FEATURE ARTICLE
Research

Processes of Care for Individuals With Work Related Asthma

Treatment Characteristics and Impact of Asthma on Work

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ABSTRACT

The prevalence of asthma among working adults continues to rise each year. The California Department of Health Services conducts surveillance of work related asthma (WRA) to classify each work related exposure using Doctor's First Reports of Occupational Illness and Injury (DFRs). Using a cross-sectional, descriptive, comparative design, additional interviews were conducted and medical records were reviewed to explore workers' and providers' perceptions of follow up care. Two cohorts were compared: workers with WRA who belonged to a large, single HMO (n = 79) and workers with WRA who underwent follow up outside this HMO (n = 76). The interview asked about providers seen, tests ordered, and the impact of asthma on work. The HMO clients were significantly more likely than the non-HMO clients to see occupational medicine specialists (p = .004) and have pulmonary function testing (p = .049) during initial treatment. Twenty-four percent of clients currently working reported missed workdays caused by asthma in the past 6 months. The findings indicate management of WRA varies by health care system in California.

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Asthma is a chronic inflammatory disease of the airways and lungs characterized by episodic and reversible symptoms of airflow obstruction (National Asthma Education and Prevention Program, 1997). The inflammatory process that occurs in asthma causes the airways to become hyperresponsive to various chemical, biological, or physical stimuli, some of which may occur in workplace settings (Milton, 1998). A variety of workplace allergens and irritants known to cause and worsen the disease have been identified (Bernstein, 1999). Asthma is also one of the leading medical conditions associated with limitation in the ability to work and lost work time (Malo, 1999). The 2002 National Health Interview Survey reported 14.5 million workdays per year were lost from 1994 to 1999 because of asthma in the United States. This reflects 2.5 days per year for each adult with asthma (Centers for Disease Control and Prevention, 2002). The cost of lost workdays as a measure of

What Does This Mean for Workplace Application?

Taking a detailed occupational health history is crucial in establishing a diagnosis of work related asthma (WRA). Every attempt should be made to determine the specific triggering agent in addition to estimating the exposure "dose" and proximity to the worker as well as the use or absence of workplace controls. Occupational health nurses caring for clients with WRA can advocate for appropriate modified duty and part time employment in cases in which workers should not be re-exposed to the suspected workplace agent. In cases of sensitizer induced WRA, complete cessation of exposure is necessary and vocational rehabilitation must be considered.
Individualized workplace asthma education and information about appropriate protection from exposure should be introduced to workers at regular intervals. This information can be incorporated into a teaching session when serial pulmonary function testing is performed so workers can better understand the connection between exposure and protection and actual lung function values.

asthma caused work disability increased by 18% among men and 24% among women from 1985 to 1990 (Weiss, 2001).

Although there are published standards of care for the diagnosis, assessment, and management of work related asthma (WRA) (Chan-Yeung, 1995; Friedman-Jimenez, 2000; Tarlo, 1998), there is little research on the processes of care delivered by health care providers after the disease has been diagnosed. Evaluation of clinical follow up care after diagnosis of WRA and the level of disability caused by asthma from both the clients' and clinicians' perspective is essential to document the impact asthma has on the ability to work. Obtaining information on the follow up care after diagnosis of WRA using surveillance methods not only helps determine the level of asthma severity and appropriate treatment for clients but also can serve as a useful tool in evaluating disability.

WRA includes new onset asthma caused by workplace exposures to sensitizers, irritants, or a combination of both, and preexisting asthma exacerbated by workplace agents. A diagnosis of WRA is warranted when evidence of an association between the pattern of airway obstruction and workplace exposure to a precipitating factor exists. The current recommended standard of care for treatment of WRA involves early recognition, removal or protection from exposure, and regular follow up to monitor health status. While prompt identification and removal from the workplace exposure is ideal for individuals exposed to a known sensitizer, data suggest health care providers fail to ask relevant questions about work exposures and their relationship to asthma symptoms (Harber, 1995). In one study of an HMO with approximately 79,000 clients with asthma, physicians documented asking about work related symptoms in only 15% of charts, and none diagnosed occupational asthma or reported the cases to the state surveillance system (Milton, 1998).

SURVEILLANCE OF WORK RELATED ASTHMA

In 1993, the California Department of Health Services, Occupational Health Branch (OHB/DHS), funded by the National Institute for Occupational Safety and Health (NIOSH), began surveillance of WRA. California joined Massachusetts, Michigan, and New Jersey, which began surveillance of WRA in 1987. All four states use the Sentinel Event Notification System for Occupational Risks (SENSOR) model, which identifies and classifies WRA based on sentinel reports. SENSOR WRA surveillance categories, case definitions, and reporting guidelines for state health departments have been described previously (Jajosky, 1999).

In California, cases are identified through Doctor's First Reports of Occupational Injury and Illness (DFRs). By law, the insurer must send DFRs to the Department of Industrial Relations, Division of Labor Statistics and Research (DIR/DLSR) whenever a physician sees a client for a work related illness or injury. The OHB/DHS also receives DFRs directly from one large HMO. In the Michigan and New Jersey SENSOR projects, medical discharge records are also actively solicited to identify potential WRA cases. Previous research indicates medical records have proven to be useful data sources for occupational disease surveillance (Balmes, 1992). Results of the SENSOR occupational asthma surveillance project both nationally (Jajosky, 1999) and in California (Reinisch, 2001) have been reported previously.

The California SENSOR program for identification of WRA reported 2,603 cases from March 1, 1993 through December 31, 2000. The SENSOR questionnaire for WRA asks participants questions related to demographics, work history, workplace exposures, employer information, workers' compensation, and medical information related to current asthma. While this questionnaire provides much needed information on the relationship between specific industries contributing to WRA and exposures in workplace settings, little information exists in regard to the follow up care workers receive after being diagnosed and the impact of asthma on work.

This study was undertaken to determine the initial, follow up, and current health care of individuals with WRA. The purpose was to describe the clinical evaluation and treatment of WRA after diagnosis through client interviews. To gain the health care provider's perspective of the actual care delivered to the client, pilot data were collected on similar questions asked of the client during the interviews using medical record review. The primary goals of this study were to assess the clinical follow up in a population based sample of participants with WRA and to describe the level of disability associated with WRA in a sample of California workers. Secondary goals included comparing the clinical follow up and level of disability caused by asthma for the same participants with WRA

Table 1

Demographics for Workers With Work Related Asthma (WRA)

	HMO (Group 1) (n = 79)	*Non-HMO (Group 2) (n = 76)*	*Total (N = 155)*
Age (years) (mean ± *SD*)	46.4 ± 11.8	46.1 ± 10.0	46.3 ± 11.0
Gender			
Male	16 (20.3%)	22 (28.9%)	38 (24.5%)
Female	63 (79.7%)	54 (71.1%)	117 (75.5%)
Years of education (mean ± *SD*)	14.2 ± 3.6	14.4 ± 2.4	14.3 ± 3.0
Race			
White*	62.0%	86.8%	74.2%
African American	11.4%	5.3%	8.4%
Asian/Pacific Islander	7.6%	2.6%	5.2%
Native American	1.3%	0%	.6%
Other	15.2%	2.6%	9.0%
Missing	2.6%	2.6%	2.5%
Ethnicity			
Hispanic	22.8%	19.7%	21.3%
Non-Hispanic	74.7%	76.3%	75.5%
Missing	2.5%	3.9%	3.2%
Type of WRA			
Irritant	36.7%	35.5%	36.1%
Sensitizer	6.3%	6.6%	6.5%
Work aggravated	49.4%	50.0%	49.7%
Reactive airway dysfunction syndrome	7.6%	7.9%	7.7%

**Post hoc χ^2 statistic (using Scheffe criteria) at $p < .05$.*

who received care through a single HMO (Group 1) and those who received care from providers outside of this HMO system (Group 2) in California.

METHODS

Participants were recruited through DFRs sent to the DIR/DLSR between 1998 and 2000. The DFR is a statewide surveillance tool based on mandated reporting of all medical claims for suspected or known occupational illnesses or injuries (Occupational Injury or Illness Reports, 1994). All DFRs were manually reviewed, and potential asthma cases were selected by trained staff and confirmed by an OHB/DHS physician; these served as the source of participants for recruitment to this study. Duplicate and secondary DFR reports were eliminated.

All participants had taken part in the initial SENSOR interview, which classified each WRA case based on information previously noted. For this study, the first WRA incident served as the starting point for health care assessment. Participants from Group 1 were contacted first. A comparison, stratified sample of potential Group 2 participants equal in number to the Group 1 sample was randomly selected based on case classifications similar to those used in the ongoing SENSOR project. The classifications used in this study (i.e., work aggravated, reactive airway dysfunction syndrome [RADS], irritant, and sensitizer) were based on the original SENSOR case classifications of work aggravated, RADS, new onset with known inducer (sensitizer), and new onset with unknown inducer (irritant). If a participant could not be contacted or declined to participate, a potential replacement participant from the same case classification was identified to ensure equal numbers of WRA types in Groups 1 and 2. Medical records were obtained with the client's consent to gather information on care delivered for the first incident and subsequent follow up periods.

DFRs were reviewed to obtain recruitment data, and participants were interviewed by telephone after receiving verbal informed consent. Prior to participation, participants were informed that only the investigators would have access to study information and no attempt would be made to contact a past or present employer. The study was approved by the University of California, San Francisco Committee on Human Research and the State of California Health and Human Services Agency, Committee for Protection of Human Subjects.

All participants were California workers age 18 or older who spoke either English or Spanish and had:

- Undergone examination by a health care provider who

Table 2

First Provider Seen for Evaluation of Work Related Asthma

	HMO (Group 1) (n = 78)		*Non-HMO (Group 2) (n = 74)*		*Total (N = 152)*		
	n	%	n	%	n	%	p *Value**
Occupational medicine	24	30.8	8	10.8	32	21.1	.003†
Pulmonologist	2	2.6	5	6.8	7	4.6	NS
Allergist	3	3.8	2	2.7	5	3.3	NS
Internist	27	34.6	19	25.7	46	30.3	NS
Family practice	1	1.3	6	8.1	7	4.6	NS
Other‡	21	26.9	34	45.9	55	36.2	NS

**Overall $\chi^2 = 17.43$, df = 5, p = .004.*

†Post hoc χ^2 test using Scheffe criteria p < .05, NS = not significant.

‡Other = emergency room physician, nurse practitioner, physician assistant, obstetrician, toxicologist.

completed and submitted a DFR noting a diagnosis of asthma, reactive airway disease, or RADS.

- Completed the initial SENSOR WRA interview and had their case confirmed and classified.
- Possessed a permanent address and telephone number.

Of 215 eligible participants who were asked to participate in the follow up interview, 155 adults agreed to participate. Three trained health care professionals conducted the interviews. Three percent ($n = 5$) of the interviews were conducted in Spanish.

A questionnaire was used to assess the type of information provided to clients after they were diagnosed and the impact of asthma on their ability to perform their job. The study assessed the types of health care providers seen by clients during initial and follow up treatment phases and what types of tests, if any, were performed to confirm the diagnosis and evaluate their disease. The questionnaire comprised 44 questions based on a critical review of the literature, multiple interviews with experts in the fields of occupational and pulmonary medicine, and questions currently used in a large scale epidemiologic study of asthma in California (Blanc, 1996).

Data were analyzed using Statistical Package for Social Sciences, version 10.0.5 (SPSS Inc., Chicago, IL). Descriptive statistics such as frequency distributions, means, and standard deviations were used to summarize demographic information. A combination of categorical, nominal, and continuous independent variables were evaluated for their relationship with the outcomes of interest. Between group comparisons incorporated the use of *t* tests for continuous, quantitative dependent variables and either chi-square or McNemar test for categorical data.

RESULTS

Demographics

Demographic and related information is provided in Table 1. The mean age of participants was 46.3 years, and women comprised 75.5% of the sample. Almost half (49.7%) of all cases were classified as work aggravated. Mean age, mean years of education, and gender were similar for Groups 1 and 2.

Census coding for race and ethnicity was used to classify all study participants on these variables (U.S. Census Bureau, 2000b). Groups 1 and 2 differed on racial identification (overall $x^2 = 14.89$, $df = 5$, $p = .01$), with significantly more white participants in Group 2 than in Group 1 (post hoc $x^2 = 13.57$, $p < .001$). Census Occupational Classification (COC) and Standard Industrial Classification (SIC) (U.S. Census Bureau, 2000a) data were obtained on all 155 workers. More than half (54.2%) of the study population was either in management or professional specialty or administrative support occupational positions. Management or professional specialty occupations included such categories as health care providers and teachers. Administrative support categories included such occupations as general office supervisors and clerical workers. More "blue collar" workers sought care outside the single HMO system (62.2%) than the HMO facility (37.8%). However, no significant differences were demonstrated on either occupational or industrial classification characteristics between Groups 1 and 2.

Initial Treatment

Questions 1 to 3 of the questionnaire addressed the initial assessment and treatment phase after asthma was found to be work related. The type of health care provider seen initially for the first incident of WRA can be found in Table 2. The majority (71.1%) of WRA clients were seen initially by general health care providers, including nurse practitioners (5.5%). Approximately 21% of clients first saw occupational medicine specialists. Significant differences were found between Groups 1 and 2 on the type of initial health care provider seen (overall $x^2 = 17.43$, $df = 5$, $p = .004$). The type of first care provider

Table 3

First Treatment Recommendations Made by Initial Provider for Workers With Work Related Asthma

	HMO (Group 1) (n = 79)		*Non-HMO (Group 2) (n = 76)*		*Total (N = 155)*		
	n	%	n	%	n	%	p *Value*
Medication changes							
Yes	53	67.1	52	68.4	105	67.7	NS
No	26	32.9	24	31.6	50	32.3	
Personal protective equipment							
Yes	16	20.3	7	9.2	23	14.8	NS
No	63	79.7	69	90.8	132	85.2	
Workplace exposure avoidance							
Yes	36	45.6	31	40.8	67	43.2	NS
No	43	54.4	45	59.2	88	56.8	
Work environment changes							
Yes	7	8.9	7	9.2	14	9.0	NS
No	72	91.1	69	90.8	141	91.0	
Different position in same company							
Yes	21	26.6	10	13.2	31	20.0	.037*
No	58	73.4	66	86.8	124	90.0	
Different position in different company							
Yes	6	7.6	2	2.6	8	5.2	NS
No	73	92.4	74	97.4	147	94.8	
Work retraining							
Yes	1	1.3	1	1.3	2	1.3	NS
No	78	98.7	75	98.7	153	98.7	
Stop work completely							
Yes	4	5.1	5	6.6	9	5.8	NS
No	75	94.9	71	93.4	146	94.2	
Other†							
Yes	7	8.9	2	2.6	9	5.8	NS
No	72	91.1	74	97.4	146	94.2	
None							
Yes	7	8.9	9	11.8	16	10.3	NS
No	72	91.1	67	88.2	139	89.7	

χ^2 test p < .05, NS = not significant.

†*Other = substitution, avoiding exertion, home environmental changes, avoiding exposures outside of work, peak expiratory flow monitoring, wear medic alert identification, homeopathic therapy.*

seen did not differ significantly based on type of WRA ($x^2 = 20.98$, $df = 15$, $p = .137$), gender ($x^2 = 2.82$, $df = 5$, $p = .727$), or type of occupation (blue collar versus white collar) ($x^2 = 5.10$, $df = 5$, $p = .404$).

Approximately 30% of the total sample reported pulmonary function testing was performed by the first health care provider. Significantly more participants from Group 1 ($n = 29$) reported having pulmonary function testing performed by the first provider than those in Group 2 ($n = 17$) ($x^2 = 3.82$, $df = 1$, $p = .049$). Clients who described seeing specialists ($n = 21$) for the initial assessment were significantly more likely to have pulmonary function testing performed ($x^2 = 12.25$, $df = 1$, $p < .001$). Allergen skin testing was significantly more prevalent in Group 1 ($p = .008$).

Treatment recommendations made by the first health care provider are summarized in Table 3. Approximately 68% of the total sample reported having asthma medication changes during the initial treatment phase, while only 1.3% of the sample reported receiving any recom-

Table 4

Workplace Asthma Education Provided

	HMO (Group 1) (n = 15)		Non-HMO (Group 2) (n = 11)		Total (N = 26)		
	n	%	n	%	n	%	p Value
Reduce exposure							
Yes	12	80.0	7	63.6	19	73.1	NS
No	3	20.0	4	36.4	7	26.9	
Personal protective equipment							
Yes	8	53.3	3	27.3	11	42.3	NS
No	7	46.7	8	72.7	15	57.7	
Medications to bring to work							
Yes	11	73.3	3	27.3	14	53.8	.02*
No	4	26.7	8	72.7	12	46.2	
Peak flow monitoring							
Yes	6	40.0	1	9.1	7	26.9	NS
No	9	60.0	10	90.9	19	73.1	
Symptom monitoring							
Yes	8	53.3	2	18.2	10	38.5	NS
No	7	46.7	9	81.8	16	61.5	
Other†							
Yes	1	6.7	3	27.3	4	15.4	NS
No	14	93.3	8	72.7	22	84.6	

*χ^2 test p < .05, NS = not significant.
†Other = latex specific exposure instructions.

mendations related to worker retraining as a result of their asthma. More providers encouraged Group 1 workers than Group 2 workers to consider transferring to a different position within their company to avoid exposure from the suspected trigger ($x^2 = 4.36$, $df = 1$, $p = .037$).

Referral and Follow up Treatment

After a WRA client was initially evaluated and treated, the first provider assessed whether the client should be referred to another clinician for asthma treatment or whether follow up care for asthma should be continued by the initial provider. Fifty-eight (37.4%) workers were referred to other health care providers (both specialists and generalists) after screening for the initial incident of WRA. Approximately 40% of the total sample referred to a consultant were seen by an occupational medicine specialist. One hundred fifteen (74.2%) workers received follow up from their initial treatment provider (including some who also received follow up by an additional consultant).

Of the 58 workers who were referred for follow up care with a consultant provider after the initial treatment phase, 30 (51.7%) described having additional tests ordered. Pulmonary function testing was ordered with similar frequency in both health care groups (76.5% vs. 76.9% for Groups 1 and 2, respectively) by the consulting provider. For workers who stated they did not receive follow up by a health care provider for further care of their WRA (n = 38), 81.6% felt their asthma was improved and follow up was not needed, 4 did not receive any recommendation by their provider for follow up, and the 3 remaining workers were told to seek further care but chose not to do so.

Workplace Environmental Assessment

Only 10 (6.5%) workers stated that a physician came to assess their workplace environment and half described these providers as occupational medicine specialists. No significant differences were identified on this variable based on health care group, WRA case classification, or occupation. Twenty-nine workers (18.7%) stated that a physician asked for exposure information (e.g., Material Safety Data Sheet) with no significant differences found based on provider type.

Asthma Education

Fifty-four percent (n = 84) of workers stated they received some asthma information from a health care provider during the course of treatment. No significant differences were identified on this variable based on case

Table 5

Impact of Asthma on Work

	HMO (Group 1) (n = 58)	*Non-HMO (Group 2) (n = 60)*	*Total (N = 118)*	p *Value*
Complete workdays lost in past 6 months				
No	45	45	90	
Yes	13	15	28	NS
Mean days lost (mean ± *SEM*)	3.22 ± 1.64	2.12 ± .87	2.66 ± .92	NS
Partial workdays lost in past 6 months				
No	47	54	101	
Yes	11	6	17	NS
Mean days lost (mean ± *SEM*)	.53 ± .21	.82 ± .52	.67 ± .28	NS
Work task difficulty (mean ± *SEM*)	.80 ± .15	.97 ± .18	.88 ± .11	NS
Job effectiveness (mean ± *SEM*)	93.0 ± 12.86	94.25 ± 11.29	93.62 ± 12.07	NS
Job duty change				
No	30	33	63	
Yes	28	27	55	NS

**NS = not significant.*

classification or occupation. More than 90% (n = 76) of all workers who received asthma education stated they received general asthma information. Although there were no statistically significant differences between Group 1 and Group 2 participants who received general or asthma management information, Group 1 providers referred their clients more often to asthma classes (x^2 = 15.43, df = 1, p = .000) and also gave instructions on when to call the clinician or seek emergency care for an asthma crisis (x^2 = 4.49, df = 1, p = .034). Specialist health care providers did not differ from generalist health care providers on referring their clients to asthma classes.

Of the 84 workers who received asthma information, 26 (30.9%) stated they received specific education about asthma in the workplace (see Table 4). The delivery of specific workplace educational information did not differ based on case classification or occupation. Of these workers, 19 (73.1%) received information on ways to reduce or minimize workplace exposure. Group 1 providers gave their clients information on medications to bring to work more frequently than Group 2 providers (x^2 = 5.42, df = 1, p = .02). Further comparisons on workplace information related to medications to bring to work revealed no significant differences based on gender (x^2 = .465, df = 1, p = .495), occupational type (blue collar versus white collar worker; x^2 = .202, df = 1, p = .653), or type of WRA (x^2 = 1.33, df = 3, p = .722).

Impact of Asthma on Daily Activities and Work

Multiple measures, such as complete and partial workdays lost, job effectiveness, and job duty changes caused by asthma, were used to assess clients' perceptions of asthma related work disability (see Table 5). Approximately one fourth of clients reported a mean number of 2.66 workdays lost because of asthma in the previous 6 months. Approximately 50% reported that at some point in their work history, they had to make job duty changes because of their asthma. Such changes ranged from wearing personal protective equipment to altering the hours and days worked (e.g., shift change, weekends only) to avoid experiencing asthma symptoms while working.

Follow up Characteristics From the Providers' Perspective

Pilot data were collected using medical records and served as a proxy for the health care providers' perspective of the care delivered to the worker to determine similar results for questions asked of the worker during the follow up interview. A total of 108 (69.7%) individuals consented to review of medical records. No significant differences between Group 1 (n = 56) and Group 2 (n = 52) workers were noted on this variable (x^2 = 1.98, df = 2, p = .372). To date, 55 (35.5%) medical record release forms have been received; of these, 37 individuals' records have been collected and reviewed for similar content asked during the interview.

Agreement Between Client Self Report and Health Care Provider Documentation

For questions whereby adequate data on findings were available to assess for agreement between client statements during the telephone interview and documentation in the medical record by the health care provider, a McNemar test was performed to determine the Kappa statistic for each variable (see Table 6). Question one of the interview, addressing the type of first health care

Table 6

Selected Process of Care Assessments After DFR From Patient and Provider Perspective

	n	% Agreement*	Kappa Statistic	p Value
First provider seen	28	64%	.478	< .001†
First provider PFT done	29	76%	.334	.041†
First provider recommended PPE	29	93%	.633	< .001†
First provider workplace exposure avoidance	29	41%	−.128	.436
First provider recommended different position same company	29	72%	.065	.694
Current provider PFT done	9	78%	.550	.099
Current provider workplace exposure avoidance	9	78%	.357	.284
Any provider asked for exposure information	21	86%	.351	.035†

**Between patient self report and provider documentation.*

†$p < .05$.

DFR = Doctor's First Report, PFT = pulmonary function testing, PPE = personal protective equipment.

provider seen for the initial incident of WRA ($n = 28$), illustrated a 64% agreement between client self report and provider documentation (Kappa = .478) and was highly significant ($p < .001$). The number of similar findings for provider documentation and client report related to asthma education was low ($n = 4$). However, these were in 100% agreement (Kappa = 1.00, $p = .046$).

DISCUSSION

This population based study provides important data on the type of health care received by California workers with WRA. Information from this project furnishes investigators with relevant, new data about the state of asthma related care received by affected workers in California. Evidence suggests testing and treatment protocols recommended in practice guidelines developed to standardize the diagnosis and management of WRA are not being performed. The data further indicate the overall health care after diagnosis of WRA can improve and evidenced based recommendations such as removal from workplace exposures are not communicated to clients nor documented by providers. Moreover, assessment and management of WRA appears to vary by the health care system in which treatment is delivered.

Identifying cases of WRA is often difficult and complex because of a multitude of causes in a vast array of industrial environments, variability in symptom presentation, and the requirement of specific diagnostic testing (Chan-Yeung, 1995). The complexity in determining whether asthma is work related contributes to underestimation and underrecognition of a disease that significantly impacts society. This research provides initial evidence that quality health care for individuals with WRA is lacking in California and an emphasis on encouraging the use of and monitoring WRA practice guidelines is necessary to improve client outcomes.

Two thirds of clients reported receiving treatment for their first WRA incident by generalist, nonspecialist health care providers. Treatment recommendations varied by clinician. For example, only 20% of clients who saw generalists received pulmonary function testing, while 50% of those who saw specialists underwent pulmonary function testing. As shown by previous published research, lack of pulmonary function testing may lead to underrecognition of WRA (Chan-Yeung, 1995) because spirometry not only confirms the presence of asthma, but also can establish work relatedness of the disease (Jajosky, 1999).

Few medical records were available. However, those that were obtained revealed 76% agreement between client self report and provider documentation on the performance of initial pulmonary function testing, which suggests workers' recall was generally accurate related to performance of this critical test. Furthermore, this finding is consistent with a practice based survey by chest physicians that identified pulmonary function testing was performed by approximately half (44%) of the specialist physician respondents who provided direct services to industries and unions (Harber, 1995).

More clients from Group 1 described seeing occupational medicine physicians during their initial treatment phase than clients from Group 2. This finding was not surprising as there are numerous integrated occupational medicine clinics within this single HMO system in California. Many of these occupational medicine clinics have onsite access to pulmonary function and immunologic testing, both of which are considered important components of confirmatory evaluation for WRA.

A total of 58 (37.4%) clients described being referred to another treatment provider for care of their WRA. Of the 35 Group 1 clients who were referred, 18 (51%) were

referred to occupational medicine specialists after seeing either a generalist or another type of specialist for their first WRA incident. Of the 23 Group 2 clients who were referred, only 5 (21.7%) were referred to occupational medicine specialists for further follow up. While this comparison was not statistically significant, it is noteworthy to observe that more than twice as many Group 1 clients were referred to occupational medicine specialists for evaluation. Again, this may reflect the ease with which referrals are made in this particular HMO system and that authorizations from outside agencies are not required to proceed with the health care provider's request.

The low number of physicians who made onsite assessments of the workplace ($n = 10$) was discouraging but not surprising. Although it is important for treating clinicians to be aware of workplace exposures, visits to the workplace involve complex dynamics and possibly conflicting sets of priorities. While clients may want clinicians to assess their workplace to develop a relevant care plan, if the care plan were to involve job change recommendations that would put clients at risk for loss of income or prestige, clients might be reluctant to have this assessment made. Furthermore, many workers fear job loss if they request that a health care provider or other qualified individual come and assess their workplace because of a potential hazard.

Group 1 health care providers furnished more information to their clients on daily symptom management. They were more likely to provide information about medications to bring to work ($p = .020$), peak flow ($p = .079$), and symptom monitoring at work ($p = .069$). Serial peak flow monitoring at work has been recommended as a method to confirm the work relatedness of asthma (Chan-Yeung, 1995; Friedman-Jimenez, 2000; Maestrelli, 1992). While some clinicians doubt the validity of peak flow monitoring because it is both effort and technique dependent, a 1998 Canadian study found unsupervised serial peak flow monitoring was more accurate than unsupervised serial force expiratory volume in one second (FEV1) monitoring in the diagnosis of occupational asthma (Leroyer, 1998). This finding is important as FEV1 has often been considered the gold standard measurement in the diagnosis and continual assessment of asthma.

LIMITATIONS

This population based study provided rich, new data on the state of initial and follow up health care for workers with varying types of WRA in California. Random stratified sampling within each type of WRA reduced sampling bias and the potential for confounders. Participants were interviewed in both English and Spanish and were from both urban and rural areas of northern, central, and southern California. The sample was racially and ethnically diverse, and representative of California's identified adult WRA population (Reinisch, 2001). However, the sample was overwhelmingly female (75.5%). In California, between March 1993 and February 1996, a higher case rate of WRA also was found among women (28 per million) than among men (18 per million) (Reinisch, 2001). Pooling potential participants for this study from an already female-heavy sample of WRA clients may have further biased the sample.

While the sample was diverse, it may not have adequately represented the growing number of low income, ethnic minority workers within the state who have been previously identified in a larger, statewide survey that examined self reported asthma prevalence (Von Behren, 2002). This limitation may be attributed, in part, to the fact that some low wage workers may not have regular, steady employment, which limits the ability to file a DFR in California. However, participants did represent all general occupational and industrial categories, from blue collar to white collar workers; workplace exposures, while not reported on in this continuation study, varied greatly.

The study findings confirm that overall follow up health care of WRA clients in California is lacking. Furthermore, care provided is not consistent with recommended standards identified in existing evidence based clinical guidelines. The study further determined that although clients from Group 1 received more uniform management, this treatment did not appear to impact their current disability more positively than clients in Group 2. However, the same could also be said of those clients who were under the care of specialists as opposed to generalist health care practitioners as there were no significant differences in current work related disability between these two groups of clients. Further longitudinal research is needed in this area to determine the impact of specific testing and treatment recommendations for WRA by a variety of health care providers, including nurse practitioners, on clinical client outcomes such as disability, pulmonary function, and functional status.

While using DFRs provides the OHB/DHS with a rich source of information in regard to the work related incident, there are numerous limitations. The forms used may be highly variable and are frequently outdated, making it difficult to consistently obtain all the required information (e.g., client contact information). In some cases, health care providers filling out the form omit key sections such as clinical findings and treatment, which may contribute to inaccurate diagnoses. DFRs do not cover self employed, maritime, or federal workers, leaving workers in these occupations underrepresented. High risk workers such as low wage workers frequently are missed because of fear of reporting or lack of steady employment with a company carrying workers' compensation insurance. These limitations all may contribute to an inaccurate account of WRA in the state.

The low number of medical records received to date also may impact the study's findings and may not truly represent the entire sample of workers interviewed. A potential for bias exists because medical records may not be released for a variety of reasons. For example, participants who are good historians may be the same people most likely to be responsible about filling out the appropriate paperwork for the release of records.

While there were no significant differences between Group 1 and Group 2 participants on work disability measures, potential confounders such as socioeconomic

status and health care benefit status were not measured in this study. This is important to note as these variables may have impacted some individuals' decisions to continue working despite their WRA because they did not have adequate health care benefits or could not afford to stop working. Furthermore, because few objective measures of asthma severity (e.g., pulmonary function testing data) were available, it is unknown whether Group 1 or Group 2 participants had more severe asthma. Previous SENSOR research conducted not only in California but also in New Jersey, Massachusetts, and Michigan also lacked these important data, citing this gap as "an apparent reflection of usual medical practice" (Jajosky, 1999). Future research also should focus on incorporating lung function measurements to determine their impact on disability and guideline efficacy.

Finally, this study was retrospective and cross sectional in design, and was based on the first incident of WRA, not necessarily the DFR incident. Some participants were asked to recall details related to their WRA health care experience that occurred as long as 7 years ago. Remarkably, many clients felt they were able to accurately recall this information because the incident was so traumatic and it affected their daily work life. However, it is possible some reported details may have been inaccurate because of this time interval.

IMPLICATIONS FOR OCCUPATIONAL HEALTH NURSING

Occupational health nurses, whether working onsite in an industrial setting or in an outside clinic, are likely to care for clients with WRA. Thus, it is important for occupational health nurses to possess both the necessary skills to identify asthma related signs and symptoms and the knowledge to manage these clients. Nurse practitioners in industrial settings need to focus on taking a thorough occupational health history that includes a detailed understanding of the circumstances of the onset of asthma as well as the temporal relationship between any recurrent exposures and disease exacerbations. Data should be gathered related to the "dose" of the causative or triggering substance as well as any environmental controls, measures, or modifications to the workplace that have been instituted. Assessment by occupational health nurse practitioners also must include a focused complete examination of the respiratory system as well as measures of pulmonary function, which may include spirometry, serial peak expiratory flow, and bronchial provocation testing.

Onsite occupational health nurses are uniquely qualified to provide worker education about occupational lung disease, especially in settings when time is needed to introduce new engineering controls to successfully eliminate potential hazards. Worker education must include both training as well as guidance in providing skills to react to different situations, including recognizing possible hazards and responding accordingly (Kaufman, 1991). For example, with workers in heavy industry who concomitantly smoke, nurses can be instrumental in educating these individuals that their effective dose of exposure to inhaled dusts and fumes may be increased as a result of smoking and that smoking cessation should be considered.

Education and monitoring for workers with WRA must be maintained at regular intervals. Pulmonary function test results provide an excellent opportunity for occupational health nurses to discuss with workers any changes in lung function status as they may relate to current exposures whether or not occupational in nature. Nurses are also well equipped to provide information to workers about asthma medications and proper inhaler technique as well as instruction on what medications should be brought to work and under what circumstances such medications should be used.

Nurse case managers working in occupational health settings can provide assistance to individuals recovering from a work related exacerbation of their disease by advocating for modified duty or part time employment (Rogers, 2003). In cases involving workers with sensitizer induced WRA who cannot return to working with the identified sensitizing agent but still are able to work, vocational retraining should be coordinated by case managers so workers can return to another form of gainful employment as soon as recovery is complete. For workers who have entered the workers' compensation system, case managers can offer expertise in navigating expected outcomes related to reimbursement of wages, rehabilitation costs, and return to work issues.

FUTURE DIRECTIONS

The findings of this study provide a preliminary foundation on which to further investigate health care practices provided to individuals with WRA using a population based sample. It also provides another example of the effectiveness of using statewide surveillance methods. As little descriptive research is available, it would be prudent to continue gathering data on health care practices associated with asthma related work disability, predictors of returning to work, and even long term socioeconomic effects related to WRA. More information is needed from the provider's perspective to determine the level of knowledge associated with treating clients with WRA and whether knowledge impacts practice behaviors. Barriers to health care delivery also need to be identified to improve adherence to WRA practice guidelines.

This study revealed the majority of workers did not receive pulmonary function testing or other forms of objective lung evaluation such as peak flow monitoring. Future exploration of WRA should target obtaining and emphasizing the need for objective pulmonary function data to establish asthma work relatedness and disease severity. Baseline and successive spirometry at designated intervals, in conjunction with symptom assessment and monitoring, should be a focus of occupational health researchers working in or with high risk industries. More than half of the participants in the study were classified as working in either management or administrative positions. While some of these workers were employed in settings such as medical clinics and schools, many others worked in traditionally "clean" workplaces and were not exposed to agents typically associated with the disease.

Certainly, this worker population and the circumstances around their exposures deserve further investigation. Emphasis needs to be placed on determining factors associated with asthma severity and poor health outcomes in this work force population.

While only 10 participants were classified as having sensitizer induced WRA, 2 clients reported they were still working with the suspected sensitizing agent. This finding is alarming, as it is well documented in the literature that these workers need to be removed from the offending agent immediately. Early removal has been associated with a better prognosis (Chan-Yeung, 1993), and continuation of exposure to a known sensitizer has been associated with deterioration of pulmonary function despite the use of personal protective equipment or relocation to a "less" exposed area (Cote, 1990). Further exploration of why workers with known sensitizer induced WRA who have been evaluated for their asthma are continually exposed remains a priority for researchers investigating methods aimed at reducing work disability associated with the disease. A multidisciplinary approach involving medicine, nursing, industrial hygiene, and other related fields focusing on implementation of effective control measures, education and training, and behavior change aimed at workers, employers, and health care providers may provide the most optimal circumstances to achieve positive health outcomes for individuals with WRA.

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