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## Selected Topics: Toxicology

### HAND SANITIZER IN A PANDEMIC: WRONG FORMULATIONS IN THE WRONG HANDS

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**Abstract—Background:** Households are increasingly stockpiling and producing hand sanitizer amid the coronavirus disease 2019 (COVID-19) pandemic, which can pose an increased risk for unintentional toxicity among children. Despite guidelines for hand sanitizer production published by the World Health Organization, many turn to streaming media for instruction. **Objective:** The purpose of this investigation was to evaluate hand sanitizer formulations and safety precautions discussed in popular do-it-yourself (DIY) YouTube videos, and to assess the frequency of calls to poison control centers for pediatric hand sanitizer exposure before and after the arrival of COVID-19 in the United States. **Methods:** The first 100 videos on YouTube with the most views using the search term “DIY hand sanitizer” were evaluated for accuracy compared with the World Health Organization local hand sanitizer production guidelines. The incidence of pediatric hand sanitizer exposure reported to participating U.S. poison control centers from January 2018 through May 2020 was reviewed from the American Association of Poison Control Centers National Poison Data System. The average number of calls between January 2020 and May 2020 was compared, and the average number of calls in March 2020 was compared with March 2019 and March 2018. **Results:** Of the YouTube videos that met inclusion criteria, 27% discussed the use of at least 96% ethanol or 99.8% isopropyl alcohol, 4.1% incorporated 3% hydrogen peroxide, 82% used glycerol or an alternative humectant, and 4.1% specified the need for distilled or previously boiled water. Most of the videos failed to describe labeling storage containers, 69% of videos encouraged the use of oils or perfumes to enhance hand sanitizer scent, and 2% of videos promoted the use of coloring agents to be more attrac-

tive for use among children specifically. There was a significantly increased average number of daily calls to poison control centers regarding unsafe pediatric hand sanitizer exposure since the first confirmed COVID-19 patient in the United States. There was a significantly increased average number of daily calls in March 2020 compared with the previous 2 years. **Conclusions:** YouTube may not be an accurate source for effective hand sanitizer concoction. Health care providers and parents should be aware of the increased surge in hand sanitizer exposure among children and should take proper precautionary measures. © 2020 Elsevier Inc. All rights reserved.

**Keywords—**COVID-19; hand sanitizer; toxicity; pediatrics; pandemic

#### INTRODUCTION

Worldwide attention has been drawn to the widespread emergence of the novel 2019 coronavirus and its subsequent illness coronavirus disease 2019 (COVID-19). In light of increasing infections appearing throughout the United States, supplies of disinfectants like hand sanitizer have been quickly depleted. In fact, according to a nationally representative survey from Consumer Reports, 74% of Americans reported difficulty in finding hand sanitizer amid the pandemic (1). The growing demand has led companies across the country to shift their efforts to hand sanitizer production. Alternatively, many Americans have tried producing hand sanitizers in their homes for personal use.

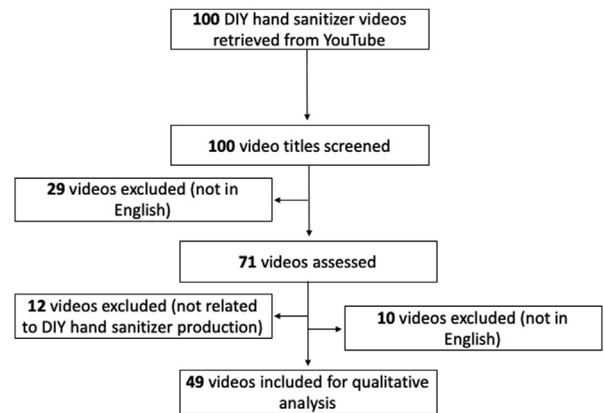
Both the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have promoted the use of alcohol-based hand sanitizers (ABHS) to reduce the infectivity and spread of pathogens due to their rapid action and broad-spectrum microbicidal nature (2–4). Although proper use of ABHS is generally safe, ingestion or ocular exposure can be associated with toxicity, especially among children. The most common adverse health effects among children for ABHS exposure include ocular irritation, vomiting, oral irritation, irritant contact dermatitis, cough, and abdominal pain (5,6). Serious adverse effects, including coma, seizure, metabolic acidosis, and respiratory depression, are rare but have been reported (7,8). Younger children have decreased liver glycogen stores, which is associated with an increased theoretical risk of developing hypoglycemia, although this has been debated (9–11).

The WHO has previously published detailed recommendations to guide the local production of ABHS in a safe and sterile manner (12). Although not intended for household production, their ABHS formulations have been proven to efficiently inactivate severe acute respiratory syndrome coronavirus 2 and have become unintended guides for personal production (13). Nevertheless, a previous investigation has shown that many individuals turn to streaming media channels like YouTube when seeking information related to COVID-19 (14). Do-it-yourself (DIY) hand sanitizer videos are widely available on YouTube and are not curated for content. This may result in unsafe production or storage of homemade hand sanitizer, which may subsequently lead to accidental exposure to unsuspecting children. The objectives of this investigation are twofold: first, to compare a series of popular YouTube videos geared toward DIY hand sanitizer production with WHO-based formulations; and second, to assess the frequency of calls to poison control centers for pediatric hand sanitizer exposure before and after the arrival of COVID-19 in the United States.

## MATERIALS AND METHODS

### Identifying DIY Hand Sanitizer YouTube Videos

The search strategy was conducted using a four-phase process flow, similar to the preferred reporting items for systematic literature reviews (Figure 1) (15). We conducted this search on YouTube due to its global distribution and large user base. YouTube was queried on May 30, 2020, using the search term “DIY Hand Sanitizer.” The first 100 videos with the most views were screened using specific inclusion and exclusion criteria. Videos were included if they were in English and discussed the homemade production of hand sanitizer. Videos were excluded if they were in a language other than English or if they did



**Figure 1. Process of do-it-yourself (DIY) hand sanitizer production video inclusion.**

not provide instructions on how to produce hand sanitizer. Each video was evaluated for discussion of the key ingredients and safety precautions described by the WHO (12).

### Unsafe Pediatric Hand Sanitizer Exposure

Data regarding hand sanitizer exposure cases in children aged 12 years and younger reported to participating US poison control centers from January 2018 through May 2020 were reviewed from the American Association of Poison Control Centers (AAPCC) National Poison Data System (NPDS) (16). The NPDS is a national database of information provided from self-reported calls from the public or health care professionals regarding an actual or potential exposure to a substance. The average number of hand sanitizer-related calls per day during the month of March was compared between each year, and the average number of hand sanitizer-related calls per day in March 2020 was compared with the previous 2 months using a two-tailed paired *t*-test.

## RESULTS

### DIY Hand Sanitizer YouTube Videos

Among the 100 most viewed DIY hand sanitizer videos that were assessed, 49 (49%) satisfied the inclusion criteria. The average number of views for included videos was 699,807 (range 162,156 to 7,939,143). Of the 49 DIY hand sanitizer videos, 36 (73%) explicitly mentioned that their formulation would protect against COVID-19. When assessing ingredients, 13 (27%) discussed the use of at least 96% ethanol or 99.8% isopropyl alcohol, 2 (4.1%) incorporated 3% hydrogen peroxide, 40 (82%) used glycerol or an alternative humectant, and 2 (4.1%) specified the need for distilled or previously boiled water.

In addition to formulation, videos were also assessed for proper hand sanitizer production safety precautions outlined by the WHO. Forty (82%) videos failed to

describe labeling the hand sanitizer storage containers, 34 (69%) videos encouraged the use of oils or perfumes to enhance hand sanitizer scent, and 1 (2%) video promoted the use of coloring agents to be more attractive for use among children specifically.

### *Unsafe Pediatric Hand Sanitizer Exposure*

There was a significantly increased average number of daily calls to poison control centers regarding pediatric hand sanitizer exposure in March 2020 (78.6 daily calls) compared with March 2019 (47.4 daily calls;  $p < 0.001$ ) and March 2018 (55.4 daily calls;  $p < 0.001$ ) (Figure 2) (17,18). The average number of daily pediatric hand sanitizer exposure calls in March 2020 was significantly higher than that in February 2020 (57.3 daily calls;  $p < 0.001$ ) and in January 2020 (51.8 daily calls;  $p < 0.001$ ).

## DISCUSSION

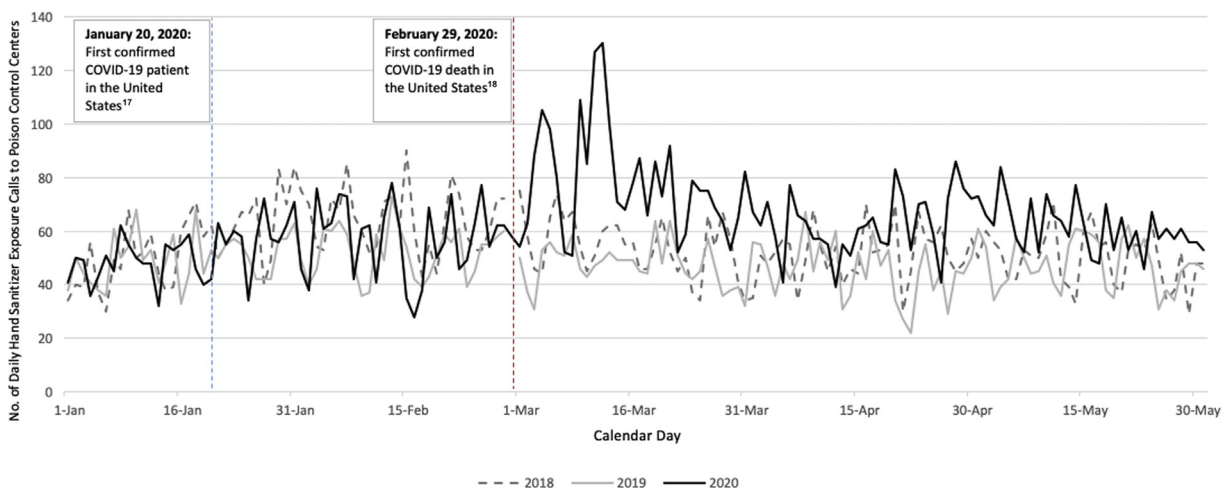
In this investigation, we found that most of the popular DIY hand sanitizer videos available on YouTube fail to meet the standards set forth by the WHO. Although the CDC and WHO strongly advocate for hand hygiene, especially amid the COVID-19 pandemic, proper formulation and storage are critical to ensure efficacy and safety. An increase in production of potentially ineffective homemade ABHS, as well as the improper storage and stockpiling of both homemade and commercial hand sanitizers, may have played a role in the increasing number of calls to poison control centers regarding unsafe hand sanitizer exposure among children 12 years and younger.

Only 27% of videos discussed the importance of using an alcohol base of at least 96% ethanol or 99.8% isopropyl alcohol. Previous studies have found that hand sanitizers with an alcohol concentration between 60% and 95%

have more effective antimicrobial properties than those with a lower alcohol concentration (19,20). However, higher alcohol concentrations are also less potent because proteins are not denatured as easily in the absence of water (4). This is precisely why the WHO advises use of an alcoholmeter during post-production quality control, a recommendation that was never made among the DIY hand sanitizer YouTube videos that were assessed. Another important ingredient that was overlooked among nearly 96% of the YouTube videos was hydrogen peroxide. Although not an active substance for hand antisepsis, hydrogen peroxide plays an important role in inactivating contaminating bacterial spores in the solution (12).

Aside from discussing hand sanitizer formulations with potentially poor efficacy, the DIY YouTube videos also failed to address critical safety measures that should be taken to prevent unsafe exposure among children. Container labeling was only mentioned in nine videos (18%). As the growing demand for hand sanitizer might also be contributing to a subsequent shortage of plastic containers, some formulations have reportedly been put in containers resembling standard single-serve plastic beverage bottles that look like water or soda (21,22). This can increase the likelihood for accidental ingestion, especially among unsupervised children. In addition, 69% of the DIY videos promoted the use of essential oils to enhance the hand sanitizer smell and one video encouraged using dyes to make the hand sanitizer more attractive for use among children. However, as young children have frequent hand-to-mouth activity and environmental curiosity, these tactics may increase the likelihood of unsafe exposure.

There are many ways to prevent harmful hand sanitizer exposure (5,16). Hand sanitizers should be kept out of reach of children and should only be used with adult supervision. A conservative amount should be applied to dry hands and should be rubbed until hands



**Figure 2. Daily poison control center calls. Number of daily hand sanitizer exposure calls in children 12 years and younger to U.S. poison control centers January through March, 2018 to 2020. COVID-19 = coronavirus disease 2019.**

are completely dry. Homemade hand-sanitizer production should be avoided unless they can be prepared and tested under sterile conditions using a curated formula. Hand sanitizers should be stored in a clearly labeled container. If a child has ingested hand sanitizer, it is important to reach a local poison control center by calling the Poison Help hotline: 1-800-222-1222. To save the number in a mobile phone, text POISON to 797979.

### Limitations

We acknowledge several inherent limitations to our investigation. The NPDS database records self-reported calls and may be subject to selection bias and information bias. Therefore, the database may underestimate the true total number of hand sanitizer exposures. In addition, it was not possible to obtain specific data for exposure details (i.e., ingestion, ocular contact), patient outcomes, or the serious effects and complications resulting in calls to the AAPCC due to the nature of the database. Nevertheless, we believe it is important to increase awareness of the availability of misinformation regarding DIY hand sanitizer videos on YouTube as well as the recent surge in calls to poison control centers associated with unsafe hand sanitizer exposure so as to encourage proper safety precautions.

### CONCLUSIONS

During the COVID-19 pandemic, hand sanitizers have become an effective alternative to handwashing when soap and water are unavailable. The use of ABHS has significantly increased compliance to hand hygiene as they are efficient, accessible, and take relatively little time to use. However, there has been a sharp rise in calls to AAPCC regarding unsafe exposure to hand sanitizer among young children. This may be secondary to increased stockpiling, homemade production, and improper storage of hand sanitizers. It is our hope that the information in this article helps health care providers quickly identify symptoms of unsafe hand sanitizer exposure and educates parents on precautionary measures to flatten the curve of unsafe pediatric hand sanitizer exposure.

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## ARTICLE SUMMARY

### **1. Why is this topic important?**

Households are increasingly stockpiling and producing hand sanitizer. Although generally safe, ingestion or ocular exposure to hand sanitizer may be harmful, especially among children.

### **2. What does this study attempt to show?**

By assessing do-it-yourself hand sanitizer videos, this study attempts to demonstrate the vast availability of misinformation related to homemade hand sanitizer production. Most videos failed to address key points, such as necessary ingredients and proper safety precautions.

### **3. What are the key findings?**

There have been a significantly increased number of calls to poison control centers across the United States to report pediatric hand sanitizer exposure since the onset of the COVID-19 pandemic. This may be secondary to poor labeling, improper storage, and increased availability of hand sanitizer among households.

### **4. How is patient care impacted?**

Harmful exposure to hand sanitizer can be prevented. We presented several tools to educate readers on safe use and storage of hand sanitizer. In addition, health care providers may see an increase number of pediatric patients experiencing from hand sanitizer toxicity in the emergency department. The information in this article should aid in quick identification and management of such symptoms.