Protecting Children From Passive Smoking

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hildhood is a time in which foundations are laid on which the adult is formed. Nevertheless, it is surprising for most to discover just how early in life arteries can show signs of structural or functional damage that may indicate vulnerability to atherosclerosis. Napoli et al were the first to demonstrate that even fetal aortas could develop fatty streaks in utero in the presence of maternal hyperlipidemia, and recently, Skilton et al have documented in vivo evidence of aortic wall thickening in at-risk newborns because of intrauterine growth restriction. Evidence of functional arterial abnormalities also has been documented in the first decade of life in high-risk children (eg, in those with familial hypercholesterolemia). Although such abnormalities do not usually lead to clinical consequences until middle adulthood, their genesis in childhood underscores the 2 key missions of atheroprevention: early detection of individuals and groups at risk and definition of strategies to prevent or reverse early atherogenic changes.

Cigarette smoke remains one of the most prevalent modifiable risk factor for atherosclerosis. Whereas early epidemiological and mechanistic studies focused on active smoking and its effects on cardiovascular events, key research in the 1990s indicated that exposure to environmental tobacco smoke (ETS) also had significant adverse consequences for arterial health. Nonsmoking adults exposed to ETS have been shown to have cardiovascular event rates 20% to 50% higher than nonexposed adults, and this risk applies whether the ETS exposure occurs in the home or at work. Is it conceivable, however, that even children might suffer arterial damage from ETS exposure? This question is addressed by Kallio et al in the current issue of Circulation.

In this elegant study, the investigators have used serial measures of serum cotinine, a nicotine metabolite with a half-life of ~24 hours, to characterize ETS exposure in 402 children who underwent arterial function assessment at 11 years of age. They examined flow-mediated dilatation of the brachial artery, a well-established technique for the noninvasive study of endothelial function. Abnormally low values of flow-mediated dilatation indicate endothelial dysfunction largely as a result of the impaired release of nitric oxide by the endothelium. Endothelial dysfunction in turn is significantly associated with the major conventional risk factors in a dose-related manner (see, for example, the article by Celermajer et al) and is predictive of cardiovascular event rates in a variety of populations (see, for example, the article by Chan et al). Kallio et al find that exposure to ETS is significantly associated with arterial endothelial dysfunction in a dose-related manner independently of traditional risk markers.

The strengths of this study include the use of an objective biomarker for ETS exposure rather than self-report or parental report, the availability of longitudinal cotinine measures over 3 years in these children, and the selection of an age group in which active smoking is highly unlikely to be a confounding factor. The dose relation of impaired flow-mediated dilatation to cotinine grouping also supports the likelihood of a cause-and-effect relationship between ETS exposure and endothelial dysfunction.

Many will be surprised that such low levels of smoke exposure, equivalent in cotinine terms to actively smoking fewer than only 1 to 2 cigarettes per day, would be associated with arterial abnormalities in children. These data are, however, quite consistent with the profoundly deleterious effects of passive smoking on endothelium previously noted in young adults (age, 22 ± 4 years), which was shown to be almost equivalent to the adverse impact of active smoking on arterial function (although noting that ETS exposure in that study was of a much longer duration than active smoking in the subjects reported). The explanation for the potent effects of ETS may relate to the fact that side-stream smoke from the end of a burning cigarette contains several potentially toxic substances in higher concentrations than the active smoker inhales directly because the active smoker often has the “benefit” of a filter and of a higher combustion temperature during the process of inhalation (when the end of the cigarette burns more brightly). Several plausible mechanisms exist whereby ETS might predispose to vascular damage with short-term exposure. ETS engenders peroxidative changes in low-density lipoproteins, which are then more susceptible to uptake by macrophages. Brief exposures to ETS also lead to increased sympathetic nerve activity and enhanced platelet aggregation. Chronic ETS exposure also is associated with a dose-related ~5-fold increased risk of (National Cholesterol Education Program-defined) metabolic syndrome in teenagers and with significantly lower high-density lipoprotein cholesterol levels in...
dyslipidemic children 2 to 18 years of age. Such ETS-related risk-factor clustering may be particularly deleterious in these groups of children.

Unfortunately, the effects of withdrawal from cigarette smoke exposure do not lead to rapid restoration of normal arterial endothelial function. We initially showed that cessation of active smoking for an average of 6 years was associated with only an ≈50% recovery of endothelium-dependent dilatation, although rheological abnormalities related to smoking appear to be more rapidly reversible with early clinical benefit. Similarly, Raitakari et al. have found only partial rather than complete reversibility of ETS-related endothelial dysfunction in young adults even ≥12 months after withdrawal from the ETS environment. Therefore, prevention of exposure is clearly the preferable means of minimizing ETS-related vascular damage in children.

Exposure to ETS in childhood has adverse health consequences beyond the cardiovascular system. For example, ETS increases the risk of asthma symptoms in children by ≈40% and that of lower respiratory illness in infants by ≈60%. For these reasons, protecting children from secondhand smoke in homes has been the focus of the US Environmental Protection Agency’s educational programs to parents to promote smoke-free rules in the home. Exposure levels to ETS also have fallen as more governments have restricted smoking in public places; for example, from 1988 to 1996, geometric mean salivary cotinine levels fell from 0.47 to 0.28 ng/mL among children with nonsmoking parents and from 3.08 to 2.25 ng/mL in children with 2 smoking parents. Nevertheless, the decrease in ETS exposure among children lags behind that in adults, with children 3 to 11 years of age still having cotinine levels more than twice as high as those measured in nonsmoking adults. Thus, reduction of ETS exposure in the home remains a key public health target.

A confluence of epidemiological, pathophysiological, and mechanistic data now implicate ETS as a risk factor for arterial disease, and the signs of early arterial damage may even be evident in smoke-exposed children. The challenge now exists to translate these data into effective public health action to minimize for our children “the ills to come and care beyond today.”

Disclosures

None.

References


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