Dust concentration and awareness of safety and health among orthopaedic clinic staffs in Hospital Kuala Lumpur, Malaysia

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ABSTRACT: Objective: The study was carried out to determine the concentration of total dust from the orthopaedic casting materials exposed to personnel and working area. The determination of knowledge, attitude, and practices (KAP) regarding occupational safety and health (OSH) aspects also conducted. Increase dust concentration above the permissible limit (PEL) would decrease the health status among the staffs. Methods: This cross-sectional study was conducted at the orthopaedic clinic public hospital in Kuala Lumpur, Malaysia. Determination of total dust concentration was using a NIOSH Manual of Analytical Method (NMAM 0501) for 8 hours and a direct reading for 10 minutes. A set of questionnaires assessing the level of KAP related to OSH at the orthopaedic clinic was distributed. Results: The results of total dust concentration in the casting room are 3.402 ± 0.003 mg/m³ from area sampling and for the personal air sampling is 5.573± 0.040 mg/m³ which are below than 15 mg/m³ PEL. Percentage of KAP level of OSH in the orthopaedic clinic indicates knowledge (96.75%), attitude (83.7%) and practices (82.85%) respectively. However, this study found that the level of knowledge related to OSH at the orthopaedic clinic had significant relationships (p <0.05) with age, job titles and area of workplaces, while OSH attitudes in orthopaedic clinics had significant relationships (p <0.05) with job titles, use of personal protective equipment (PPE). Level of practice of OSH at orthopaedic clinics, there was significant relationship (p <0.05) with age, job titles and use of PPE. Conclusion: The risk to total dust concentration exposure in this study are relatively low, however, some literature suggested duration of exposure-response even though in the low concentration can be a predisposing factor toward to health occupational illnesses. Medical health surveillance should be implemented in every 6 months to monitor staff’s health status.

Keyword: orthopaedic casting materials; exposure limits; KAP; OSH

1. Introduction

In the hospital the application of the orthopaedic cast is to stabilize, protect, promote healing a bony fractures or soft tissue injuries of the patients. Thousands of healthcare workers internationally utilise orthopaedic cast daily use in surgery departments, orthopaedic clinic, emergency departments, and wards [1]. Orthopaedic cast such as plaster of Paris (POP) are made up from Calcium Sulphate (CaSO4)2 have been the most commonly used as an immobilization for acute cases or as long-term...
immobilization splinting for bony fractures or injuries. Alternatively, to the POP is a synthetic fiberglass casting or polypropylene substrate impregnated with water activated polyurethane resin. These bandages are water-activated in a similar manner to POP, but they can be weight-bearing within thirty minutes and very much stronger, stiffer and lighter. They are widely used for constructing secondary casts, particularly weight-bearing casts.

However, during the process of cutting, trimming and removing the orthopaedic cast the dust generated and exposed to the healthcare workers. Previous study indicated, that’s healthcare workers in the orthopaedic clinic have expressed concern over potential hazard of high level of dust produced in the casting room. The workers experienced of irritation around wrists, neckline and face during a cast removal. A very limited study has been done to determine the level of dust in the real setting like casting room in the orthopaedic clinic. It should be noted that the previous study was conducted as a simulation rather than in an actual clinical setting due to reduced time requirements and cost concerns.

1.1. The dust exposures and occupational hazard towards the worker

Dust in general term is comprises of solid particles formed by crushing or other mechanical forces on parent material, which are generally greater than 0.5 microns in particles size. Technically dusts particles range in size from 0.1 to 25 micrometres (0.00001 to 0.001 inch) in diameter. Regardless of the exact constituents of dust, the total surface area containing dusts retained in the lungs of humans is an important determinant of toxicity. Very fine dusts of respirable dust may inflict different damage to the lungs than larger respirable size fractions. In 2005, Pott and Roller conducted the ‘19 dust study’ to test carcinogenicity of several dusts using intratracheal instillation. Quartz was used as a positive control due to its known toxicity. Exposure to single instillation doses of 20 mg, delivered in two doses of 10 mg each, resulted in 77.8% incidence of total lung tumours. Yang et al. (1996) administered a respiratory questionnaire and conducted spirometry on 412 Taiwanese in the dusty environment workplace. They were exposed to low mean value of respirable dust levels of about 4 mg/m³ however the prevalence of respiratory symptoms was higher but FVC and FEV1 were reduced, in comparison with controls.

2. Material and methods

This cross-sectional study with stratified universal sampling strategy was performed in the orthopaedic clinic in Kuala Lumpur public hospital, Malaysia. This study was carried out from February 2017 through December 2017. A total of 43 participants were participated in this study from a three different location in the orthopaedic clinic which is the POP room, consultation room and registration counter. This study was approved by Malaysia Registry Ethical Committee (MREC) and registered under the National Malaysia Medical Research (NMMR) (ref. num. 16-1113-30812 IIR), and also obtained approval from Research Ethical Committee, National University of Malaysia (ref. num. UKMPP1/111/8/JEP-2018-403) and from Cyberjaya University College of Medical Science Ethical Committee. Each participant was giving an informed consent and voluntary to participated in this study.

The concentrations of total dust had been measured in 3 different areas in the orthopaedic clinic (POP room, consultation room and registration room) and Personal Sampling. Total dust sampling was performed in accordance with National Institute for Occupational Safety and Health Method 0501 (NMAM 0501) and measured by gravimetric analysis. The air sampling pump collections was performed using High-Volume Air Sampler Model Con-2 Area Collection System to collect total dust from the three study area location. Sampling pump was done in 8 hours at each sampling station and the flow rate was set at 2.0 l/min. Filter papers SKC Omega Specialty Division, Membrane Cellulose Acetate with the pore size of 0.8 µm and diameter 37 mm and 47 mm was used (PVC filter). A 37 mm PVC filter is loaded in filter cassette that attach to Gillian Air Plus for personal air sampler. In order to get the optimum total dust concentration direct reading device DustTrak EVN3 was been use.

1.2. Questionnaire
A questionnaire on respiratory health was modified from the Finnish Environment and Asthma Study and originated from American Thoracic Society[17]. A questionnaire that were distributed consist of 2 parts. Part A consist of sociodemographic of respondent that included age, gender, race, marital status, period of working, place of working and use of PPE. Part B meant to assess level of knowledge, attitude and practice on occupational safety and health of orthopaedic clinic.

The data were statistically analyzed, using Chi-Square tests or Fisher Exact test, where applicable with a preset probability of p˂0.05. Experimental results are presented as arithmetic mean ± Standard Division. Statistical test was conducted, using SPSS software (version 25.0, Chicago, IL, USA).

### Table 1. The level of total dust concentrations for area and personal sampling in the orthopedic clinic

| Type of sampling | Concentrations (mg/m³) | Permissible Exposure Limit (PEL) |
|------------------|------------------------|----------------------------------|
| Area | 3.402 ± 0.003 | 15 |
| Personal | 5.573 ± 0.040 | |

### Table 2. Relationship between level of knowledge and study factors

| Variables                      | Knowledge (N=43) |                      |                      |               |       |
|-------------------------------|------------------|----------------------|----------------------|----------------|-------|
|                               | Average n (%)    | High n (%)           | \(\chi^2\)           | P             |       |
| Age                           |                  |                      |                      |               |       |
| 20-25                         | 0 (0)            | 2 (6.5)              | 11.42                | 0.022*        |       |
| 26-30                         | 4 (33.3)         | 8 (25.8)             |                      |               |       |
| 31-35                         | 7 (58.3)         | 6 (19.4)             |                      |               |       |
| 36-40                         | 0 (0)            | 7 (22.6)             |                      |               |       |
| >41                           | 1 (8.3)          | 8 (25.8)             |                      |               |       |
| Your job titles in the orthopedic clinic? |                  |                      |                      |               |       |
| Specialist                    | 0 (0)            | 3 (9.7)              | 9.99                 | 0.041*        |       |
| MO                            | 0 (0)            | 4 (12.9)             |                      |               |       |
| AMO                           | 1 (8.3)          | 10 (32.3)            |                      |               |       |
| SN                            | 2 (16.7)         | 2 (6.5)              |                      |               |       |
| PPK                           | 9 (75)           | 12 (38.7)            |                      |               |       |
| Area of workplace;            |                  |                      |                      |               |       |
| Specialist room               | 6 (50)           | 7 (22.6)             | 10.01                | 0.019*        |       |
| MO room                       | 2 (16.7)         | 12 (38.7)            |                      |               |       |
| Dressing room                 | 2 (16.7)         | 0 (0)                |                      |               |       |
| POP room                      | 2 (16.7)         | 12 (38.7)            |                      |               |       |

*Significant, P<0.05

### 3. Results and discussions

Table 1 details the demographic background of the respondents. It shows that the most of respondents were equivalence male (53%) and female (47%). Majority of the respondents (30%) are age between 31 to 35 years old. Job titles indicated Health Attendance (49%) among the higher respondent who working in the orthopedic clinic. Working area show registration counter (33%) and Plaster of Paris (POP) room (33%) were crowded with the staffs and patients as well. Most of the
respondents (42%) already been working in the orthopedic clinic for 1 to 5 years of services. Orthopedic clinic staffs (72%) served the service in the orthopedic clinic for 31 to 40 hours throughout a week however about 84% of respondents are not involved in working extra hour or over time.

1.3. Health effects towards exposure to orthopedic cast dust

We studied workers in one of the busies orthopedic clinic in Malaysia hospital. Healthcare workers in a orthopedics clinic experienced increased cough, wheezing, breathlessness, nasal symptoms, skin symptoms and ever asthma compared to ward staffs. Interestingly, these effects were detected at concentrations of respirable dust, consisting mainly of orthopedic cast dust, that were below the threshold limit value for respirable dust of 5 mg/m³.

Air concentrations of total dust had been monitored in the clinic in February 2017 until December 2017 (Table 2), the major component of this being an orthopaedic casting dust. Air sampling measurement and analyses revealed the total dust concentration obtained from the area sampling mean $3.402 \pm 0.003$ mg/m³ meanwhile for the personal sampling are mean $5.573 \pm 0.040$ mg/m³ from the mean of six samples strategy (three personal dan three environmental) and were taken throughout 8 hours working period. The result from the air samples were compared with the Permissible Exposure Limit (PEL) according the OSHA (USA 2005) standard guidelines[18]. The personal air samples were higher (24%) compared to the environmental sampling which indicated that the dust concentration is higher surround with POP room staffs who handling the applying and cutting process of orthopaedic casting materials. Result from the direct sampling device for 10 minutes during the cutting off the orthopaedic cast are presented in Figure 1. As observed, the average level of total dust concentration was 0.136 mg/m³ which below the PEL. Figure 3 shows the total dust concentration for 10 minutes direct air sampling without no activity of cutting off the orthopaedic cast was 0.109 mg/m³ which is below the PEL for total dust concentration according to the OSH 2005 standard guideline. However, this finding shows there are increased level of dust concentration while cutting off the orthopaedic cast in the POP room (44.5%).

Equations (1)

$$C = \frac{(W_2 - W_1) - (B_2 - B_1)}{V}$$

Where,

- $C =$ total dust concentration (mg/m³)
- $W_1 =$ Filter weight (tare) before sampling (mg)
- $W_2 =$ Filter weight with dust post sampling (mg)
- $B_1 =$ Mean weight (tare) blank (mg)
- $B_2 =$ Mean weight blank post sampling
- $V =$ Pump air flow rate (cc/mnt)

(Source: NIOSH USA standard 2015)
4. Conclusions
This study showed most of the staff have high level of KAP on regards of OSH awareness in the orthopaedic clinic. Medical health surveillance should be implemented in every 6 months to monitor staff’s health status. However, there are needs of comprehensive study to be taken to determine to level of fiberglass cast dust concentration and the effects to respiratory and skin condition among the orthopaedic clinic staffs which involved other hospital.

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