Research Report

Diagnosis of occupational rhinitis to dust and gasses using peak nasal inspiratory flow

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ABSTRACT

Background: The recent development in technology and industry has increased the incidence of occupational disorders of which eventually affect the productivity and cost of related industries. Whether the products or the waste-materials are harmful to airway function, it needs to be investigated. **Purpose:** To study the incidence of occupational \rhinitis (OR) caused by exposure of sodium lauryl sulfate dust and irritant gases in the workplace. **Methods:** In this prospective study, 115 industrial workers who were exposed daily to multi–irritant material were investigated with questionnaire, anterior rhinoscopy, nasal endoscopy, peak nasal inspiratory flow (PNIF) meter, skin prick test, and nasal mucous scrapping before (V1) and after 8 hours (V2) work. The diagnosis of OR was made when symptoms of rhinitis worsened on workdays and a decrease of PNIF (≥20%) at V2. In addition, hours of daily exposure to irritant, years of working, improper usage of personal protection device (nasal and oral mask), and smoking were assessed by bivariate and multivariate analysis. **Result:** 32 workers of 115 (27.8%) were diagnosed as OR based on increased rhinitis symptoms during workdays and decreased PNIF after work. Incidence of OR increased in workers who had worked >10 years=2.15 (IC 95%:1.19-3.87, p=0.009) and who did not use personal protective equipment properly (p=0.04, RR:2.3, IC 95%:1.29-4.28). **Conclusion:** Exposure to occupational reagent such as sodium lauryl sulfate dust and multi-irritant gasses was a causal factor of OR. A proper perusal of personal protection equipment (PPE) is mandatory in workplace to minimize the risk of developing OR.

Keywords: Occupational rhinitis, nature exposure of occupational agents, peak nasal inspiratory flow, nasal obstruction, personal protection equipment.

ABSTRAK

Latar belakang: *Kemajuan teknologi dan industri akhir-akhir ini, meningkatkan pemaparan saluran napas terhadap produk atau sisa industri yang merupakan zat iritan. Sebagai akibatnya, insidens kelainan akibat kerja semakin meningkat, yang dapat mempengaruhi produktivitas dan peningkatan beban biaya industri. Seberapa besar pengaruhnya terhadap fungsi saluran napas, hal ini masih perlu diteliti lebih lanjut.* ***Tujuan:*** *Penelitian dilakukan untuk mengetahui insidens Rinitis Akibat Kerja (RAK) yang diakibatkan pajanan debu sodium lauryl sulfate dan gas iritan di tempat kerja.* ***Metode:*** *Pada studi prospektif ini, 115 pekerja yang terpajan setiap hari dengan material multi-iritan diteliti berdasarkan kuesioner, pemeriksan rinoskopi anterior, nasoendoskopi, Peak Nasal Inspiratory Flow (PNIF) meter, uji cukit kulit dan kerokan mukosa hidung sebelum (V1) dan sesudah 8 jam (V2) bekerja. Diagnosis RAK ditegakkan jika didapati perburukan gejala hidung disertai dengan penurunan (>20%) hasil PNIF pada V2. Sebagai tambahan, waktu pajanan iritan (jam), masa kerja (tahun), penggunaan alat perlindungan diri (APD) seperti masker hidung dan mulut secara kurang benar, serta kebiasaan merokok dianalisis dengan analisis bivariat dan multivariat (model regresi logistik).* ***Hasil:*** *32 dari 115 pekerja (27,8%) didiagnosis sebagai RAK berdasarkan perburukan gejala hidung selama bekerja dan penurunan PNIF sesudah bekerja. Insidens RAK meningkat pada pekerja yang telah bekerja lebih dari*

10 tahun=2.15 (95% IK:1,19–3,87, p=0,009) dan para pekerja yang tidak menggunakan APD (masker hidung dan mulut) secara benar, yaitu (p=0,04, RR: 2.4, 95% IK:1,29–2,48). ***Kesimpulan:*** *Pajanan bahan kimia seperti debu sodium lauryl sulfate dan berbagai gas iritan merupakan faktor penyebab RAK. Penggunaan APD secara benar adalah mutlak untuk menurunkan risiko terjadinya RAK.*

Kata kunci: *Rinitis akibat kerja, pajanan alamiah bahan berbahaya di tempat kerja, peak nasal inspiratory flow, hidung tersumbat, alat pelindung diri*

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INTRODUCTION

Occupational rhinitis (OR) may be defined as rhinitis caused by exposure to agents in the workplace.[1] According to Castano,[2] there is still no definition and classification of occupational rhinitis discussed in depth in the medical professional literature. The proposed definition of occupational rhinitis as a variant of rhinitis characterized by intermittent and sometimes permanent airflow limitation, due to causes and conditions attributable to the work environment. This definition based on a physiopathology finding, namely the demonstration of variable or permanent nasal airway limitation, and its necessary work-relatedness.

Nasal obstruction is a cardinal symptom of all types of rhinitis. Wilson[3] stated both acoustic rhinometry and rhinomanometry are recognized to be sensitive and reliable methods in assessment of nasal obstruction. However, these measurements require trained personnel and technical difficulties have been acknowledged. Alternatively, measurement of nasal inspiratory peak flow using a peak nasal inspiratory flow (PNIF) meter has been widely introduced as a tool for objective assessment of nasal obstruction.[4,5] PNIF meter is a simple, portable, cost effective, and reliable objective measurement of nasal obstruction. Up to now, PNIF has been used to evaluate medical and non-medical therapies as an outcome measure in nasal challenge test.[6,7]

Despite known and well documented respiratory health problems from exposure to single irritant gasses, such as ammonia or sulfur dioxide, there still lack of epidemiological and occupational data of OR due to exposure of multi-irritant hazard material, such as sodium lauryl sulfate, hydrogen sulfide, nitrogen dioxide, and lead (Pb). Sodium lauryl sulfate has been known as irritant material for eyes and skin. This material is a basic anion surfactant and foaming agent for different applications. Ammonia, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, and lead also have been known as irritant gasses (air pollutant) to upper and lower respiratory system.[8] However, in the literature, there is no report whether exposure of these occupational agents in the workplace will cause OR in workers.

METHODS

One hundred and fifteen laborers working in production department of the chemical manufacturing company in Depok, West Java Indonesia, were recruited in this study. Inclusion criteria were all workers who had exposed to multi-irritant hazard material such as sodium lauryl sulfate dust and irritant gasses such as ammonia, nitrogen dioxide, hydrogen disulfide, sulfur dioxide, carbon monoxide, and lead (Pb) as a result of industrial machinery emission. Subjects with ongoing viral rhinitis, rhinosinusitis and previous history using corticosteroid (within less than

4 weeks) or antihistamine (within less than 2 weeks) were excluded from the study. Informed consent was signed and workers were assured of confidentiality. The approval of this study was obtained from the Ethics Committee of Faculty of Medicine University of Indonesia. A total of two visits were scheduled for each study subject, before start working (VI) and 8 hours after the work (V2). The study was conducted on Monday only in order to have sufficient wash-out period from the previous week exposure. They were asked to complete a questionnaire followed by a thorough rhinology examination and PNIF measurement at each visit. The video documentations of the two visits of PNIF measurements were made for each worker. The self-written questionnaire consisted of inquiries regarding rhinitis symptoms, personal history and family history (i.e. smoking), and usage of personal protective equipment (i.e., nasal and/or oral mask). Clinical symptoms reviewed from each study subjects including nasal blockage, rhinorrhea, sneezing, itchy nose, nasal burning sensation, smell disturbance, post nasal drip, dry mouth, and chronic sore throat. The additional question of onset of the symptoms which was arising or triggering in the working environment and lessening while away from working area and during holiday were also obtained.

Nasal examination was performed by routine method (anterior rhinoscopy) and rigid endoscopic examination. Rigid endoscopic examination enabled to see the presence of pus secretion and small nasal polyps of middle meatus. Assessment of all other signs of abnormality including the narrowing of nasal cavity due to edematous of nasal mucosa, type of nasal secretion, hyperemic or livid mucosa of inferior turbinate, septal deviation, hypertrophic inferior turbinate, and crusting.

Each subject was taught how to use the Nasal Peak Flow Meter (In Check peak nasal inspiratory flow meter; Clement Clarke International Ltd, UK) by the first author. PNIF examination was repeated three times and the highest score were accepted as PNIF value. The first (baseline PNIF) was performed before work (V1) and the second was 8 hours after subject being exposure (V2).

Diagnosis of occupational rhinitis (OR) in this study was based on history of rhinitis symptoms (i.e.: nasal congestion, sneezing, rhinorrhea, and itching) which worsened during workdays and relieved during holidays, and supported with minimal 20% decrease of PNIF score at V2.

Skin Prick Test (SPT) was performed only in subjects with confirmed diagnosis of OR, using a battery of common inhalant allergens in the region, including Blomia tropicalis (Blo t), Dermatophagoides pteronyssinus (Der p) and Dermatophagoides farinae (Der f), cockroach, alternaria, and bermuda grass, which were purchased from Stallergenes, (Stallergenes, Cedex, France). A positive SPT result was made when a wheal was ≥3 mm greater than the negative control.[9] Prior to skin testing, subjects were asked to refrain from taking the first generation antihistamines for 72 hrs, 7-10 days for the 2nd generation antihistamines and nasal or systemical glucocorticosteroids for 4 weeks or more.

The incidence of occupational rhinitis was calculated by dividing the number of cases rate by the total number of study subjects. The interaction between the rhinitis and risk factors such as smoking, duration of work, and improper usage of personal protection equipment were calculate using univariate analysis by the chi-square test and p values <0.05 were considered significant. Then, logistic regression analysis was performed to identify determinant factors. The covariates included in the model were duration of work and improper usage of personal protection equipment. Statistical

analyses were performed using SPSS 15.0 (SPSS Inc., Chicago, IL)

RESULTS

A total of 115 subjects had completed the study, consisted of 110 males and 5 females aged from 19 to 54 years old (mean age of 32.54 years). Based on our working definition, 32 workers (27.8%) were diagnosed as having OR, with positive skin prick test results were found in 19 of them (60%).

There was a significant increase in prevalence of OR with increasing length of chemical irritant exposure (p=0.009). Relative risk (RR) for those who work >10 years was 2.15 (CI 95%: 1.19-3.87). Stepwise logistic regression analysis revealed that duration of work >10 years was a determinant factor of OR. There was also a significant increase in the incidence of OR with the history of improper usage of personal protective equipment/nasal and oral mask (p=0.04; RR 2.3 Cl 95%: 1.29-4.28). There was no statistical difference between smoker and non smoker workers in the occurrence of OR (p=0.76; RR=1.10 Cl 95%: 0.60-1.99).

By comparing the nasal symptoms between OR and non-OR groups (Table 1), there were significantly higher percentages of burning sensation of the nose (31.3% vs 61.4%) and chronic sore throat (12.5% vs 33.7%) between OR and non-OR groups, respectively. However, their 95% confidence interval (CI) were all lower than 1. There was no significant difference of other symptoms between these two groups.

Table 1. Nasal symptoms of workers with occupational rhinitis (OR) and without OR (Non-OR)

Symptoms	OR n=32 (%)	Non OR n=83 (%)	RR*	95% CI**	P Value
Nasal blockage	9 (28.1)	32 (38.5)	0.71	0.36-1.38	Ns
Sneezing	17 (53.1)	52 (62.7)	1.28	0.42-1.35	Ns
Nasal burning sensation	10 (31.3)	51 (61.4)	0.40	0.21- 0.77	0.004
Postnasal drip	10 (31.3)	28 (33.7)	0.92	0.48-1.74	Ns
Rhinorrhea	9 (28.1)	18 (21.7)	1.28	0.67-2.41	Ns
Itchy nose	4 (12.5)	15 (18.1)	0.72	0.28-1.82	Ns
Smell disturbance	2 (6.2)	4 (4.8)	1.21	0.37-3.91	Ns
Chronic sore throat	4 (12.5)	4 (4.8)	0.37	0.14-0.97	0.023

*RR: Relative Risk
**95% CI: 95% Confidence Interval

There were significant differences of clinical signs between OR and non-OR groups, such as the narrowing nasal cavity due to mucosal oedema (RR: 4.94, CI 95%: 2.77-8.81), and hyperaemic inferior turbinate (RR: 4.48, IC 95%: 2.79-7.18). (Table 2). There is also significantly coefficient variances of 0.044 and 0.042 of the reduced mean value of the PNIF in OR patients (n=32) between V1 (184.8±46.2) and V2 (133.1±36.5), but no difference by comparing the PNIF value in non-OR group.

Table 2. Results of rhinology examinations in both occupational rhinitis (OR) and without OR (non OR) groups.

Signs	OR (n=32)	Non-OR (n=83)	RR	95% CI	P value
Narrow nasal cavity	20 (62.4%)	9 (10.8%)	4.94	2.77-8.81	0.000
Serous secretion	14 (43.7)	21 (25.3%)	1.77	1.00-3.15	NS
Hyperemic mucosa	13 (40.6%)	3 (3.6%)	4.48	2.79-7.18	0.000
Septal deviation	8 (25.0%)	22 (26.5%)	0.98	0.50-1.95	NS

*RR: Relative Risk

**95% CI: 95% Confidence Interval

DISCUSSION

The increasing prevalence of OR in workers exposed to sodium lauryl sulfate dust and multi-irritant gasses makes it necessary to identify and evaluate the respective risk factors. This high prevalence of OR observed among workers in our study may be due to poor control measures in the working place studied. Most workers did not have knowledge about the proper usage and did not realize the importance of using oral and nasal mask to minimize the exposure to irritant dusts and gasses.

The immune system defends against foreign substances through two types of response: natural immunity and specific (acquired) immunity. Specific immunity is induced through recognition of specific antigens and variability in the host response due to acquired immunity is well recognized. Irritant gasses are not antigenic, so the host response is mediated through the so called natural immune response.[10] Irritant neurons also play a role in host defense. Meggs[11] used the term neurogenic inflammation which is triggered by the nervous system due to chemical stimulation. There is strong evidence that neurogenic inflammation has an important role in asthma and rhinitis. The neuropeptides substance P (SP), neurokinin A (NA), and calcitonin gene-related peptide (CGRP) are now known to coexist in sensory neurons and to have potent vasodilatory properties, which will result in nasal congestion. The sensory fibres involved in neurogenic inflammation have been identified as C-fibres with slow velocity.[12] The common chemical sense is a nasal sensation provoked by airborne chemicals which is experienced as a burning and painful sensation in the upper airways result from exposure of trigeminal nerve endings to the irritants.[11]

The diagnosis of OR is often complex and required nasal provocation tests with the relevant occupational agent. The challenge can be carried out in the form of a nature exposure, especially if the relevant allergen is unavailable.[5] In this study, the subjects have routinely exposed to a mixture of multi-irritant hazard material (e.g., sodium lauryl sulfate dust) and irritant gases (e.g., ammonia, nitrogen dioxide, hydrogen disulfide, sulfur dioxide, carbon monoxide, and lead) as a result of industrial machinery emission. Therefore, we have chosen the challenge with exposure to nature during a stand period of normal working hours. Secondly, the study was performed on Monday where the workers had not been exposed to occupational substances for at least two days through the weekend, which provides more reliable baseline conditions for the study.

In this study, the diagnosis of OR was based on medical and professional history with work-related rhinitis symptoms, rhinology examinations, and objective PNIF measurements before and after exposure.

Nasal obstruction is one of the most common and cardinal symptoms of rhinitis. Therefore, we had included subjective and objective measurements for this symptom, which has proven to be more sensitive than symptoms assessment alone in the diagnosis of OR. For example, nasal burning sensation and chronic sore throat appear to be the commonest symptoms, but not expulsive, as 63% and 62% non-AR subjects who had shown these two symptoms but showed negative results from endoscopic and PNIF examinations. Therefore, we suggest that objective measurement are important in diagnosis of OR. However, further studies need to be performed in order to understand the causative effect of individual substance in the workplace with irritable symptoms alone, and/or eventual nasal mucosal inflammation after natural exposure.

Common methods used to objectively measure nasal patency and resistance include rhinomanometry (Rhim), acoustic rhinometry (ARm), and PNIF determinations.[4,5] Rhinomanometry is a well established technique that directly determines nasal airflow and airflow resistance.[13] Acoustic Rhinometry is a newer technique that acoustically measures the nasal cross-sectional area (CSA) means[14] and thus assesses structural pathologies of the nasal passage. However, it needs special equipment and time consuming especially in this study that all measurements should be done in a short time period at the workspace. In this circumstance, the use of PNIF appears to be most suitable as it is portable and easy to use. After a short time training by the investigators, all subjects were able to do it correctly. The reproducibility of PNIF has been shown to be sufficiently good as the mean coefficient of variation has been calculated at less than 5%. This value was, however, smaller than those reported by Cho[15] (coefficient of variation 10.1%) and Wilson[3] (coefficient of variation 8%). In conclusion, exposure to multi-irritant, hazardous material and irritant gasses in the workplace could causes high prevalence of occupational rhinitis. In additional to common irritable symptoms, nasal mucosal inflammation caused by natural exposure to these substances will result in a significant reduction of nasal patency which could be ignored if a routine medical check-up is not implemented. Secondly, duration of exposure and improper use of personal protective equipment are also important risk factors for the development of occupational rhinitis.

To our knowledge, this is the first study of occupational rhinitis due to exposure of multi-irritants such as sodium lauryl sulfate dust, ammonia, nitrogen dioxide, hydrogen sulfide, sulfur dioxide, carbon monoxide, and lead. It is necessary for workers to be educated about health problems associated with occupational substances. The workshop authority should also perform health care surveillance regularly, educate workers about personal safety equipment, and maintain a safe working environment.

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