Case Report

Glacial Acetic Acid Adverse Events: Case Reports and Review of the Literature

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ABSTRACT

Glacial acetic acid is a dangerous chemical that has been associated with several adverse drug events involving patients over recent years. When diluted to the proper concentration, acetic acid solutions have a variety of medicinal uses. Unfortunately, despite warnings, the improper dilution of concentrated glacial acetic acid has resulted in severe burns and other related morbidities. We report on 2 additional case reports of adverse drug events involving glacial acetic acid as well as a review of the literature. A summary of published case reports is provided, including the intended and actual concentration of glacial acetic acid involved, the indication for use, degree of exposure, and resultant outcome. Strategies that have been recommended to improve patient safety are summarized within the context of the key elements of the medication use process.

Key Words—adverse events, glacial acetic acid, medication errors

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Glacial acetic acid is the trivial name used to refer to pure acetic acid in an anhydrous state. It is a colorless, hygroscopic, weak acid that is available in concentrations of 99.5% to 100%. Similar to the German name *Eisessig* (ice-vinegar), the word “glacial” is derived from the ice-like crystals that form at 16.6°C (61.9°F), slightly below room temperature.¹ Although classified as a weak acid, glacial acetic acid is a corrosive poison that can cause injury or death when human tissue is exposed to it. At concentrations of 10% to 25% (1.67–4.16 mol/L), it acts as an irritant; but at concentrations greater than 25% (>4.16 mol/L), it is corrosive and should be handled in a fume hood.² Skin contact may produce blistering or burns, while liquid or spray mist may produce tissue damage particularly on mucous membranes of the eyes, mouth, and respiratory tract.³

Acetic acid has been used for centuries in food production, manufacturing, cleaning, and even medical

purposes. Generally, undiluted glacial acetic acid has no medical use, but a review of the literature reveals that acetic acid in diluted concentrations has been used for a variety of indications. Diagnostically, such indications include oral screening and lesion identification⁴ (1%, mouth rinse) and Barrett’s esophagus⁵ (1.5%–2.5%, spray). As treatment, it has been used for bladder and wound irrigation⁶ (0.25%–0.5%, irrigation solution). Slightly higher concentrations have been used for otitis externa,⁷ iontophoresis,⁸ ear wax removal,⁹ and cervicospasy after an abnormal Pap smear¹⁰ (1%–5%, topical solution). Controversially, it has also been used for wound infections,¹¹ vaginal douching,¹² and as a neutralizing diluting agent for alkali skin burns.¹³ Yet even more concentrated, acetic acid has a place in renal cyst sclerotherapy¹⁴ and hepatocellular carcinoma¹⁵ (50%, injection).

A number of acetic acid products are commercially available. Prediluted, ready-to-use USP formulations

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include products such as acetic acid/aluminum acetate and premixed irrigation solutions. Dietary vinegar (5%) has also been used medically for irrigation and topical application. Sometimes, however, concentrated chemical-grade glacial acetic acid is used, but it requires a pharmacist's skill to compound and dispense before it is acceptable for human use. Despite warning labels on the container, repeated incidents of concentrated glacial acetic acid being dispensed instead of a diluted form have caused patient injury. We describe 2 reports of injuries due to glacial acetic acid and a review of the literature of similar cases with recommendations for patient safety.

CASE REPORTS

Patient Case 1

A 59-year-old female was admitted to the hospital to undergo a wide local excision of a lesion on her vulva. Acetic acid 4% was to be used in the procedure to demarcate the abnormal epithelium. Although there was confusion over whether the strength ordered electronically was 0.25% or 4%, ultimately the order that was delivered to the operating room was prepared by the pharmacist as acetic acid 80%. No explanation was given regarding how this difference occurred. The acetic acid solution was poured onto the indicated area; within a minute of application, a strong acetic acid smell was noted. The surgeon requested the strength of the solution be verified, and an inspection of the label visible on the bottle indicated acetic acid 80%. The procedure was terminated and 4 L of normal saline was used to irrigate the area, followed by an injection of bupivacaine 0.25% with epinephrine 1:200,000 and the application of silver sulfadiazine cream. The patient experienced second-degree partial thickness chemical burns on her labia minora and majora, perineum, rectum, and sacrum extending to the lower lumbar back. Subsequent treatment included topical lidocaine, triple antibiotic cream, and oral opiate analgesia and antibiotics.

Patient Case 2

A 50-year-old male paraplegic who had an indwelling suprapubic catheter developed problems with the build-up of particulate matter in the catheter. Acetic acid solution 0.25% was ordered for catheter clearance, but an error occurred when the telephone order was placed resulting in a prescription for acetic acid 25%. Because the pharmacist had never compounded an acetic acid solution at

that concentration, he declined to dispense the prescription and referred the patient back to his physician. Because the prescribing physician was unavailable, a covering physician recommended the patient wait to speak with the prescriber because there was confusion over the order. However, the patient was not advised that a 25% acetic acid solution posed a danger. In the interim, the patient went to a different pharmacy that agreed to compound the prescription. The pharmacist filling the prescription did not question the strength, even though they later stated that they knew it was inappropriate for the intended purpose. Use of the 25% solution caused severe burns to the urethra and bladder and "melted" the catheter around the patient's penis. The patient required inpatient treatment, after which he chronically complained of burning sensations in his penis and bladder.

DISCUSSION

Multiple reports have been published advising of the dangers associated with the use of glacial acetic acid in clinical patient care. **Table 1** summarizes 18 cases of injury that have been reported in the literature.¹⁶⁻²⁷ An additional report appears in the literature of 5 women who were treated in a colposcopy clinic with glacial acetic acid instead of acetic acid 5% as a result of a computer entry error, although no detectable harm was reported.²⁸

As can be seen from these cases, serious patient harm has resulted from the use of concentrated glacial acetic acid. Root cause analyses have revealed that problems associated with inaccurate medication reconciliation; improper prescribing, dilution, and labeling; inappropriate packaging; an absence of checks and balances; inadequate drug information resources; and lack of familiarity regarding the properties of glacial acetic acid are common causes of errors among health care providers. Other causes have been attributed to the fact that glacial acetic acid is not a drug and therefore not regulated by the US Food and Drug Administration (FDA). Thus, precautionary labels applied to product packaging by the chemical industry (**Figure 1**)²⁹ are often inconsistent, inconspicuous, or even absent when compared to those customarily seen on FDA-approved drugs.

Based on these findings, several patient safety strategies have been recommended in an effort to avoid incidents with glacial acetic acid. These recommendations are gathered from previous *ISMP*

Table 1. Glacial acetic acid injuries reported in the literature

Reference	Strength intended	Strength dispensed	Indication for use	Duration of exposure	Result of exposure
16	0.25%	10%	Bladder irrigation	2 days	Hematuria and bladder tissue damage
16	0.5%	50%	Irrigation	NS	NS
17	0.49%	47%	Wound irrigation	1 application	2nd and 3rd degree finger burns
18	4%	99%	Colposcopy	1 application	Cervical and vaginal burns
19	3%	99.5%	Vulvar condyloma	1 application	Vaginal and vulvar burns requiring surgery
19	3%	99.5%	Scrotal application	2 applications	Severe scrotal burn
19	99.5%	99.5%	Wart removal	1 application	Severe skin burns due to inappropriate packaging
20	0.25%	99.5%	Wound irrigation	2 days	Burns necessitating bilateral amputation at hip
20	5%	99.5%	Colposcopy	1 application	Vaginal bleeding and blistering
20	3%	99.5%	Surgical irrigation	1 application	1st and 2nd degree burns
21	NS	99.5%	Rectal condyloma	1 application	Tissue damage requiring prolonged hospitalization
22	4%	99.5%	Anoscopy	1 application	Severe anal burns
22	5%	99.5%	Surgical procedure	1 application	Severe skin burns, permanent scarring
23	10%	99.5%	Iontophoresis	1 application	1st degree burn, minor scarring, skin discoloration
24	5%	99.5%	Surgical procedure	1 application	Burns requiring skin grafts
25	5%	99.5%	Penile condyloma	1 application	Severe genital burns
26	NS	100%	Iontophoresis	1 application	Full-thickness chemical burn to shoulder
27	5%	100%	Cervical biopsy	1 application	Cervicitis and vaginal bleeding

Note: NS = not stated.

Medication Safety Alert! publications and other case reports^{19-23,30} and have been organized according to ISMP's Key Elements of the Medication Use System³¹ (Table 2). This set of recommendations can serve as a tool for managing this recurring problem.

CONCLUSIONS

The storage and use of glacial acetic acid inherently poses a potential danger and can cause patient injury when not properly diluted. Medication safety experts have advocated for several strategies that

can mitigate the risk, for both patients and health care providers, involved in the use of this chemical. The application of these strategies to the medication use process can work to establish a system with fail-safes that prevent glacial acetic acid from reaching the patient.

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Figure 1. Glacial acetic acid chemical warning label. (Used with permission from SmartSign. <http://www.smartsign.com>)

Table 2. Recommendations for safe use of glacial acetic acid

Patient Information

Perform an accurate medication reconciliation and use the patient as a historian in cases where they have been mixing their own irrigation solutions to avoid confusion.

Drug Information

Maintain drug information references (eg, clinical, compounding, recipes, MSDS) on glacial acetic acid that are accurate and up to date.

Communication of Drug Orders

Require that acetic acid be ordered on a patient-specific basis.

Require prescribers to indicate a specific acetic acid concentration and its intended use.

Discourage the use of the term “glacial” in all patient orders for acetic acid solution.

Drug Labeling, Packaging, and Nomenclature

Order acetic acid 5% as vinegar to reduce the potential for confusion with glacial acetic acid.

Dispense in appropriate packaging to facilitate ease of use and avoid accidental spillage.

Prominently affix unique labels on packaging to differentiate acetic acid concentrations.

(continued)

Table 2. Recommendations for safe use of glacial acetic acid (CONT.)

Drug Storage, Stock, Standardization, and Distribution

Completely remove concentrated glacial acetic acid (99.5%) from pharmacy stock.
Only stock commercial formulations (eg, 2% otic, 0.25% irrigation) for patient use.
Compound irrigation solutions from vinegar (5%) or other prediluted forms of acetic acid.
Segregate glacial acetic acid in a secured pharmacy area away from the compounding area.
Prominently post signage where glacial acetic acid is stored indicating it must be diluted.
Dilute glacial acetic acid upon delivery and store for future use.
Develop a standard formula for pharmacy compounding of dilute acetic acid solutions.
Ensure glacial acetic acid is only stored in the pharmacy and not in clinical patient care areas.
Stock baking soda as a neutralizing agent in each patient care area that uses acetic acid.

Drug Acquisition, Use, and Monitoring

Outsource preparation of acetic acid solutions to a reputable compounding pharmacy.
Require pharmacy to purchase acetic acid solutions for all patient care areas.
Restrict choices in purchasing software so glacial acetic acid cannot be selected by mistake.
Verify the correct strength of acetic acid has been ordered and received from the vendor.

Staff Competency and Education

Educate staff about differences between glacial acetic acid and diluted forms of acetic acid.

Quality Processes and Risk Management

Determine the lowest acetic acid concentration required to be medically effective in your facility and standardize available concentrations.
Require that orders be sent to the pharmacy at least one day before an acetic acid solution is to be used to allow sufficient time to compound the product and avoid rushing the task.
Require independent double-check procedures for glacial acetic acid for steps involving purchasing, order entry, compounding, labeling, and dispensing.
Maintain a compounding log of all glacial acetic acid dilutions for each step in the procedure including signatures of those who prepared and checked the product.

Note: Cited from ISMP Medication Safety Alert! and the Pennsylvania Patient Safety Authority.¹⁹⁻²³ MSDS = material safety data sheet.

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