A review of interventions for reduction of residential environmental tobacco smoke exposures among children

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OBJECTIVE: To describe individual-level interventions to reduce residential environmental tobacco smoke (ETS) exposure among children and to summarize the evidence of the effectiveness of the interventions.

PATIENTS AND METHODS: A search of electronic databases (from 1987 to 1998) was conducted for studies designed to reduce ETS exposure of children through the use of interventions that included strategies other than parental smoking cessation. Twelve articles that presented nine unique interventions (six interventions were designed for well children and three interventions targeted children with asthma) were found. Information about location, target population, design, sample size, tested intervention and results were summarized for each study.

RESULTS: Only one of the six interventions designed for well children produced significant reductions in ETS exposure, while all three of the interventions that targeted children with asthma reported small to moderate reductions in ETS exposure or respiratory symptoms.

CONCLUSIONS: The number of interventions for ETS reduction published to date is minuscule relative to the magnitude of the associated health problems. Some ETS reduction interventions for children have shown significant reductions in exposure, but most interventions, especially those designed for well children, have had little effect. Little is known about which specific intervention components may be effective. Parental characteristics that may predict positive response to intervention efforts have not been identified. More research is needed to develop effective interventions that can be integrated with physician visits in the perinatal and early childhood periods. Adapting standard guidelines on counselling for parental smoking cessation may be a promising approach if the barriers identified by health professionals can be addressed adequately.

Key Words: *Environmental tobacco smoke; Interventions; Paediatrics; Parental behaviour; Passive smoking; Respiratory illness*

Un examen des interventions pour réduire l'exposition des enfants à la fumée secondaire en milieu résidentiel

OBJECTIF : Décrire les interventions individuelles pour réduire la fumée secondaire en milieu résidentiel (FSR) auprès des enfants et résumer les observations relatives à leur efficacité.

PATIENTS ET MÉTHODES : Une recherche a été menée dans les bases de données électroniques (entre 1987 et 1998) afin de trouver les études conçues pour réduire l'exposition des enfants à la FSR par d'autres stratégies d'intervention que de convaincre les parents d'arrêter de fumer. On a découvert douze articles exposant neuf interventions uniques (six destinées aux enfants en santé et trois, aux enfants asthmatiques). L'information sur le lieu, la population ciblée, la méthodologie, la dimension de l'échantillon, les interventions mises à l'essai et les résultats a été résumée pour chaque étude.

RÉSULTATS : Une seule des six interventions conçues pour les enfants en santé a découlé en une réduction substantielle de l'exposition à la FSR, tandis que trois des interventions visant à réduire l'exposition à la FSR ou les symptômes respiratoires auprès des enfants asthmatiques ont donné des résultats minimes à moyens.

CONCLUSIONS : Le nombre d'interventions pour réduire la FSR publiées jusqu'à maintenant est minuscule relativement à la magnitude des problèmes de santé connexes. Certaines interventions pour réduire la FSR auprès des enfants ont permis de diminuer cette exposition de manière marquée, mais la plupart d'entre elles, surtout si elles visaient des enfants en santé, ont eu peu d'effets. On ne sait pas vraiment quels éléments de chaque intervention sont efficaces. On n'a pas repéré les caractéristiques parentales susceptibles de favoriser une réponse positive aux efforts d'intervention. Des recherches supplémentaires s'imposent donc pour élaborer des interventions efficaces pouvant être intégrées aux soins de santé systématiques pendant la période périnatale et la petite enfance. L'adaptation de directives normalisées sur le counseling afin d'inciter les parents à arrêter de fumer pourrait constituer une démarche prometteuse si les obstacles repérés par les professionnels de la santé sont éliminés de manière pertinente.

Environmental tobacco smoke (ETS) is a major contaminant of indoor air and has many harmful effects on the health of children and infants (1,2). ETS is composed of the sidestream smoke emitted from the burning end of a cigarette, cigar or pipe, and the tobacco smoke exhaled by a smoker. ETS is a complex mix of more than 4000 chemical compounds; at least 43 of these compounds are known to be carcinogenic (1,3). Children are at greater risk from ETS than adults because they have smaller airways and exchange more air relative to their body weight (4).

Each year in Canada, an estimated 171 paediatric deaths from sudden infant death syndrome, and respiratory and cardiovascular disease are attributed to ETS exposure (5). Annually in the United States, antenatal tobacco use and/or postnatal ETS exposure is responsible for 1900 to 4800 infant deaths from perinatal disorders and 1200 to 2200 deaths from sudden infant death syndrome (2). Among infants and children, morbidity related to ETS exposures is substantial and includes many adverse health effects (6) such as lower respiratory tract infection (eg, bronchitis, tracheitis, laryngitis, chronic cough and pneumonia) (1,2,7); poor lung function as measured by forced expiratory volume and peak expiratory flow (1,8); middle ear disease (9,10); increased severity and incidence of asthma (1,11); lung cancer in adulthood (12); externalizing (aggressive) child behaviour (13); airway complications during general anesthesia (14); and impaired growth and general health of children with cystic fibrosis (15). Exposure to adult smoking also predisposes children to smoke. Children of parents who smoke are more likely to smoke themselves as adolescents and adults (16).

Exposure of children to ETS from one or more smokers occurs in 33% to 46% of Canadian households (17-19). Another 41% of households do not have a smoker but allow visitors to smoke in the house; that leaves only 19% of Canadian homes completely smoke-free (20). In the United States, 42% to 62% of the paediatric population is exposed to household ETS (1). Because ETS exposure is so widespread, the societal burden in terms of paediatric morbidity, mortality and associated costs is staggering; in 1997, the associated costs were estimated to be \$12.8 billion in the United States alone (21).

According to surveys (19,22,23), the general public's awareness of the hazards of ETS is high among smokers and nonsmokers (70% to 90%, respectively). Despite this high level of awareness, only 20% to 34% of homes in North America are reported to be smoke-free (17). Therefore, it is unlikely that general awareness will translate into behavioural change without more active intervention. Three major strategies have been used to reduce ETS exposure: legal or regulatory interventions; public information campaigns; and individual-level programs.

Legal or regulatory interventions include cigarette package labelling, laws that restrict smoking in public places and judgments, for some individual children, that

award custody to nonsmoking parents (24,25). In Canada in 1994, for example, warning labels, such as "tobacco smoke can harm your children", were used on cigarette packages, but the effect of the labelling is not known. The number of regulations that restrict smoking in public settings where children are present, such as child care facilities, schools and restaurants, is increasing. However, the home, which is the predominant locus of ETS exposure, is an environment where legislative and regulatory approaches are not likely to be applied because of traditions relating to the sanctity of the home and doubts about enforceability (26). Several states, including California, Oregon and Massachusetts, have included ETS awareness in broad public information campaigns to reduce tobacco use, but little information is available about the impact that these campaigns had on reducing household ETS exposure.

More focused interventions at the individual level may be necessary to reduce or eliminate ETS exposure for most young children. The purpose of the present review is to describe individual-level interventions that have been undertaken to reduce residential ETS exposure among children, to summarize evidence about the interventions' effectiveness and to make suggestions for action against ETS exposure in the homes of children.

PATIENTS AND METHODS

Data sources

With the assistance of the Ontario Tobacco Research Unit, Toronto, Ontario, a search of five databases from January 1987 to December 1998 was conducted. The databases searched were MEDLINE, Smoking and Health, Toxline Plus, PsychInfo and EMBASE. Using the indexing terms appropriate to each database, the search strategy employed three elements: terms to retrieve intervention studies (ie, randomized, controlled trials) or evaluations of interventions; terms to retrieve studies about ETS exposure in the home; and terms to retrieve studies about parental smoking behaviours around children. Search terms used included 'ETS', 'intervention', 'passive smoking', 'parents', 'home' and 'air pollution'.

Data selection and extraction

Fifty-five potentially relevant references (including literature reviews and empirical studies) were found. The articles were retrieved, and their reference lists were searched. From this initial survey of the literature, a set of inclusion criteria for the present review was developed. The review was restricted to English language reports of empirical studies that investigated the effectiveness of home- or clinic-based interventions that aimed to reduce the exposure of children to ETS in their homes. Studies that were designed to address only parental smoking cessation, with ETS reduction as a secondary aim, were not included. Interventions that targeted the parents of both well children and children with chronic respiratory illness were examined. Studies were included if it could be

TABLE 1: Basic characteristics of interventions for residential environmental tobacco smoke (ETS) exposure reduction designed for well children and children with asthma

Study	Study location	Target population	Intervention
Woodward et al (27)	Adelaide, South Australia	Mothers who smoked during pregnancy	<ul style="list-style-type: none"> • "A Healthy Start – Bringing Up Baby Smoke Free" kit, a letter from director of the neonatal intensive care unit at hospital and advice
Chilmonczyk et al (28)	Portland, Maine	Smoking mothers (10 or more cigarettes/day) with infants brought to well-baby clinics	<ul style="list-style-type: none"> • Physicians telephoned mothers to report and explain infants' urinary cotinine results, and wrote letters with recommendations for changing household smoking habits
Vineis et al (29)	Rivoli, Italy	Nonsmoking and smoking parents of newborn babies	<ul style="list-style-type: none"> • Antismoking education: 15 min of counselling by a nurse and two booklets (active and passive smoking materials prepared for the study)
Greenberg et al (30)	Alamance and Chatham Counties, North Carolina	Smoking and nonsmoking mothers of infants up to six months of age	<ul style="list-style-type: none"> • Four home visits by a public health nurse during infants' first six months of life, education regarding passive smoking and worksheet
Bondy et al (31)	Kingston, Ontario	Smoking parents	<ul style="list-style-type: none"> • Brief, personalized counselling session provided by a health professional about ETS health risks
Eriksen et al (32)	Oslo, Norway	Families with at least one smoker and preschool children	<ul style="list-style-type: none"> • Communication between a 'health visitor' and the family at one well-child visit, a 5 min session on passive smoking, and ETS reduction and cessation brochures
Murray and Morrison (33)	Vancouver, British Columbia	Smoking and nonsmoking parents of children with asthma	<ul style="list-style-type: none"> • Referral to an allergy clinic (since 1985, referring doctors were advising parents not to expose asthmatic children to ETS)
McIntosh et al (36)	Ann Arbor, Michigan	Smoking parents with asthmatic children aged six months to 17 years	<ul style="list-style-type: none"> • Physician counselling, a pamphlet, a self-help manual and a personalized letter from the physician about the children's cotinine test results
Wahlgren et al (35)	San Diego, California	Smoking parents of children (six to 17 years) with confirmed asthma requiring pharmacotherapy	<ul style="list-style-type: none"> • Six-month series of outpatient behavioural counselling sessions (30 min each) during clinical visits for parents and children, with a \$50 incentive for study completion

established that at least a quasi-experimental design was used (ie, an intervention or significant practice change was made and the study included a control or comparison group). All abstracts were screened, and a subset of papers that met the study's criteria were selected independently by each author of the present paper. Three discrepancies were reconciled through discussion. After this process, 12 papers that described nine unique studies were selected for an in-depth review. The results are summarized by study so that results are not distorted by duplicate reports.

Data synthesis

Two of the studies were set in Europe, one in Australia and the other six in North America. The basic characteristics of all the studies are provided in Table 1. Further study details and results, according to target population

(well children or children with respiratory illnesses) are presented in Tables 2 and 3.

Table 2 displays the six intervention studies that involved well children. The earliest intervention study (27) was published in 1987. The investigators used a controlled trial that was aimed at mothers who smoked during pregnancy and their partners; the trial emphasized both parental smoking cessation and ETS exposure reduction. Three groups participated in the postnatal study: one group received written information, a letter from the director of the neonatal intensive care unit, telephone follow-up after one month and a home visit after three months; another group received written information only; and a comparison group for which only outcome measures were recorded. The follow-up rate was good. The authors described the intervention group as inexpensive, unobtrusive, specifically designed for the target

TABLE 2: Details about interventions for residential environmental tobacco smoke (ETS) exposure reduction designed for well children

Study	Sample	Proportion followed-up	Study design	Variables	Outcomes and findings
Woodward et al (27)	184 mothers who smoked during pregnancy	57/62 (91.9%) minimal contact group 54/61 (88.5%) intervention group 46/61 (75%) control group	Controlled trial, with group allocation by month of delivery	<ul style="list-style-type: none"> Self-reported smoking habits, maternal and infant urinary cotinine levels, and infants' ETS exposure 	<ul style="list-style-type: none"> No significant difference in smoking cessation, relapse rates or maternal urinary cotinine levels. No significant difference in infant ETS exposure or urinary cotinine levels 3 months later
Chilmonczyk et al (28)	103 mothers who smoked*	27/52 (51.9%) intervention group 29/51 (56.9%) control group	Randomized, controlled trial	<ul style="list-style-type: none"> Infant urine cotinine level and mothers' household smoking habits 	<ul style="list-style-type: none"> Mean log ratio of follow-up urine cotinine measurements was 6% lower in intervention group than in control group (not a statistically significant difference) 2 months later
Vineis et al (29)	Total 1142 nonsmoking and smoking parents of newborn babies	1015/1142 (88.9%) assigned 304/402 (75.6%) intervention group 443/613 (72.3%) control group	Population-based, nonrandomized trial (quasi-experimental)	<ul style="list-style-type: none"> Smoking habits according to social class 	<ul style="list-style-type: none"> Strong association between smoking habits and social class. Limited effectiveness of the intervention in decreasing the number of smokers 24 months later
Greenberg et al (30)	659 smoking and nonsmoking mothers of newborns recruited†	329/493 (66.7%) intervention group 330/440 (75%) control group	Randomized, controlled trial	<ul style="list-style-type: none"> Exposure to tobacco smoke, cigarette consumption, infant's urinary cotinine level and incidence or persistence of infant's acute lower respiratory symptoms 	<ul style="list-style-type: none"> Intervention group exposed to 5.9 fewer cigarettes/day ($P=0.0002$) in subgroup of smoking mothers. No significant difference in cotinine levels. Prevalence of lower respiratory symptoms: 14.6% in intervention group versus 34% in control group ($P=0.02$) at 12 months
Bondy et al (31)	24 smoking parents with at least one child under the age of 18 years	14/14 (100%) intervention group 10/10 (100%) control group	Randomized, controlled trial (pilot study)	<ul style="list-style-type: none"> Salivary or urinary cotinine analysis of parent and child living in the home and awareness of the risks of ETS 	<ul style="list-style-type: none"> Although high levels of awareness about health risks of ETS in both groups, no significant differences in reduction of cigarettes, restrictions on smoking in the home or in cotinine levels of parents and children 3 to 6 weeks later
Eriksen et al (32)	443 families with at least 1 smoking adult recruited	178/221 (80.5%) intervention group 185/222 (83.3%) control group	Randomized, controlled trial	<ul style="list-style-type: none"> Two self-administered questionnaires: one questionnaire before health visit about adults' daily smoking and measures taken to reduce children's exposure to ETS; second questionnaire one month after health visit about smoking behaviour changes 	<ul style="list-style-type: none"> No significant difference among groups with respect to change in smoking behaviours (reducing or quitting smoking, or stopping smoking indoors). No significant association between information and positive behavioural change (trying or preparing to stop smoking) 1 month later

*37 paediatric, family practice and hospital-based clinics were approached and 30 (81%) agreed to participate; †The analysis focused on 121 smoking mothers

group and administered by committed research staff. The intervention did not produce any significant reductions in maternal smoking or infant ETS exposure. The authors suggest that the intervention may have produced better results if it were delivered during pregnancy rather than postnatally. Women who decreased smoking during pregnancy saw the postpartum period as a release from responsibility for the fetus; they had little awareness of the

risks to the baby posed by postnatal smoking. The researchers also acknowledged that a stronger intervention program that emphasized the hazards of postnatal smoking to mother and infant may have been more effective, but they feared that a more intensive program would elicit more refusals to participate. Although the overall sample size was 157, the three-group design produced smaller numbers per group and, thus, had a lower power to de-

TABLE 3: Details about interventions for residential environmental tobacco smoke (ETS) exposure reduction designed for children with asthma

Study	Sample	Proportion followed-up	Study design	Variables	Outcomes and findings
Murray and Morrison (33)	807 smoking and nonsmoking parents of children with asthma*	415/415 (100%) earlier group 392/392 (100%) later group	Quasi-experimental, before and after design comparing children seen before July 1986 and those seen after and up to 1990	<ul style="list-style-type: none"> Children's asthma symptoms, parent's smoking behaviours, skin prick tests (allergies), forced expiratory spirometry reading, bronchial responsiveness to histamine and expired air carbon monoxide concentration 	<ul style="list-style-type: none"> Later period children exposed to fewer cigarettes/day by 93 smoking mothers (7 versus 3 cigarettes smoked while in the same room as the child for earlier versus later group, respectively, $P=0.005$) and by 111 smoking fathers (5 versus 2 cigarettes smoked while in the same room as the child for earlier versus later group, $P=0.001$). Improvement in asthma scores for earlier versus later group (7.5 versus 6.5, respectively, $P=0.047$) and lung function FEV₁% (79.2 versus 93.7, respectively, $P=0.000$)
McIntosh et al (36)	92 smoking parents from four paediatric pulmonary clinics	72/92 (78.3%). 37 assigned to intervention group and 35 to control group. Proportions followed-up not reported by group	Randomized, controlled trial	<ul style="list-style-type: none"> Parents' self-reported smoking status, urine cotinine level, attempts to quit smoking, cessation of smoking inside home and maintenance of outside smoking 	<ul style="list-style-type: none"> 86% of parents in treatment group and 43% of parents in control group ($P=0.001$) <i>tried</i> to quit smoking inside the home. No significant difference among groups in those reporting smoking outside the home at 4 to 6 months
Wahlgren et al (35)	91 smoking parents randomly assigned to three groups: counselling, monitoring and usual care	84/91 (92.3%). Counselling 29, monitoring 23, usual care 32. Proportions followed-up not reported by group	Two-year follow-up of randomized, controlled trial (at 20 and 30 months) extended from Hovell (34)	<ul style="list-style-type: none"> Daily peak flow measures, symptom diary recordings, children's ETS exposure and health status, and parents' smoking rates 	<ul style="list-style-type: none"> Significantly fewer cigarettes smoked while parents were in the same room as the child means 1.3, 2.8 and 3.0 for counselling, monitoring and control groups, respectively. A significantly larger proportion of the counselling group reported zero exposure (21.4%) compared with 3.6% and 3.8% for monitoring and control groups, respectively, $P=0.05$ at 20 months

*Data from charts for $n=807$ children were analyzed for asthma severity and lung function. Data on 93 children with smoking mothers (40 before, 53 after) and 111 children with smoking fathers (47 before, 64 after) were analyzed for the exposure analysis. FEV₁ Forced expiratory volume in 1 s

tect small differences among groups. In addition, the groups were not fully randomized but assigned according to birth month. For example, fewer women in the intervention group were able to quit smoking during pregnancy, which could have produced a bias toward the null hypothesis.

The study by Chilmonczyk et al (28) tested an intervention in primary care offices that targeted infants of smoking mothers during well baby visits. The low intensity strategy consisted of a telephone call about the infants' cotinine level and a letter that emphasized strategies to keep smoke away from the infants rather than smoking cessation. The study was unique among the clinic-based interventions because the cotinine measurements were incorporated into the intervention

and were used to assess outcome. About half of the original study participants were lost to follow-up because of noncompliance with the study protocol. Disappointing follow-up rates were attributed to the low educational levels of the participants. The intervention did not significantly influence infant exposure levels to ETS in the household. The mean log ratio of the follow-up to initial urine cotinine measurements was 6% lower in the intervention group than in the control group, but the difference was not statistically significant. The small sample size at the end of the study most likely jeopardized the power of the study to show a reasonable effect, even in a situation in which bias due to loss to follow-up would most likely have been in the direction of showing a difference.

The first study with a more satisfactory sample size, by

Vineis and colleagues (29), conducted a population-based, quasi-experimental study with an intervention group of 304 participants and a control group of 443 participants. All parents of newborns in a local health unit catchment area were assigned to a group based on the month of well baby clinic attendance. The low intensity intervention consisted of nurse counselling and pamphlets, and focused on both parental smoking cessation and ETS reduction. No further intervention was pursued. A reasonable and balanced level of follow-up (about 74%) was achieved in the study, but the only outcome measured was self-reported parental smoking cessation. Mothers in the intervention group were slightly more likely to quit smoking, but the difference was not statistically significant. Because no objective outcome measure was used, a positive result that was attributable to reporting bias may have been expected, but this was not the case. It was also unfortunate that ETS reduction behaviours were not measured because they may have been more achievable than quit rates, and any change among groups may have been detectable given the sample size. Contamination between groups may have created bias toward the null hypothesis because, essentially, all the parents lived in the same town and may have shared information.

In 1994, Greenberg and associates (30) reported on a home-based intervention in a large sample ($n=659$) of smoking and nonsmoking mothers of newborns who were recruited during the early postpartum period in local hospitals. The study was a strong randomized, controlled design (using a Solomon four group design). Its primary objective was to reduce infant ETS exposure by moving the source of the smoke away from the infant. The intervention was more intensive compared with most of the studies reviewed, consisting of four home visits, telephone support and worksheets. A moderate proportion of the sample was followed-up, but most of the analysis focused on the subgroup of about 120 smoking mothers. Greenberg et al (30) found some positive effects in subgroup analysis, including a reported reduction in the number of cigarettes smoked near the infant per day among smoking parents and a reduction in persistent respiratory symptoms among children of lower socioeconomic status. There was no significant difference in the urinary cotinine levels among the two groups. The authors noted concern about the limitations of using urinary cotinine levels as a measure of passive smoking and mentioned the possibility that maternal reporting bias may have produced one of the positive findings. However, these concerns are minimal given that the study was large, well designed and had a more intensive intervention with reasonable follow-up and sufficient power.

The study by Bondy et al (31) was a small, randomized pilot study of an intervention for ETS reduction for smoking parents of mixed-age children who were recruited by community-based health professionals. The intervention focused on ETS hazards and consisted of an initial coun-

selling session, with a follow-up counselling session after three to six weeks. Cotinine levels of parents and children were measured at follow-up. Although high levels of awareness about the health risks of ETS were found in both the intervention and control groups, there were no significant differences in the reduction of cigarettes smoked in the home, restrictions placed on smoking in the home or cotinine levels. The authors noted parental resistance to any restrictions of smoking behaviour in the private domain of the home. Because this pilot study used only a small sample size ($n=24$), it was insufficiently powered to compare outcomes statistically between groups.

The intervention study by Eriksen et al (32) targeted 443 families with at least one smoking parent and at least one preschool-aged child; participants were recruited from community health clinics in a randomized, controlled design. The intervention consisted of a brief counselling session, and brochures about ETS and smoking cessation at a well child visit. Follow-up measures (a questionnaire only) were pursued one month later during a home visit. No significant differences in any of the smoking behaviours that were measured (quitting smoking, stopping smoking indoors and reducing smoking consumption) were found between the groups. The one-month observation time was most likely not enough to measure a full smoking cessation effect. There also may have been contamination between the treatment and control groups. The intervention itself may have been too weak to produce an effect, but the power of the study was probably adequate for a moderate effect size. No objective outcome measures were used, but in the context of a negative study, measures to reduce reporting bias are moot.

Three of the ETS intervention studies focused on children with asthma and their smoking parents (Table 3). All of these interventions were reported by the authors to be at least partially effective in reducing asthma symptoms (33), decreasing ETS exposure (34,35) or motivating parents to attempt to quit smoking (36). The interventions directed toward at-risk children and their parents ranged from increasing general awareness among parents about the hazards of ETS to formal behavioural counselling.

Murray and Morrison (33) compared separate groups of mixed-aged children who were referred consecutively from an asthma clinic three years before and four years after routine physician advice about the harmful effects of ETS was instituted. The sample size ($n=807$) was sufficient to show differences in outcomes. The investigators reported that a general increase in parental awareness of the harmful effects of ETS was associated with concurrent reductions in reported ETS exposure, improved lung function and decreased severity of asthma in children. Although the parents did not smoke any fewer cigarettes in each period, they reported smoking less frequently in the house and when they were in the same room as their asthmatic children. Although the results were encouraging,

the quasi-experimental study design was weak with respect to attributing the differences in clinical measures to the introduction of advice. This design is particularly vulnerable to historical changes external to the study. Many improvements in treatment have occurred during the time of the study, which may be an alternate explanation for positive changes in symptoms. In addition, without randomization, there is a lack of confidence in the equivalency of the groups at baseline. Guilt associated with exposure of a chronically ill child to ETS may have resulted in more reporting bias than may be the case among parents of well children. For this reason, parental reporting bias may be an additional explanation for the positive results in this study.

The randomized, controlled intervention reported in 1994 by McIntosh et al (36) was conducted in relatively small samples (37 in the intervention group and 35 in the control group) of smoking parents of mixed-aged children with asthma. In addition to the 'usual care' (counselling by the child's physician and a pamphlet) received by the control group, the intervention group received a personalized letter explaining the children's cotinine test results, and a self-help manual on ETS and cessation for parents. The follow-up rate (78.3%) at four to six months was good. The intervention did not produce any statistically significant differences in reported smoking behaviours in the home or in urinary cotinine levels, but more parents in the intervention group reported *trying* to quit smoking within the home. Although the sample size of the study was too small to detect any significant differences produced by the intervention, the actual difference would be clinically significant if it was found in a larger study. The authors also found that parents tended to aim for complete smoking cessation rather than the more modest outcome of changing smoking location. The authors observed minimal use of the manual by parents. Because the 'usual care' group also had access to information about the hazards of ETS and cessation advice, there may not have been enough difference among groups to demonstrate large differential effects. Given that cessation often takes several attempts, the follow-up period may have been insufficient to show a cessation effect.

Wahlgren et al (35) tested a randomized counselling intervention that involved 84 smoking parents with early school-aged children who had asthma; participants were recruited from asthma clinics. Their three-level intervention was based on learning principles, consisting of a six-month series of counselling sessions, printed materials and included monetary incentives for attendance. Follow-up was longer term, extending to 30 months. Significant differences were found in the reported number of cigarettes smoked indoors, but differences in quit attempts and two-week symptom ratings were not significant. Reporting bias may be an explanation for the positive findings, and the clinical significance of small differences in numbers of cigarettes smoked indoors is questionable.

DISCUSSION

Our review found that interventions to reduce ETS exposure in children and infants have been, to date, mostly unsuccessful. There may be a number of reasons for this disappointing conclusion, including the timing and intensity (both content and duration) of the interventions, inadequacy of outcome measures, characteristics of the target populations and methodological flaws in the design of the studies.

Interventions that involve personal contact vary in intensity and duration of the person-to-person contact. In the studies that we reviewed, the level of contact ranged from minimal (a 3 min session), brief (a 5 to 10 min session) or more extensive (sessions longer than 10 min). Interventions that involved personal contact may also vary in follow-up, from one-time only contact to several contacts over an extended period of time. Changes in smoking behaviours occur over extended time periods, and require reinforcement and sustained encouragement (32). A single session with a physician is unlikely to provide the sustained support necessary to create significant changes in ETS exposure within families with a smoker. Although, intuitively, a more intensive intervention would be expected to be more effective, even some of the more intensive programs among those that we reviewed had negative results.

Much stronger messages about smoking cessation are given to women during pregnancy. The first six weeks after birth appear to be a time when women are particularly vulnerable to relapse (23). Therefore, studies in which the intervention *begins* in the postnatal period may have a poor effect because of background relapse rates. It may be important to have postnatal ETS interventions that are integrated with and continue from antenatal cessation interventions.

All of the interventions that were reviewed for this study involved personal counselling and education, and most of the counselling was supplemented by written self-help materials such as worksheets, pamphlets and booklets. These materials were typically developed by investigators for a study; the investigators provide little information about the extent to which the materials were based on learning principles or pretested for general appeal, comprehension and acceptability. One report suggested that the self-help manuals provided were poorly used. More research is needed on more novel delivery methods such as interactive computer programs or videos.

The outcomes of interventions of the studies that we reviewed were most typically measured using a questionnaire-based, self-report of either the quantity of cigarettes consumed or the location of smoking in the home. Concerns about reporting bias leading to spurious positive results may be overstated in light of the mostly negative findings of these studies, especially those conducted among well children. Although parental self-report data may be influenced by a social desirability bias (6), self-reports have been found to be in good agreement with co-

tinine levels (37). Urinary cotinine measures have been used to verify the quitting status of participants during cessation trials and are being used as objective measures of exposure in many of these studies; however, the reliability of detecting much lower passive smoking levels may be problematic (30,31). 'Noise' in the cotinine measures in the studies reviewed in this paper may have led to some of the nonsignificant findings, especially in small samples.

Among the intervention studies that we reviewed, the interventions that targeted families of children with asthma tended to be more successful in reducing ETS exposure than the interventions that were designed for well children, but only one of these interventions that was sufficiently designed with strong internal validity (35) had a positive outcome. An improvement in a child's asthma symptoms (eg, less wheezing and coughing) is a direct reward for the parents' efforts in reducing ETS exposure. Parents of children with asthma and other respiratory illnesses may be more conscientious and responsive to interventions that bring noticeable improvement to their children's health, but this has yet to be shown definitively.

Methodological flaws in the studies most likely played a role in the overall findings of this review. With respect to design, most of the studies were randomized, controlled trials; however, the stronger designs tended to report the negative results. Some of the most positive findings were reported in studies with the weakest designs, with many plausible alternate explanations for the results. Study power was a larger problem, with more than half of the studies having relatively small sample sizes, which may have limited their ability to show a small or moderate effect. On the other hand, negative results were also seen in the larger studies. Loss to follow-up will introduce bias if participants lost differ in important ways from those participants who remain (eg, if heavier smokers who are less likely to quit or change behaviour drop out of the study) the results may be biased toward spurious, positive findings. In the set of studies reviewed in this paper, even interventions with excellent follow-up failed to demonstrate significant effects. The timing of outcomes may have played a role in that the short follow-up periods of some of the intervention studies may have been insufficient to measure a full smoking cessation effect. Contamination between the treatment and control groups may have resulted in a bias toward a null finding in a few of these studies. Finally, in some of the studies, there did not appear to be enough difference between the 'usual care' treatment and the intervention treatment to produce statistically significant differences in smoking behaviours.

Although the effectiveness of interventions for ETS reduction in infancy and childhood is disappointing, the magnitude of the health problems associated with exposure compels health professionals to take action. Physicians' offices may be a setting with great potential for effective intervention regarding ETS exposure be-

cause they have already been shown to be effective settings for smoking cessation advice (38). Samet et al (26) noted that "health care providers would appear to have a central and critical role to play as they interact with parents at key times: during pregnancy, at birth, at well-child visits and at visits for illnesses which may be ETS-related."

Two surveys characterized paediatricians' office-based practices on parental ETS reduction and smoking cessation, and identified barriers to more intensive action (22,39). In the first study, Frankowski et al (22) received responses to a questionnaire on providing cessation advice to parents from 91% of 92 Vermont paediatricians and 99% of 682 parents in randomly selected Vermont practices. Forty per cent of the physicians reported that they routinely asked parents about their smoking status, but only 11% of the respondents reported recording this information in patient charts. The majority of physician respondents (94%) advised at least 60% of their patients' parents to quit smoking. Identified barriers to giving such advice were a lack of time, believing that parents did not expect such advice and being ill at ease about providing the advice. In addition, only a very small proportion of the paediatricians had received training in how to counsel parents about tobacco use. In contrast, over half of the parent group (56%) agreed that paediatricians should counsel parents to quit smoking and 52% of *parents who were current smokers noted that they would welcome such advice*. Only 15% of the smokers reported that they would respond negatively to cessation advice. When advising smokers about ETS exposure of their children, paediatricians most often emphasized the hazards to the child and parents themselves rather than the health benefits of stopping, and were more likely to recommend keeping smoke away from the child than cutting down or quitting. Typically, interventions did not go beyond advice, with less than one-quarter of physician respondents advising that a smoking quit date be set or prescribing nicotine replacement therapy. A large majority of parents (81%) also agreed that paediatricians should discuss the effects of ETS exposure and 56% believed that it was the paediatrician's job to counsel parents to quit smoking.

The second survey, of 281 New Jersey paediatricians' practices regarding ETS, was published in 1995 by Hy-mowitz (39) (54% response rate). Although an encouraging 88% of respondents reported advising new parents about ETS hazards and 80% of respondents encouraged parents to create a smoke-free home, only 32% distributed materials on ETS, 26% assisted with the selection of a quit date, 15% prescribed nicotine replacement therapy and 11% arranged follow-up visits specifically to discuss smoking-related issues with smoking parents of newborns. Paediatricians were much less likely to provide ETS (18%) or cessation (24%) information more generally in their practices.

Overall, the survey results indicate that parents expect ETS education and intervention to a greater degree than

paediatricians predict. Furthermore, it has been shown that smokers identify physicians as the best source of motivation to quit and the most effective source of assistance compared with friends and relatives, regulations, higher taxes or public service announcements (38). In addition, the majority of paediatricians report that they do ask about parental smoking status and ETS, and provide basic counselling about hazards, at least to parents of newborn infants. Because parents of newborns are younger and most would have few or infrequent health problems, the paediatrician may be the only physician who they see during this stage of their lives. Enhancing current paediatric practice on ETS for greater effectiveness seems to be warranted.

The United States National Cancer Institute, on the basis of smoking cessation trials, developed the 4-A model as a guide for physicians to deliver effective cessation interventions (40). The model has four steps – Ask, Advise, Assist and Arrange follow-up – that are based on evidence that simply asking and advising about smoking cessation are not sufficient interventions to achieve behavioural change. In the absence of more evidence on ETS-specific interventions, it seems wise to use this approach in the paediatric context as well, and indeed some authors have suggested that the model be adapted for this purpose (38,41). Suggestions from these authors, as well as suggestions based on our review of interventions, are presented below, according to each stage of the model.

Ask

- Ask all parents about the smoking status of all household members and ETS exposure from all sources (ie, in the home, at child care settings, at the homes of grandparents, friends and relatives), and record this information routinely in a child's chart.

Advise

- Outline the health effects of ETS exposure.
- Allow time for the information to be assimilated and accepted.
- Stress the benefits to the entire family of cessation and exposure reduction, including fewer sleepless nights and lost work days.
- If parents are unwilling or unable to quit smoking, provide information about the most effective way to reduce exposures (smoking outdoors only); emphasize avoidance of in-car smoking, smoking while breastfeeding and other high exposure situations, and that simply opening a window or blowing smoke in another direction is ineffective.
- Provide simple, attractive, supportive materials such as pamphlets, fact sheets, videos and posters, during visits and in the waiting room.
- Gear materials to different literacy levels (eg, lengthy self-help manuals may not be read by some parents).
- Use visits for illnesses (respiratory tract infections, otitis media) related to ETS exposure as 'teachable moments'.

- Provide the above messages consistently and frequently, and during well-child visits.
- Emphasize that some health improvements can be immediate (eg, relief of asthma symptoms).

Assist

- Prescribe nicotine replacement therapy and drugs known to assist with cessation, and offer to arrange or refer patients to cessation groups or programs.
- Set dates for cessation and/or ETS elimination and record the decisions in writing.
- Positively reinforce any attempts at behavioural change.
- Tie improvements in a child's health or symptoms to parental behavioural change.
- Support parents in their attempts to achieve exposure reduction from other household members who smoke.

Arrange follow-up

- Make follow-up appointments to discuss ETS issues.
- Provide continuity postnatally with messages and programs that have been received antenatally. Silence about the smoking issue during the postnatal period may be interpreted to mean that there is a lack of any health risks or concerns, which may contribute to a relapse.
- Understand that cessation is a gradual and sometimes lengthy process, and that while creation of smoke-free environments can be immediate, behavioural change in that area may also be gradual.

More resources may be obtained from the following organizations: The United States Environmental Protection Agency, Health Canada, the Canadian Cancer Society, United States Centers for Disease Control and Prevention, national and provincial lung associations, National Clearinghouse on Tobacco and Health, Physicians for a Smoke-free Canada, local health units, the Heart and Stroke Foundation, the Canadian Institute for Child Health and the Canadian Council on Smoking and Health.

CONCLUSIONS

A few of the studies reviewed for this paper were able to produce some reductions in ETS exposure among infants and children, but most studies have had no effect. It is essential that more research be completed to both improve the understanding of why interventions generally fail to produce reductions in ETS exposure for children and to elucidate the elements of effective interventions. Despite insufficient information about effectiveness, the enormous health consequences of ETS exposure to infants and children are compelling enough for health professionals to take preventive and interventional action, and for barriers to such action to be addressed. There is tremendous potential for short and long term improvements in infant and child health if ETS exposure can be eliminated.

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