

Silica Gel: Non-Toxic Ingestion with Epidemiologic and Economic Implications

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ABSTRACT: **Background:** Exposure to silica gel, a common desiccant, is considered common and non-toxic although data are limited.

Objectives: To evaluate the characteristics of silica gel ingestion, and to attempt to estimate the associated health care costs.

Methods: We conducted a one year retrospective review of charts of a national poison information center to characterize ingestions of silica gel and estimate its direct cost to health care services. Cost evaluation was based on emergency department and community clinic tariffs (NIS 807/US\$ 213 and NIS 253/US\$ 67, respectively).

Results: A total of 546 cases were recorded, 2.1% of the annual calls to the poison information center. Most ingestions occurred in children younger than 6 years old (91.4%, 65.2% < 2 years). Median monthly exposure was 42; the peak (74) occurred in April, before the Passover holiday. Sixty calls (11%) came from health care facilities and the rest were reported by the public; 2.7% were symptomatic, mainly mild self-limited mouth and throat discomfort. The direct annual treatment cost of patients who referred themselves to health care facilities without consulting first with the Poison Center (n=60) was NIS 24,598/US\$ 6507 (emergency department and community clinic visit fees).

Conclusions: Silica gel ingestion is relatively common, occurring mainly in young children; it is rarely symptomatic but is a source of unnecessary referrals to health care facilities. The potential annual saving by preventing unnecessary referrals due to poison information center advice was estimated at NIS 375,678/US\$ 99,383. The availability of poison information center services may prevent unnecessary referrals to health care facilities and thus save costs.

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drated to highly porous granules [1]. It is marketed wrapped in semi-permeable bags that are put inside product packaging (e.g., shoes, leather bags, electronic appliances, medications) in order to prevent humidity. Unintentional ingestion of desiccants is common [2,3]. Some 42,592 cases of desiccant ingestion were recorded in the 2008 report of the United States National Poison Data System (NPDS) [2]. That report does not specify the types of desiccants ingested, nor does it relate specifically to silica gel. Silica gel is considered to be non-toxic [3-5], unlike other desiccants such as calcium chloride that can be harmful [5]. To our knowledge, no study has evaluated the characteristics of exposure to this specific desiccant. The objectives of our study were to evaluate the characteristics of silica gel ingestion and to estimate the direct associated health care costs.

MATERIALS AND METHODS

The study was conducted using previously reported retrospective poison information center chart review methodology [6,7]. The Israel Poison Information Center (IPIC) at Rambam Health Care Campus is the national poison information center of Israel and the only facility that serves both the general public and health care facilities 24 hours a day. Reporting to the IPIC is voluntary. Case records in the IPIC database reflect information provided by the caller. All IPIC consultations are provided by clinical toxicologists. Data are recorded in a comprehensive structured form that includes caller and patient demographic details, route, site and circumstances of exposure, time elapsed until consultation, clinical manifestations in a system-oriented approach, evaluation, management and follow-up recommendations. The exposure and causative agents are classified according to a previously prepared list of categories, classifications and sub-classifications available at the IPIC. Subsequently, all data are entered and stored in a dedicated database using Microsoft® Access 2007 software on an SQL server. All records are subjected to routine quality control.

A computerized query using the key words *chemicals / miscellaneous / silica gel* was used to retrieve all records of silica gel ingestion during a one year period, 1 January 2008 to 31 December 2008. A silica gel exposure was determined as

Desiccants are hygroscopic substances, mainly salts and gels that absorb water. Their commercial use is abundant. Silica gel is a common desiccant prepared by acidification of sodium silicate (Na₂SiO₃) to a gel that is washed and dehy-

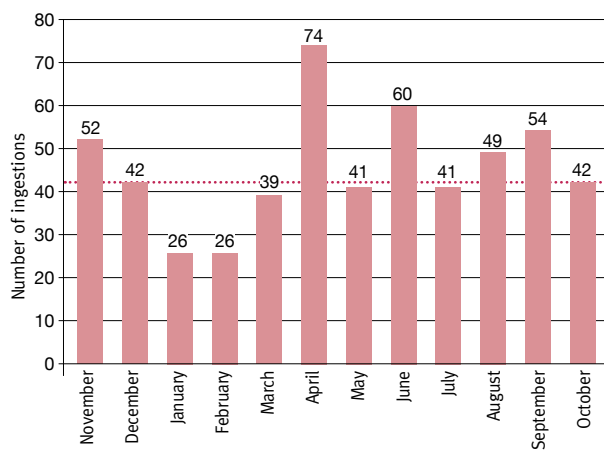
such if the writing on the bag was “silica gel” or “non-toxic” and “desiccant”; silica gel is the only available commercial non-toxic desiccant in Israel. Demographic and clinical data were abstracted from the records, transferred to an electronic spreadsheet (Microsoft® Excel 2007 software), and subjected to descriptive analysis. Health care cost associated with exposure to silica gel was evaluated based on emergency department and community clinic tariffs: New Israeli Shekels (NIS) 807/US\$ 213 and NIS 253/US\$ 67, respectively, obtained from the accounting department of the Israel Ministry of Health. The study was approved by the Institutional Review Board of Rambam Health Care Campus.

RESULTS

During the study period, 546 cases of silica gel ingestion were recorded, representing 2.1% of all calls made to the IPIC. Of these, 486 (89%) were reported by the public and 60 (11%) by health care facilities; 43 (7.8%) of the latter were community clinics and 17 (3.2%) were emergency departments (EDs). Most calls were made soon after the exposure (75% within 15 minutes, 94% within 1 hour). The vast majority of cases involved children under 6 years old (n=499, 91.4%), mainly younger than 2 years of age (n=356, 65.2%). Twenty-three exposures (4.2%) involved children older than 6 years, 16 (2.9%) involved adults, and age was unknown in 8 cases (1.5%). All ingestions were unintentional. The monthly median number of cases was 42 (7.7%), range 26–74, interquartile range 40–53. Peak exposure was observed in April (n=74, 13.5%). The monthly distribution of calls is presented in Figure 1.

Symptoms were recorded in only 15 patients (2.7%) [Table 1]. The most common symptom reported was mouth and throat discomfort. All symptoms developed immediately after ingestion and were mild in severity and self-limited. No

Figure 1. Distribution of monthly ingestions of silica gel. Dotted line represents the median number of cases per month



objective physical findings were reported. The symptomatic patients did not require medical intervention. The IPIC recommended home observation in all cases; none was referred to a health care facility. The 60 cases reported by physicians from EDs and community clinics were patients who self-referred without prior consultation with the IPIC. None of these patients required treatment or observation; the IPIC recommended immediate home discharge.

The direct cost of health care facilities treating self-referred patients exposed to silica gel was NIS 24,598/US\$ 6507 (17 ED visits x NIS 807/US\$ 213 ED fee, and 43 clinic visits x NIS 253/US\$ 67 clinic fee).

DISCUSSION

Silica gel ingestions are frequently reported to the IPIC. Most exposures occurred in young children under the age of 6 years; they were rarely symptomatic. Symptoms occurred immediately after ingestion, were mild (mainly mouth and throat discomfort) and self-limited. It is suggested that these symptoms might be related to the foreign body characteristics of silica gel. These findings support the common presumption that silica gel is non-toxic or minimally toxic [3-5]. The U.S. NPDS reported a similar incidence of desiccant exposures (1.8% vs. 2.1% of calls made, respectively) and age distribution (89% vs. 91.4% younger than 6 years old, respectively) [2]. The severity of exposures in the U.S. report was recorded in only 14.3% of the cases; 95% of these were asymptomatic compared with 97.3% in our study.

Peak exposure to silica gel was recorded in April. This finding can be explained by the abundance of silica gel in consumer products (e.g., new shoes and electronic appliances) and the surge of shopping during spring and the Jewish holiday of Passover.

In our study, about 10% of the reported exposures referred themselves urgently and unnecessarily to health care facilities, most probably due to the parents’ anxiety.

The total annual cost to the health care system, assuming self-referral of all cases of silica gel ingestion to the ED (without prior consultation with the poison information center), could have been NIS 440,622/US\$ 116,567 (546 cases x NIS 807/US\$ 213 ED fee). The potential annual saving of national health

Table 1. Clinical manifestations of silica gel ingestions*

Clinical manifestation	No. of cases (%)
Asymptomatic	531 (97.3%)
Mouth and throat discomfort	14 (2.5%)
Cough	3 (0.5%)
Vomiting	2 (0.3%)

*Some patients had more than one manifestation

care costs by preventing unnecessary referrals due to poison information center advice is estimated to be NIS 375,678/US\$ 99,383: ED charges for 486 patients advised to stay at home minus poison information center cost (NIS 34/US\$ 9 per call, internal estimation).

Consulting with a poison information center was previously shown to be cost-effective [8-10]. Our study highlights this added value of poison information centers in the case of silica gel, a relatively common and non- or minimally toxic exposure. Previous studies showed that parents and caregivers tend to comply with poison information center advice [11,12], emphasizing the importance and cost-saving ability of poison information center consultations in cases of exposure to silica gel.

The limitations of our study include its retrospective design, reliance on voluntary reporting and history provided by the caller, and limited follow-up. These limitations are known drawbacks of studies on poison information center studies, but their significance is reduced by the large number of patients included.

CONCLUSIONS

Although silica gel ingestion is not clinically significant, it can lead to unnecessary referrals to health care facilities and the resultant costs, culminating in a superfluous burden. Timely advice from a poison information center would reduce the extent of this problem.

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