Institution: Queen Mary University of London

Unit of Assessment: A1 (Clinical Medicine)

Title of case study: The evidence base for harms from environmental tobacco smoke

1. Summary of the impact

Epidemiological research at Queen Mary, commissioned by the Department of Health, demonstrated a clear and causal link between exposure to environmental tobacco smoke and both ischaemic heart disease and lung cancer. The evidence contributed significantly to public and political debates on whether to ban smoking in public places. It informed the rebuttal of heavy tobacco industry lobbying and had a pivotal influence on changes in the law in Scotland (2006), England and Wales (2007), and Northern Ireland (2007), as well as in many countries outside UK, which led to highly significant reductions in environmental pollution from secondhand smoke. Many health benefits were subsequently attributed to the ban, notably a 17% reduction in incidence of acute myocardial infarction.

2. Underpinning research

The Wolfson Institute of Preventive Medicine at Queen Mary has a long tradition of undertaking policy-relevant research (empirical studies and systematic reviews and meta-analyses) to identify environmental harms with a view to informing changes in policy and legislation. Here, we describe the most significant programme of work since 1993, which built the evidence base on passive smoking and informed the far-reaching legislative changes banning smoking in public places.

In 1996, the Department of Health (DH) (England) commissioned Professor Wald's team to prepare a report to evaluate the strength of evidence on the harmful effects of environmental tobacco smoke and quantify the risk. A background paper [1] and two shorter BMJ publications resulted [2,3].

Particularly innovative was the paper on ischaemic heart disease [2]. In this meta-analysis, Wolfson researchers included all 19 acceptable published studies of heart disease risk in lifelong non-smokers who lived with a smoker and in those who lived with a non-smoker, five large prospective studies of smoking and ischaemic heart disease, studies of platelet aggregation and studies of diet according to exposure to tobacco smoke. The relative risk of ischaemic heart disease with exposure to environmental tobacco smoke was 1.30 (95% CI 1.22 to 1.38) at age 65. At the same age, the estimated relative risk associated with smoking one cigarette per day was similar at 1.39 (1.18 to 1.64), while for 20 per day it was 1.78 (1.31 to 2.44).

The researchers were the first to recognise that this result from several large rigorous cohort studies established that the dose-response relationship between tobacco smoke intake and risk of ischaemic heart disease was non-linear, indicating that the seemingly disproportionately large effect of passive smoking was not surprising. Two separate analyses indicated that non-smokers who live with smokers eat a diet that places them at a 6% higher risk of ischaemic heart disease, so the direct effect of environmental tobacco smoke was to increase risk by 23% (14% to 33%). Platelet aggregation provided a plausible and quantitatively consistent mechanism for this low dose effect. The increase in platelet aggregation produced experimentally by exposure to environmental tobacco smoke would be expected to have acute effects that increased the risk of ischaemic heart disease by 34%.

Whilst many primary studies already existed, fewer than half had produced a definitive result and there was controversy about the significance of 'positive' studies, especially in relation to whether and how confounding variables such as diet had been accounted for. In contrast, the findings from the Queen Mary meta-analysis were definitive and compelling (Figure 1): breathing other people's smoke is an important cause of ischaemic heart disease, increasing a non-smoker's risk by almost a quarter. The potential impact on exposed individuals of avoiding environmental tobacco smoke was equivalent in magnitude to someone with hypertension taking a blood pressure-lowering drug.

The meta-analysis on environmental tobacco smoke and lung cancer [3] followed a similar design, synthesising findings from 37 published studies in lifelong non-smokers who lived with a current

smoker or lifelong non-smoker. The risk estimate was compared with that from linear extrapolation of the risk in smokers using seven studies of biochemical markers of tobacco smoke intake. Results were similar: the excess risk of lung cancer was 24% (95% CI 13% to 36%) in non-smokers who lived with a smoker (P < 0.001). Adjustment for the effects of bias (positive and negative) and dietary confounding had little overall effect; the adjusted excess risk was 26% (7% to 47%). Furthermore, the dose-response relation of the risk of lung cancer with both the number of cigarettes smoked by the spouse and the duration of exposure was significant, and tobacco-specific carcinogens were found at significant levels in the blood and urine of non-smokers exposed to environmental tobacco smoke. Again, the conclusion was definitive and compelling: breathing other people's cigarette smoke is a significant and preventable cause of lung cancer.

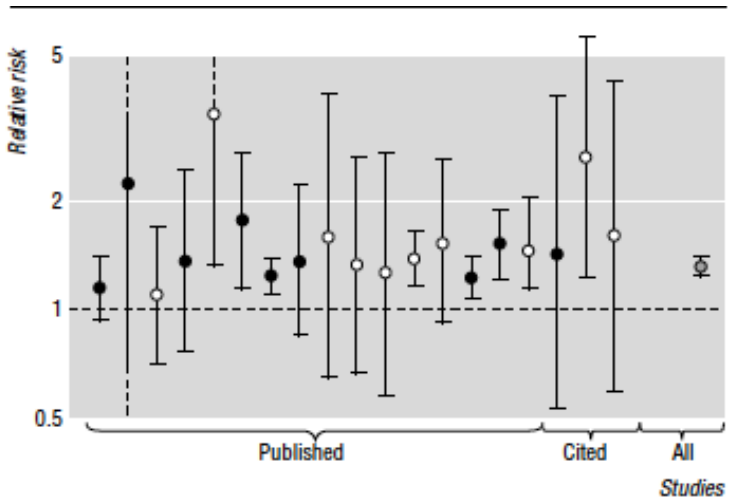

Fig 1 Relative risk estimates (with 95% confidence intervals), adjusted for age and sex, from nine prospective studies (solid circles) and 10 case-control studies (open circles) comparing ischaemic heart disease in lifelong non-smokers whose spouse currently smoked with those whose spouse had never smoked (16 published studies (from left to right[18-33]) and three with results cited by others from abstracts or theses[2 34])

Figure 1 (reproduced from reference 2 below), showing how meta-analysis by Wolfson researchers reduced uncertainty on the relation between environmental tobacco smoke and ischaemic heart disease

Further research referenced below includes a detailed exposition of the statistical methodology used for these analyses [4] and later work in collaboration with other research teams worldwide to update the evidence base, partly in response to lobbying from the tobacco industry, who initially strongly rejected the findings of the early meta-analyses [5,6,7].

3. References to the research

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4. Details of the impact

4a. Change in perception of risk by policymakers and the public

The Department of Health, having commissioned the work, promptly accepted the Queen Mary team's conclusions on the risk and the size of the effect. Legislation banning smoking in public places was advocated in 1998 by the government's Scientific Committee on Tobacco and Health, of which Professor Wald was a member [8]. The publication of the original meta-analyses led to widespread media coverage. Professor Law appeared on BBC and ITV news, and was interviewed together with a tobacco industry representative by John Humphrys on the Today Programme.

4b. Change in policy and legislation in UK

A ban on smoking in public places was proposed by the Chief Medical Officer Sir Liam Donaldson, in his annual public health report for 2002 [9]. A Public Health White Paper, *Choosing Health*, published in 2004, announced a total ban on smoking in public places [10]. Following this, there was considerable discussion in parliament on whether the ban on smoking in public places should be partial (eg with private clubs exempt and taking account of a possible adverse effect on businesses and the hospitality industry) or total, including a widely publicised threat by Sir Liam to resign if a total ban was not upheld. Legislation, which had already come into force in Scotland in 2006 [11], was passed in England and Wales in 2007 [12].

4c. [Failed] attempts by the tobacco lobby to rebut the research findings

The tobacco industry undertook a sophisticated lobbying campaign, much of it indirectly by funding the hospitality industry, in an effort to discredit the work of Queen Mary (and other) researchers [13]. These efforts contributed to the delay in definitive legislation in UK until 2006-7. But ultimately, clear messages from the Department of Health-commissioned Queen Mary meta-analyses about the serious health risk (Figure 1) outweighed speculative (and as it turned out, unfounded) arguments about potential loss of revenue and collapse of hospitality businesses [14,15].

4d. Change in practice: smoking bans were effectively implemented

Contrary to predictions that this law would be widely flouted, it proved highly effective from the outset, with (for example) an estimated 98% compliance from businesses within six months of its introduction in England and Wales [16]. As a direct result, levels of tobacco-related toxic chemicals ('fine particulate matter') in ambient air of bars fell by 91%, and cotinine levels in the saliva of non-smoking bar and restaurant workers by 76%, in the same period in England [16]. Similar findings were documented in Scotland [17]. A Cochrane review synthesised 30 studies of exposure to second hand smoke from across the world, 19 of which measured this using biomarkers, and confirmed a consistent and significant reduction following the introduction of smoking bans [18]. Importantly, there was no evidence of compensatory increases in smoking in the home – indeed some studies documented a decline in children's exposure to tobacco smoke at home [19, 20].

4e. Change in policy and the law beyond the UK

Smoke-free legislation is now widespread. For example, all EU Member States have some form of regulation aimed at limiting exposure to second-hand smoke [21,22]; most US states have also introduced such bans, as have some low-income countries such as Vietnam and Bhutan.

4e. Reduction in smoking-related morbidity and mortality in UK and worldwide

Smoking bans in public places have had widespread and dramatic impacts on human health [15]. The following examples were selected from dozens of potentially relevant ones:

- Reduced hospital admissions for acute coronary syndrome / myocardial infarction. We cite a BMJ study based on English data and an international meta-analysis of 10 studies that estimates a 17% reduction in the incidence of acute myocardial infarction as a result of smoking bans [23,24];
- Reduced hospital admissions for childhood asthma [25]; and
- Reduced pregnancy complications (preterm delivery and small for gestational age) [26].

4f. Changes in public attitudes to smoking

Acknowledging a background trend of declining public support for smoking in bars, workplaces and other public places, there is evidence that even citizens initially opposed to the bans showed a shift in attitudes over time, with a growing perception of the personal, health and environmental benefits

of smokefree policies [27-29]. Short-term quit rates reported by the NHS Stop Smoking Service showed a 23% increase following the introduction of the smoking ban, though rates of sustained quitting attributable to the ban are harder to document [15].

5. Sources to corroborate the impact

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