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The Effect of Isotonic Saline Nasal Irrigation on Mucociliary Transport Time on Traffic Volunteer Officers in Surakarta, Indonesia

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Abstract

The traffic volunteer officer spends 6–8 hours daily in contaminated, dusty air environments, inhaling harmful particles through the respiratory tract. Isotonic saline nasal irrigation removes inflammatory mediators and improves mucociliary function. The study aims to investigate the effect of isotonic saline nasal irrigation on mucociliary transport time for traffic volunteer officers in Surakarta, Indonesia. We conducted this experimental study on 51 male traffic volunteer officers in Surakarta who met the inclusion and exclusion criteria, using a one-group pretest-posttest design. The researchers conducted the study at the Surakarta police station. The saccharin test assessed mucociliary transport time before and after two weeks of nasal irrigation with an isotonic saline solution. We used the Kolmogorov-Smirnov test to determine if the data were normal, and employed the Wilcoxon signed-rank test or the paired samples t-test to test the hypothesis. The most common age group was 45–60 (49%), and most traffic volunteer officers had a working period of 6–10 years (47.1%). Before isotonic saline nasal irrigation, traffic volunteer officers' mean mucociliary transport time was 10.67 ± 2.63 minutes. After two weeks of isotonic saline nasal irrigation, the mean value decreased to 7.96 ± 2.16 minutes. The mucociliary transport time has significantly reduced after isotonic saline nasal irrigation (p < 0,001). Isotonic saline nasal irrigation improves mucociliary transport by shortening the time it takes for mucociliary transport in traffic volunteer officers. This makes the nasal mucosa more resistant to inflammatory mediators, irritants, and infectious agents.

Keywords: Irritants, isotonic saline solution, mucociliary transport time, nasal irrigation, traffic volunteer officers.

Introduction

The traffic volunteer officer has to help the police officers control the traffic congestion in Surakarta city. These officers daily work in contaminated and dusty air environments, inhaling harmful particles through the respiratory tract [1]. Heavy traffic and a high level of industrial development cause air pollution, which is the main problem with environmental health in urban areas [2]. Air pollution in Surakarta tends to increase every year. In 2017, the Surakarta City Environment Agency measured air pollution and found that the average nitrogen dioxide (NO2) level was 45.4 μg/Nm3. The highest level, with a value of 119.56 μg/Nm3, was obtained on Adisucipto Road in front of the Manahan Stadium. Pollution components, especially ozone, dust particles, and sulfur dioxide, have an inflammatory effect on the airway, which increases membrane permeability, thereby facilitating the penetration of allergens and irritants into the mucous membrane and interactions with immune system cells [2][3].

A mucociliary transport system serves as a first-line defense mechanism in the nose's airway. The mucociliary transport system plays an essential role in keeping the upper airways clean by actively carrying inhaled particles, such as dust, bacteria, viruses, allergens, and other toxins trapped in the mucous layer, to the nasopharynx for swallowing or coughing. Disruption of the mucociliary transport system will disrupt the cleaning of the particles so that the contact of the particles with the nasal mucosa becomes longer. This condition can cause inflammation or ulceration of the nasal mucosa directly [1][4]. The mucociliary transport time of motorcycle riders who drive for 8–12 hours a day has an extension of the standard value (> 12 minutes) in 32% of samples and occupations that have a high risk of exposure to traffic pollution, such as taxi drivers and bus drivers who work in an environment with air pollution for a long time [5].

Traffic volunteer officers, better known as Supeltas, spend 6 to 8 hours daily to help regulate traffic. Supeltas regulate traffic in several areas, particularly on crowded streets. They rarely use protective devices (masks), resulting in frequent upper respiratory tract infections [6]. Nasal irrigation is an easy technique to maintain the hygiene of the nose and sinuses by using a saline solution. Isotonic saline nasal irrigation improves the nasal mucosa's resistance to inflammatory mediators, irritants, and infectious agents by removing inflammatory mediators, improving mucociliary function, and directly cleaning the irrigation [7][8][9]. No research has ever been conducted on the effect of nasal irrigation on mucociliary transport time in voluntary traffic officers. Performing isotonic saline nasal irrigation is expected to improve the health and life expectancy of traffic volunteer officers, enabling them to carry out their duties properly. The study aims to investigate the effect of isotonic saline nasal irrigation on mucociliary transport time for traffic volunteer officers in Surakarta, Indonesia.

Material and methods

The study was experimental with a one-group pretest-posttest design conducted on 51 male traffic volunteer officers in Surakarta, Indonesia. The study was carried out at the Surakarta police station. It received approval from Dr. Moewardi Hospital Surakarta and the Faculty of Medicine, Sebelas Maret University Research Ethics Committee, # 589/VI/HREC/2018, carried out by the Declaration of Helsinki. The population of this study was the Traffic Volunteer Officers (Supeltas) in Surakarta, Indonesia. The study sample consisted of all traffic volunteer officers who worked to regulate traffic. The independent variable is nasal irrigation with isotonic saline solution, while the dependent variable is

mucociliary transport time. Samples included in the study met the inclusion and exclusion criteria. Criteria for inclusion are all traffic volunteer officers who are willing to act as research subjects by signing informed consent. Patients with septum deviation grade III, diabetes mellitus, mass in the nose, history of nose and sinus surgery in the short term (less than three months), and immunocompromised patients are excluded from this study.

Nasal irrigation with isotonic saline solution flows a solution with a solute concentration equal to the cell's concentration into the nose. The solution used is 0.9% NaCl. The sample was taught to do nasal irrigation with a pot containing 0.9% NaCl. The nasal saline was administered with isotonic saline (0.9% NaCl) for two weeks, two days a day. The phone numbers of samples are recorded to control sample compliance. Mucociliary transport is the cilia's movement to move the mucus's mucous component towards the nasopharynx. The time of mucociliary transport measured by saccharin testing was recorded from the start of saccharin placed under the inferior turbinate until it felt sweet. Measuring instruments using a stopwatch, and the results are minutes.

The saccharin test assessed mucociliary transport time before and after two weeks of nasal irrigation with an isotonic saline solution. Then, data collection and analysis were carried out. A Kolmogorov-Smirnov test carried out the data normality test. If the test results are obtained with a *p-value* <0.05, then the data is said to have an abnormal distribution. Conversely, if the value of $p > 0.05$, then the data has a normal distribution. A paired t-test is used as the hypothesis test when the data are normally distributed. The Wilcoxon test evaluates the hypothesis if the data are not normally distributed. Data processing uses the computer program SPSS, version 22.0 for Windows.

Results

This research was conducted on 54 traffic control volunteers (Supeltas) in the Surakarta City area. Three respondents dropped out, so the number of samples until the end of the study was 51. Three respondents dropped out because two did not attend the saccharin test after nasal irrigation, and one refused to undergo a second saccharin test (after 14 days of nasal irrigation).

Table 1: Overview of Basic Characteristics of Research Subjects

Characteristics	Frequency	Percentage
Age		
20–35 yo	8	15.7%
35–45 yo	16	31.4%
45–60 yo	25	49.0%
> 60 yo	2	3.9%
Gender		
Male	51	100.0%
Female	0	0.0%
Length of work		
0–5 y	17	33.3%
6–10 y	24	47.1%
11–15 y	10	19.6%

Most Traffic Control Volunteers (Supeltas) are 45–60 years old, or 25 people (49.0%). This study also showed that traffic control volunteers were all male. Most respondents were traffic control volunteers with a 6–10 year working period, namely 24 people (47.1%), as shown in **Table 1**.

Using the Kolmogorov-Smirnov test, *a p-value* <0.001 was achieved. The distribution of mucociliary transport data for the pretest and posttest noses was not normally distributed in this study. Hence, the hypothesis test used was the Wilcoxon test.

Table 2: The Effect Length of Work with Mucociliary Transport Time

Length of work	Pretest Mucociliary Transport Time (Mean±SD)	*p**
0–5 y	9.65 ± 2.45 minutes	0.007
6–10 y	10.46 ± 2.48 minutes	
11–15 y	12.90 ± 2.08 minutes	

*Kruskal Wallis test, significant if $p < 0.05$

Respondents with 0–5 years of work obtained an average mucociliary transport time before isotonic saline nasal irrigation of 9.65 ± 2.45 minutes. Respondents with a working period of 6–10 years of 10.46 ± 2.48 minutes and respondents with an active period of 11–15 years of 12.90 ± 2.08 minutes, as shown in **Table 2**. The longer the respondent is exposed to vehicle fumes, assessed by a long working period, the longer the mucociliary transport time.

The statistical test results give a value of $p = 0.007$, which means that the effect of length of work on mucociliary transport time is statistically significant.

Table 3: The Effect of Using Nasal Irrigation with Isotonic Saline Solution at Mucociliary Transport Time

Saccharine	Mucociliary Transport Time (minutes)		*p**
	Pretest	Postest	
Mean+SD	10.67 ± 2.63	7.96 ± 2.16	≤ 0.001

*Wilcoxon test, significant if $p < 0.05$

Before being treated using nasal irrigation with isotonic saline solution, the time of nasal mucociliary transport was obtained with an average value of 10.67 ± 2.63 minutes, with a minimum value of 7 and a maximum value of 16. After being treated using nasal irrigation with isotonic saline during transport, nasal mucociliary values averaged 7.96 ± 2.16 minutes, with a minimum value of 5 and a maximum value of 13, thus reducing the mean nasal mucociliary transport time by 25.4%, as shown in **Table 3**. The Wilcoxon test results obtained were statistically significant at $p \leq 0.001$.

Table 4: Impact of Using Nasal Irrigation with Mucociliary Transport Time on Length of Work

Length of work	Mucociliary Transport Time (minutes)		*p*
	Pretest	Posttest	
0–5 y*	9.65 ± 2.45	7.35 ± 2.12	≤ 0.001

6–10 y*	10.46 ± 2.48	7.75 ± 2.07	≤ 0.001
11–15 y**	12.90 ± 2.08	9.50 ± 1.90	≤ 0.001

* Wilcoxon test
** Paired t-test

Table 4 shows that respondents with a working period of 0–5 years, 6–10 years, and 11–15 years experienced a significant decrease in posttest mucociliary transport time compared to the pretest ($p \leq 0.001$). The treatment using nasal irrigation with isotonic saline solution reduces mucociliary transport time in all respondents, which is suitable for respondents with a working period of 0–5 years, 6–10 years, and 11–15 years.

Discussion

Mucociliary transport is a mechanism of ciliary movement to drain secretions from the nasal cavity to the nasopharynx. The mucociliary transport time is called the duration at which particle matter travels along the surface of the nasal cavity through mucociliary transport [10][11].

The speed of mucociliary transport varies greatly. Active cilia remove particles in the mucous palate at a rate of 3–25 mm/minute, with an average rate of 6 mm/minute, in healthy people. According to Maul J. et al. (2013), the mucociliary transport time in healthy adults is <12 minutes on the saccharin test. In this study, 16 respondents (31.4%) experienced impaired mucociliary transport time before nasal irrigation. Brant et al. (2014) conveyed the time of nasal mucociliary transport in motorcyclists who drive for 8–12 hours a day, five days a week, experiencing elongation from normal values (>12 minutes) in 32% of samples examined [5]. The mucociliary transport time of most respondents (68.6%) at the pretest (before nasal irrigation with isotonic saline fluid) was obtained within normal limits. Probably because the air pollution parameters in the Supeltas postal area are still below the normal threshold, it has not caused a disturbance in mucociliary transport.

Based on several studies, outdoor workers exposed to high air pollution can cause nasal complaints due to reduced mucociliary transport function [5]. Brant et al. (2014) reported that traffic controllers, taxi drivers, and motorists are also at risk of high air pollution exposure, similar to motorbike riders. Traffic volunteer officers (Supeltas) spend 6–8 hours every day to help regulate traffic at the location of work posts spread in several areas, especially on crowded and crowded streets. Supeltas automatically inhale dust and pollutant particles, which enter their nose and airway. People also rarely use protective devices (masks). Exposure to dust, irritants, and pollutants that occur continuously and over time can lead to health problems [6] [12] [13].

Nasal irrigation is an easy technique to maintain the hygiene of the nose and sinuses by using a saline solution. According to the physiological nasal mucosa and paranasal sinuses, nasal irrigation widely uses saline solution. Direct irrigation cleaning, enhanced mucociliary function, and the elimination of inflammatory mediators improve the nasal mucosa's resistance to inflammatory mediators, irritants, and infectious pathogens [7][8][9]. The results showed that before being treated with nasal saline with isotonic saline solution, nasal mucociliary transport received an average value of 10.67 ± 2.63 minutes; after being treated with nasal irrigation with isotonic saline, the mucociliary transport time of the nose obtained an average value of 7.96 ± 2.16 minutes, thus reducing the mean nasal mucociliary transport by 25.4%. Therefore, there is a significant effect on the use of nasal irrigation with isotonic saline solution at the mucociliary transport time of the supeltas officer.

Nasal irrigation with isotonic saline solution can improve sinonasal mucosal function through several physiological effects, namely direct washing of colonies of pathogenic microorganisms and irritants on the nasal mucosal surface, reduction of inflammatory mediators, reduction of mucosal edema, reduction of mucin secretion, and increased mucociliary transport by increasing the frequency of movement cilia [14][15][16]. Since 1988, researchers have conducted studies on the role of nasal irrigation as an adjunct therapy for cases of rhinosinusitis and allergic rhinitis. Most of the studies aimed at cases of rhinosinusitis and allergic rhinitis [17][18]. Research on the nasal irrigation of workers in polluted and dusty environments is still rare. Research on polluted or dusty air environment workers has been done by Sofyan and Tami (2017), who researched street vendors on the edge of Medan City's main road, increasing pH after nasal irrigation with isotonic saline solution [19][20].

One limitation of this study is that we did not measure pollutant levels in all Supeltas posts. The content of air pollutants at each point in Surakarta has different parameters that can affect the difference in mucociliary transport time. This study also did not use controls due to the limited number of samples.

Conclusions

Isotonic saline nasal irrigation improves mucociliary transport by shortening the time it takes for mucociliary transport in traffic volunteer officers. This makes the nasal mucosa more resistant to inflammatory mediators, irritants, and infectious agents. There is a need for further research by measuring the level of air pollution in each traffic volunteer officer (Supeltas) post to know the objective status of air pollution in each post.

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