Outbreak Reports

Dichloromethane-Induced Poisoning from Acrylic Paint Cleaner — Shenzhen City, Guangdong Province, China, 2023

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Summary

What is already known about this topic?

Dichloromethane (DCM) is a colorless and transparent organic solvent that commonly causes poisoning during occupational contact.

What is added by this report?

Unknown to teachers and students, they were utilizing an acrylic paint cleaner that contained DCM. At the time of the poisoning incident, the art room was occupied beyond its capacity with inadequate local ventilation. The primary cause of the incident was determined to be the students' inhalation of DCM during the cleaning process.

What are the implications for public health practice?

The unclear composition of environmental cleaning products available for purchase online presents a major obstacle for consumers trying to assess their toxicity. It is imperative that robust regulatory measures and proactive public education campaigns are implemented to mitigate instances of poisoning.

At 20:00 on June 9, 2023, the Nanshan CDC in Shenzhen City received an incident report from a local hospital. It stated that several students from a nearby school began experiencing discomfort after cleaning an art room with an acrylic paint cleaner. Five of these students were treated in the emergency department upon suspicion of organic solvent poisoning. In response, the CDC swiftly assembled a team comprised of professional staff and members of the Shenzhen Field Epidemiology Training Program to investigate the incident. An amalgamation of epidemiological inquiries, laboratory tests, and field hygiene investigations indicated that the poisoning was due to the use of an acrylic paint cleaner containing dichloromethane (DCM) during the cleaning process, and subsequent inhalation of the DCM.

INVESTIGATION AND RESULTS

Investigators established the incidence of exposure in this incident via multiple routes: consultation with the hospital's outpatient records, interviewing relevant doctors, school physicians, class teachers, as well as students, and the distribution of questionnaires to the affected individuals. The case definition criteria were as follows: Exposure was defined as any faculty member or student who entered the art room from 15:10 to 15:50 on June 9, 2023. Suspected cases were those presenting with symptoms such as dizziness, headache, nausea, vomiting, or upper respiratory tract irritation within a short time following the exposure, given that other causes could be excluded. Clinically diagnosed cases were those amongst the suspected pool that received a diagnosis of "accidental poisoning of chemical products and harmful substances".

As of June 12, the CDC had identified 44 exposed individuals with a total of 34 cases, involving 28 suspected and 6 clinically diagnosed infections. All identified cases were from the same classroom, boasting an equal distribution of males to females and an age range of 10–11 years. The attack rate stood at 77.3% (34/44). As delineated in Table 1, the predominant clinical symptoms were dizziness (58.8%), headache (55.9%), nausea (50.0%), fatigue (32.4%), eye irritation (29.4%), and upper respiratory tract mucosal irritation (26.5%). Symptoms became evident within 20 minutes of commencing cleaning procedures, with the earliest narrative of symptoms observed at 15:20 on June 9, and the latest by 16:35 on the same day. For four of the affected students, the specific time of symptom onset was not ascertainable, reflecting an average incubation period (median) of 15 minutes. Symptom duration varied between 10 minutes and two days (Figure 1). The clinical manifestations and corresponding duration for the six clinically diagnosed cases are illustrated in Supplementary Table S1 (available in https://weekly.chinacdc.cn/). However, no

TABLE 1. The clinical manifestations of 34 cases of acrylic paint cleaner poisoning in a school in Shenzhen City, Guangdong Province, China, 2023.

Symptoms	No. of cases	Percentage (%)
Dizziness	20	58.8
Headache	19	55.9
Nausea	17	50.0
Fatigue	11	32.4
Irritation in the eyes	10	29.4
Mouth and nose irritation/pharyngeal foreign body sensation	9	26.5
Abdominal pain	9	26.5
Vomiting (≥1 time)	7	20.6
Skin irritation (burning and numbness)	6	17.6
Syncope	2	5.9
Cold limbs	1	2.9
Rapid heartbeat	1	2.9

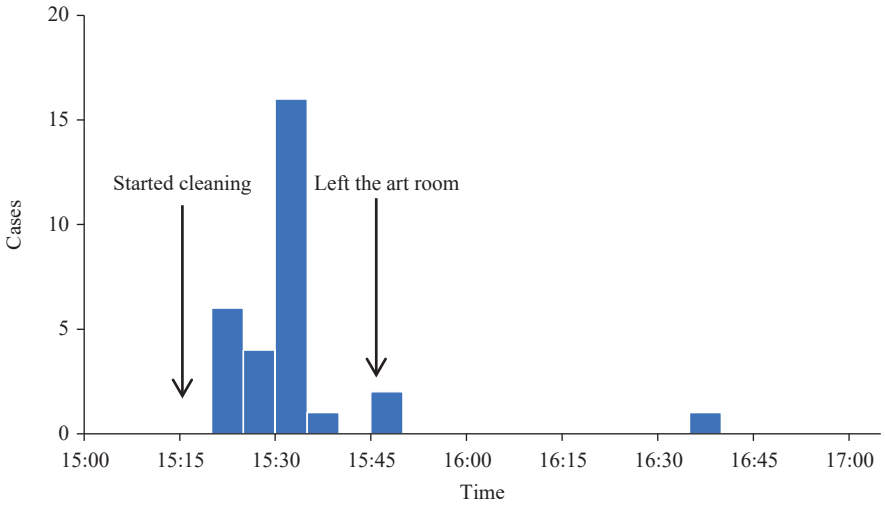

FIGURE 1. The onset times of 30 cases of acrylic paint cleaner poisoning in a school in Shenzhen City (5-minute intervals), Guangdong Province, China, 2023.

abnormalities were observed in blood electrolytes, liver function, myocardial enzymes, routine blood tests, or electrocardiograms. Following oxygen administration and milk consumption, symptomatic relief was reported among all affected cases, with no severe cases or fatalities noted.

A field investigation, alongside interviews with the art teacher and students, unveiled the specifics of the cleaning process, the ventilation conditions of the room, and the source of the paint cleaner used. Around 15:15 on June 9, students initiated the cleanup process in the art room, applying the paint cleaner to stains on the sink and floor, subsequently scouring them with steel wool balls. Roughly five minutes into the process, the room field with a pungent odor and accompanying irritants. Shortly thereafter, several students began reporting symptoms of discomfort, notably dizziness and nausea.

The field hygienic investigation revealed that the art room, situated on the third floor of Building B, encompasses a north-south oriented space measuring 10.8 meters in length and 8.6 meters in width, totaling an area of 92.9 square meters. The room's ceiling height reaches 3.3 meters.

The south-facing side of the ground-level corridor features two doors and three windows, beneath which sit rows of cupboards with hinged door panels. These cupboards held several plastic paint bottles. On the north side, a single window overlooks a rectangular hand-washing sink fitted with three faucets. The art

room's ceiling features a north-south oriented timber framework, with split wall-mounted air conditioning units installed in both the northeast and northwest ceiling corners. The air conditioner's outlet is located approximately 2.9 meters above the floor level.

At the time of the investigated incident, the art room's air conditioner was operating. Both the front and back doors were open, whereas the classroom windows were closed. Most students were crouched to clean the floor, situating their respiratory belts roughly 50 cm above the floor and away from the air conditioner vents. Despite the congregation of individuals, the site's overall ventilation was deemed adequate.

However, a localized poor ventilation issue was observed in the vicinity of the hand-washing sink, which sits away from the door. The details of this scenario can be seen in Figure 2.

A total of eight bottles of an inferior cleaning product were purchased from an online retailer. During the incident at hand, five and a half bottles, equivalent to 5.5 liters, were utilized. Furthermore, the retailer only supplied sky-blue, flimsy gloves devoid of any product identification on the exterior packaging; there were no masks or comprehensive instructions provided for chemical safety.

Professionals collected 20 mL of acrylic paint cleaner on site for qualitative analysis of its volatile components and to determine its peak area percentage. Meanwhile, simulated field air sampling was performed. Briefly, after pouring approximately 20 mL of the acrylic paint cleaner in the sink and the ground for 10 minutes, 6 L of air samples were collected in activated carbon tubes for the detection of the presence

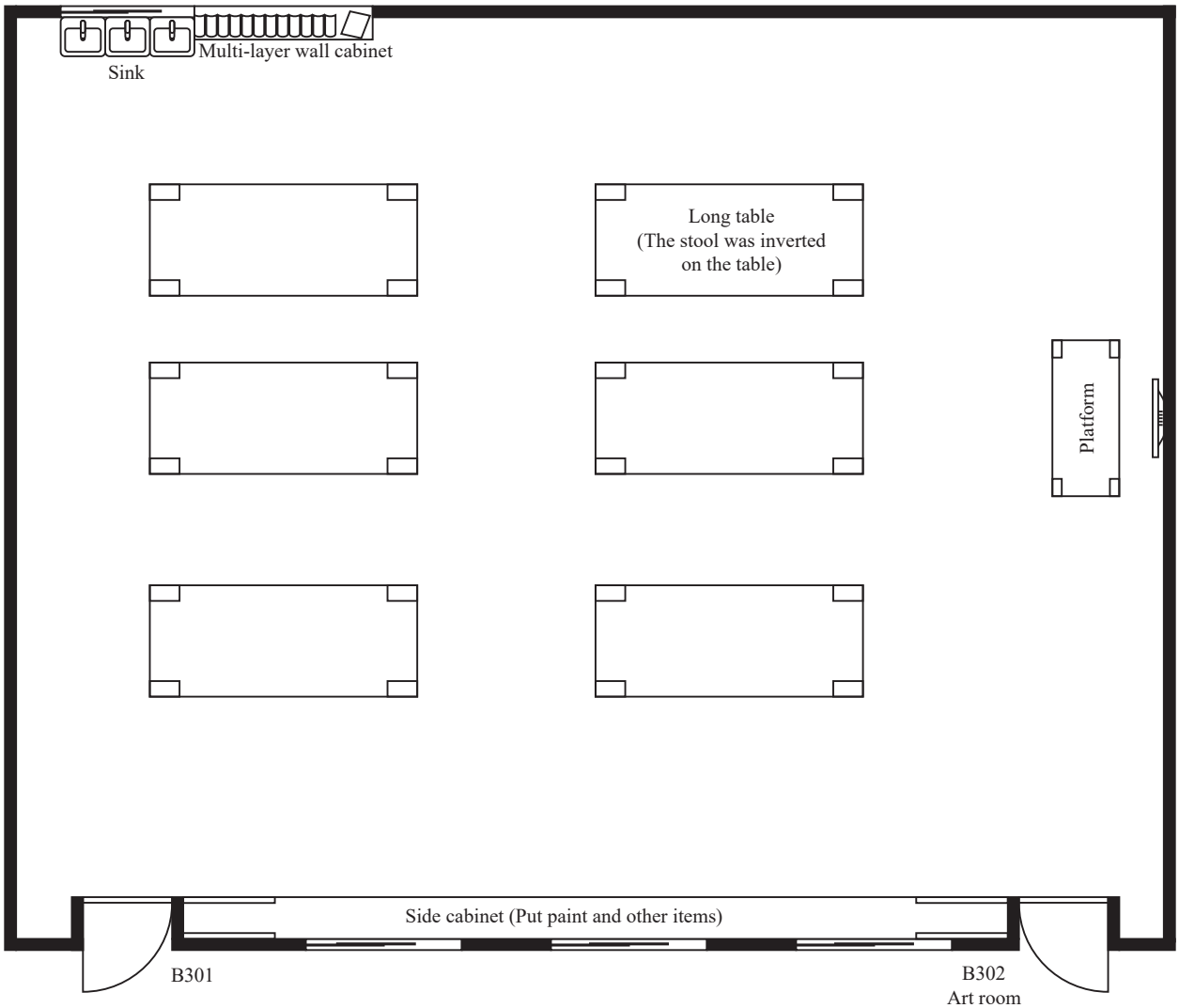

FIGURE 2. The art classroom floor plan in a school in Shenzhen City, Guangdong Province, China, 2023.

of chemical toxicants. The analysis revealed that the peak area percentage of air was 25.37%, while the peak area percentage of DCM was 73.14% (Supplementary Table S2, available in https://weekly.chinacdc.cn/). The primary toxic substance detected in the air samples was DCM.

DISCUSSION

Masked as eco-friendly cleaning solutions, online paint cleaner retailers are selling counterfeit and substandard products. These vendors neglect to provide adequate safety instructions for the chemical products, and they often fail to supply appropriate protective equipment for consumers. This negligence increases the risk of poisoning when unsuspecting consumers utilize these products. Therefore, corresponding government departments ought to intensify their investigations and manage the unlawful sale of chemicals occurring on online retail platforms. Available art pigments and pigment cleaners on the market must include explicit instructions regarding their composition and concentration, along with appropriate usage cautions. Pertinent authorities need to amplify public outreach and education initiatives to enhance public awareness on the topic of chemical safety.

Instances of acute and chronic DCM poisoning are not uncommon (*1*–*3*) and can potentially be fatal (*4*–*5*). Research has suggested that DCM could be linked to an increased risk of diseases such as liver cancer, pediatric germ cell tumors, teratomas, acute myeloid leukemia, and bile duct cancer (*6*–*8*). In Europe, the sale and utilization of paint strippers containing DCM levels of 0.1% or higher have been prohibited (*9*), however, no similar regulation exists in China.

The application of DCM as a paint remover in the art field has not been extensively studied. Through qualitative analysis of volatile organic components in acrylic paint cleansers, it has been discovered that DCM represents a peak area percentage of 73.14%. When users such as art students directly pour DCM, which has a volatile nature at room temperature, onto surfaces like sinks and floors, it accelerates the volatilization process.

This practice, combined with inadequate ventilation in the art studio and direct inhalation of DCM by the students during cleaning, led to this poisoning incident. It's noteworthy this incident took place in an educational institution, implicating the environmental health of the school and the safety of its students, and thus, warrants particular concern.

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REFERENCES

1. Kim H. A case of acute toxic hepatitis after suicidal chloroform and dichloromethane ingestion. Am J Emerg Med 2008;26(9):1073.e3 – 6. http://dx.doi.org/10.1016/j.ajem.2008.03.050.
2. Kobayashi A, Ando A, Tagami N, Kitagawa M, Kawai E, Akioka M, et al. Severe optic neuropathy caused by dichloromethane inhalation. J Ocul Pharmacol Ther 2008;24(6):607 – 12. http://dx.doi.org/10.1089/jop.2007.0100.
3. Mahmud M, Kales SN. Methylene chloride poisoning in a cabinet worker. Environ Health Perspect 1999;107(9):769 – 72. http://dx.doi.org/10.1289/ehp.99107769.
4. Testud F, Martin O, Charretton M. Fatal methylene chloride poisoning during paint-stripping operations. Clinical course, metrologic data and toxicological overview. Arch Mal Prof 2002;63(5):382-7. https://www.researchgate.net/publication/279647869_Fatal_methylene_chloride_poisoning_during_paint-stripping_operations_Clinical_course_metrologic_data_and_toxicological_overview.
5. Hoang A, Fagan K, Cannon DL, Rayasam SDG, Harrison R, Shusterman D, et al. Assessment of methylene chloride-related fatalities in the United States, 1980-2018. JAMA Intern Med 2021;181(6):797 – 805. http://dx.doi.org/10.1001/jamainternmed.2021.1063.
6. Park AS, Ritz B, Ling CX, Cockburn M, Heck JE. Exposure to ambient dichloromethane in pregnancy and infancy from industrial sources and childhood cancers in California. Int J Hyg Environ Health 2017;220(7):1133 – 40. http://dx.doi.org/10.1016/j.ijheh.2017.06.006.
7. Kumagai S. Two offset printing workers with cholangiocarcinoma. J Occup Health 2014;56(2):164 – 8. http://dx.doi.org/10.1539/joh.13-0262-CS.
8. Knox KE, Dodson RE, Rudel RA, Polsky C, Schwarzman MR. Identifying toxic consumer products: a novel data set reveals air emissions of potent carcinogens, reproductive toxicants, and developmental toxicants. Environ Sci Technol 2023;57(19):7454 – 65. http://dx.doi.org/10.1021/ACS.EST.2C07247.
9. Liu XR. Dichloromethane containing paint remover will be banned in Europe. Chin Community Doctors (Med Prof Mon) 2009;11(4):130. https://d.wanfangdata.com.cn/periodical/ChlQZXJpb2RpY2FsQ0hJTmV3UzIwMjMwODMxEg5RSzIwMDkwNDI4Mjk0NhoIb3Vwc2h5cWs%3D. (In Chinese).

SUPPLEMENTARY MATERIALS

SUPPLEMENTARY TABLE S1. The clinical manifestations and their duration in six clinically diagnosed cases of poisoning in a school in Shenzhen, China, 2023.

Case No.	Sex	Age (years)	Symptoms	Duration (hours)
1	Female	11	**Dizziness**, headache, nausea, vomiting, pharyngeal foreign body sensation, numbness in the right hand, and rapid heartbeat	48
2	Male	11	**Dizziness**, nausea, vomiting, abdominal pain, unsteady gait, and syncope	3
3	Male	10	**Dizziness**, headache, fatigue, nausea, vomiting, **eye and nose irritation**, pharyngeal foreign body sensation, abdominal pain, syncope	3.5
4	Male	11	**Dizziness**, fatigue, nausea, **eye and nose irritation**, and abdominal pain	5.5
5	Female	10	Dizziness, headache, **fatigue**, eye irritation, skin irritation, and cold limbs	48
6	Male	10	**Dizziness**, irritation of the mouth and nose, and numbness of the right hand	0.4

Note: Bold font indicates the first symptom of that particular case.

SUPPLEMENTARY TABLE S2. The peak area percentage of volatile components in the acrylic paint cleaner.

No.	Retention time (min)	Peak area	Peak area percentage (%)	Name of component
1	4.658	183,050,585	25.37	Air
2	5.074	2,845,801	0.39	Water
3	8.087	1,718,782	0.24	Dimethoxymethane
4	8.587	527,680,423	73.14	Dichloromethane
5	11.036	91,043	0.01	N-hexane
6	20.018	6,120,725	0.85	Dimethylformamide

Note: The peak area of each component was normalized to obtain its percentage.