions spread outwards to evidence-based public health, to evidence-based management, to evidence-based policy, to 'evidence-based everything'. The very moment interventions pass into these public domains they become more complex, as do the problems they seek to resolve, as are the situations and locations into which they are inserted, and as are the demands on the evidence needed to evaluate them. Box 1 provides a brief outline of the dynamics of modern interventions – and a first taste of the vast evidence requirements:

Box 1: The dynamics of complex social programmes

Programmes are active, not passive. Interventions do not work in and of themselves; they only have affect through the reasoning and reactions of their recipients.

Programmes have long implementation chains and multiple stakeholders. Recipients are many and varied; reactions to programmes thus differ; outcomes are thus generally mixed.

Programmes are embedded in complex social systems. Recipients are rooted in different localities, institutions, cultures, histories, all of which shape the fortunes of a programme.

Programmes are implemented amidst the turbulence of other interventions. The policy agenda is delivered through a multitude of interventions, each one interfering with the reception of another.

Programmes beg, steal, borrow and adapt. Practitioners work constantly to improve the delivery of interventions rather than preserving uniformity to meet evaluation and trial requirements.

Programmes are the offspring of previous interventions. Social problems are longstanding; interventions evolve to try to combat them; the success of a current scheme depends on its history.

Programmes change the conditions that make them work in the first place. An intervention's success is always time limited since alleviating a problem always involves changing its concomitant causes.

The processes sketched here are not indiscriminate 'noise'; they are part and parcel of modern interventions (Davidoff, 2009). And if policy is to be evidence-based, research is needed to accommodate them. The question for the paper is just how much of this fluctuating terrain can be 'evidenced'? As the reviewer trawls the databases and search engines for the requisite information will they find enlightenment, or will the research prove lopsided in coverage, uneven in quality and contested in its conclusions? In short, as researchers strive for an empirical grip on the complexity of modern interventions, what is the balance of known knows, unknown knows, and unknown unknowns?

Should we ban smoking in cars carrying children?

The paper attempts to answer this question via a case study. We draw here on a review recently carried out by the authors on the potential effectiveness of a law banning smoking in cars carrying children (ref). This paper presents a selection of key findings. The focus, however, is to provide a social science perspective on what

statisticians call the ‘uncertainty’ of the evidence and what philosophers think of as the ‘decidability’ problem.

Legislative interventions carry all the complexity described in box 1. In particular they have a long implementation chain, which means that successful laws need to navigate the competing sensibilities of law-makers, pressure groups, parents, enforcement agencies and, in this instance, smokers and non-smokers. A massive range of assumptions, ideas, or what are sometimes called ‘programme theories’, lies behind them (Rogers et al, 2000). Successful laws have to be justified, designed, drafted, publicised, rendered unambiguous and made enforceable. An abbreviated list of some of key pitfalls worthy of interrogation in comprehensive review is presented in Box 2. The catalogue is organised under four main questions, each one carrying a sample of critical sub-issues that need to be ‘evidenced’ in order to warrant the claim that there is a sound empirical foundation for the intervention.

Box 2: Testing questions of the efficacy of a ban on smoking in cars carrying children

1. **Is the severity of the problem sufficient to justify a law?** 1.1. Does exposure to second-hand smoke in cars leads to ill-health? 1.2. What toxicity levels are encountered in a car when cigarettes are smoked? 1.3. Does ventilation make a difference? 1.4. Are the toxicity levels comparable to other risky environments in which smoking bans already operate? 1.5 How does the potential harm compare to formally approved air quality standards?
2. **Is there likely to be public support for such a law?** 2.1 What is the overall magnitude of support for such a law? 2.2 What are the levels of support amongst smokers? 2.3 What is the motivation behind public support? 2.4. Does endorsement depend on the extent and success of previous smoking bans in work and public places?
3. **Is there likely to be effective pressure group opposition to the ban?** 3.1 Has the tobacco lobby opposed this particular ban and will they do so in future? 3.2 What is the broader strategy behind tobacco company opposition to smoking control? 3.3 How does the ‘smoke-free’ lobby interpret and respond to tobacco industry tactics?
4. **Is the law enforceable?** 4.1 What are the main barriers and facilitators in discharging the law? 4.2 What is the optimal enforcement strategy - police action, community surveillance, self-regulation or public information?

As we shall see, such a catalogue has to capacity to extend and extend; answering one question will often trigger several more. The concept map in Box 2 serves, nevertheless, as a credible starting point for this paper, rehearsing some typical bones of contention upon which evidence has to adjudicate. Put simply, in order to offer an evidence-based recommendation that such a ban will work, a review would need to discover: i) significant evidence about risk and harm, ii) substantial information on positive levels of public support, iii) credible data on muted levels of lobby group opposition, and iv) trustworthy research that the law is enforceable.

In other papers the author has pursued all of the questions in great empirical detail. An account of the review method and the detailed findings may be found elsewhere

(refs). The purpose of this paper is to pursue Rumsfeld's Paradox – his vacillation about the extent to which policy prognostication can be settled by empirical enquiry. Faced with a deep-seated problem and with an intervention that is complex in structure, intricate in its implementation, contested among interest groups, and difficult to enforce – to what extent can the evidence be decisive in guiding policy?

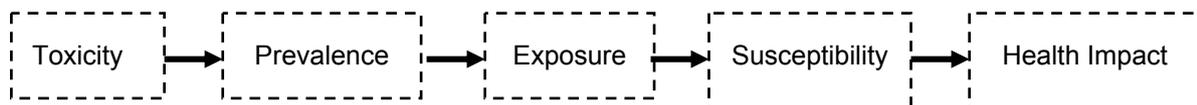
In answering this puzzle we will indeed encounter research questions that terminate in known knowns, known unknowns and unknown unknowns. To add a pleasing symmetry, we even light upon an example that might be considered an unknown known. In the end, however, Rumsfeld's typology fails to capture the many types and varying degrees of certainty and uncertainty that confront policy evaluation. The paper aims to provide a more comprehensive account of the indeterminacies of evidence. To do so it calls intermittently on a large philosophical literature, which has addressed broadly the same problem as the 'underdetermination of scientific theory', which may be defined as follows – 'the evidence available to us at any time may be insufficient to determine what beliefs we should hold in relation to it' (Stanford ref). It should be made clear however, that the issue addressed here is not some abstract, rainy day problem for philosophers – rather it is the basic predicament of evidence-based policy.

1. Is the severity of risk sufficient to justify the law?

'The dose makes the poison' (after Paracelsus 1567)

There is now a substantial, accumulating body of evidence on the dangers of subjection to second hand smoke, much of it summarised in the US Surgeon General's Report: *The Health Consequences of Involuntary Exposure to Tobacco Smoke* (2006). Vast as his report is (24.5 MB to be precise) the Surgeon General has nothing to say about the health impact of the microenvironment inhabited by the child cocooned with a smoker in cabin space of the car. The review thus begins by hunting evidence on this very specific known unknown. Figure 1 represents the causal chain and predicament of primary researchers (and their systematic reviewers) in trying to determine the risks involved.

Figure 1: The second-hand-smoke causal chain: from dose to response



First is the matter of the pollutants under study. Secondhand smoke is a complex mixture of thousands of chemicals emitted from burning tobacco, all with potential health effects, 50 of them considered to be potentially carcinogenic. Tracing their lingering concentrations in vehicles is difficult, especially under different volume, speed and ventilation conditions. At step two there is prevalence, the extent of within-vehicle smoking and smokers. This is also difficult to monitor closely in the

private space of a moving vehicle and reliance is generally placed on potentially erratic self-report in surveys. Then we move to the rear seat of the car the equally taxing matter of estimating the extent of subjection to second-hand smoke of children in these locations. Cars, of course, are but one of the many, many micro-environments through which children pass and measuring the extent of their exposure and isolating its effects is as fearsome an example of the 'attribution problem' as one could ever meet. Step four is susceptibility, which governs the reactions to a potential toxin. Science is only beginning to understand how sensitivity varies from one species to another and from one individual to another, with genetic makeup, body mass, rate of breathing and ability of the metabolic systems to eliminate toxins all bringing variability to the response. Children's bodies are suspected of showing greater sensitivity to most toxins, another factor that needs be inserted into the risk equation. Finally we come to health impact, once again furiously difficult to chart because of the potential pathways of so many toxins to so many organs and thus to myriad disease pathologies - short-term, long-term and terminal.

1.1 Does exposure to second hand smoke in cars lead to ill health?

The research puzzle, in short, is that of attributing causality to one opaque factor in blur of individual, family, domestic and everyday environments. Dealing with this mix of knowns, half-knowns and yet-to-be-knowns is always the lot of environmental health analysis and we turn first to an account of progress made. We discovered five papers that attempted to span the full causal chain, studying how exposure to second hand smoke in cars impacted on subsequent health outcomes. Evans and Chen's (ref) research provides a typical example utilising the 2005 Canadian community health survey to chart the association between home and vehicle environmental tobacco smoke (ETS) and chronic bronchitis. Respondents are asked to self-report on:

- a) whether there were regular smokers in their household
- b) whether there was regular exposure to smoke in cars
- c) whether they had been diagnosed with chronic bronchitis
- d) a range of potential background intervening variables

Results are reported as follows: 'The proportion of respondents who reported ETS exposure in the home and vehicle was 9.0% and 8.4% respectively. The prevalence of self-reported doctor diagnosed bronchitis was 1.5%. When considered separately, home and vehicle ETS were both statistically associated with chronic bronchitis in children and adolescents aged 12-19 years. Neither home nor vehicle ETS exposure was significantly associated with chronic bronchitis in age groups greater than 19 years. When home and vehicle exposure were considered together and, and sex, age, allergies, marital status and race were controlled for, home ETs exposure was not a significant predictor of chronic bronchitis while vehicle ETS was.'

In short, the study lays claim an interesting, intricate little web of associations. The findings are interpreted as warranting further curbs on smoking and in particular that

vehicle ETS might be more of a threat than home ETS. It is our first snapshot of evidence and our first opportunity to consider the status of such findings

The evidence here is, of course, associational and derives from survey data and so comes with the standard caveat that correlation does not imply causation. None the less, it is worth breaking down the reasons why the policy inferences are not yet warranted. These data, perforce, do not follow and monitor unfolding disease pathologies. They are a snapshot relying on self-report of different events at different times. Accordingly, there are several reasons why we cannot yet consider the reported outcomes to be 'evidenced'. Some may be considered technical difficulties, potentially capable of resolution. Other impediments apply because the system study is so complex that the task of establishing the causal pathways lies at the very boundary of research capability.

The findings here are highly susceptible to the vagaries of the respondents' memories and are subject to bias through arbitrary operationalisation and question wording. What is understood as 'regular exposure' may vary from respondent to respondent. Correlations are prone to vary according to how the independent variables are operationalised and 'frequency of exposure' can be measured in many different ways from the one in use. The best known problem of this ilk is 'systematic exposure misclassification bias', which may well be present here in that participants with active respiratory symptoms and a formal diagnosis have much more cause to recall exposure to ETS. These issues are raised not to condemn this particular study but to establish a more generic type of technical uncertainty that besets this form of public health evidence. What such studies produce are indicative tendencies rather than known knowns.

This aside this study also raises the most profound and limiting methodological issue – complexity itself. The research task here is to assess the contribution of one microenvironment, itself consisting of a spasmodic history of a hundreds of car journeys taken over many years and under many conditions, and then comparing them to a lifetime of irregular exposure to many equally complex air quality environments, and then attempting to discover the onward influence of the former but not the latter upon the individual's health profile, a complex dynamic in itself responding to many, many other influences other than air quality. Even the most powerful longitudinal research system could not track all of these pathways and the current one-shot survey provides only rough estimates in respect of a few byways of the process. Such research is indeed tantamount to discerning the influence of the needle in the haystack. Much more will be said about this issue – suffice to log here a core source of uncertainty in evidence based policy, the complexity of processes and structures into which interventions are embedded.

Any single study is unlikely to find its way across such an imbroglio. A perhaps more feasible method of establishing the impact of in-vehicle cigarette smoke is to amass evidence separately about all the crucial stepping stones in figure 1. And indeed there are very many studies measuring toxicity, prevalence, exposure and

susceptibility. We move on to consider a handful of characteristic findings, posing the same question about their conclusiveness.

1.2. What toxicity levels are encountered in a car when a cigarette is smoked?

Several studies have attempted measurement, under different driving conditions, of toxicity levels in cars when smoking occurs in the vehicle. In most cases case a volunteer smoker is asked to light up and an air quality monitor, strategically located, is set to record the fluctuations in toxicity levels. As with all 'in vivo' experiments, these studies have to contend with significant natural variation in the behaviour under study. The investigation requires a smoker and a child (substituted by an air quality monitor) but, thereafter, the encounter will vary according to: traffic conditions, climatic conditions, speed of vehicle, type of vehicle, duration of journey, number of passengers, number of smokers, number and frequency of cigarettes smoked, proximity of smoker and passenger, history of smoking in the car, and the ventilation conditions. The latter, the matter of whether smoking drivers open windows or operate air conditioning is a crucial bone of contention between proponents and opponents of the law and we turn shortly to closer consideration of this matter.

The pioneering inquiry (Edwards et al ref) provides us with some typical data. The principal investigator drove the car (in which no smoking had previously occurred for 10 months) while another investigator smoked cigarettes under specified conditions. Data was collected using a *TSI SidePak* AM510, a portable real time air quality monitor measuring average levels of respirable particulates (known as 'PM 2.5') over 1-minute periods. The *SidePak* was located on a child's booster seat in the rear of the car at approximately the height of the nose of a small child sitting in the back of the car. Ambient air was monitored before the experiment began and in-car during the journey. Three cigarettes were smoked: with window open and cigarette held outside; with window half open and cigarette in car; and with all windows closed.

Mean PM2.5 levels during smoking of the first cigarette were 199 $\mu\text{g}/\text{m}^3$, (peak 217 $\mu\text{g}/\text{m}^3$), during the second cigarette 162 $\mu\text{g}/\text{m}^3$ (peak 181 $\mu\text{g}/\text{m}^3$), and during the third 2926 $\mu\text{g}/\text{m}^3$ (peak 3645 $\mu\text{g}/\text{m}^3$). Fifteen minutes after the third cigarette was extinguished, PM2.5 levels were 631 $\mu\text{g}/\text{m}^3$, and did not return to the baseline level until almost 40 minutes after the cigarette had been put out. PM2.5 levels observed during smoking were many times higher than in ambient air (3-4 $\mu\text{g}/\text{m}^3$) which was measured 'next to a busy traffic roundabout'. In summary and in terms of orders of magnitude, one can say that this study uncovers considerable variation of toxicity across the smoking conditions but these are marginal compared to the almost thousand-fold difference between the mean closed and the ambient comparison.

Such data might understandably be termed 'hard evidence' and indeed they come closest to the elusive 'known knowns' in this review. A more accurate description of their status might read 'conditional knowns'. In specific and specified circumstances – low speeds, windows closed, passengers in close proximity, several cigarettes

smoked etc – vast levels of toxins are observed.

1.3 Does ventilation make a difference?

One of these conditions, especially, has aroused much research interest. What happens when the driver opens windows or operates the air conditioning? This ‘ventilation solution’ has for some time being part of the argument of ‘pro-choice’ lobby and evidence is needed to settle the debate. We thus turn to the most rigorous inquiry on this proposition. Ott et al’s (2008) study involved more than a hundred air change measures in a variety of vehicles under many different ventilation and driving conditions.

The first aim of the inquiry is to provide some metrics on air change – just how much air is shifted under different driving conditions? The basic measure used in this regard is air changes per hour (ACH) and opening a single window by 3" turns out to ‘increase ACH by 8 to 10 times’. Ventilation, it seems, causes air change rates (hardly surprising for that is what it means). But what of the effect on dangerous toxins? Ott and colleagues provide the most comprehensive body of data on particulate mass concentrations, summarised brutally here in Table 1

Table 1: Particulate concentrations under different ventilation conditions

Speed	Windows	AC/Ventilation	Max PM _{2.5}	Mean PM _{2.5}
20	closed	AC Max	3184	1113
20	Passenger window fully open	AC off	371	97
60	Passenger window open 3"	AC off	608	119
60	closed	Vent off	3212	1150

Exposure levels in ug/m³

Ott et al’s study thus teaches us that ventilation does affect the presence of toxins – though their removal varies according to molecular structures (heavier and more dangerous particles are harder to remove). We have further evidence here of the very high levels of contaminants under adverse conditions. We also have new evidence in the middle rows of the table of the fall in rates under more benign circumstances. In short, the study adds a level of scientific certainty and refines our understanding of the conditions that make up a ‘conditional known’.

But, to return to the question at hand – what does this study signify for potential legislation? It provides, of course, just a fragment of evidence and the question once answered only begets several more. Many smokers who drive cars carrying children do so under informal rules about reducing their consumption during journeys and having windows open in order to achieve ‘safe levels’. Are they correct? We have splendid evidence on how toxicity gradients vary under different in-car conditions but have yet to open the issue of acceptable air quality standards.

1.4 Are toxicity levels comparable to other environments in which smoking bans already operate?

One way of approaching this question is to examine precedents and relativities - comparisons of the vehicle toxicity data uncovered above with measurements of air quality made in other domains already subject to smoking restrictions. The rationale for doing so is obvious – ‘if intervention was needful *there*, then surely the same applies *here*’. This sentiment is uttered in virtually all lobbying for banning smoking in cars carrying children. The ‘smoky bar’, the *bête noir* of public health advocates, is the favoured precedent and we turn to an inquiry that throws some light into that smog.

Edwards et al (date) is the most substantial study of air quality in of pubs and bars in the UK. It was conducted in 2005, before the introduction of smoking bans in these establishments. Sixty four pubs came under scrutiny, chosen to span different communities. The mean fine particle level (PM_{2.5}) across all sites was 285.5, though as with in-car measures, large variations in air quality were uncovered according to pub location, usage, time of week, time of day etc. In the worse category (pubs in deprived areas) mean levels were 400 ug/m³, with a range of 54 – 1395 ug/m³, figures that the authors and indeed policy-makers considered strong support for this particular ban.

Drawing parallels on air quality levels across the two situations is not straightforward, however. If we recall the studies examined in 1.2 and 1.3, peak levels in cars under closed conditions are over 3000ug/m³, seemingly even more dangerous. Then again, if a comparison is drawn with mean levels in a well ventilated car, Ott’s measure at 97ug/m³ is lower than the means in any of the establishments above. The upshot, perhaps laboured by these simple comparisons, is that as toxic environments, both cars and pubs vary widely according to context and usage. There is no Archimedean point from which we can declare a given, objective difference between car and bar.

The crucial difficulty is the matter of duration of exposure. Many of the reported measures are of ‘mean prevalence’. The ‘means’ refer to quite different time intervals and circumstances. In-car, the mean typically refers to air quality during the smoking of a single cigarette and not the entire journey. In-pub, the mean refers to the contributions of many smokers over an extended period of time. Much of the argument for banning smoking in such venues was that high levels of air contaminants persisted over the entire shift of the bar worker. Once again, in terms of policy implications the evidence is ambiguous. In a world of conditional knowns, there is no such thing as a clear precedent.

1.5. How does the potential harm compare with formally approved air quality standards?

Another option for gauging the risk associated with in-vehicle smoking is to compare it with publicly sanctioned benchmarks – the formal air quality standards of recognised by official agencies such as the US Environment Protection Agency (EPA). These have considerable attraction for evidence-based policy, being what

Rumsfeld might term 'official knowns'. We begin by extracting EPA's headline figure of the 'primary standards' for PM_{2.5} concentrations (using their July 2009 update ref). Primary standards are intended to set limits to protect public health, including the health of 'sensitive' populations such as asthmatics, children and the elderly. They are derived from 'systematic reviews of medical and toxicological research in many domains in which poor air quality presents a risk'. Two exposure figures are presented limiting the acceptable standards of ambient air to:

- 15ug/m³ annually
- 35 ug/m³ in a 24-hour period.

It is clear that base levels of 35ug/m³/24hr represent very low magnitudes indeed when compared to the car exposure levels reported earlier. If we consider a situation in which a child makes routine car journeys involving typical mean exposure during smoking of the order of 3000 ug/m³, it is clear that such events will contribute significantly to exceeding the daily recommended limits. There are provisos, of course. The EPA is required to produce standards for the widest range of potential toxins in the widest range of environments and, accordingly, guidelines tend to the generic and are not intended not adjudicate upon the momentary details of exposure in microenvironments, such as the rear seat of vehicles. The crucial difference is that PM_{2.5} levels reported in the car studies focus on instantaneous and short-term exposure; the EPA concentrates on long-term exposure. As with the smoky bar studies, there is no precise basis for comparing like with like.

Consider next the primary standard of the Office of US Surgeon General: "The scientific evidence indicates that there is no risk-free level of exposure to second hand smoke" ... "The US Surgeon General has concluded that breathing even a little second hand smoke is bad for your health" (ref). *Ipsa facto*, it follows that any amount of smoking in cars carrying children should be considered a significant risk. Under these standards we move from strong to unequivocal support for the in-car ban.

How is this zero magnitudes to be explained and should it be regarded as an authoritative standard (absolute known) for the in-car smoking ban? It transpires that they are underpinned by a fundamental change in the interpretation of 'risk'. In classic academic toxicology an ancient principle governs the measurement of risk: 'All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy' (Von der Besucht, *Paracelsus*, 1567). This is often rendered 'the dose makes the poison', under the idea that a substance only becomes poisonous when ingested at above some safe or acceptable level. Caffeine is often forwarded as an exemplar – commonplace in range of foodstuffs without leading to illness but capable of causing death at 50-times standard exposure levels. Historically, the Paracelsus maxim has been considered the cornerstone of public health standards, deriving 'dose-response curves' to define the acceptable concentrations of contaminants in food, public drinking water, and the environment.

More recently an alternative credo has come to the fore, known as the precautionary principle: 'The precautionary principle states that, in cases of serious or irreversible threats to the health of humans or ecosystems, acknowledged scientific uncertainty should not be used as a reason to postpone preventive measures. The principle originated as a tool to bridge uncertain scientific information and a political responsibility to act to prevent damage to human health and to ecosystems' (Martuzzi and Tickner. WHO report)

http://www.euro.who.int/InformationSources/Publications/Catalogue/20041119_1

It transpires then that the Surgeon General's new standard and, incidentally, the most recent benchmarks published by WHO, are squarely based this credo. As we trust we have made clear in the discussion on complexity (Figure 1), 'acknowledged scientific uncertainty' inevitably persists about the risks associated with smoking in cars carrying children. The new principle is thus designed for such a scenario – but what is its status? By definition the zero emission, zero concentration, zero tolerance standards are not empirically derived – they concede that the evidence is not yet in. Their role is thus to acknowledge uncertainty but to remove doubt; they are literally 'unknown knows'. Whilst this neologism provides pleasing symmetry to Rumsfeld's typology (it completes the missing, fourth permutations of knows and unknowns), it betokens a move from evidence to advocacy. Invoking the maxim forecloses debate and stifles the search for further evidence (Tickner et al, 2003). From the perspective of Paracelsus's principle precautionary propositions are illogical. They deny the dose-response rule in lumping together the dangers of a lifetime's exposure of non-smoking spouse to a smoking partner with the infinitesimally small exposure when the passer-by passes by a marooned smoker expelled to the street corner.

Interim Summary 1

The above represents a brief synopsis of some key studies of the toxicology of second hand smoke in cars carrying children. Some powerful evidence comes to light. *Under the worse ventilation conditions and in terms of peak contamination*, the evidence permits us to say that smoking in cars generates fine particulate levels of over 3000ug/m³. In terms of broad orders of magnitude encountered in the realm of air-quality studies this is a concentration very rarely experienced. What does this statement signify in terms of the underdetermination thesis and, more particularly, what should policy makers make of it?

The summary proposition above is italicised in order to reemphasise our main conclusion that what emerges from these studies are contingent truths. They are 'conditional knowns' in several senses, all due to the bounded nature of each piece of primary research. The evidence above does not uncover an absolute risk threshold. The risk calculation turns first of all on the matter of volume - the capture of high concentrations of respirable particulates in a tightly confined area. As we have seen, a conditional truth emerges, namely that – at peak levels and without alleviating conditions, car cabin air quality levels constitute a danger. Such much is

warrantable. But the risk calculation does not end there. The threat from second-hand smoke, quite literally, becomes diluted as people respond to it. That response is biological and social. We know that risks change with the differential ability to metabolise and expel toxins and there is further evidence to suggest that the very young are most susceptible. We also know that people will respond socially by adapting ventilations conditions, adjusting their smoking frequency, tailoring their smoking behaviour with different types of passengers and indeed by passing laws against smoking. Our review pieced together evidence on all of these conditions. Save for the data on ventilation, we have had little space to rehearse it all here.

Although it contains many highly significant pointers and comparisons the evidence cannot tell us of the exact contribution that exposure to smoking in cars makes to the ill-health of children. Our task at this point is thus to evaluate the authority and sanction of evidence when the issue under investigation depends on many, many contingent conditions, which change over time and with location. This conundrum on the limited reach of evidence was first raised by the French philosopher Duhem (1914) under the notion of 'holistic underdetermination'. Transposed to the problem under study, the problem is that there is no single test of hypotheses such as one positing that a children's exposure to second-hand smoke in cars (x) causes significant health risks (y). Rather, Duhem's argument goes, the effect of x on y depends on a series of *conjoined hypotheses*, which are potentially limitless and thus permanently open to revision, leaving us without scientific certitude. We will not explore the philosophical defence of empirical science here, other than note it has been mounted most convincingly by Laudan (1990).

The consequences of the contingent nature of the evidence in evidence based policy do need appraising, however, and we begin to spell out some implications here. The first of which is to acknowledge that policy decisions do indeed rest on *whole sets* of partial and conditional knowns. Evidence can inform such decisions but cannot carry a decision by producing information on every eventuality. What is required is a logic, guiding us on how to proceed in the absence of universal knowledge. We need some way of bundling and applying the evidence to support better rather than perfect decision making.

This first section leaves us short of a strategy for doing so. As we have discovered, the process is not improved by an indefinite wait on the grounds that 'more research is needed'. But this lack of certainty does not require a leap into the arms of the precautionary principle. Wisely, this tenet tells us not to wait for certitude. Unwisely, as above, it then slopes back to certitude via the production of arbitrary, absolute standards that sit most uncomfortably with the mass of conditional truths produced by the science. Similarly, there is no short cut via the upholding of precedents. Standards established for the smoky bar or the general environment depend themselves on conjoined sets of conditions, which cannot be read across into the family transport environment. Our first interim conclusion tells us no more than evidence based policy is a journey rather than a destination. We turn next to

examine the voyage through public opinion, seeking clues on how evidence may be consolidated.

2. Is there likely to be public support for such a law?

'No written law has ever been more binding than unwritten custom supported by popular opinion'
Carrie Chapman Catt

Wise legislators consider not only the grounds for a law but also its acceptability to the recipient community. Adherence to a law (unlike, for example, responses to medication) is strongly conditioned by levels of public support, which are often variable and fickle. Gathering evidence on the public support is a routine task of social science and this section considers the certainties and uncertainties in the evidence provided by the methods of opinion polling. We sample attitudinal evidence on in-vehicle smoking bans, following the sub-questions in box 2, namely: overall support; opposition by smokers; reasons for support; changing dynamics of support.

2.1 What is the overall magnitude of support for such a law?

There have been many attempts to gauge levels of support for in car smoking bans, much of the evidence been drawn from items with national public health surveys. As an illustration of some typical data, we sketch some Australasian evidence. In the first major attempt to gauge opinion (Bauman et al, 1994) undertook a random household survey in New South Wales using 'standard methods for assessing the prevalence of smoking and attitudes.' They reported their results for the question, 'Do you think it should be illegal to smoke in cars when travelling with children?' as follows: 'of the 1461 adult responders, 72% agreed, 27% disagreed and 1% were undecided'. A much later telephone survey (Dunn et al.'s 2008) assessed knowledge and attitudes and self reported behaviours with regards to second-hand smoke in cars and homes. Using random digit dialling they interviewed 1026 adults in Queensland. Overall support for smoking bans was high (though varying depending on passengers) – 63.8% (non-smoking adults) to 80.5% (children under 12 and pregnant women). Stronger support still emerges from Thomson et al's (2009) public health survey of a national sample of 1376 New Zealand *adult smokers* survey. This contained the item 'Do you think smoking should be allowed in cars with preschool children in them?'. Results which were weighted to reflect the national population of smokers showed that, '... 95.9% disagreed (95%CI: 4.7%–97.1%) and only 3.0% agreed with this question', leading the authors to conclude that: 'there appears to be almost universal support for not allowing smoking in cars carrying children, from smokers themselves.'

Many, many other studies exist but these give an initial and not untypical picture. Support appears high, indeed very high and possibly increasing. But what is the status of the data? Should Rumsfeldians regard them as known knowns? There are two problems with such survey evidence – attitudinal responses can be unreliable

and the data, perforce, provides only a snapshot of opinion at particular time and place.

Survey responses can never be taken entirely at face value. Well known technical problems exist due the slipperiness of question wording. Quick eyes will spot the above questions carry subtle differences of emphasis that might shape the willingness to support a ban. Public compassion might well differ for 'children', 'children under ten' and 'pre-school' children, not to mention the 'elderly', 'pregnant women', 'non-smokers', etc. Probably even more of a threat in the present case is the 'social desirability effect'. Respondents, naturally enough, prefer to be on the side of the angels and thus often 'fake good' (Wales and Seemen, 2006) when confronted by a stranger asking questions about sensitive topics. Put in a nutshell, the problem is that smoking addicts, who suffer routine stigma on top of slow poisoning, may well choose to dissemble. Being technical problems there are, of course, technical solutions here. Attitudinal information can be hardened using consistency checks and mounting investigations that compare what people say and what they do. The other fallback is simply to be guarded in making inferences from the data and to regard such as evidence as tendencies (provisional knows) rather than absolutes (known knowns).

Tendencies and propensities might not, however, satisfy all policy-makers. Trends that might apply in the open swards of New Zealand or in smoke-averse Australia might not apply to their bailiwick. In general it is true to say that the studies reviewed in this section were all made in jurisdictions which were at least in the initial stages of contemplating such a ban. The poll that policy makers require is a sample of 'their patch, right now'. Short of supplying a referendum on each pending policy change there seems little the evidence broker can do to meet this particular need (though, contrarily, we note that single questions referendums suffer the 'wording' issue even more sharply).

In short and in terms of prima facia evidence on public support, policy makers will often lack immediate, local evidence and be left confronting a 'known unknown'. Is there a way around this predicament? As we have seen, the way forward is to develop conjoined hypotheses rather await the all-clarifying datum. So is there available information on the closer texture of support that might provide additional lessons?

2.2. What are the levels of support amongst smokers?

A great deal of evidence exists charting the contours of endorsement for in-vehicle smoking bans. There are studies relating support, or lack of it, to gender, education, social class, employment, poverty, region, cultural background, nationality, health status and so on (refs). Policy makers estimating support for their legislation will need to pay heed to the voices of the relevant constituencies. Moreover, since the

crucial task is to gauge headwinds to the passage of the law through this climate of public opinion, the most pertinent data relates to the attitudes of the most palpable foes, namely smokers.

We reproduce three further nuggets of evidence, which are indicative of a more general picture. Dunn et al's (2008) Australian study reports 'Most respondents believed that laws prohibiting smoking should be implemented as soon as possible in cars (74.2%) and homes (71.9%). Smokers were less likely to support laws prohibiting smoking in cars being introduced now or as soon as possible (61.7%) than were non-smokers (74.2%)'. Jalleh et al.'s (2006) research provides a further nuance on Australian opinion. Support for a 'total ban' on smoking in vehicles was 24% among smokers and 49% among non-smokers. But, as is the norm, such endorsement is highly conditional and changes markedly to 84% amongst smokers and 87% amongst non-smokers when 'a child is in the car'. Moving to a different nation and population segment, Leatherdale's (date) survey discovered: '90.2% of Canadian youth reported that ... smoking should be allowed around children in cars ... although the prevalence was highest among non-smoking youth (91.8%), most smoking youth (72.9%) also reported that smoking should not be allowed around children in cars.'

What is the status of this evidence? All of the provisos raised in section 2.1 apply again. This is survey data. These are indicative trends and tendencies that are subject to measurement error and reporting bias. Unsurprisingly, the evidence indicates that smokers are more reluctant than non-smokers in endorsing a potential ban. Even so, the data reveal persistently that this is not diametric opposition. Indeed, the majority of smokers in these studies, and in many others, would appear to support the ban. To repeat, words are not deeds, and the spectre of the social desirability effect looms large in these responses. But 'faking good' is only one of the possible reasons for the smokers' expressed disquiet at children's exposure to second hand smoke. A review needs to consider further explanations in order to harden fragile uniformities into solid explanations.

2.3 What is the motivation behind public support?

Public opinion research, of course, does not only report on opinions, it delves into the reasoning behind them. Firm evidence on this motivational base can help solidify the picture derived in the previous sections about the broad measure of support for the proposed ban. Why the general endorsement? Wherefrom the smokers support? We uncovered two bodies of evidence capable of interpreting these outcomes: the first highlights the profound protective instincts that surround children in public health matters; the second concerns the depth of regret than smokers feel about their tobacco use.

There are many studies, both quantitative and qualitative, indicating that smoking is modified in the presence of children. Here we illustrate two typical nuggets of

information from studies that spell out the rationale. Gillespie et al.'s (date) New Zealand survey reports that smokers do care about protecting children from the harm of second hand smoke (SHS) and nearly half will not smoke in the presence of children. 'Of the respondents who reported that they did not smoke at all when they were around children, nearly half (46.5%) said that this was because they did not want to expose children to SHS. Setting a good example for children was also reported as an important reason for not smoking in the presence of children (25.6%).'

The fifty Scottish smokers in Phillip's qualitative study (date) made their concerns about the effects of second-hand smoke quite clear: The most important consideration was not to harm children. 'Many thought that children were particularly at risk because they were still developing', with this consideration being more important than aesthetic concerns (e.g. the smell of the smoke). Smokers made clear efforts to not harm children and reported modifications in their behaviour in the presence of children: "All respondents with partial or no restrictions described how they would temporarily modify these in particular circumstances. For example, partial restrictions would become stricter in the presence of children and grandchildren, or relaxed if adult visitors were smokers."

This widespread perception of the vulnerability of children is often seized upon in jurisdictions which have implemented law. Several studies of policy process in smoking control have observed this motif. Moulton (date) reports how a 'save the children' ethic was prominent during the preparation and enactment of the 2008 bill banning smoking in cars carrying children in Nova Scotia, Canada. Local officials are reported as saying: 'The council ... has once again reflected the conscience of the community while dealing with an issue on behalf of an element of the population, that is, children, that don't often have the right to change the environment in which they might find themselves ... children don't often have a voice for themselves on health issues ... cars are an environment where they can't walk away.'

The same thread emerges from a 'qualitative narrative review' by Freeman et al (date) summarising the 12-year Australian history of advocacy for smoking bans in cars. The authors analysed data from the print news media seeking out the ascendant themes. A key motif framed the issue as being about the protection of defenceless children with no choice about being exposed to SHS. This theme was explicit in 35% of articles. Highly emotive terms such as "gas chamber" and "child abuse" (eight and 10 instances respectively) were used to describe the conditions experienced by a child inside a smoky car." Opposition to the ban was also evident in the news media. Dissent, however, related only to political issues such as the spread of the nanny state and enforcement difficulties, leading the authors to conclude: 'Invoking the protection of vulnerable children in the debate about smoking in cars called up an almost invincibly powerful sub-text for advocates.'

A different body of evidence teaches us that smokers, as a collective, are most unusual in the ranks of peer-groups and interest-groups in as much as they have an

ambivalent attitude to membership of their group. Many studies, over the years, have demonstrated that significant proportion of them want to quit. Several different estimates exist in the literature, a recent paper by Lee and Kahende (2007) suggesting that in the US in any given year nearly 2 in 5 cigarette smokers try to quit, but fewer than 10% succeed. Many studies have tried to understand the dissonance that follows as smokers come to terms with cessation failure in the face of addiction. We highlight the largest study attempting to gain a measure of the degree of that contrition.

Fong and colleagues (2004) conducted a random-digit-telephone survey of 8,000 smokers across four countries (US, UK, Canada, and Australia). Respondents indicated whether they strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with the statement: 'If you had to do it over again, you would not have started smoking'. The proportion of respondents who agreed or strongly agreed was 90% and nearly identical in each country. 'Regret was more likely to be experienced by older smokers, women, those who had tried to quit more often, those who perceive quitting as conferring health benefits, those with higher levels of perceived addiction, those worried about future damage to health, those who perceived smoking as lowering the quality of life, those who perceived the higher monetary costs of smoking, and those who perceived that smoking is not socially accepted. This predictive model was the same in all countries'.

On the basis of this evidence the authors declare that: 'Regret is a near-universal experience among smokers'. Methodological caution about potentially leading question wording, superficial telephone interviews, and, in this instance, the possibility of 'faking sorrow' must always be expressed. Nevertheless, these orders of magnitude are rarely seen in opinion polling and, together with the persistent data on the numbers seeking to quit, there is evidence of a powerful tendency here. But with what consequence?

The authors argue that this 'near universal regret' is a powerful constraint on a smoker's future choices and, accordingly, that knowledge of this should feed into tobacco control policy. A straightforward inference is that remorse about their own habit means that even hardened smokers will have little interest in conscripting a new generation of smokers. In short, smokers do not and will not tend to proselytise. 'Regret' may be a significant part of the explanation for the muted levels of opposition to the ban on smoking in cars carrying children and thus becomes a serviceable fragment of evidence explaining the lack of opposition to such a ban.

2.4. Does endorsement depend on the extent and success of previous smoking bans in work and public places?

It has already been noted that the vast majority of the available research emanates from counties in which tobacco control has already gained purchase. An obvious corollary is that support for a particular ban is elevated the more extensive the previous legislation in that policy domain. If smoking bans have been enacted on

public transport, followed by office and indoor workplace restrictions, followed by smoke-free restaurants and finally bars, pubs, and gambling venues, then the hypotheses is that public opinion is softened up for the next location, namely private cars. Known colloquially as 'domino theory' and in tobacco control circles as 'denormalisation theory', this thesis come under considerable research scrutiny.

Hammond et al (2006) analyse further results from the four nation study reported on earlier (Fong et al 2004) that pertain directly to the smokers' perceptions of denormalisation. Most smokers (81%) agreed with the statement that 'there are fewer and fewer places I feel comfortable smoking'. An identical percentage agrees that: 'society disapproves of smoking'. Further research from the busy Fong et al (date) but this time in Ireland probes the smoker's experience of legislation. Adult smokers were surveyed by telephone before and after the implementation of the Irish workplace smoke-free law in March 2004. The relevant and paradoxical finding was that even when smokers did not support such a ban at inception, they often did so after it was introduced: "Increase in support was most dramatic in venues where pre-policy support was lowest (for example, bars/pubs and restaurants), suggesting that policy-makers that stay the course in implementing comprehensive smoke-free policies are likely to experience increased support among smokers after implementation." This, the authors suggest, is may be explained by a body of, "findings in social psychology that changing behaviour is often followed by changes in attitudes and beliefs consistent with the behaviour change."

Whilst we have growing evidence that most smokers feel a sense of regret about smoking and know that they face increasing societal disapproval, the domino theory is still in need of refinement. Insufficient studies exist to indicate whether legislative incrementalism has a precise cadence (an optimal order in which the dominos must fall, with car bans at point x of the sequence) or whether it is a matter of sheer persistence (Fong's assertion that policy makers merely have to 'stay the course'). The exact grounds on which smoker's accept restrictions remains unclear. Phillips et al.'s (date) qualitative study on 'smoking ethics' and 'moral identities' gives an indication of the subtleties involved:

'Two factors emerged as important in how smoking restrictions were managed or moderated. These related to the meaning of the home and social identity. The home was seen as being a private space, a place of relaxation and comfort. This seemed to bring with it notions of choice about when and where respondents smoked in the home and about how others should respect their views ... An acceptable social identity pivoted around being seen to be a "considerate" smoker or non-smoker who would appropriately modify their behaviour or restrictions for family and friends or on certain special occasions.'

Putting these two codes of practice together suggest that smokers may *at some point* begin to resist the steady incrementalism of smoking bans. Does the ban on smoking in cars carrying children represent that point? Phillips et al's (date) data suggest that it is *not*:

“Smoking restrictions in the car seemed to be more robust than in the home, suggesting that the car occupies an intermediary position between public and private space; its confined nature also seemed to encourage stronger rules.”

The studies reviewed here begin to tackle an issue of great subtlety, trying to chart and interpret smokers’ reactions to the tightening grip of legislation. Strong evidence exists showing that smokers are well aware of progressive weight of legislation and from that finding alone there is support for the domino theory. But the evidence is yet to reveal an infallible pathway of compliance.

Interim Summary 2

Our review labours end, once again with a conditional known. A sizable number of studies have shown significant levels of support for a ban in smoking in cars carrying children. The vast majority of this evidence comes for surveys, polls and attitudinal inquiries. These methods trade in tendencies and probabilities rather than uniformities and certainties. There is always an imponderable gap between what people say and what they do. Moreover, this evidence is narrow in its population base, emanating from localised studies in specific time periods.

However, these specific indeterminacies do not negate the contribution of the evidence reviewed. For, as we have seen, evidence is constructed in the intersection of ‘conjoined hypotheses’ – and this section uncovers an important strategy for weaving together the findings. A more compelling source of certainty lies, we submit, in the process of *explanation building*. The import of public opinion is not just a matter of a percentage of affirmation here or a percentage there. Attitudes are rooted in reasoning and those roots are open to investigation. In this case, the solidity of support is attested in further evidence on the grounds for that support, namely the beliefs about the vulnerability of children, the sentiments of regret about taking up smoking, and the acknowledgement that sympathy for the smoking habit is prone to decline under incremental legislation. Realist synthesis constructs tests and refines explanations and what this review provides is an account of why and in what circumstance public opinion will harden in favour of a ban. Like all hypotheses, these theories are provisional, falsifiable and open to further testing. But it is via this process of building conjectures and seeking evidence, for or against, through which science and evidence based policy approaches (but never reaches) certainty

3. Is there likely to be effective pressure group opposition to the ban?

“Those who do not know the plans of competitors cannot prepare alliances”. Sun Tzu: The Art of War
Cigarettes occupy a distinctive but not unique place in modern commerce. In liability law they face the perpetual challenge of being condemned as a ‘tangible good that may cause harm’. And yet their sale, save for restrictions on youth purchasers, is perfectly legal. Legislation restricting smoking behaviour has thus tiptoed its way through the judiciary – attempting to restrict a potentially dangerous activity whilst

recognising the legality of its market. Against this background, it is well documented that the tobacco lobby has mounted a sustained campaign attempting to thwart the steady encroachment of legislation. Truculent opposition has been mounted against smoking bans in public places, against health warnings, against advertising restrictions and, until 1998, against the very idea that smoking was a health risk (Glantz and Balback, 2000) .

Under review here is the narrower question about whether the tobacco industry will mount opposition to the banning of smoking in cars carrying children. It turns out that there is precious little published evidence on the said issue – given that it covers a very recent twist in legislation. Only a very few jurisdictions in Australia, Canada and Malta have enacted the ban. What is more, lobbying is a covert business, much of it out of the public eye and absent from research reportage. Political processes generate politicised evidence. Put in this way make the reviewer’s task sounds most Rumsfeldian – a quest to uncover concealed truths from the lips of unwilling sources – a prime ‘known unknown’.

3.1 Has the tobacco lobby opposed this particular ban and are they likely to do so in future?

Our search in this block began by seeking materials on existing tobacco company resistance to legislation on smoking in cars carrying children. Basically, there was only one sighting in an academic journal and a fragmentary one at that. Freeman et al’s (2008) aforementioned analysis of Australian newspapers examined the themes underpinning arguments for and against the ban, discovering that the ‘welfare of children’ is the dominant concern for those supporting proscription. We have already quoted the vital passage which continues as follows:

‘Invoking the protection of vulnerable children in the debate about smoking in cars called up an almost invincible sub-text for advocates. Unlike all other advocacy for smoke-free areas, this debate was not contested by the tobacco industry or other commercial interest groups motivated by the potential to see restrictions reduce sales and further denormalise use. Indeed, one tobacco company was publicly supportive of legislation’.
(Freeman et al, 2008)

It turns out that British American Tobacco (Australia) was the supportive party in this instance. Their submission the Preventative Health Task force contained the following statement:

Smoking in cars carrying children: BATA Position Summary

BATA supports the sensible regulation of tobacco products, while ensuring that adult smokers can make informed choices about the use of such products. We accept that environmental tobacco smoke is an issue of public importance and believe that smokers should be mindful of others' comfort and should not smoke around young children. We do not support attempts to ban or regulate against smoking in private dwellings or private vehicles that are not containing children. We believe that people should not smoke around young children. However, we think this is more effectively achieved through education and encouraging greater personal responsibility amongst smokers. Governments at all levels need to be very careful in balancing the civil rights of the smokers with those of non smokers.

Here then is a clear statement of principle – ‘we believe that people should not smoke around young children’. Is this an isolated statement or a common cry? A more detailed analysis of the websites of tobacco companies worldwide reveals an echoing chorus of support for a range of smoking restrictions on children. For example:

‘Despite the best efforts of society, youth smoking continues to be a real problem worldwide. Our position has always been very clear: minors should not smoke. It is wrong for minors to smoke and we do not engage in any activities to encourage minors to become smokers. Smoking is and should be an adult choice’ ([Japan Tobacco International website](#))

Much of the impetus for tobacco companies to concede the risks associated with smoking and thus to inform adults of and shield children from those dangers stemmed from the US Master Settlement Agreement (MSA). This is an accord struck between US tobacco companies and state Attorneys General, which released the companies from some lawsuits and future tobacco-related health care costs – in exchange for compensation payments and the curtailment of certain cigarette marketing practices. This linkage between the MSA and company policy on children and young people can be observed directly on the R J Reynolds website:

After many years of intense national debate, the major issues regarding cigarette marketing and underage smoking have been comprehensively addressed through a Master Settlement Agreement signed Nov. 23, 1998, by the major U.S. tobacco companies and 46 states and a number of U.S. territories ... The MSA prohibits taking "... any action, directly or indirectly, to target Youth ... in the advertising, promotion or marketing of Tobacco Products, or ... any action the primary purpose of which is to initiate, maintain or increase the incidence of Youth smoking" ([R J Reynolds Website](#))

Evidence gathers suggesting that the tobacco lobby is unlikely to mount a sustained campaign of opposition to any proposed legislation on banning smoking in cars carrying children. Such public testimony places a direct onus on the tobacco companies to ‘practice yourself what you preach’. Whether this maxim is actually followed is, of course still open to question. Rumsfeldians know that, when it comes to weapons of mass destruction, public relations pronouncements are not entirely trustworthy.

3.2 What is the broader strategy behind tobacco company opposition to smoking control?

The methodological argument gathering through the paper is that evidence-based policy is build more adequately on explanatory wholes rather than empirical fragments. One way of hardening the inference that the tobacco industry will pay no more than lip service in regard to this particular law is to examine broader corporate strategy against the steady encroachment of smoke-free legislation. Does this history of lobbying suggest the law will prevail unopposed? The phrase ‘tobacco wars’ is often used to describe the 50-year battle of lawsuits between the ‘free-choice’ and ‘smoke-free’ lobbies. It is useful to conduct a brief overview of how the battleground has shifted, better to understand: i) where companies devote their current legal and

marketing energies, and ii) if and to what extent the soft focus on children constitutes an exception to the longstanding hostilities.

Amongst the strategies deployed over the years include: 'aggressive and uncompromising litigation' driving legal costs beyond the resources of most plaintiffs (Gostin, 2008); funding research attacking the 'junk science' behind claims that smoking causes disease (Stolley, 1991; Sterling, 1975); repeating the attack in relation to the dangers of second-hand smoke (Ong et al 2001; Bero 2005; Tong et al, 2005; Tong et al 2007); seeking delay in smoke-free bar legislation by calling for further evidence on the utility of a 'ventilation solution' and raising economic arguments about loss of business (Magzamen and Glantz (2001); creating front organisations such as the Associates for Research in the Science of Enjoyment (ARISE) to demonstrate that smoking cessation was itself stressful (Smith, 2006); litigation strategies to oppose tobacco control media campaigns (Ibrahin et al, 2006); buying influence through the funding of agencies such as the Centre for Corporate Social Responsibility, University of Nottingham (Cohen, 2001).

Given the Master Settlement Agreement, many of these forms of procrastination and delay have now been vanquished and/or exhausted, bringing us to current position, the era of so-called 'corporate social responsibility' (CSR). Several papers have explored the tobacco company's adaptation of CSR strategies (Chapman 2004; Hirschorn 2004; Palazzo and Richter, 2005). The first change is the public acknowledgement of the grave dangers of smoking:

Cigarette smoking is a leading cause of preventable deaths in the United States. Cigarette smoking significantly increases the risk of developing lung cancer, heart disease, chronic bronchitis, emphysema and other serious diseases and adverse health conditions. No tobacco product has been shown to be safe and without risks, and quitting tobacco use significantly reduces the risk for serious diseases ... Governments, public health officials, tobacco manufacturers and others can play a role in providing adult tobacco consumers with accurate information about the various health risks. R J Reynolds website:

The research goes on to identify a shift in tobacco industry strategies (in terms of lobbying, PR and litigation) under this new CSR regime. These are centred on:

- i) The defence of a legal commodity and the right to remain in control of the legitimate marketing opportunities to further commerce.
- ii) The defence of smoking as an adult activity in which individual choice should pertain and the corresponding duty to assist in preventative activities for youth.

As an example of the first impulse compare the conciliatory statements above on the protection of children with the muscularity of the tobacco lobby's response to a contemporaneous threat to a key marketing tool:

Philip Morris Limited ... will file a joint lawsuit seeking to overturn the ban on display of tobacco products at retail stores in Ireland ... before the High Court in Dublin on October 6, 2009. Plaintiffs will be challenging the tobacco display ban on the grounds that it severely restricts their ability to provide trade and services thus violating Irish constitutional law and EU law. The tobacco display ban came into effect in Ireland on July 1, 2009. Outside Ireland, a display ban exists in Iceland as well as some provinces of Canada. We know from our experience in Iceland that a total ban on tobacco display does not work, is costly to implement and ineffective at reducing smoking levels ... this legislation just serves to hand the tobacco business over to smugglers and

counterfeiters. Ireland already has one of the worst illegal cigarette problems in the EU, and this ban is making it worse. No one likes to litigate, but we have unfortunately arrived at a point where we see no alternative. We ask the Irish government, 'what type of industry do you want?' One that is legitimate, and supports effective regulation, or one that is run by criminal gangs selling cheap, illegal cigarettes on street corners?

As an entirely typical example of the second strategy, we reproduce BAT's overview of their activities in youth prevention:

In 2008 our companies in 83 countries reported engaging with governments on preventing under age access to tobacco products. Our companies in 34 countries reported engaging with governments for a regulated minimum age where none exists or to raise the age to 18 where it is lower. Our companies in 69 countries reported running or supporting youth smoking prevention programmes in 2008, spending a total of £4.3 million, including contributions to industry campaigns. More than 80 per cent of the total effort was focused on retail access prevention.

This miniature review of company documentation suggests that 'Tobacco War' hostiles continue apace even though the industry claims that it is in sustained retreat from the youth market. It is a further indication, perhaps, that the tobacco industry will not oppose and perhaps even support a ban on smoking in cars carrying children. Before, however, we hail the discovery of a 'known known' a troubling question needs settling - is this all spin or substance?

3.3 How does the 'smoke-free' lobby interpret and respond to the tobacco industry position?

The choice of whether to contest legislation and the success, or otherwise, of such a strategy does not, of course, rest entirely in the hands of tobacco lobby. Ranged against it are the powerful forces of the 'smoke-free' lobby. This movement includes many foundations and charities (Action on Smoking and Health, Citizens Lobbying Against Smoker Harassment, Teens Against Tobacco Use, etc.) as well as a phalanx of professional bodies and associations (American Cancer Society, American Heart Association, British Medical Association, Royal College of Paediatrics and Child Health, etc.).

Decisions on when and whether to press ahead with legislation are conditioned in this partisan clash. Under investigation in this brief section of the review is a process referred to by the inelegant terms 'pork barrel politics'. This suggests that lobbying parties usually work with considerable knowledge of the plans of the opposing factions. Vested interests are locked against each other and rather than anticipating outright victory the factions concentrate their efforts at known points of vulnerability in order to obtain their respective 'share of the pork'.

The anti-smoking lobby employs a vast repertoire of measures aiming to empower smokers to quit successfully and to motivate young people to stay tobacco-free. An indication of the breadth of these activities can be obtained by examining the 'master index' of anti-tobacco links of the website at www.TobaccoFree.org. Young children constitute a focal point of interest, with campaigns attempting to undermine tobacco company attempts to recruit 'new smokers' and to provide the 'tools of resistance' to enable them to do so. It is beyond the scope of this review to cover all of this

material. Instead, the aim is to follow the punch and counter-punch of lobbying as it bears upon limiting youth exposure.

A number of studies challenge the idea that industry 'youth smoking prevention programmes' have any impact, suggesting that they are deliberately ineffectual. Landeman et al (2002) explored some of the presentational tactics in industry advertising campaigns, noting how easily the 'adult-choice' exhortation could be interpreted as a lure to 'forbidden fruit'. Many interventions, such as Lorillard's 'Tobacco is Whacko' campaign, encourage teens to visit company websites where they can fill out surveys and enter sweepstakes, providing the company with mailing lists and access to further advertising which would otherwise be illegal. The paper also indicates that formal impact evaluations of tobacco industry youth prevention schemes is non-existent – companies relying on superficial measures of 'media hits' as a sign that they are 'working'.

By contrast, a large-scale multivariate survey (sponsored, incidentally, by the US National Cancer Institute) tracking the impact of 'tobacco-company, youth-targeted smoking prevention programs' discovered that they had 'no beneficial outcomes for youth' (ref). More generally, there is evidence that the 'smoke control lobby' has turned its back on youth access programmes (Ling et al , 2002), responding to evidence from studies such as Jones et al (2002) on unproductive programmes requiring that retail outlets seek proof of age at purchase. Teens simply use other means and older friends to obtain cigarettes. In short, there is building evidence suggestion that tobacco lobby has chosen deliberately to support the very schemes that the smoke control lobby consider ineffective.

We uncovered an additional strand of research contending that the tobacco industry finds more surreptitious routes into the youth market. A paper by Heulton et al (2006) reports that 80% of US adult smokers report beginning smoking before age 18 and estimates the annual revenue from youth consumption at \$1.2 billion. Accordingly, other researchers have conducted inquiries on how this market is being sustained *indirectly*. Dewhirst and Sparks (2003) report how sports sponsorship (now banned in some countries) works by 'intertextuality' – that is by linking brands to other desirable youth-oriented activities. A recent US innovation is the production of Camel 'Orbs', 'Sticks' and 'Strips' (flavoured 'candy-like' products that release nicotine and tobacco upon chewing). The first report has recently appeared on the resulting poisoning in children following from consumption in this 'unsolicited' market (Connolly et al 2010).

Interim summary 3

This section asks whether the tobacco lobby is likely to oppose a law banning smoking in cars carrying children and begins with direct testimony from the tobacco

companies claiming that they will not do so. We sought to deepen this anecdotal evidence by examining the broader dynamics of the 'tobacco wars' and the tobacco industry attempts to stifle smoking control. Following the constraints of the Master Settlement Agreement, the evidence suggests that companies have made a strategic compromise – seeking to protect and expand legal markets whilst funding youth prevention programmes. There is little or no evidence to show that these latter schemes serve significantly as deterrents and some evidence indicating that the industry uses indirect and subliminal strategies to maintain the youth market. In terms of overt actions, such as counter litigation opposing a ban on cars carrying children, the tobacco companies thus have scant room to manoeuvre – being trapped in a pincer movement of their own conciliatory, legally-underwritten pronouncements and the invincibly powerful sub-text on the 'protection of children' that is applied by the smoke-free lobby. We end, as ever, with a conditional known. *Given the history of these political manoeuvres*, legal counter action to the proposed ban is likely to be precluded.

The 'evidence' called upon in this section is highly politicised. All the empirical materials dealt with above consist of or reflect strongly the perspectives of advocates. The task is thus to synthesise pre-chosen, pre-interpreted evidence *from both sides of a debate*. Tobacco company pronouncements, perforce, reflect tobacco company interests. Just as incontrovertibly, it should be acknowledged that much of the empirical research in journals such as *Tobacco Control* is written with the objective of enhancing tobacco control. This raises the old conundrum of whether it is possible for anyone, most especially the reviewer, to avoid taking sides. It is a 'known known' in terms military conflict or tobacco wars that opponents see the world differently. Does this mean that in attempting to explain their actions, the observer has to decide who the good guys are and who the bad guys are – and then accept the 'truths' of the former?

Whilst this may have been Rumsfeld's *modus operandi*, it is not the method adopted here. We have extended the strategy utilised in the previous section of consolidating the evidence into explanations. The inference drawn here that tobacco companies have limited room for legal manoeuvre on the particular issue of smoking in cars carrying children reflects analysis of the *wider system* of pork-barrel politics. Our analysis does not claim, God-like, to pronounce upon the respective truth of each piece of testimony. Rather, the evidence is used to construct an *explanation* of how the warring parties seek advantage. An analysis of these *rules of engagement* shows, in the specific instance of the legislation about children, how the machinations fall conclusively against the tobacco industry.

4. Is the law enforceable?

Italian Proverb: "Better no law than laws not enforced"

This section of the review takes us much further down the implementation chain. We assume at this point that all the grizzly obstacles in the form of risk measurement, regulation drafting, public support, lobby group opposition and so forth have been settled. Appropriate legalisation is on the statute books. It is illegal to smoke in cars carrying children. If you continue to do so – you will be fined.

But will you? Jacobson and Wasserman remind us that public health laws sit on the margins of criminal justice, often lacking clarity in this vital final stage:

'When deciding what their legislative goals should include public health advocates need to incorporate into their strategy the locus of enforcement and implementation responsibility and the sanctions available to the enforcement agency. Failure to specify enforcement mechanisms in the legislation will lead to delays in implementing and enforcing the laws as well as compliance problems'. (Jacobson and Wasserman, 1999)

In terms of a law banning smoking in cars carrying children the potential impediments are clear. It is quite possible than the legislation will be stymied at street level in a pincer movement between smokers' scepticism about whether a fleeting infraction will be detected and police ambivalence about the lack of a mandate and the absence of resources to act in this arena. Our review thus has two tasks: i) to discover the key ambitions for enforcing such a law and to chart their potential barriers and facilitators: ii) to assemble the evidence on how and with what success enforcement strategies have worked in this area of public health law,

Both of these tasks face severe methodological problems. Because these laws have only recently arrived on the statute books in very limited jurisdictions (ref), little is published on either the planning or the actuality of enforcement. Such a scenario threatens the very idea of evidence based policy – novel interventions do not and, seemingly, cannot have an empirical base on which to foot policy recommendations. In section 3, we struggled in drawing inferences from an information base that was hidden; here, it is almost non-existent. Is retreat inevitable? Do we now seek sanctuary in the common cry about known unknowns, namely – 'more research is needed'? Or can the strategy of theory testing and explanation building assist once again?

4.1 How will enforcement work? What are the theories, facilitators and barriers?

At each step in the implementation chain, realist synthesis commences by eliciting the key theories that underpin emerging interventions. As Jacobson and Wasserman suggest, at inception there is often no clear plan of *how* bans will be policed and *how* sanctions will be applied. Our review examined many potential sources in search of

such tactics in documents such as 'The New South Wales Tobacco Action Plan: A Vision for the Future' or 'A Smokefree Future: A Comprehensive Tobacco Control Strategy for England' (refs). Modern policy documents of this ilk operate glossily at high levels of abstraction, covering 'visions', 'rationales', 'targets and target groups', 'strategies for preventing uptake', 'strategies for aiding quitting', and then 'delivery'. And indeed on these latter sections planning appear to go little beyond identifying responsible bodies and partnership.

Detailed ideas on enforcement tend to be voiced by the practitioners who will ultimately bear responsibility and these enter the review radar in a bricolage of news reports and web commentary, such as the following. The first is from a piece entitled: 'Enforcing smoking ban not a police core function':

The Police Commissioner, Karl O'Callaghan, today addressed a parliamentary inquiry into proposed legislation, which aims to outlaw smoking in cars with children. He told the inquiry that the Health Department should pay for monitoring and prosecutions. "It's not a police core function," he said. "Police have responsibility for public order, keeping the peace, road safety ... We have never been asked to police health laws ... So this is something completely new for us, and I think the community would say well why are police doing this sort of work?"

<http://www.abc.net.au/news/stories/2009/02/10/2487789.htm>

A different theory (policing works) is forwarded in another news item from South Australia:

MORE than 400 people have been cautioned or fined for smoking in cars with children in South Australia since the controversial law was introduced. The state led the nation by introducing a law prohibiting smoking in vehicles in the presence of people under 16 in May 2007, in a bid to protect children from passive smoking. Since then, police have fined 317 people and cautioned 85.

<http://www.news.com.au/adelaidenow/story/0,,26318329-5006301,00.html>

Yet another theory (no fines!) is embedded in another version of the law:

Finnish regional daily Etela-Suomen Sanomat reported ... that the government would propose banning smoking in cars carrying children, adding a bill would be handed to Parliament within a fortnight ... The paper added that the ban was part of a range of proposed amendments to the Act on Measures to Restrict Tobacco Smoking. Etela-Suomen Sanomat reported that the ban would not be enforced by fines as these would clash with privacy legislation.

Still another view (self-enforcement) is embedded in the following press release from ASH Australia:

A practical and popular measure

Concerns over enforcement should not be a barrier to further safety measures. Enforcement by police is similarly opportunistic in monitoring seat belt use, mobile phones and drink-driving. The first two months after the measure came into force in South Australia saw 14 fines for smoking in cars carrying children. Smoke-free cars carrying children are likely to be largely self-enforcing – since community support is strong. A 2004 survey of over 1300 Australians in 800 households showed over 90% (including 73% of smokers) support banning smoking in cars carrying children.

www.ashaust.org.au/lv4/ACTcarsASHsubm09.doc

These speculations, which typify much of the public debate, are in some agreement that the putative offence being difficult to discern would, therefore, be difficult to

police. Consensus then disappears on who takes responsibility for enforcement and how they would do so: the police by opportunistic monitoring; the police by secondary enforcement; other public health authorities; self-regulation; symbolic authority and community surveillance.

To complete this brief overview of perspectives we examine the theories of the putative offenders, many of whom question the practicalities of enforcement. Dozens of claims can be found declaring the law to be unenforceable, none put more engagingly than this one:

The Curmudgeon Sounds Off: Let's Pass Another Unenforceable Law

A legislator in New Jersey has proposed a law that would ban smoking while driving ... It's just plain silly and should be ridiculed off the agenda ... So let's add another unenforceable law to the books. While we're at it, let's ban the following activities while driving – applying make-up; shaving; eating of any kind; drinking, not only alcoholic beverages but also coffee, tea, milk, soda, and water; disciplining the kids; conducting heated arguments; diddling with the radio or CD player; swaying to and fro in time with the music on the stereo; fixing one's hair; reading maps or other printed materials; reaching over to the passenger's seat or the back seat for something; blowing one's nose ... The possibilities for prohibited activities are enormous.

Our review thus moves forward with a core theory about offender scepticism and what are best described as rival theories about enforcement and sanctions. The purpose of realist synthesis is to refine programme theories and the suggestion here is that one can add to this remit the idea of 'adjudicating' between different theories – attempting to discover which enforcement strategy works best in which circumstances.

4.2. What is the optimal enforcement strategy?

Having established the pertinent question we turn to the stumbling block – the sheer lack of evidence with which to answer it. Whilst it is true that there is no formal evidence on the enforcement of bans on smoking in cars carrying children, dozens of other laws, bans and edicts operate in similar scenarios. In this instance we are interested in the hypothesis on whether enforcement works in a configuration defined by three primary elements: 'cars', 'smoking' and 'children'. Prohibitions already operate on other smoking activities, on other in-car activities and on other behaviours infringing on the welfare of children. Many of these share the same core difficulties – the offence is hard to spot and difficult to intercept, offenders are sceptical about being caught, police have other priorities and limited resources, a 'private space' is under surveillance, and so on. Often such legislation has many more years under its belt and, more to the point, has amassed a body of evaluation tracking the efficacy of enforcement. Accordingly, in this section we examine briefly research on the extent and success of the enforcement of: i) bans on using mobile phone in cars and ii) obligatory use of safety restraints when carrying children in cars. After understanding how enforcement works in these two domains, we consider their contextual similarities and differences with the law under to study in an attempt to seek transferable lessons.

Banning hand held phones in cars. Jonal et al's UK study (date) is one of many showing a significant immediate reduction in usage following the law. Road side observations measured a reduction in prevalence from 1.85% to 0.97% over a period of ten weeks before and 10 weeks after the introduction of legislation. However, longer term follow-up studies (McCart date, Hussain date, Rajalin date, Taylor date) show a clear 'U' shaped effect of the legislation, that is that usage rates fall after the law comes into effect, but that with time, rates climb again. The only exception to this rule was seen in Washington D.C. (Mccartt date) where immediate post legislation usage rates were maintained.

Many other studies shed light on why they may be a 'rebound' in usage and thus offer potential advice on how it may be avoided. The underlying reason for lack of compliance is simple enough and reported in several studies. Foss (date) carried out a pre- and post law survey in North Carolina, discovering that the pre-law 'hunch' that there would be relatively little enforcement was actually reinforced by their post-law experience of enforcement activities, or lack thereof. Studies by McAvoy (date) in New South Wales and Rajalin (date) in Norway also indicate that cell-phone using drivers feel that it is unlikely that they would be caught in their local area, Drivers were aware of the law, its consequences (criminalisation) and safety risks (liability for crashes) – but, in the absence of expectations about regular enforcement, small but significant levels of recalcitrance remain.

So how can risk perceptions be raised? Unsurprisingly, research reveals that substantial and sustained enforcement is the basic requirement. McCartt et al's (date) study in Washington DC (the case without the substantial 'rebound') found that in 12 months following the enactment of the law 9,718 citations were issued for drivers talking on hand held phones (8% of total vehicle citations) as well as a further 4,500 warnings. Taylors et al's (date) studies in Melbourne found similar levels of activity. Significantly they also noted the use of other tactics to maintain the law in the mind's eye. These include the targeting of drivers at particular risk (for young drivers the ban includes hands-free phones), the use of plain-clothed 'spotters' passing on 'sightings' to arresting officers, and the instigation of periodic, high-visibility 'days of action' to refresh the initiative. Risk perception may also be sustained unwittingly if routine roadside surveillance is present. Hussain's UK study (date) compared observance rates at two urban sites. Compliance was higher in the location covered by cameras (even though these were checking speed rather than in-car activity).

In short, this particular ban is not discharged by legislation alone. Sustained enforcement activities, high-visibility, prescribed penalties, further targeting and periodic blitzes seem the order of the day. It is no coincidence that these ingredients are close to those recommended in US Department of Justice guidance on how to mount successful police 'crackdowns' across all policing operations (Scott, 2003).

Compulsory child safety restraints. Evaluations of laws mandating child safety restraints in cars have been underway since the eighties and tend to show highly

significant positive results. Wagenaar and Webster's (1986) study of the impact of such a law in Michigan provides us with some typical early results. The study involved time series data for a five year period. Data on the usage of seat restraints was based on accident records and thus on direct observation rather than on malleable self-report. Use of restraints increased from 12% to 51% after the instruction of the law (a 25% decrease in injury also followed). The authors apply appropriate caution on the matter of attribution, noting that the new law was accompanied by a high profile information campaign. Significantly, as with many other such studies (Zaza et al, 2001), no data specific was collected on the extent of police efforts to enforce the legislation.

A later Japanese study by Desapriya et al. (2004) used official traffic accident data on child casualty to measure the effectiveness, benefits and usage of safety seats for child passengers aged 1–5 years before and after legislation in Japan. Their data covered the period before and after the introduction of legislation in 2000 requiring all 0-5 year old children to be restrained in appropriate seats when travelling in private vehicles. Restraints usage increased from 8% (1998) to 60% by 2000 but dropped back to 51.7% by 2003. Interestingly, certain forms of injury increased following the legislation and this was attributed to improper use of restraints

The researchers provide a number of explanations for the increase and partial drop in compliance. The Japanese legal system at the time was overburdened with existing prosecution requirements and the ensuing bureaucratic burden was seen as more time-consuming than warranted by the offence. Most significantly, penalties were low (demerit point on license rather than monetary). Furthermore, the authors report that there was an absence of media and educational campaigns on the safety benefits of child restraints. This is a significant result – the law impacted (if with some fade) in inauspicious circumstances in which enforcement effort is minimal.

A recent Italian study by Collarile and colleagues (2008) begins to explain why. A mail survey with 514 respondents was conducted before and after the introduction of a law mandating the use of child safety restraints. The change, based on self-report, of 'appropriate' child restraint usage changed from 74.7% to 92.5%. The study uncovers telling information on the motivations behind the change. Nearly all (95.5%) parents were aware of the consequences of disobeying the law on child restraints whilst driving. However, it was not the fear of the penalty but the protection of children that appeared to drive compliance: 'The most frequent reasons for using child restraint systems were ensuring child safety (reported by 99.2% of responders), avoiding monetary fines (16.7%) and avoiding losing license points (13.6%)'. Interestingly, another study focussing on financial carrots rather than legal sticks comes to the same conclusion. Aspler et al's (2003) inquiry concluded that providing financial incentives to boost safety seat usage did not generate the intended gain: 'many of these parents did not need to be persuaded to use restraints – they simply needed to learn what to use and then to be given easy access'.

The above examples give a first indication of some of the evidence on the enforcement of two 'neighbouring' public health laws. Can we extrapolate these findings across to the law under review here? Extrapolation is the attempt to extend knowledge about known knowns into knowledge about known unknowns. As such it is a perilous venture in both science and policy making.

We have a clear indication that enforcement regimes and compliance levels differ in these two mini case studies. The safety seat legislation seems to have more self-momentum. The majority of child restraint legislation is followed by sustained increase in compliance and even in those cases in which police action is negligible, compliance rates do not return to pre-legislation levels. Cell phone compliance, by contrast, dissipates more rapidly and more markedly without a systematic programme of crackdowns.

This brings us to the tricky business of making inference across to the ban on smoking in cars carrying children. Put simply – is it closer to the laws on cell-phones or safety-seats? All three misdemeanours are similar in that they occur in the private spaces of family cars. All three are hard to detect in busy traffic without the intensive use of police time, a resource for which there is much competition. All three involve pulling over and arresting drivers involves on the grounds of 'reasonable suspicion' and thus have to overcome a range of legal technicalities. There are, nevertheless, crucial differences between the laws, which provide grounds for hypothesising that enforcement regimes should differ:

1. A classic premise in evaluating the effectiveness of criminal law is to investigate the possibility of 'displacement'. In this instance stubborn cell-phone addict may (at some expense) continue to parlay by going go hands-free. However, complying with the safety restraint legislation requires safety seat installation and the cigarette addict's only recourse from the law is a smoke-free car.
2. The respective misdemeanours also suggest a potential difference in police reponsibility. Driver inattention (a traffic offence) is *raison d'être* behind the mobile phone ban, whilst improvements in public health lie squarely at the root of the safety seat and smoking legislation.
3. A third significant difference turns on broader cultural values in regard to the potential victim. In the cell phone example the law is there to protect other drivers, pedestrians and indeed cell-phone users from accident and injury. In the cases of the seat belt and smoking-free laws, the welfare of children is paramount.

On all three dimensions, the smoking and child seat legislation share more on common with each other than they do with the cell phone ban and on these grounds an inference might be drawn that enforcement patterns might also be more similar. The third comparison is especially compelling. The evidence in this section indicates that the steady increase in usage of child restraints in cars is rooted in motivations about safeguarding children rather than a strategy of avoiding fines. Whilst we have

no evidence to report on how families have adapted to the ban on smoking in cars carrying children, the evidence discussed earlier (section 2) suggest that there is considerable *pre-intervention* public support for the smoking ban on the same grounds. Post-intervention compliance may thus be significantly supported by self-enforcement.

Interim Summary 4.

Drawing parallels with the enforcement regimes in these two kindred ‘in-car’ laws, suggests that the smoking ban bears close similarities with the legislation on child safety restraints and thus may be expected to be self-enforcing to a considerable extent. Whilst the urge to safeguard children may be expected to drive compliance there is no evidence to suggest that it is the entire solution. A supporting programme combining safety promotion and education, alongside periodic but well publicised sanctions may also provide a useful role.

Let us reprise more closely the empirical warrant for the above proposition. Evidence-based policy normally requires that interventions have a history and undergo many replications. The laws banning smoking in cars carrying children have not rolled out sufficiently to gather a significant evidence base on their enforceability. Instead, we have proposed that a theory-driven approach may be drafted in to do the job. As before, this works by explanation building – the explanations in this instance having a further layer of complexity. The logic is as follows. Different laws require different enforcement regimes – ranging from those based self-compliance to those requiring rigorous surveillance and punishment. The evidence on safety restraint compliance and hand-held phone abstinence allows us to build an explanation showing that the former has been enforced more successfully thanks to a tide of public support. The theory also specifies the range of conditions about police priorities, victim identities and displacement opportunities, which have fostered this support. This theory about the conducive contexts for optimal compliance is then fed back to the law under consideration and conclusions are drawn about its likely efficacy.

To be sure, this is a long inference chain. Inevitably, some of the links must be considered provisional and may benefit from further refinement. For example, the risks associated with a car crash with an unbelted child are much more tangible than the dangers associated with the inhalation of microscopic particles. So whilst both laws might benefit significantly from the basic human urge to safeguard children, public support might be at a somewhat different stage of development.

Conclusion

The empirical basis of objective science has thus nothing ‘absolute’ about it. Science does not rest upon rock-bottom. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or ‘given’ base; and when we cease our attempts to drive our piles into a deeper layer, it is not because

we have reached firm ground. We simply stop when we are satisfied that they are firm enough to carry the structure, at least for the time being. (Karl Popper, *The Logic of Scientific Discovery*)

There is no such thing as a typical policy intervention or a quintessential programme. Legislative instruments of the type considered here are worlds away from interventions based on, say, financial incentives or peer learning. But what they all have in common is a sprawl of ambitions, stakeholders, localities and histories. In this respect, evidence-based policy has to deal with a standard predicament. Research synthesis can only provide partial information on the medley of issues that face the decision maker. That information, as here, is likely to draw upon inquiry conducted in diverse research traditions – toxicology, social psychology, political science, socio-legal studies, etc. Accordingly, that information is also likely to be partial in research quality and political leanings. So what does this tell us about the warrant of evidence?

In terms of the immediate issue of children's involuntary exposure to second hand smoke in vehicles, we have attempted to reflect the balance of known knowns, known unknowns and even unknown knowns (a final word on unknown unknowns follows). We have uncovered evidence on four issues – 'toxicity', 'public opinion', 'lobbying' and 'compliance' – topics on which the policy maker should ponder before enacting such a law. Each domain reveals its truths but in ways that are highly conditional and multiply contingent. Thus, smoke pollution in cars is dangerously poor – if exposure is frequent and ventilation absent. Public opinion is likely to be supportive – especially if other smoke-free laws have been passed. Lobby group opposition may well be muted – in the word if not the deed. Compliance tends to wax and then wane – unless public support can be nurtured.

The paper arrives at the ultimate question. Does the evidence in evidence-based policy turn out to be a never-ending network of conditionalities and contingencies? Our answer, taking inspiration from the Popper quotation above, is yes and no. The 'yes' has been in apparent throughout the paper. We have shown that a considered approach to making policy in this particular domain requires evidence on four quite different issues. Each one of those rapidly subdivides into four or five different questions and the process continues. One question receives an answer ... but it is usually a partial answer that will beget further questions ... and the process carries on *ad infinitum*. Recall, for example, how the quest to uncover pollutant levels in cars led us via the measurement of small particulates and interior volume, to questions about frequency of exposure and ventilation, to comparisons on smoking prevalence in other environments, and onto philosophical questions about the precautionary principle. The whole exercise has this structure.

But what of the 'no'? Again, take note of Popper. What emerges from the swamp of descriptions, snapshots, measures and correlates is a 'bold structure of theories'. Throughout, we have shown that it is possible to enwrap and harden the available data into explanations. One fragment of evidence makes sense of another and these

together help to account for a third, and so on. It is these explanatory configurations that are the product of evidence based policy. Recall, for example, how survey evidence on support for this smoking ban solidifies thanks to attitudinal data on the near-inviolable beliefs on child welfare, which coagulates with further testimony on near-universal regret for starting smoking. The whole exercise has this structure and through it decision making becomes more rational. To paraphrase – we simply stop when we are satisfied that explanations are firm enough to carry the policy decision, at least for the time being.

Evidence does not come in finite chunks offering certainty and security to policy decisions. Programmes and interventions spring into life as ideas about how to change the world for the better. Evaluation research allows us to refine those explanations and systematic review allows a refinement of those refinements. The review process should be understood as a means of building, adjudicating and extrapolating programme theories. Evidence based policy will only mature when it is understood that it is a continuous, accumulative process in which the data pursues but never quite draws level with unfolding policy problems. The whole point is the steady conversion of ‘unknowns’ to ‘knows’.

It may well be that policy makers are too busy, too stubborn or too stupid to digest the significance of the qualifications and contingencies that govern whether a policy will work (this subject is much studied but not pursued in this paper). Nevertheless we arrive at the inescapable, long-and-short of it – evidence-based policy deals in conditional truths and provisional explanations.

Postscript

Our Cook’s tour of the uncertainties awaiting a smoking ban has unearthed an exotic selection of knowns and unknowns. But what of Rumsfeld’s most chilling challenge – the unknown unknowns? These, recall, are things that we don’t even know that we do not know. Their presence has been acknowledged for some time in policy circles. More than half a century ago, in answer to a press question about the supreme challenge of government, the patricianly UK prime-minister, Harold MacMillan replied: ‘events dear boy, events’. And it is ‘events’, of course, that may blow any evidence-based advice off course. A nuclear strike would reduce air quality by more than the odd ug/m^3 and render pointless smoking bans and everything else besides. The death a celebrity associated with heavy parental smoking might change profoundly the public mood. A government may be elected that is ‘tobacco-friendly’ and the tightening grip of legislation may loosen. In the very act of naming such events I have, of course, transformed them to the status of known unknowns. And this latter twist fall perfectly within overall thesis here. Once contemplated, unforeseen eventualities become part of the family of unintended consequence, which become recognised outliers and one can then begin the slow process of hauling in the data to interrogate them. The whole point is the steady conversion of ‘unknowns’ to ‘knows’.

At any particular juncture, of course, some eventualities remain unforeseen, unknown, and unknowable. Perhaps Rumsfeld, in his own time, was such an event.

References

Davidoff F

Glantz S and Balback E (2000) *Tobacco Wars: Inside the California Battles*. Los Angeles University of California Press

Evans J and Chen Y (2008) in a Canadian population: The Canadian Community Health Survey, 2005' *Inhalation Toxicology* 21: 244-49

Sackett D, Rosenberg W, Muir Gray J, Brian Haynes R, and Scott Richardson W (1996) 'Evidence based medicine: what it is and what it isn't' *BMJ* 1996; 312:71-72

Rogers P, Hacsı T, Petrosino A, and Huebner T (2000) *Program Theory in Evaluation: Challenges and Opportunities* San Francisco: Jossey Bass

Tickner et al Int Jnl of Epidemiology 2003

Healton C, Farrelly M, Weitzenkamp, D, Linsey D, and Haviland M (2006) *Tobacco Control* 2006: 15: 103-106,

Dewhirst and Sparks (2003) Intertextuality, Tobacco Sponsorship of Sports, and Adolescent Male Smoking Culture, *Journal of Sport and Social Issues* 27(4) 372-398

Connolly G, Richter P, Alegus A, Pechacek T, Stanfill S and Alpert H (2010) Unintentional Child Poising through Ingestion of Conventional and Novel Tobacco Products *Paediatrics* 125(5) 895-899

Landman A, Ling P, and Glantz S Tobacco Industry Youth Smoking Prevention Programmes: Protecting the Industry and Hurting the Tobacco Control. *American Journal of Public Health* 92(6) 917-930

Gostin L (2008) *Public Health Law: Duty, Power, Restraint*, Los Angeles: University of California Press

Ibrahim J and Glantz (2006) Tobacco industry litigation strategies to oppose tobacco control media campaigns *Tobacco Control* 15: 50-58

Cohen J (2001) Universities and Tobacco Money *BMJ* 323 1-2

Bero L (2005) Tobacco Industry Manipulation of Research *Public Health Reports* 120: 200-208).

Ling P, Landman A, Glantz S (2002) It is time to abandon youth access tobacco control *Tobacco Control* 11: 3-6

Tong E, England L and Glantz S (2005) Changing Conclusions on Secondhand ASmoke in a Sudden Infant Death Syndrome Review Funded by the Tobacco Industry *Paediatrics* 115(3) 356-366

Stolley P (1991) When Genius Errs: R A Fisher and the Lung Cancer Controversy *American Journal of Epidemiology* 133(5) 416-425

Ong E and Glantz S (2001) Constructing “sound science” and “good epidemiology”: Tobacco, lawyers, and public relation firms *American Journal of Public Health* 91(11) 1749-1757

Tong E and Glantz S (2007) Tobacco Industry Efforts Undermining Evidence Linking Second Hand Smoke with Cardiovascular Disease *Circulation* 116: 1845-1854

Smith E (2006) ‘It’s interesting how few people die from smoking’ Tobacco industry efforts to minimize risk and discredit health promotion’ *European Journal of Public Health* 17(2) 162-170

Magzamen S and Glantz S (2001) The new battleground: California's experience with smoke-free bars *American Journal of Public Health* 91(2) 2001 245-52

Sterling T (1975) A critical reassessment of the Evidence bearing on smoking as the cause of lung cancer *American Journal of Public Health* 91(11) 1749-1757