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Incidence and characteristics of chemical burns

Dong-Hee Koh [a], Sang-Gil Lee [b], Hwan-Cheol Kim [c,*]

[a] Department of Occupational Environmental Medicine, International St. Mary's Hospital, Catholic Kwandong University, Incheon, South Korea
[b] Occupational Safety and Health Research Institute, Korea Occupational Safety and Health Agency, Ulsan, South Korea
[c] Department of Occupational and Environmental Medicine, Inha University School of Medicine, 100 Inharo, Nam-gu, Incheon, South Korea

ARTICLE INFO

Article history:
Accepted 31 August 2016
Available online xxx

Keywords:
Chemical burns
Burns
Corrosion

ABSTRACT

Objectives: Chemical burns can lead to serious health outcomes. Previous studies about chemical burns have been performed based on burn center data so these studies have provided limited information about the incidence of chemical burns at the national level. The aim of this study was to evaluate the incidence and characteristics of chemical burns using nationwide databases.

Methods: A cohort representing the Korean population, which was established using a national health insurance database, and a nationwide workers' compensation database were used to evaluate the incidence and characteristics of chemical burns. Characteristics of the affected body region, depth of burns, industry, task, and causative agents were analyzed from two databases. The incidence of chemical burns was calculated according to employment status.

Results: The most common regions involving chemical burns with hospital visits were the skin followed by the eyes. For skin lesions, the hands and wrists were the most commonly affected regions. Second degree burns were the most common in terms of depth of skin lesions. The hospital visit incidence was 1.96 per 10,000 person-year in the general population. The compensated chemical burns incidence was 0.17 per 10,000 person-year. Employees and the self-employed showed a significantly increased risk of chemical burns undergoing hospital visits compared to their dependents.

Conclusion: Chemical burns on the skin and eyes are almost equally prevalent. The working environment was associated with increased risk of chemical burns. Our results may aid in estimating the size of the problem and prioritizing prevention of chemical burns.

1. Introduction

Burns are one of the most common occupational injuries. Burns can be caused by heat, electricity, or chemical exposure. Chemical burns are reported to comprise 1.4–8.5% of all admission cases due to burns [1]. Chemical burns can lead to serious health outcomes, including skin burns benefiting from skin grafts. For example, severe hydrofluoric acid burns can lead to skin burns as well as life-threatening hypocalcemia, which can eventually lead to death. Chemical burns on the eyes can also lead to permanent damage in visual function [2]. Inhalation or ingestion of caustic agents can cause severe complications in internal organs such as the esophagus and

* Corresponding author.
E-mail address: carpediem@inha.ac.kr (H.-C. Kim).
http://dx.doi.org/10.1016/j.burns.2016.08.037

lungs, even leading to death. Even in milder cases, reactive airway dysfunction syndrome (RADS) can also occur after inhalation of acid or alkali [3].

The causative agents of chemical burns may vary according to geographical location, population structure, and industrial structure. Acids and alkalis are the most common types of causative agents involved in chemical burns. For acids, sulfuric acid, hydrochloric acid and hydrofluoric acid are representative agents, and for alkalis, sodium hydroxide and potassium hydroxide are representative agents. Both acid and alkali agents can cause immediate skin burns when one is exposed. Acids and alkalis are extensively used in electroplating and semiconductor manufacturing industries. These are also widely used in various industries including wastewater treatment facilities, laboratories and restaurants. Solvents also can cause skin burns. For example, contact with dichlormethane does not cause burns immediately but when the contact is prolonged (e.g., a worker wears a glove with a pin-hole and does not recognize it for several hours) it causes skin burns [4]. Other chemicals such as white phosphorus used for ammunition production can also cause chemical burns [5]. The various causative agents and affected body parts extracted from the literature are listed in Supplementary Table 1.

Chemical burns can occur in occupational settings, domestic non-intentional injury and criminal assault, but occupational settings are reported to comprise up to 67.8% of all chemical burns admissions [6]. Chemical burns often lead to serious health problems and disabilities. To prevent chemical burns, epidemiological studies regarding the incidence and characteristics are necessary as a priority. Many studies examined characteristics of chemical burn in terms of demographics of patients, causative agents, depth of burn, and total burn surface area (TBSA). However, these studies were mainly conducted by reviewing records of patients admitted in burn centers [7]. These burn center-based studies provided detailed information on chemical burns but because these studies were based on severe cases with admission to hospitals, it has been impossible to estimate the overall incidence including minor chemical burns which did not undergo admission. According to Heinrich's rule, for every one major injury in the workplace, 29 are minor injuries and 300 cause no injuries [8]. Aforementioned studies have limitations to estimate the overall size of chemical burns, and in addition, these studies could only provide the incidence in regions where hospitals were located.

In the present study, we aimed to estimate the chemical burn incidence in the general Korean population using representative, nationwide databases. In addition, we intended to examine characteristics of chemical burns, which would aid efforts to prevent chemical burns.

2. Methods

2.1. Data source for the general population

Korea has a single insurer system which is operated by the National Health Insurance Service (NHIS). The NHIS covers all citizens, except for 3% of the population under the Medical Aid Program (MAP) [9]. NHIS has collected claim data, including eligibility data and medical treatment records. Recently, the NHIS publicly released the National Health Insurance Service-National Sample Cohort (NHIS-NSC) database. The NHIS-NSC consisted of one million Koreans (2% of the population) sampled from the entire population in 2002 using a complex multistage sampling method [10]. The eligibility status of the one million Koreans, medical treatment records, and periodic health checkups records were all followed until 2013 and were integrated into the NHIS-NSC database. We used this NHIS-NSC database to elucidate the incidence and characteristics of chemical burns.

We restricted the study period from 2009 to 2013. The reason in this regard was that the medical treatment records of the people under the MAP were incomplete before 2008 in the NHIS-NSC. We used 2008 data for detecting non-incident cases, thus, we excluded chemical burn subjects who visited the hospitals for out- or in-patient care both in 2008 and 2009, consecutively. We further restricted age groups to between 20 and 60 years of age because we aimed to examine chemical burns in the working age population.

Chemical burns cases were operationally defined using the Korean Classification of Diseases (KCD) code which was based on the 10th revision of the Internation Classification of Diseases (ICD-10). The three-digit ICD codes for chemical burns are listed in Table 2. Chemical burns were categorized by the body part of the burns, the depth of the burns, and the extent of the burns (TBSA). The body parts afflicted by the chemical burns were simply categorized into skin, eye (T26), and internal organs (respiratory (T27) and gastrointestinal tract (T28)). Skin chemical burns were sub-categorized into five regions in terms of affected region: head & neck (T20), shoulder & trunk (T21), upper extremities (T22), hand & wrist (T23), lower extremities (T24), and foot &ankle (T25). For classifying the depth of chemical burns on the skin (T20-T25, T29, T30), the 4th digit of the ICD was used: 4, 5, 6, 7 represent unspecific, first, second, and third degree burns, respectively. Only a few cases were recorded using the extent of chemical burns (T32 code). If a patient visited a hospital between 2009 and 2013 and the conditions were coded as one of the chemical burns, the patients were regarded to have had a chemical burn.

In the NHIS system, insured persons are divided into 'employee insured' and 'self-employed insured' [11]. The self-employed insured is a category other than the employed insured and its dependents include self-employed persons, farmers and fishermen. We further divided the insured category into three groups in terms of job status: employee (employee insured policyholder), self-employed (self-employed policyholder), and dependents (dependents of employee insurance policyholders or self-employed insurance policyholders, or people under the MAP).

2.2. Workers' compensation data

Korea has a single workers' compensation insurance system which is operated by the Korea Workers' Compensation & Welfare Service (COMWEL) [12]. It covers all workplaces with one or more workers. An average of 1.7 million companies and 14.7 million workers between 2009 and 2013 were

Please cite this article in press as: D.-H. Koh, et al., Incidence and characteristics of chemical burns, Burns (2016), http://dx.doi.org/10.1016/j.burns.2016.08.037