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## Are Operating Room Nurses at Higher Risk of Severe Persistent Asthma? The Nurses' Health Study

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### ABSTRACT

**Objective:** To assess the associations between operating room (OR) nursing, a category of health care workers at high risk of exposure to various inhaled agents, and asthma severity/control among women with asthma.

**Methods:** The level of severity/control in nurses with prevalent doctor-diagnosed asthma in 1998/2000 was compared, using nominal logistic regression, in OR nursing ( $n = 69$ ) and administrative nursing ( $n = 546$ ) from the

US Nurses' Health Study for whom detailed information on asthma and nursing employment status was available.

Results: We observed a significant association between OR nursing, compared with administrative nursing, and severe persistent asthma (adjusted odds ratio, 2.48; 95% confidence interval, 1.06 to 5.77).

Conclusions: Our findings suggest that nurses working in the OR are at a higher risk of severe persistent asthma. Further studies with detailed estimates of occupational exposures, especially to disinfectant/cleaning agents, are warranted.

Operating room (OR) nurses are known to be at higher risk for occupational injuries, work-related stress, and particularly high exposure to various toxic agents, including infectious agents, radiation, noise, latex gloves, and anesthetic gases, among health care workers.<sup>1–3</sup> Operating room nurses have also been identified as one of the highest-exposed group to disinfectant/cleaning agents as compared with those working in other hospital units.<sup>4</sup> Regarding diseases, besides well-described skin disorders, reproduction disorders, infectious diseases, musculoskeletal complaints, and occupational injuries,<sup>1</sup> relatively little attention has been paid to the association between OR nursing and respiratory diseases, such as asthma.<sup>2</sup>

Health care workers account for a significant component of the US workforce, especially among women.<sup>5</sup> Disinfectants and cleaning agents make a deleterious contribution to asthma prevalence in health care workers, particularly for nurses.<sup>6,7</sup> Some specific disinfectants/cleaning agents used by female hospital workers have been reported strongly associated with current asthma.<sup>8</sup> Nurses have been identified at increased risk of occupational asthma,<sup>9</sup> adult-onset asthma,<sup>10</sup> and asthma exacerbation.<sup>11</sup> In these studies, nurses were often compared with worker groups with potentially heterogeneous socioeconomic status.<sup>10–12</sup> In addition, data on the association between occupational exposure and asthma severity/control remain sparse.<sup>11,13,14</sup> No study has evaluated the association between employment as an OR nurse, who may be specifically at high risk of exposure, and asthma severity/control.

The US Nurses' Health Study (NHS), an ongoing prospective cohort study of female registered nurses, is a unique opportunity to study OR nurses.<sup>2</sup> In the present study, we sought, among women with prevalent asthma, to examine the association between employment as an OR nurse with the level of asthma severity/control, by comparing OR nurses to administrative nurses, women of otherwise similar professional training and socioeconomic status.

## METHODS

The NHS began in 1976 when 121,700 female nurses aged 30 to 55 years and living in 11 US states responded to a mailed health questionnaire.<sup>15</sup> Follow-up questionnaires on lifestyle factors and newly diagnosed medical conditions, including asthma, are sent biennially. The study has institutional review board approval and is being conducted according to the ethical guidelines of Brigham and Women's Hospital (Boston, Massachusetts).

In 1992, information was requested on current work status, with options including full-time and part-time nursing (OR nursing, inpatient or emergency department nursing, outpatient or community nursing, nursing education, nursing administration, other nursing), nonnursing employment, homemaker, and retired. The 1996 questionnaire included questions about current work (retired, homemaker, nonnursing employment, nursing), allowing an update of the 1992 job status for retirement and women who had become full-time homemakers. No information on OR nursing status was available at the time asthma status was evaluated in detail. For the present analysis, we combined nursing education and nursing administration into one group, hereafter referred to as administrative nurses.

In 1998 and 2000, a supplemental questionnaire on asthma was sent to every participant who reported a prevalent physician's diagnosis of asthma before 1996 (using biennial information). It collected information confirming a physician's diagnosis of asthma, as well as the dates of symptom onset and diagnosis, asthma symptoms, medications and hospitalizations for asthma. On the basis of these detailed questionnaires, we defined persistent doctor-diagnosed asthma, using the following definition of asthma: "participant reiterated on the supplementary questionnaire that a physician had diagnosed her as having asthma, and she reported using an asthma medication since diagnosis" (previously described as "asthma definition 1"<sup>16</sup>). All nurses with a concomitant diagnosis of chronic obstructive pulmonary disease were excluded from the present analyses. As described previously,<sup>17</sup> we used a definition of asthma severity (outcome variable) that divided participants into four mutually exclusive groups: mild intermittent (used as the reference), mild persistent, moderate persistent, and severe persistent. This classification system was based on the 1997 US National Institutes of Health asthma guidelines,<sup>18</sup> and took into account 17: "days kept from work or usual activities within the past 12 months," "days per week with wheeze or whistling sound in chest, shortness of breath, or cough over the past 4 weeks," and "breathing between asthma flares over the past 4 weeks" (see Table 1). According to current recommendations,<sup>19,20</sup> this definition of severity is better thought of in terms of "asthma control" or "asthma severity/control" and we have used the term "asthma severity/control" in this article.

#### [TABLE 1 ]

In the present analyses, women working in 1992 as an OR nurse were compared with administrative nurses, who were considered a nonexposed reference group. Among OR (n = 1054) and administrative (n = 7661) nurses working in 1992, 616 had persistent asthma in 1998. Among them, we included OR (n = 69) and administrative (n = 546) nurses in 1992 for whom it was possible to determine the level of asthma severity (n = 615; see Fig. 1). For a sensitivity analysis (n = 437), we further excluded 179 women who became homemakers or retired during 1992 to 1996.

#### [FIGURE 1 ]

Thus, we examine, among women with prevalent doctor-diagnosed asthma, the cross-sectional association between reported employment as an OR nurse in 1992 and asthma severity/control in 1998/2000 (outcome in four categories) by using

polytomous logistic regression, with calculation of odds ratios and 95% confidence intervals (CIs). Models were adjusted for age (in quantitative), body mass index (in quantitative), and smoking habits. All analyses were conducted using SAS, version 9.1 (SAS Institute, Inc, Cary, NC).

## RESULTS

Table 2 describes the characteristics of the population in 1992, according to nursing status: OR nursing versus administrative nursing. Women had an average age of 54 years in 1992. Characteristics of the studied population were similar in the OR and administrative nursing groups regarding age, race/ethnicity, menopausal status, body mass index, smoking habits, and having had a recent physician examination.

### [TABLE 2]

Table 1 shows that nurses with prevalent asthma were on average about 60 years old in 1998. Characteristics of the studied population were similar in the OR and administrative nursing groups regarding reported allergy and taking a medication for asthma (not shown). After adjustment for age, the association between OR nursing, compared with administrative nursing, and doctor's visits for urgent treatment of asthma within the past 12 months remained significant (odds ratio, 1.83; 95% CI, 1.04 to 3.21). When studying asthma severity/control (Table 3), using mild intermittent asthma as the reference group, no association was observed between OR work and moderate persistent asthma, whereas a statistically significant association was observed with severe persistent asthma (odds ratio, 2.50; 95% CI, 1.12 to 5.57). Further analysis was adjusted for age, smoking habits, and body mass index, and the association remained statistically significant.

### [TABLE 3]

To further examine this finding, we performed a sensitivity analysis that excluded the nurses who became homemakers or retired between 1992 and 1996. Similar results were observed in this smaller sample ( $n = 437$ ), with statistically significant associations with the number of days kept from work or usual activities within the past 12 months (odds ratio, 1.84; 95% CI, 1.01 to 3.37) and occurrence of breathing symptoms between asthma flares most of the time over the past 4 weeks (odds ratio, 3.06; 95% CI, 1.07 to 8.75). A borderline significant association was observed for doctor's visits for urgent treatment of asthma within the past 12 months (odds ratio, 1.78; 95% CI, 0.93 to 3.41;  $P = 0.07$ ). Similar odds ratios (adjusted only for age because of the relatively small sample) were observed for the OR nurses, compared with administrative nurses, for the comparison of intermittent asthma (reference group) versus mild persistent (odds ratio, 1.36; 95% CI, 0.66 to 2.77), moderate persistent (odds ratio, 0.67; 95% CI, 0.28 to 1.57), and severe persistent asthma (odds ratio, 3.68; 95% CI, 1.32 to 10.28).

## DISCUSSION

We observed clinically and statistically significant associations between OR nursing and severe persistent asthma. We investigated for the first time the association

between OR nursing and asthma. The results call for further studies that more directly examine the adverse impact of OR work on major respiratory diseases, such as asthma.

A recent literature review on the “risks and health effects in operating room personnel”<sup>1</sup> emphasized that OR nurses have particularly high exposure to various hazards, including infectious agents, radiation, noise, latex gloves, and anesthetic gases but did not discuss exposure to disinfectant/cleaning agents, an inhaled exposure that has been previously identified among nurses.<sup>9</sup> Among health care workers, OR nursing was judged by experts to be one of the highest exposed group (in addition to emergency department and intensive care unit nurses) to disinfectant/cleaning agents, a common and regular exposure in hospitals.<sup>4,21</sup> Operating room workers are exposed to other toxic agents, including latex gloves and anesthetic gases,<sup>1</sup> that are less commonly encountered in other units. They may also differ from those working in administrative units for other possible exposures (eg, work-related stress), but it was not possible to take into account such exposures in the present analysis. Various disinfectant/cleaning agents are used every day by health care workers for health care hygiene and the frequency of disinfecting/cleaning tasks has increased in recent years in an effort to protect patients from nosocomial infections.<sup>4</sup> This exposure may represent an important public health issue, especially in women, who are more exposed to these kinds of products than are men.<sup>4,22,23</sup>

Our current results on the association between OR nursing and asthma severity/control in American nurses are consistent with results from European studies. In the French Epidemiological study on the Genetics and Environment of Asthma,<sup>14</sup> a strong association between occupational exposure to cleaning agents and asthma severity was evidenced (odds ratio, 7.2; 95% CI, 1.3 to 39.9), when comparing subjects with adult-onset asthma with those without asthma. In the European Community Respiratory Health Survey, Henneberger et al,<sup>11</sup> comparing health care nursing with white-collar jobs among adults with current asthma, observed an association of borderline significance (relative risk, 1.7; 95% CI, 0.99 to 2.9) with severe exacerbation of asthma (as defined by emergency treatment, use of oral steroids, or hospitalization overnight for breathing problems). We observed, as expected, an increase in odds ratios for the association between OR nursing and asthma severity/control when we excluded women who had become homemakers or retired by 1996.

For women with mild persistent asthma, the lack of association is consistent with results from the Epidemiological Study on the Genetics and Environment of Asthma,<sup>14</sup> where the comparison of women with mild adult-onset asthma with those without asthma led an odds ratio of 1.2. One hypothesis was that asthma caused or exacerbated by work exposures quickly becomes severe because of persistent exposure, thus making it difficult to “detect” an association between exposure and the mild phase of the disease.<sup>14,24</sup> The not significant odds ratio below one that we observed for moderate persistent asthma in NHS might be explained by a healthy survivor effect.<sup>25</sup> For example, one can hypothesize that the asthma of nurses who changed jobs became moderate, while the asthma of those who stayed in the same job became severe.

Regarding asthma status in the NHS, a previous validation study confirmed 95% of the nurses' reports of doctor-diagnosed asthma.<sup>16</sup> Furthermore, to limit



misclassification error, all nurses with a concomitant diagnosis of chronic obstructive pulmonary disease were excluded from the present analyses. Although asthma severity is difficult to define in epidemiology, the use of severity scores, following international guidelines, has made it possible to evaluate the role of risk factors.<sup>14,26</sup>

We observed a higher proportion of “days kept from work or usual activities” among the OR nurses compared with administrative nurses ( $P = 0.09$ ). Respiratory work disability has been scarcely studied<sup>27,28</sup> and has been shown to be associated with asthma severity.<sup>29</sup> One recent study reported more respiratory-related absence from work (in the past year) in health care workers than in the general population.<sup>30</sup> The NHS is an ongoing study of a cohort of registered nurses with high response rates (consistently greater than 90% in the NHS cohort), which minimized selection bias.<sup>2</sup> We evaluated asthma severity/control through a specific questionnaire on asthma status. A limitation of this study relates to the cross-sectional analysis because we evaluated severity/control among participants with persistent doctor-diagnosed asthma in 1998/2000, without information available regarding the evolution of asthma severity/control. The lack of information regarding OR nursing status at the time asthma status was evaluated in detail is also a limitation. To limit the effect of this misclassification bias, we performed a sensitivity analysis that excluded the nurses who became homemakers or retired between 1992 and 1996, and similar results were observed. In a study among health care workers, results from Delclos et al<sup>31</sup> suggested a differential misclassification bias in occupational exposures evaluated by self-report. Differential misclassification of exposure is less likely to be present when using less-subjective estimates, such as job status or job-exposure matrices.<sup>31,32</sup> Therefore, the odd ratio observed in the present study might be underestimated because of nondifferential misclassification of outcome and job status.

In summary, we observed among nurses with prevalent doctor-diagnosed asthma, a statistically significant association between OR nursing, as compared with administrative nursing, and likelihood of severe persistent asthma. Although our results require cautious interpretation because of small sample size issues, they are consistent with the hypothesis that working as an OR nurse may induce more severe asthma or worsen asthma control. Further studies with precise information on both relevant exposure periods in relation to asthma activity and lifetime exposure estimates to various hazards, such as disinfectant/cleaning agents, anesthetic gases, latex gloves, and work-related stress, are warranted among OR.

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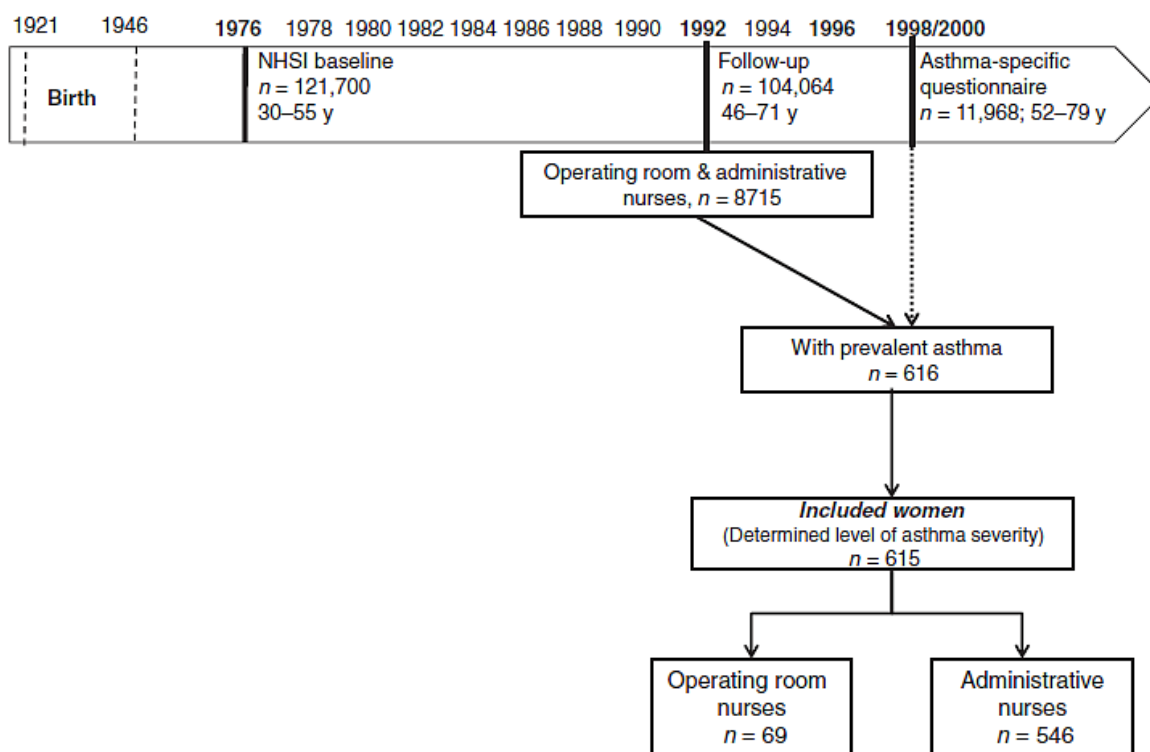
**TABLES**

**TABLE 1.** Description of the Respiratory Symptoms in Operating Room and Administrative Nurses With Asthma, Nurses' Health Study, 1998 ( $n = 615$ )\*

	Operating Room Nurses	Administrative Nurses	<i>P</i>
<i>n</i>	69	546	
Age in 1998, mean (SD), y	59 (5)	60 (5)	0.10
Age doctor first diagnosed asthma, mean (SD), y	35 (19)	38 (19)	0.21
<i>Within the past 12 months, %</i>			
Admitted to stay overnight in hospital because of asthma	3	2	0.78
Visited hospital emergency room for treatment of your asthma	7	5	0.33
Visited doctor's office/clinic for urgent treatment of your asthma	31	20	0.03
Days kept from work or usual activities	40	30	0.09
<i>Symptoms over the past 4 weeks, %</i>			
Wheezy or whistling sound in chest			
Never	43	38	0.73
<1/wk	22	25	
1-3/wk	11	16	
4-6/wk	6	7	
Daily	18	14	
Shortness of breath			
Never	47	34	0.06
<1/wk	17	26	
1-3/wk	8	17	
4-6/wk	5	7	
Daily	23	16	
Cough			
Never	33	30	0.43
<1/wk	18	19	
1-3/wk	23	16	
4-6/wk	9	8	
Daily	17	26	
Breathing between asthma flares, %			
No symptoms	47	43	0.11
Some symptoms on some days	30	40	
Some symptoms on most days	9	11	
Symptoms most of the time, requiring an inhaler for relief	14	6	

\*Detailed information regarding asthma was obtained from the supplementary asthma questionnaire from 1998/2000.

FIGURE 1. Flow chart of the studied population to assess the cross-sectional association between reported employment as an operating room nurse versus administrative nurse (in 1992) and asthma severity/control, among women with doctor-diagnosed prevalent asthma (1998/2000). Prevalent definition of asthma: participant reiterated on the asthma supplementary questionnaire (1998/2000) that a physician had diagnosed her as having asthma, and she reported using an asthma medication since diagnosis. NHSI, Nurses' Health study.



**TABLE 2. Baseline Characteristics of Operating Room and Administrative Nurses in the Nurses' Health Study in 1992 (n = 615)**

	Operating Room Nurses (n = 69)	Administrative Nurses (n = 546)
Age, mean (SD), y	53 (5)	54 (5)
Race/ethnicity, white, %	97	97
Menopausal status, %		
Pre	32	23
Post	68	77
Smoking habits, %		
Never smokers	41	41
Former smokers	46	46
Current smokers	13	13
Body mass index, mean (SD), kg/m <sup>2</sup>	27 (5)	28 (6)
Body mass index, %, kg/m <sup>2</sup>		
<20.0	1	3
20.0–24.9	39	32
25.0–29.9	25	31
≥30.0	28	28
Missing	7	6
Physician examinations, %		
No physician visits	4	10
Screening visits	54	67
Symptom-related visits	41	22
Missing	1	1

**TABLE 3. Association Between Type of Nursing and Asthma Severity, 1998, Nurses' Health Study (n = 615)\***

	Nurses, n		Unadjusted		Adjusted <sup>1</sup>		Adjusted <sup>2</sup>	
	Administrative	Operating room	Odds ratio	95%CI	Odds ratio	95%CI	Odds ratio	95%CI
Mild intermittent	188	23	1.00	Reference	1.00	Reference	1.00	Reference
Mild persistent	159	22	1.13	0.61–2.11	1.08	0.58–2.01	1.08	0.58–2.02
Moderate persistent	163	13	0.65	0.32–1.33	0.65	0.32–1.33	0.60	0.29–1.27
Severe persistent	36	11	2.50	1.12–5.57	2.72	1.21–6.12	2.48	1.06–5.77

\*Asthma severity was evaluated as previously published by Barr et al<sup>17</sup>, in four classes (mild intermittent; mild, moderate and severe persistent), based on the 1997 National Institutes of Health asthma guidelines<sup>18</sup>, and taking into account “days per week with cough, wheeze, or shortness of breath during prior 4 weeks”, symptoms between exacerbations and “days prior year in which asthma interfered with work or usual activities”. According to current recommendations<sup>19,20</sup> this definition of severity should be more labeled control or “asthma severity/control”.

<sup>1</sup>Adjusted for age (in quantitative)

<sup>2</sup>Adjusted for age (in quantitative), Body mass index (in quantitative), Smoking habits (in 3 categories: never smokers, former smokers, current smokers)

CI, Confidence interval