Designing Intervention Effectiveness Studies for Occupational Health and Safety: The Minnesota Wood Dust Study

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Background *A planning model was used to guide the design of a randomized controlled study of the effectiveness of tailored interventions in lowering dust exposures in small woodworking shops.*

Methods *Guided by Green's PRECEDE–PROCEED model, we used a planning committee, focus groups and a pilot study to gain information on small woodworking shops, causes of and controls for high dust levels, and barriers and incentives surrounding availability and use of dust controls.*

Results *The planning committee identified key characteristics of small woodworking shop owners. Focus groups with owners and employees served to further elucidate why dust control was considered unimportant. The pilot study gave measures of dust exposures, tasks, and use of controls. Interventions focused on providing owners with technical and economic assistance to lower dust levels and an educational program for employees discussing health effects and effective methods of dust control.*

Conclusions *The PRECEDE–PROCEED model proved a useful framework for designing an intervention in the occupational setting.* Am. J. Ind. Med. 41:54–61, 2002.
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KEY WORDS: intervention; effectiveness; occupational health and safety; wood; dust; planning committee; focus group; pilot study; PRECEDE–PROCEED

INTRODUCTION

The most difficult and yet most important element of an intervention effectiveness study involves identifying and designing the intervention itself. Health and safety professionals use a hierarchy of controls when selecting the appropriate methods for preventing or minimizing workplace hazards. Typically, this hierarchy proceeds from engineering controls to personal protective equipment and finally to administrative controls [Burton, 1997]. This simplified model, however, fails to recognize important individual and environmental factors that affect the long-term success of an intervention. To date, most studies of occupational health interventions have focused on single

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elements of the control hierarchy in a few locations or processes and have failed to recognize the effect of environmental and organizational factors [Goldenhar and Schulte, 1994].

PRECEDE–PROCEED is a useful model that extends the hierarchy of controls approach for designing occupational health and safety interventions. This model was developed by Green and colleagues [Green et al., 1980; Green and Kreuter, 1991] for planning and designing educational interventions aimed at changing health behaviors. PRECEDE is derived from the Predisposing, Reinforcing, and Enabling Constructs for Educational Diagnosis and Evaluation. The model was later expanded to include Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development (PROCEED).

We applied the PRECEDE–PROCEED model to the development of an intervention to reduce exposures to wood dust, a known carcinogen. The effectiveness of the intervention was then assessed in a randomized controlled trial (The Minnesota Wood Dust Study) conducted with 48 woodworking businesses in the Twin Cities, Minnesota region. Since the PRECEDE–PROCEED model has not been routinely applied in the occupational setting, the purpose of this paper is to introduce readers to the model and describe how we used it to collect the information necessary to design the intervention and conduct the trial.

Description of PRECEDE–PROCEED

The PRECEDE–PROCEED framework defines intervention development as a systematic process involving nine phases (Table I). The first five phases are diagnostic in nature, during which researchers actively involve members of the target community to ensure the problem is clearly defined and representative of community needs. The last four phases are concerned with implementing and evaluating the intervention. For the purpose of this paper we will focus only on the first five diagnostic phases. Phases six through nine (implementation and evaluation) are described elsewhere (Lazovich et al., in review).

The first phase of the model, social diagnosis, calls for a broad assessment of the target community's health needs. In the second phase, epidemiologic diagnosis, a specific intervention target is selected from a list of high priority needs, following a review of medical, epidemiologic and other data. Phase 3 requires identification of the specific behavioral and environmental factors linked to the health problem identified in Phase 2. The outcomes of this phase are specific objectives identifying what changes in behavior are expected of which individuals. Phase 4 involves a more in-depth analysis of behavioral and environmental factors. Behavioral factors include predisposing factors (knowledge, beliefs, attitudes), which are affected by enabling factors (availability of resources and skills), which are in turn affected by reinforcing factors (the opinions and influences of key individuals). The final, fifth phase assesses organizational and administrative resources, drawing on coalitions and political alliances with community leaders to ensure support for planned activities.

Preliminary Assessments

The decision to focus on wood dust reduction in the woodworking industry was directed in part by the funding agency, which solicited applications that targeted proven workplace carcinogens. Wood dust is a nasal carcinogen [IARC Working Group, 1995]. Exposure to wood dust also results in numerous other respiratory health effects, including other cancers, allergic rhinitis, asthma, and irritation [Goldsmith and Shy, 1988; Enarson and Chan-Yeung, 1990; Roscoe et al., 1992; Chan-Yeung and Malo, 1995; Demers et al., 1997]. The National Institute for Occupational Safety and Health [Pederson and Sieber,

TABLE I. PRECEDE–PROCEED Model

Phase	Description
1. Social diagnosis	What are the community's perceptions of its needs concerning the health problem of interest?
2. Epidemiologic diagnosis	Which health problems are of greatest importance to the community? How does the health problem of interest fit into the broader quality-of-life issues of the community?
3. Behavioral and environmental diagnosis	What are the important determinants for the health problems? How important is each determinant and how easily can it be changed?
4. Educational and organizational diagnosis	What predisposing, reinforcing, and enabling factors would allow initiation and maintenance of change in health behaviors? What should be the target(s) of intervention?
5. Administrative and policy diagnosis	What policies (e.g. regulations) and resources (e.g. time, people, money) facilitate or hinder implementation of the intervention(s)?
6–9. Implementation and evaluation	Putting the intervention into place and measuring its success. Data analysis should include measures for evaluating the process (was implementation according to protocol?), the impact (what changes occurred in behavioral and environmental factors?), and the outcome of the intervention (what effect did it have on health?)

1988] estimates that approximately 1,246,200 workers are employed in logging, woodworking and carpentry trades (SIC 24 and 25); 64% of these are employed in the manufacture of wood products. We estimate that about 15,000 workers are engaged in the manufacture of wood products in Minnesota.

We focused on small woodworking businesses in Minnesota, because wood processing is one of the primary industries in the state, with numerous small businesses located in the metropolitan Twin Cities area. Small businesses are particularly lacking in expertise in and resources for implementing health and safety controls [Pederson and Sieber, 1988; Wiatrowski, 1994], which can make the design of effective interventions a significant challenge. Small businesses account for a large and growing fraction of the workforce. In the United States, 56% of all employees in private industry work in businesses with fewer than 100 employees. Of all private businesses in the United States, 98% have fewer than 100 employees and 87% have less than 20 employees [Wiatrowski, 1994; Bureau of the Census, 1996].

Our deliberations involved considerable discussion about who should be the intervention target. While concerned with employee health, we recognized that employees are not solely responsible for their exposures. If dust controls are not available or are ineffective, an employee may have a limited ability to lower his or her exposures. The primary target of our intervention, therefore, must be the business owner, who holds the key to both the availability and effectiveness of dust controls. Employees are secondary targets, because they must recognize the need for lowering exposures and make use of controls if they are available.

Environmental factors that would influence owner (and employee) behavior include factors external to the business (such as regulatory policies) and factors inherent to a small business (such as financial resources). Wood dust exposure is regulated in Minnesota at an 8-hr time-weighted average (TWA) airborne concentration of 5 mg/m^3 dust and a short-term exposure limit of 10 mg/m^3 for hard- and softwoods (excluding Western Red Cedar). Western Red Cedar (a known sensitizer) carries a TWA of 2.5 mg/m^3 [CFR, 1989]. Wood dust is a recognized fire hazard and building codes specify its collection and control by businesses. In some communities, wood dust is a regulated environmental contaminant and cannot be emitted to the environment via the air or disposed of through regular solid waste channels.

A variety of controls may be used to reduce employee exposures to wood dust. The most appropriate form of engineering control for wood dust relies on techniques that remove the dust near its source of generation, before its dispersal into the environment [ACGIH, 1998]. Dust capture can be accomplished for large stationary tools (e.g. table saws) by connecting them to a centralized system, which operates by drawing air at the point of generation into an inlet connected by ductwork to a cleaning device (e.g. a filter) before release to the external or shop environment. Centralized systems can operate either in a fixed configuration with all inlets continuously open or they may be equipped with a means of closing and opening individual inlets as needed. The latter configuration is more often found in small woodworking shops where tools are used only periodically; however, employees must remember to open the inlet before using a tool.

Hand-held powered tools (e.g. sanders and routers) are more difficult to control than stationary tools. They may be connected to centralized vacuum systems, but more often they are equipped with individual bag filters or small vacuum collectors. They may also be operated in booths that remove dust before returning clean air to the work environment. Downdraft tables, in which air is drawn downward through a grid and filter, may be useful for some applications. Centralized and booth systems are the most effective at collecting dust, but also the most expensive.

Individual bag filters provided with hand-held powered tools are generally ineffective at lowering dust levels and quickly become clogged. Individual vacuum systems can be very effective if they are of sufficient power and are less expensive than the centralized vacuum, booth or downdraft systems [Hampl et al., 1992; Martin and Zalk, 1997].

METHODS

Approximately 18 months were available for developing study methods, including interventions, prior to the start of the main trial. In the context of the PRECEDE–PROCEED model, this time period was devoted almost entirely to gathering the information required in phases 4 and 5, based on what we had learned from phases 1 through 3, described above. We also identified a number of practical issues that would determine the nature and implementation of our intervention activities (Table II). We utilized a number of techniques in this 18-month period, including a planning committee of key informants, a pilot test of outcome measures at five representative sites, and focus groups with owners and workers. Each of these is described in more detail below.

Planning Committee

A planning committee was formed and served in an advisory capacity throughout the development phase of the study. It consisted of 10 members, including small woodworking shop owners, government officials, technical college instructors, health and safety professionals, and trade association representatives. Committee members were contacted by telephone and in person and were formally invited by letter to participate in bimonthly meetings

TABLE II. Intervention Design Issues

Issue	Key questions
Woodworking shops	How many shops are available and where are they located?
	What kinds of products do they make?
	What size should they be (# of employees, dollar sales, amount of production)?
	How do we gain and maintain access?
	Number of shops needed to detect statistical differences?
Dust measurements and other evaluations	Should we conduct personal or area samples?
	How many samples do we need?
	Who do we sample?
	How do we sample (sampler, method, analysis)?
	What is the effect of task on dust levels?
	Should we conduct surveys of attitudes and behaviors?
	How do we measure effect of each element of the intervention?
	What do we use for process, impact and outcome measures?
	How can we use measures to "tailor" interventions?
	How many samples are needed to detect statistical differences?
Interventions	With whom should we intervene (owners or employees)?
	What types of interventions should we use?
	How much time and money should we spend on interventions?
	When should we intervene and how often?
	Who should conduct interventions?

throughout the development period. Participants were asked to advise the study team about the development and implementation of dust controls that would be feasible and acceptable to small woodworking businesses, assist in shop recruitment, and disseminate final study results. Members were offered a small honorarium and travel expenses for their participation. Planning committee meetings were held every 2 to 3 months for a total of nine times during the 18-month planning phase.

We had hoped for the participation of employees on the planning committee and attempted to recruit such representatives. However, volunteering employees found it difficult to attend our planning committee meetings, due to work and time constraints. Arranging meetings at different times of the day and different days did not improve attendance.

Pilot Study

The pilot study was undertaken at five woodworking shops in the Twin Cities area recruited with assistance from members of the planning committee. These shops produced a representative range of the products found in small woodworking shops (store fixtures, millwork and molding, parts, and cabinets). Personal inhalable dust levels were measured for all workers, while tasks and the use and availability of dust controls were observed. A protocol for measuring central dust control systems was developed and tested.

Focus Groups

Separate focus group meetings were conducted with six workers and three owners to gather information about barriers and facilitators of wood dust control in small shops. A combined focus group of owners and employees was not contemplated, because it was unlikely that employees would feel free to express their opinions in the presence of owners. Workers were asked to describe their knowledge of wood dust health effects, the tasks that create high levels of dust, the types and use of dust controls in their shop, and what methods of education they thought were most effective. Owners were asked about health effects, effects of wood dust and its control on production, advantages and disadvantages of different types of controls, and how they obtain information about controlling wood dust.

RESULTS

Described here the results of the planning committee, pilot study, and focus groups and the understanding they provided about (1) the predisposing, enabling and reinforcing factors affecting the control of exposure to wood dust by both employees and owners (Phase 4), and (2) the organizational and administrative resources available to this community for implementing changes (Phase 5).

Planning Committee

Members of the planning committee knew that wood dust was a health concern and were aware of its carcinogenicity. Some members were aware of the sensitizing nature of some wood types but most were unaware of other long-term respiratory health effects. They thought that wood dust control was important for both health and product quality. Other hazards in the shop, such as machine guarding, noise, solvent vapor exposures from painting and glue operations, and eye injuries from flying objects, were thought by some of the members to be more important than wood dust.

Planning committee members described the most important barriers to using dust controls to be difficulties with:

- Maneuvering hand-held sanders with attached controls around bulky pieces;
- Changing experienced employees' work habits, and
- Affording central dust collectors, sanding booths, downdraft tables and other similar effective, but expensive controls.

The planning committee confirmed our professional knowledge that the installation of a central collection system is a key dust control method for small woodworking shops. While this group outlined a number of barriers to the use of controls for hand-held powered sanders and routers, members were also clearly open to ideas for better control, as they recognized these operations as being very dusty. Expense, ease of use and time were important factors for acceptance of such controls.

Planning committee members were aware, in general, of operations causing the highest levels of dust (sanding and routing with hand-held powered tools), but were skeptical of most methods for controlling dust from these operations. They were generally unwilling to accept that vacuuming might be effective in cleaning. They argued that vacuuming takes more time and slows the work process.

We learned from the planning committee, as well, that:

- Most owners of small woodworking shops are isolated from their peers and do not participate in trade associations or other professional organizations.
- Competition between woodworking shops causes owners to rely on equipment suppliers for information about the best methods of dust control.
- Suppliers are not always knowledgeable about dust collection systems and their proper design.
- Many owners obtain their first centralized dust collection system from other owners whose shops have outgrown their system and are acquiring a larger one.

Focus Groups

The focus group with owners validated what we had learned in the planning committee about their knowledge, attitudes, and behavior toward wood dust. Wood production employees who participated in a separate focus group indicated that they have a strong interest in knowing more about health hazards from wood dust exposure. They described common barriers preventing the use of dust control (Table III). They discussed the need for increased awareness of potential health effects, training when first hired, and incentives as methods for increasing motivation. They indicated the strongest preference for in-person training by peers and a strong disapproval of videos and pamphlets as educational tools. They also indicated that tours of other woodworking shops were an attractive method for sharing information.

Pilot Study

The pilot study gave us an understanding of the variety of typical controls used to lower dust levels in small woodworking shops, as well as the range of dust exposures and tasks responsible for high levels [Brosseau et al., 2001]. We identified 53 different wood production tasks, which were grouped into four categories (sanding, cutting, cleaning, and miscellaneous). All five shops had some form of central dust collection system for stationary tools. Several had bag filters attached to their hand-held power sanders. However, these tools were infrequently selected by workers. One shop had no dust controls available for sanding tasks.

TABLE III. Barriers to Dust Control Noted by Wood Production Employees

The central dust collector is not always turned on when using a machine
Switches are difficult to reach
Some shops turn their central collectors on and off during the day; people forget to turn the collector on
Leaving all the blast gates open causes the suction to drop
It is too expensive to run the central dust collector all the time
People are too lazy to open and shut blast gates
Bag filters are bulky, tiring and difficult to use
Hoses get in the way
Cleaning with vacuums is too time-consuming and slows down productivity
Vacuums are not effective at getting dust out of small holes
Vacuums are not as effective at cleaning off parts as blowing with compressed air
Controls are too expensive for small shops
Using a broom is faster than a vacuum; the hose gets in the way

We found that sanding with hand-operated power tools produced some of the highest levels of dust; we also found that centralized dust collection systems, while frequently available, were generally not adequately designed, maintained or employed. Almost all workers used compressed air to ''blow off'' machinery and products. Vacuuming was a very rare cleaning procedure.

One shop (a cabinet manufacturer) had significantly higher levels of dust, due largely to uncontrolled sanding operations. On average employees spent 50% of the time cutting, 15% sanding, 23% cleaning, and 12% doing miscellaneous, non-woodworking tasks (e.g. measuring and reading blueprints). Dust controls were available from 32 to 88% of the time. When available, employees used controls from 78 to 99% of the time.

Intervention Design

Pilot study results led us to focus recruitment on cabinet and fixture shops, where uncontrolled sanding is a frequent operation. We identified an inexpensive portable vacuum system and power sander combination that could be used by shops where sanding was an infrequent operation. For shops where sanding operations took place more often, suppliers of other types of sanding controls (booths, downdraft tables, centralized vacuum systems, etc.) were identified. We located a variety of small shops in the area using the latter types of controls and developed fact sheets describing how the control was used at this shop, its advantages and disadvantages, and a contact name and phone number.

Our intervention activities focused on encouraging owners to increase the availability of more effective dust controls, including better-designed central collection systems for all stationary tools and greater availability of efficient collection systems for sanding operations (Table IV). Through the use of tailored recommendations, technical and financial assistance, and input from employees, we hoped to increase owners' knowledge about what causes high levels of dust. Improved knowledge and focused recommendations were expected to increase the likelihood that owners would make changes in their shop that would lead to lower dust exposures. Our activities with employees were focused on increasing their knowledge about effective controls and eliciting their ideas for specific improvements in their shops.

Final Study Design

The final design for the intervention trial called for between 50 and 60 shops (one-half control and one-half intervention) drawn from cabinet, fixture and furniture manufacturers with 5–25 production employees. Shops must have been in business for at least 1 year and located within a 60-mile radius of metropolitan Minneapolis and St. Paul. Ten workers were randomly selected over 2 days (5 workers per day) and sampled for personal dust exposures using the same protocol described for the pilot study. Fifteen-minute observations of tasks and use of dust control were made for each sampled worker throughout the day. Central dust collectors were evaluated for efficiency by measuring air velocity and flow for the main duct and comparing measurements to manufacturer's specifications and ''best-design'' values.

A personalized, tailored letter with sampling results and recommendations for lowering dust levels was prepared. Shops were then randomized into the control or intervention group. Shops in the control group received the letter by mail; intervention shops received a personal visit from a study researcher. Intervention shops then received further assistance, as described in Table IV. Ultimately, 48 shops (24 control, 24 intervention) were successfully recruited into the study; one shop was lost to follow-up (Lazovich et al., in review).

DISCUSSION AND CONCLUSIONS

The PRECEDE–PROCEED model proved to be a useful framework on which to base planning for this study. It encouraged us to work closely with the community of small woodworking shops as we developed a better understanding of the types of controls, their availability and use, and the barriers and incentives among owners and employees for controlling dust. Understanding all of the factors that would influence both owners' and employees' adoption of our recommendations was crucial to designing and implementing an effective intervention.

Our work with the planning committee was key to establishing our credibility within this community. While recognizing that a variety of health and safety hazards exist in these shops, we hoped that by focusing on one such hazard we could help owners and employees gain familiarity and confidence with lowering its effects. This, in turn, would extend to further efforts by owners and employees to minimize other hazards in a shop.

Our team included professionals from epidemiology, behavioral sciences, industrial hygiene, occupational medicine and forest products. The range of skills and knowledge from this variety of researchers brought considerable strength to the development phase of this study. The team's diversity added to our level of understanding of the many issues we faced; it also enhanced our creativity in finding solutions and designing intervention activities.

One limitation of this study was the lack of involvement of employees in our planning activities, other than as participants in a small focus group. We found no easy solutions to this; employees in most small businesses are generally not affiliated with a professional organization or union.

TABLE IV. Description of Interventions

Component	Intervention description	Type of control emphasized	Reasons for selecting intervention activity	Expected results	Target of activity
Preliminary recommendations	Formal meeting with owner including: (1) discussion of letter with results of dust sampling, task & ventilation use sampling, ventilation system measurements, and recommendations for improving dust levels; and (2) discussion of all further intervention activities	Engineering	Knowledge of dust levels and controls will motivate owner	Owner will adopt or improve controls	Owner
Introduction to intervention activities			Personal interaction with study researcher will build rapport and enhance initial agreement to make changes		
Detailed technical assessment and recommendations	Second letter sent to owner describing further dust control system measurements and additional recommendations for improving system operation	Engineering	Detailed information about central dust control systems will motivate owner Personal interaction with study researcher builds rapport and personal relationship	Owner will adopt or improve central dust collection system	Owner
Worker training	Educational session with employees (owner also invited)	Administrative	Knowledge of health effects and dust controls will motivate employees to use controls, if available	Employees will use dust controls more frequently	Employees (directly)
			Build employee confidence and remove stigma from making effort to lower dust levels	Employees will feel responsible for using controls to protect themselves and their peers	Owners (indirectly)
			Increase interaction among employees and encourage employees to make suggestions to owners about lowering dust levels	Employees will be motivated to recognize problem areas and communicate their suggestions to owners	
Helping owner set priorities Small grant	Final meeting with owner to provide overview of all intervention activities, give a prioritized list of recommendations, offer a small grant (US$ 650) if one of these recommendations is carried out	Engineering Administrative	Motivate owner to make at least one change Provide information and technical assistance Further build personal relationship between study personnel and owner	Owner will select at least one activity to carry out	Owners
Tour	Owners & two employees (of owner's selection) invited to a short education session on dust collection systems and health and safety programs followed by a tour of a "model" shop	Engineering	Motivate owner to make changes in shop	Owner will be motivated to make health and safety and dust control changes in shop	Owners
		Administrative	Provide information and technical assistance Build relationships between individual shop owners Give owners an opportunity to see how other shops control dust	Employees will be motivated to use dust control and make recommendations to owners	Employees

A more important limitation was our reliance on health and safety professionals as the primary means of informing and motivating owners about wood dust control. Future studies should focus on ways to utilize peers or suppliers in delivering health and safety messages and encouraging owners to make changes.

Intervention development is an iterative process requiring input from a wide variety of resources. Including each of the elements discussed here and allowing enough time for their completion are key issues in assuring both a well-informed intervention and a well-designed outcome measure. Following a planning model such as PRECEDE–PROCEED assures that the full range of important questions and issues are addressed throughout intervention development. In hindsight we would have allowed an even longer planning period and would have included a pilot test of the intervention activities for a greater appreciation of the difficulties involved in implementation.

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REFERENCES

ACGIH. 1998. Industrial Ventilation: A Manual of Recommended Practice. Cincinnati: American Conference of Governmental Industrial Hygienists.

Brosseau LM, Parker DL, Lazovich D, Dugan S, Milton T, Pan W. 2001. Inhalable dust exposures, tasks, and use of ventilation in small woodworking shops: A pilot study. Am Ind Hyg Assoc J 62:322–329.

Bureau of the Census. 1996. County business patterns 1994, United States. Washington, DC: US Department of Commerce, Bureau of the Census.

Burton DJ. 1997. General methods for the control of airborne hazards. In: DiNardi SR, Editor. The occupational environment—its evaluation and control. Fairfax, VA: American Industrial Hygiene Association.

CFR. 1989. Subpart Z, toxic and hazardous substances, Table Z-1-A limits for air contaminants. Code of Federal Regulations Title 29 Part 1910.1000 Air Contaminants.

Chan-Yeung M, Malo JL. 1995. Occupational respiratory diseases associated with forest products industries. In: Harber P, Schenker M, Balmes J, Editors. Occupational and environmental respiratory diseases. St. Louis, MO: Mosby.

Demers PA, Teschke K, Kennedy SM. 1997. What to do about softwood dust? A review of respiratory effects and recommendations regarding exposure limits. Am J Ind Med 31:385–398.

Enarson DA, Chan-Yeung M. 1990. Characterization of health effects of wood dust exposures. Am J Ind Med 17:33–38.

Goldenhar LM, Schulte PA. 1994. Intervention research in occupational health and safety. J Occup Med 36(7):763–775.

Goldsmith DF, Shy CM. 1988. Respiratory health effects from occupational exposure to wood dusts. Scand J Work Environ Health 14:1–15.

Green LW, Kreuter MW. 1991. Health promotion planning: an educational and environmental approach. Mayfield, CA: Mountain View.

Green LW, Kreuter MW, Deeds SG, Partridge KB. 1980. Health promotion planning: a diagnostic approach. Mayfield, CA: Mountain View.

Hampl V, Topmiller JL, Watkins DS, Murdock DJ. 1992. Control of wood dust from rotational hand-held sanders. Appl Occup Environ Hyg 7(4):263–270.

IARC Working Group. 1995. Wood dust and formaldehyde. Lyon: International Agency for Research on Cancer.

Lazovich D, Parker D, Brosseau L, Milton F, Dugan S, Pan W, Hock L. Effectiveness of a worksite intervention to reduce occupational exposure: The Minnesota Wood Dust Study. Am J Public Health (in review).

Martin JR, Zalk DM. 1997. Carpenter shop wood dust control: practical experience to reduce hardwood dust exposures below the American Conference of Governmental Industrial Hygienists Threshold Limit Values. Appl Occup Environ Hyg 12(9):595–605.

Pederson DH, Sieber WK. 1988. National Occupational Exposure Survey Vol. 3: Analysis of management, interview responses. Cincinnati, OH: US Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

Roscoe RJ, Steenland K, McCammon CS, Schober SE, Robinson CF, Halperin WE, Fingerhut MA. 1992. Colon and stomach mortality among automotive wood model makers. J Occup Med 34: 759–770.

Wiatrowski WJ. 1994. Small businesses and their employees. Monthly Lab Rev (October):29–35.