

# Summary Report

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## Aluminum potassium sulfate

Prepared for:

Food and Drug Administration

Clinical use of bulk drug substances nominated for inclusion on the 503B Bulks List

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## Frequently Used Abbreviations

API	Active Pharmaceutical Ingredient
EMA	European Medicines Agency
EU	European Union
FDA	Food and Drug Administration
IRB	Institutional Review Board
IV	Intravenous
OTC	Over-the-counter
ROA	Route of administration
SME	Subject matter expert
UK	United Kingdom
US	United States

## **INTRODUCTION**

This report was created to assist the Food and Drug Administration (FDA) in their evaluation of the use of aluminum potassium sulfate (UNII code: 09OXB01F3O), which was nominated for use as a bulk drug substance in compounding by outsourcing facilities under section 503B of the Federal Food, Drug, and Cosmetic Act.

The aim of this report was to describe how aluminum potassium sulfate is used in clinical research and practice to diagnose, prevent, or treat disease. Due to the broad, exploratory nature of this aim, scoping review methodology was used. Following the scoping review framework, a systematic literature review was conducted and healthcare practitioners were consulted to identify how aluminum potassium sulfate has been used historically and currently.<sup>1-3</sup> Assessment of study quality and risk of bias were not performed because the aim of this report was not to make specific recommendations on the use of this substance in clinical practice.<sup>1,4,5</sup> Rather, the aim was to summarize the available evidence on the use of aluminum potassium sulfate and thereby assist the FDA to determine whether there is a need for the inclusion of this substance on the 503B Bulks List.

## **REVIEW OF NOMINATION**

Aluminum potassium sulfate was nominated for inclusion on the 503B Bulks List by Cantrell Drug Company.

Aluminum potassium sulfate was nominated as a non-invasive option for treating hemorrhages via a 1% irrigation product.

Nominators provided references from published peer-reviewed literature to describe the pharmacology and support the clinical use of aluminum potassium sulfate.<sup>6-15</sup>

The reason provided for nomination to the 503B Bulks List was that there is no FDA-approved product manufactured and there is no other marketed product that meets the patient-specific conditions.

## **METHODOLOGY**

### *Background information*

The national medicine registers of 13 countries and regions were searched to establish the availability of aluminum potassium sulfate products in the United States (US) and around the world. The World Health Organization, the European Medicines Agency (EMA), and globalEDGE were used to identify regulatory agencies in non-US countries. The medicine registers of non-US regulatory agencies were selected for inclusion if they met the following criteria: freely accessible; able to search and retrieve results in English language; and desired information, specifically, product trade name, active ingredient, strength, form, route of administration (ROA), and approval status, provided in a useable format. Based on these criteria, the medicine registers of 13 countries/regions were searched: US, Canada, European Union (EU), United Kingdom (UK), Ireland, Belgium, Latvia, Australia, New Zealand, Saudi Arabia, Abu Dhabi, Hong Kong, and Namibia. Both the EMA and the national registers of select EU countries (Ireland, UK, Belgium, and Latvia) were searched because some medicines were authorized for use in the EU and not available in a member country and vice versa.

Each medicine register was searched for aluminum potassium sulfate; name variations of aluminum potassium sulfate were entered if the initial search retrieved no results. The following information from the search results of each register was recorded in a spreadsheet: product trade name; active ingredient; strength; form; ROA; status and/or schedule; approval date. Information was recorded only for products with strengths, forms, and/or ROA similar to those requested in the nominations.

In addition to the aforementioned medicine registers, the DrugBank database (version 5.1.5) and the Natural Medicines database were searched for availability of over-the-counter (OTC) products containing aluminum potassium sulfate. The availability of OTC products (yes/no) in the US and the ROA of these products were recorded in a spreadsheet. Individual product information was not recorded.

### *Systematic literature review*

#### Search strategy

A medical librarian constructed comprehensive search strategies for Ovid MEDLINE and Embase. The search strategies used a combination of controlled vocabulary terms and keywords to describe two concepts: aluminum potassium sulfate, and irrigation, instillation, hemostasis, or hemorrhage (refer to Appendix 1 for full search strategies). Results were limited to human studies in English language. Searches were conducted on February 2, 2021. In addition, the ECRI Guidelines Trust<sup>®</sup> repository was searched on February 2, 2021 for clinical practice guidelines that recommended the use of aluminum potassium sulfate and provided sufficient information on dosing and administration.

Results were exported to EndNote for Windows version X9.3.3 (Clarivate Analytics), and duplicates were removed. The de-duplicated results were uploaded to Covidence (Veritas Health Innovation) for screening.

#### Study selection

Studies in which aluminum potassium sulfate was used in the nominated dosage form, ROA, and/or combination product to diagnose, prevent or treat the nominated disease or condition, or other conditions not specified in the nomination, were included. Studies were excluded if they were: written in a language other than English; reviews or meta-analyses; surveys or questionnaires (cross-sectional design); designed to evaluate cost-effectiveness, mechanism of action, pre-clinical use, safety, or toxicity; or any study design other than a randomized controlled trial conducted in a non-US country. Studies were also excluded if aluminum potassium sulfate was used as: an FDA-approved product in the nominated dosage form, ROA, or combination; a dosage form, ROA, or combination that was not nominated; or an unspecified dosage form or ROA. Studies in which aluminum potassium sulfate was used to diagnose, prevent, or treat autism were excluded due to a separate project examining the use of compounded substances in individuals with autism. Studies that did not meet the inclusion criteria but provided valuable information about the pharmacological or current or historical use of the substance were noted and put in a separate group in the EndNote library. Two reviewers independently screened titles and abstracts and reviewed full-text articles. A third reviewer reconciled all disagreements.

#### Data extraction

The following information was recorded in a standard data extraction form: author names; article title; journal; year of publication; country; study type; historical use of aluminum potassium sulfate; setting; total number of patients; number of patients who received aluminum potassium sulfate; patient population; indication for use of aluminum potassium sulfate; dosage form and strength; dose; ROA; frequency and duration of therapy; use of aluminum potassium sulfate in a combination product; use and formulation of aluminum potassium sulfate in a compounded product; use of aluminum potassium sulfate compared to FDA-approved drugs or other treatments; outcome measures; authors' conclusions. One reviewer extracted data from the included studies; a second reviewer checked the data extraction.

## *Interviews*

Semi-structured interviews with subject matter experts (SMEs) were conducted to understand how and in what circumstances aluminum potassium sulfate was used in a clinical setting. The systematic literature review and the indication from the nomination were reviewed to identify medical specialties that would potentially use aluminum potassium sulfate. Potential SMEs were identified through recommendations and referrals from professional associations, colleagues' professional networks, and authors of relevant literature. Select outsourcing facilities were contacted for interviews and referrals to additional SMEs. SMEs provided oral informed consent to be interviewed and audio recorded. Interviews lasting up to 60 minutes were conducted via telephone, audio recorded, and professionally transcribed. The transcriptions and notes were synthesized for qualitative data analysis.

In addition to interviews with individual SMEs, a roundtable discussion with pharmacists was held. Participants were identified through outreach to professional associations that would potentially purchase compounded products from outsourcing facilities. A prequestionnaire was distributed to those who agreed to participate to collect information about the types of facilities at which participants worked and the products they purchased from outsourcing facilities (Refer to Appendix 2 for complete survey and *Results of survey* section for results of prequestionnaire). The roundtable lasted 60 minutes and was conducted via Zoom, audio recorded, and professionally transcribed. The transcriptions and notes were synthesized for qualitative data analysis.

## *Survey*

A survey was distributed to the members of professional medical associations to determine the use of aluminum potassium sulfate in clinical practice. The online survey was created using Qualtrics® software (refer to Appendix 2 for complete survey). A Google™ search was conducted to identify the professional associations in the US for the relevant medical specialties. An association's website was searched to identify the email of the executive director, regulatory director, media director, association president, board members, or other key leaders within the organization to discuss survey participation. If no contact information was available, the "contact us" tab on the association website was used. An email describing the project and requesting distribution of the survey to the association's members was sent to the identified person(s). Associations that declined, did not respond, or did not provide significant data in project Years 1 and 2 were not contacted to distribute the project Year 3 surveys.

The survey was posted on the project website and the survey link was distributed to the associations that agreed to participate (refer to Appendix 3 for associations that participated and those that did not).

Participation was anonymous and voluntary. The estimated time for completion was 15 minutes with a target of 50 responses per survey.

The University of Maryland, Baltimore Institutional Review Board (IRB) and the FDA IRB reviewed the interview and survey methods and found both to be exempt. The Office of Management and Budget approved this project.

## CURRENT AND HISTORIC USE

### *Results of background information*

- Aluminum potassium sulfate is not available as an FDA-approved product in the nominated dosage form and ROA.
- Aluminum potassium sulfate is not available as an OTC product in the US.
- There is a current United States Pharmacopeia (USP) monograph for aluminum potassium sulfate.
- Aluminum potassium sulfate is not available in the nominated dosage form and ROA in any of the national medical registries searched.

Table 1. Currently approved products – US

*No approved products in the US*

Table 2. Currently approved products – select non-US countries and regions

*No approved products in the selected non-US countries and regions*

### *Results of literature review*

#### Study selection

Database searches yielded 238 references; 1 additional reference was identified from searching ECRI Guidelines Trust® and the references of relevant systematic reviews. After duplicates were removed, 197 titles and abstracts were screened. After screening, the full text of 38 articles was reviewed. Nine studies were included; after multiple reports of the same study were merged, there were 7 included studies. Twenty-nine studies were excluded for the following reasons: wrong study design (27 studies); duplicate study (1); language other than English (1).

Refer to Figure 1 for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.

#### Characteristics of included studies

The 7 included studies were published between 1982 and 2020. There was 1 experimental study, 3 observational studies, and 3 descriptive studies. The 7 studies were conducted in the following countries: India and US.

A total of 290 patients participated in the 7 included studies. The number of patients in each study ranged from 1 to 217.

The outcome measure was resolution of hematuria.

Refer to Table 5 for summary of study country, design, patient population, intervention and comparator, and outcome measures.



## Use of aluminum potassium sulfate

Sixty-eight patients received continuous bladder irrigation with aluminum potassium sulfate for either bladder hemorrhage, hematuria, and/or hemorrhagic cystitis in concentrations ranging from 1% to 2%. Duration of treatment ranged from 6 hours to up to 72 hours.

Refer to Tables 6 and 7 for summaries of dosage by indication.

Aluminum potassium sulfate was neither used as a compounded product, nor was it used in a combination product (refer to Tables 8-10).

In 5 studies, the authors' concluding statement recommended the use of alum irrigation for bladder hemorrhage, hematuria, and/or hemorrhagic cystitis.<sup>16-20</sup> In 1 study, the authors concluded that alum irrigation is not proven to be useful for patients with severe hemorrhage and as a result should only be used in patients with mild bleeding.<sup>21</sup> In 1 study, the authors' concluding statement said that while alum is effective in controlling hematuria, it has a high rate of recurrence and therefore "is more useful as a stop-gap procedure to tide over the emergency, for which it still remains the drug of choice."<sup>22</sup> Refer to Table 5 for summary of authors' conclusions.

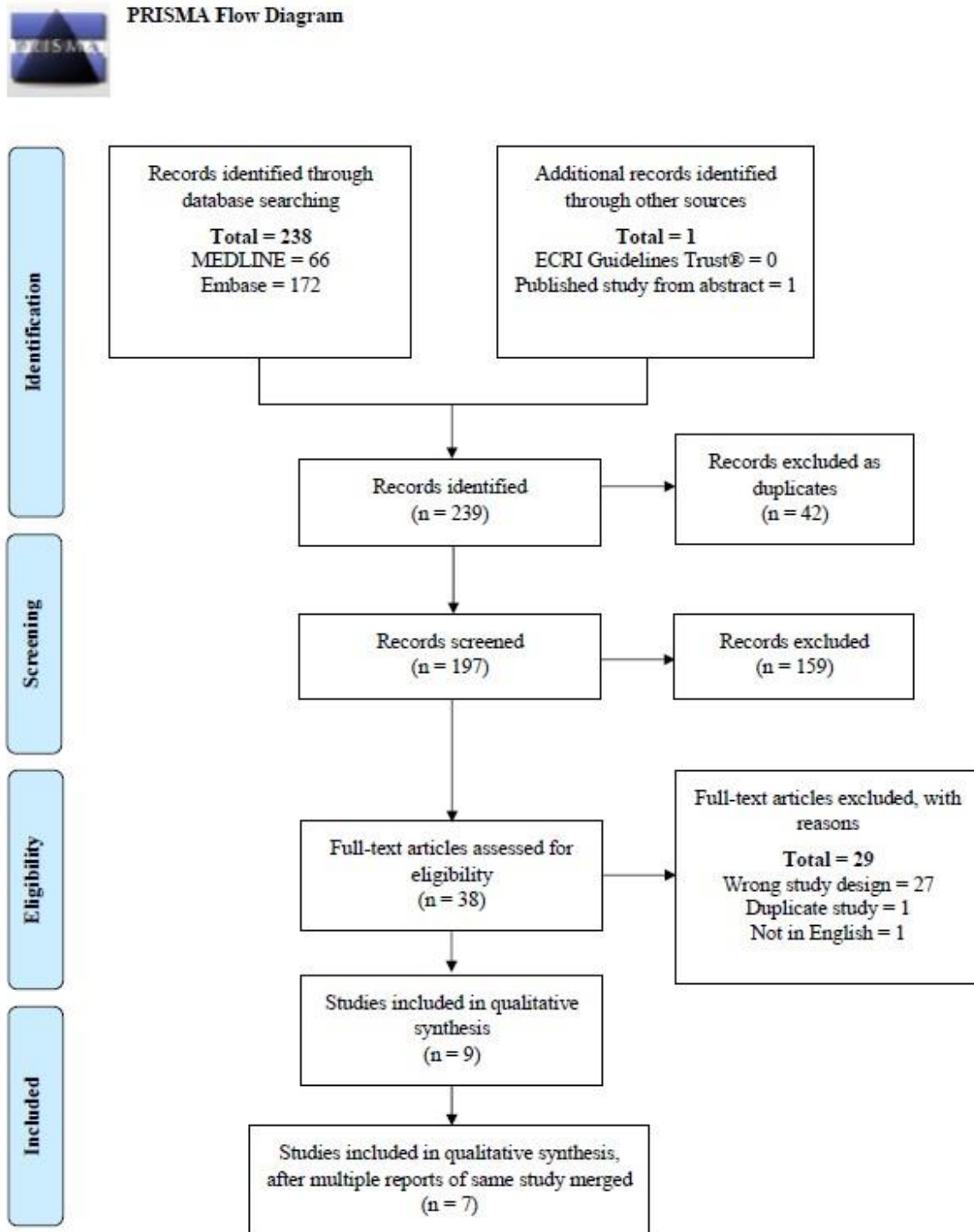
## Pharmacology and historical use

The 7 included studies provided valuable information about the pharmacology and historical use of aluminum potassium sulfate.

The first report of using alum irrigation for the treatment of hemorrhagic cystitis was in 1982.<sup>16,18</sup> One study commented that the supposed mechanism of action is "the induction of protein precipitation at the cell surface, decreased capillary permeability, vasoconstriction, hardening of the capillary endothelium, and a reduction in edema and inflammation."<sup>16</sup> Furthermore, unlike the alternative formalin instillation which must be administered under general anesthesia in the operating room, alum "can be delivered bedside."<sup>16</sup> However, due to renal excretion of alum, practitioners should be careful about using it in patients with renal impairment "as aluminum toxicity resulting in neurologic symptoms has been reported with inappropriate use."<sup>16</sup>

Throughout the included studies, there were several methods described for the preparation of the alum solution. One study from 2020 described preparing a 1% solution "by mixing 50 g of aluminum potassium sulfate with 5 L of sterile water."<sup>16</sup> Another study from 1982 mentioned two different methods of preparation from different hospitals; one hospital simply diluted powdered alum with distilled water and did not sterilize the final product; the other used a 0.22  $\mu$  Millipore filter to sterile the final solution.<sup>23</sup> The authors reported no problems with either method, stating "either method would be acceptable," and that "since alum has a shelf-life of 3 to 4 years we have no qualm about making up some of this solution and leaving it on the shelf for short intervals in the event of an emergency."<sup>23</sup> Two studies from 1992 and 1987 reported using an autoclave to sterilize the alum solution.<sup>19,22</sup> One study from 2016 said that alum can be made with either aluminum ammonium sulfate or aluminum potassium sulfate.<sup>20</sup>

Figure 1. PRISMA flow diagram showing literature screening and selection.



Adapted from:

Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol.* 2009;62(10):1006-1012. Available from: <http://www.prisma-statement.org/>.

Table 3. Types of studies

<b>Types of Studies</b>	<b>Number of Studies</b>
Descriptive <sup>16,17,19</sup>	3
Observational <sup>18,20,21</sup>	3
Experimental <sup>22</sup>	1

Table 4. Number of studies by country

<b>Country</b>	<b>Number of Studies</b>
India <sup>22</sup>	1
US <sup>16-21</sup>	6
Total US: 6 Total Non-US Countries: 1	

Table 5. Summary of included studies

Author, Year, Country	Study Type <sup>a</sup>	Patient Population (% male, age)	Intervention/Comparator (# of patients)	Primary Outcome Measure	Authors' Conclusions
<b>Indication: Bladder hemorrhage, hematuria, and/or hemorrhagic cystitis</b>					
Efros <i>et al.</i> , 1994, US <sup>21</sup>	–	217 Patients who underwent bone marrow transplant (gender and age not specified)  57 Patients experienced cystitis, 12 developed grade 3 cystitis requiring acute intervention	<ul style="list-style-type: none"> <li>Continuous bladder irrigation, Foley catheter drainage, and hydration (12)</li> </ul> 5 Patients received intravesical aluminum potassium sulfate and 6 patients received intravesical formalin	Resolution of hematuria	“Alum irrigations have not proved to be useful for the patient with severe hemorrhage and are used only in cases of mild bleeding.”
Egan <i>et al.</i> , 2020, US <sup>16</sup>	Case report	1 Patient who underwent kidney transplant presenting with adenovirus-induced hemorrhagic cystitis (100%, 41 y)	<ul style="list-style-type: none"> <li>Continuous bladder irrigation with alum (1)</li> </ul>	Resolution of hematuria	“Our case report suggests alum irrigation is a safe and effective management strategy for gross hematuria secondary to adenovirus hemorrhagic cystitis.”
Mukamel <i>et al.</i> , 1986, US <sup>17</sup>	Case reports	5 Patients who presented with severe bladder hemorrhage (80%, range 57-77 y)	<ul style="list-style-type: none"> <li>After failing saline irrigations and repeated fulgurations of bleeding vessels, used irrigation of aluminum potassium sulfate solution (5)</li> </ul>	Resolution of hematuria	“The results in our 5 patients confirm the efficacy and safety of alum solution in controlling bladder hemorrhage. No toxic side effects were noted in the bladder, kidneys or bowel in all 5 patients, including the patient who had perforation of the bladder with direct contact of the solution with the abdominal viscera. This treatment can be instituted without anesthesia. It is well tolerated by severely ill patients and causes no pain or discomfort. Therefore, we recommend irrigations with alum before instituting other means to control bleeding, such as formalin instillation or embolization of the iliac arteries.”

Author, Year, Country	Study Type <sup>a</sup>	Patient Population (% male, age)	Intervention/Comparator (# of patients)	Primary Outcome Measure	Authors' Conclusions
Ostroff and Chenault Jr, 1982, US <sup>18</sup> Ostroff and Chenault Jr, 1983, US <sup>23</sup>	–	6 Patients with massive bladder hemorrhage due to radiation cystitis, carcinomatosis of the bladder, or severe hemorrhagic cystitis (gender and age not specified)	<ul style="list-style-type: none"> <li>Continuous irrigation of alum in the form of either aluminum ammonium sulfate or aluminum potassium sulfate (6)</li> </ul>	Resolution of hematuria	“We believe that continuous irrigation of a 1% solution of alum in sterile water through a large 3-way Foley catheter merits further method is effective, inexpensive and without discernible side effects, and requires no anesthesia, open surgery or elaborate radiologic procedures. Alum irrigation should be the method of choice in patients presenting with significant bladder hemorrhage.”
Praveen <i>et al.</i> , 1992, India <sup>22</sup>	Prospective randomized, controlled study	19 Patients who presented with vesical hematuria (52.6%, mean 52.1 y)	Intravesical instillation of: <ul style="list-style-type: none"> <li>15(s) 15Me PGF<sub>2α</sub> (10)</li> <li>Alum solution (9)</li> </ul>	Resolution of hematuria	“Though alum is very effective in controlling hematuria, the high incidence of recurrence makes it necessary to follow it by some other definitive procedure. Hence it is more useful as a stop-gap procedure to tide over the emergency, for which it still remains the drug of choice.”
Thompson <i>et al.</i> , 1987, US <sup>19</sup>	Case reports	2 Patients with intractable hematuria secondary to adenocarcinoma of the prostate (100%, range 65-77 y)	<ul style="list-style-type: none"> <li>Intravesical alum (2)</li> </ul>	Resolution of hematuria	“The success of intravesical alum in controlling intractable bleeding from hormonally unresponsive carcinoma of the prostate is encouraging. We would suggest that other clinicians consider this nontoxic and efficacious technique when confronted with similar difficult cases.”
Westerman <i>et al.</i> , 2015, US <sup>24</sup> Westerman <i>et al.</i> , 2016, US <sup>20</sup>	Cohort	40 Patients with hemorrhagic cystitis after failing previous treatments (77.5%, mean 76.5 y)	<ul style="list-style-type: none"> <li>Alum instillation (40)</li> </ul>	Resolution of hematuria	“Intravesical alum instillation is associated with minimal morbidity and results in resolution of bleeding in approximately 60% of patients. Approximately one-third of patients maintain a durable response to treatment. Given its favorable safety/efficacy profile, intravesical alum should thereby be considered a first-line treatment option for patients with [hemorrhagic cystitis].”

Abbreviation: “–”, not mentioned.

<sup>a</sup>As defined by authors.

Table 6. Dosage by indication – US

<b>Indication</b>	<b>Dose</b>	<b>Concentration</b>	<b>Dosage Form</b>	<b>Route of Administration</b>	<b>Duration of Treatment</b>
Bladder hemorrhage, hematuria, and/or hemorrhagic cystitis <sup>16-21</sup>	250-300 cc/hour	1-2%	Solution	Intravesical, irrigation, transurethral	6-48 hours Median 2 days [Interquartile range 1, 2.5]

Table 7. Dosage by indication – non-US countries

<b>Indication</b>	<b>Dose</b>	<b>Concentration</b>	<b>Dosage Form</b>	<b>Route of Administration</b>	<b>Duration of Treatment</b>
Hematuria <sup>22</sup>	5 mL/minute	1%	Solution	Intravesical	Until return became completely clear Up to 72 hours

Table 8. Number of studies by combination

*No combination products were nominated*

Table 9. Compounded products – US

*No compounded products from included studies*

Table 10. Compounded products – non-US countries

*No compounded products from included studies*

### *Results of interviews*

One hundred eighty-four SMEs were contacted for interviews; 64 agreed to be interviewed, and 120 declined or failed to respond to the interview request. Two SMEs discussed aluminum potassium sulfate. Between these 2 SMEs, there was 1 medical doctor and 1 nurse practitioner. The SMEs specialized and/or were board-certified in oncology and urology, working in academic medical institutions. The SMEs had been in practice for 12 to 13 years.

One SME stated that they work in outpatient oncology and that aluminum potassium sulfate is not used in that setting but that it is possible that it is used inpatient.

The other SME has used aluminum potassium sulfate as a continuous irrigation for patients with bladder hemorrhage, typically due to radiation. However, the SME stated that it is usually in patients who are “in super bad shape in the hospital with refractory bleeding.” The SME continued that “I can’t say that it’s always been the most successful, but there’s nothing else that you can do at that point.” If the clot can be removed from the bladder and an aluminum-based continuous irrigation is started, it can help with hemorrhage. When aluminum potassium sulfate is used, the pharmacy must be called to make liters of it, “because when you’re continuously infusing it into the bladder, you can go through three liters in an hour.” The infusion typically runs for 24 hours and then if the patient is doing okay the infusion rate can be slowed. Once the infusion is “on a trickle, we turn it off and then see if they can maintain without bleeding and then go from there.” If the patient responds well, the bleeding should stop within a day or two. However, if the patient does not respond within a few days, it likely will not work and the practitioners will escalate therapy.

Other options include instilling formalin in the bladder but “it’s not good for the bladder, but you’re almost fixing the inside of the bladder just because there’s nothing else that you can do to make it stop bleeding and it’s bleeding diffusely.” Some practitioners have tried silver nitrate and Amicar® (aminocaproic acid) continuous bladder irrigations. There have also been cases where the bladder has been arterially embolized.

One issue with aluminum potassium sulfate is that it “can form coagulums with the clots,” which can cause an “alum ball” which is a “ball of coagulated stuff that you have to then go back into the OR [operating room] and try to get out.” There is also some risk for aluminum toxicity; the SME has not seen it in person, but when patients are not doing well, they are being checked frequently for the occurrence of aluminum toxicity. Despite these issues, they said that if they did not use aluminum potassium sulfate, they would not have any alternatives, so it is still used, but infrequently.

A roundtable discussion with representatives from a variety of practice settings was held to discuss the use of outsourcing facilities to obtain compounded products. Forty-three participants attended the event, refer to Table 15 for characteristics of the facilities that the participants represented. A prequestionnaire was also distributed to participants, refer to Tables 15-18 for results of the prequestionnaire.

While a majority of the participants purchased some compounded products from an outsourcing facility, the percentage of products obtain varied from less than 1% to the majority of compounded products used at one participant’s facility. A participant stated “we have this method that we use where if we can buy it commercially ready to administer, we do that. If we can’t buy it in that format, then we buy it in a vial, for example, that can be snapped into a Mini-Bag Plus, because we’re a Baxter house, as a second preference. If we can’t buy it in either of those two formats and we can get it from a 503B, then we do that. And our last resort is compounding internally.” Two participants commented that they will not outsource a product unless 2 outsourcing facilities that they contract with are able to compound the product. This

redundancy will allow for a quick flip to the other outsourcing facility if there is an issue with a product compounded from one outsourcing facility, minimizing the impact to the participant's facility.

Participants were asked to discuss the decision-making process used at their facility to determine what products to obtain from an outsourcing facility. One major theme that emerged from this discussion was that many of the products purchased from outsourcing facilities are used in critical care areas, like emergency departments and operating rooms. Participants commented that outsourcing facilities are able to provide ready-to-use products that have longer beyond-use-dates compared to products compounded in-house allowing these products to be stocked in automated dispensing cabinets in these units. One participant commented that "we're always going to outsource a PCA [patient controlled analgesia] syringe because we can store it in a Pyxis machine versus us making it and storing it in a fridge." Another participant commented on the benefits of storing medications in an automated dispensing cabinet, stating that "operationally, if you have a STAT medication or something that needs to be delivered within 10 to 15 minutes, if you're looking at us doing it, you're looking at a five-minute gown and glove. If we don't have somebody in the IV [intravenous] room, if you're doing 797 right, it's five minutes. It's four minutes to tube it. It's three minutes to make it, and then you have a dosage system or a camera system, a few minutes more. We are not able to meet that need or they're just contaminating the IV room if they are trying to do it."

Having ready-to-use products available also minimizes the need for compounding and product manipulations to occur on the floor. This can be especially beneficial in children's hospitals as they face a unique need in that they are already having to perform a lot of manipulations to products due to a lack of concentrations or sizes available. One participant commented that "at baseline, already, we manipulate about 80% of what we dispense to patients" and another stated that "there's a number of drugs that require additional manipulation, to get them to a concentration that's appropriate for kids." One participant stated that "we're trying to minimize compounding, expedite actual therapies to patients in that setting [operating room], minimize manipulations as much as possible." Similarly in the emergency department, one participant stated they prefer ready-to-use products for some floor-stock items, like vasopressor infusions, to prevent compounding from occurring on the floor and another commented that "we absolutely buy as many presser drips as we can." One participant remarked that they have received requests from anesthesiologists for products that are commercially available in vials that require manipulation prior to administration to be purchased as syringes from outsourcing facilities stating that "they would prefer to have a syringe form."

Another theme regarding deciding what products to purchase from an outsourcing facility was focused on the utilization and volume of a product that is needed and the overall impact this would have on the pharmacy workload. Critical care areas, like the emergency department and operating room, typically have a high product utilization and overall turnover leading to several participants obtaining products intended for use in these areas from outsourcing facilities. Participants stated that they evaluate the volume of product needed and the frequency in which that volume is needed compared to the time it would take pharmacy staff to prepare this volume. One participant commented that "we look at the impact that it'll have on staff. If our staff are needing to batch, or if we need to mass produce these in particular to meet the patient demand, then those are the items that we're going to look to potentially move out." Another participant, while they do not obtain a lot of products from outsourcing facilities, stated that "when we do purchase from 503B's, typically it would be if we just don't have the capacity to keep up with what the demand is." One participant also commented that they will obtain labor intensive and more complicated products, like epidurals and cardioplegia solutions, from outsourcing facilities to reduce the workload on pharmacy staff. The COVID-19 pandemic has also impacted the operations of hospitals with one participant who stated that "it's just really high volume, and the bigger the hospital, the



higher the volume, especially when you have one disease state in half of your hospital” and another who expressed that “without 503B, we would’ve been in significant trouble.” One participant commented that “even though the number might be small [percent of products obtained from outsourcing facilities], some of the reasoning is quite critical, and the amount of time that it saves is very significant for beyond what we’re able to do and when.” Additionally, challenges with recruiting and retaining pharmacy technicians impact decision-making with one participant stating “it is not feasible for us to meet the high volume for some common medications to repackage or compound from commercial presentations to a convenient, ready to use dosage form or package. The outsourcing facilities thus become a force multiplier, if you will, to offset some of the shortages in staffing.”

In addition to the evaluation of the workload on pharmacy staff, the type and capabilities of the facility also impacted the decision-making process. One participant commented that they do not have an established clean room and therefore perform sterile compounding in a segregated compounding area. United States Pharmacopeia (USP) <797> standards limit the beyond-use-date that can be assigned to these products and, as the participant stated, “we obviously need to provide product with much extensive beyond use dating than we can provide.” Several participants also commented that they do not perform high-risk compounding in-house and therefore, all of these products are outsourced. There are challenges with mid-size hospitals being able “to operationalize testing compounds we make for extended stability.” One participant stated, “we might make our own syringes if we could get extended dating, but I believe my operations colleagues don’t always know how to do this and adhere to the letter of the law.”

One participant also commented on the impact that The Joint Commission has had on pushing pharmacies to obtain products from outsourcing facilities. The 2018 medication management standard MM.05.01.07 was intended to move IV admixture preparation out of the nursing unit. This forced pharmacies to consider strategies to make IV admixtures available for use on the floor. Additionally, NPSG.03.04.01 states that all medications and solutions should be adequately labeled, including in operating room and other settings in which procedures are performed. USP <795> and <797> are applicable in operating room settings, stating that products should be labeled and used with one-hour, which may be problematic if syringes are drawn up at the beginning of the day and cases are canceled or delayed. The participant also commented on the cost related to purchasing premade products from manufacturers stating that “predatory pricing on premixes is present in the market.”

Standardization of products, including concentration, volume, and labeling, was also a driver for obtaining products from an outsourcing facility. However, such standardization may not always be possible. One participant stated that when evaluating similar facilities, you would expect them to have similar needs regarding the concentrations and volumes of products utilized. However, the products utilized in a facility are often developed in-house over decades based on physician and nurse requests, and more recently, appropriateness for an automated dispensing cabinet. As a result, one participant observed, “these practices had evolved somewhat disparately, even if we had clinical practice guidelines, nobody was putting concentrations into those guidelines and volumes into those guidelines.” This has led to challenges with obtaining certain products from outsourcing facilities. As another participant said “I think we made nine different epidural concentrations, all driven by anesthesia, and they want what they want and 503Bs may not offer that. No one else in the country is buying that same concentration a 503B isn't going to go through the expense of adding that to their product list.” The participant continued that “similar with the ADCs [automated dispensing cabinets], we've run into situations where dextrose 50% goes on shortage and the 503Bs would be selling it in a syringe. For safety reasons and for crash cart reasons, without having to retrain thousands of nurses of where things are placed, they said, ‘no, we can't have it, and that's too big it won't fit,’ we want it in this format and then we're stuck again because there's no 503B offering a format during that shortage that fits where it needs to go. Then we're stuck in

sourcing.” Additionally, while a commercially available product may be available, the volume may not be appropriate. One participant stated that “3% saline for instance, is sold in a 500 mL bag, but the clinical guideline is a 150 mL bolus. We're either going to draw that out or we're sending it to the ER with stickers all over it saying only give 150 [mL].” The participant continued that “it would be great if the FDA could look at the size of the container that they're approving and whether that's a realistic dose, is it a unit dose or isn't it.”

Participants had differing opinions on the use of outsourcing facilities to obtain drugs during a shortage. Several participants stated that they will typically first restrict use of a drug on shortage, in order to conserve supply, before turning to an outsourcing facility. One participant commented that “most of the time, I will probably pursue restricting, conserving, and looking at all available options prior to going to an outsourcer on my end” and another stated, “I can only think of one time in recent history where we went to an outsourcer.” One participant commented that “503Bs can't accept the additional volume if it's a true shortage. If you're not with them pre-shortage, you're not going to get products when you need it during the shortage” continuing that “typically in a shortage, you learn to live without them. You have to.” Additionally, in the event of the shortage being the result of lack of an API, outsourcing facilities are likely to be equally affected and unable to provide assistance. However, one participant stated that they first began working with outsourcing facilities because of shortages. This participant commented that “what the 503Bs are starting to do, some of the large ones, is that they are also conducting validation studies on API. If sterile becomes short, they quickly switch to producing through API, which ASHP [American Society of Hospital Pharmacists] and the FDA allows.” This “adds a lot of flexibility so they can bounce back and forth and really try to insulate us from shortages.”

A few participants commented on the use of API by outsourcing facilities. One commented that as long as they are conducting end product sterility and stability testing and the product meets quality standards, they are not concerned with the starting ingredients. As long as buyers are familiar with regulations and know what to look for, another participant commented, there should not be any issues with purchasing products compounded starting from API. Another participant stated that as more outsourcing facilities began using API, they became more comfortable with them doing so. However, one participant observed that most outsourcing facilities are switching to sterile-to-sterile and only using API if there is a shortage, stating, “I think the FDA has really looked closely at API, and they're slowly pushing the 503B outsourcers to a sterile to sterile.” Only 1 participant commented that they prefer sterile-to-sterile. Another participant stated that the companies they use are all sterile-to-sterile.

A few participants commented on the need for preservative free products, particularly in pediatric patients. The example of methadone was provided as it is used for patients with neonatal abstinence syndrome but is only available as a preservative containing product. So, there is a need for this product to be compounded from API as a preservative free product. One participant stated that “if there's not a preservative-free containing option, it really should be something that should be able to be compounded for bulk... especially for the pediatric patient population.” However, another participant from a children's hospital stated that the need for a preservative free option has never been a reason why they have obtained a product from an outsourcing facility. Preservative free is also an issue for ophthalmic products, however, one participant observed this is more on the 503A side. One participant stated that obtaining ophthalmic products from outsourcing facilities has been a challenge and that there are products they would like to obtain from outsourcing facilities but are not able to, forcing them to compound them in-house. This participant also commented that there are 2 outsourcing facilities that compound ophthalmic products but when they reviewed the facilities, they did not pass their internal quality standards; one facility had been banned from distributing products in California by the Board of Pharmacy. There is an additional challenge with obtaining cephalosporins and beta-lactams due to the potential cross reactivity

in patients with allergies. One participant stated that there are some cephalosporins they would like to obtain from an outsourcing facility but cannot because “they would have to build a separate clean room with a dedicated HVAC [heating, ventilation, and air conditioning], so you're talking millions of dollars in investment for actually very low volume. Right now, the ROI [return on investment] isn't there.” Another participant stated that the concentrations required for ophthalmic antibiotics are not available but the labor and risk of compounding these products in-house is not worth it.

A few participants commented on purchasing nonsterile products from outsourcing facilities. LET (lidocaine-epinephrine-tetracaine) gel, for use as a topical anesthetic, was the most commonly obtained product along with buffered lidocaine to put in J-tips. Another participant stated that they obtain diclofenac suppositories from an outsourcing facility due to the high cost of indomethacin suppositories. One participant commented that most of the products they outsource are nonsterile products, generally for oral or topical administration due to a lack of commercially available products being available. The participant stated that they purchase low dose naltrexone for oral use in patients with refractory fibromyalgia and ketamine troches for patients with chronic pain. The participant continued that while the evidence does not support many of the ingredients used in topical pain products, “However, there are select patients. It's very rare that taking that cream away from them actually causes more harm than good.” A few participants commented that there is a gap in the market for nonsterile products with one stating “I think that there is a large opportunity for more nonsterile products to be produced by 503Bs.” Another stated that as their facility grows and acquires more outpatient clinics, they receive a lot of questions regarding obtaining products for office use. The participant noted that they often have to refer these clinics to outsourcing facilities but stated “there's not many 503Bs are doing the non-sterile for clinic use.” As a result, the inpatient pharmacy is often asked to take on this role but “you don't have the space or the staff to do that.”

Based on the responses to the prequestionnaire (refer to *Results of survey*), participants were asked questions regarding specific products obtained from outsourcing facilities. Several participants reported using alum (aluminum potassium) as a bladder irrigation for hemorrhagic cystitis refractory to other treatment options. Participants commented that this is high-risk compounding; they purchase alum from an outsourcing facility because they do not perform high-risk compounding in their facility. One participant commented that their policy states that high-risk compounding is not allowed except for alum. This participant wanted to move away from compounding alum in-house and stated that the addition of aluminum potassium to the bulks list might allow this to happen. Another participant had compounded alum in-house from non-sterile ingredients; however, there had been challenges with crystallization after storage. A few participants commented that there is a sterile alum powder available, which they purchase to compound in house. One participant had concerns regarding this powder, stating that “I've talked to that company, but I've had some concerns for them because they don't sell it as a drug. The owner was selling you a chemical, we're selling you a bulk API. It's just sterile. They were fuzzy and I never followed up but, when I asked about their process for verifying the sterility, as you would with a sterile product, we do USP [United States Pharmacopeia] <71> Sterility Testing. They couldn't really give me an answer. They just say they tested for sterility.” The participants commented that alum is only needed a few times a year. However, as one participant observed, “when you need it, it's an emergency” and another noting that it “is a challenge for anybody who has the cyclophosphamide-induced hemorrhagic cystitis.” As a result, one participant maintains a small inventory of alum product that is purchased from an outsourcing facility but “more times than not, they go unused and expire.” Another stated that they do not keep it in stock because there is a minimum purchase and there are only a few cases a year for whom they need to use alum. The participant had it STAT shipped when needed. Another participant stated that “we had a meeting with the head of urology who was baffled, why they're

even ordering it. He was like, ‘this is an old, really old. I don't even know why we're using it’ and basically approved for us to not even make it anymore for now.”

Two participants commented on the use of glycerin at their facility. One stated that they purchase it from a 503A because they were not able to find an outsourcing facility that provides this product. The participant commented that glycerin is used in 3 different concentrations at their facility, 1 for ophthalmic use, 1 for neurologic use in trigeminal neuralgia, and 1 for instilling into “a very specific kind of pump that's used to deliver a very specific kind of chemotherapy.” When there are breaks in the chemotherapy regimen, the pump has to be filled with something and by using glycerin “it can go three months or something like that, so it's a huge patient satisfier to have that concentration available.” The participant also commented that since they have been unable to find an outsourcing facility that compounds the concentration needed for trigeminal neuralgia, they have patients who have been waiting years for treatment. The other participant stated that they compound it in-house but said that it is not done very frequently. The participant commented that it is very difficult to sterilize due to the thickness of the product.

Four participants stated that they obtain sodium citrate as ready-to-use syringes for use as a locking solution in patients undergoing dialysis with one commenting that “our nephrologists, like it in place of heparin for some patients to keep the ports patent or so they don't have to go to alteplase or some of the other drugs.” There is a commercially available product; however, it is only available as a 500 mL bag and the dose needed is typically less than 30 mL. If the syringes are prepared in-house, then the beyond-use-date is limited to 12-24 hours depending on storage which results in waste.

One participant stated that they obtain papaverine from outsourcing facilities for use in urology as Bimix (papaverine/phentolamine) and Trimix (papaverine/phentolamine/alprostadil).

While none of the participants obtained sodium phosphate or aspartic acid from outsourcing facilities for use in cardioplegic solutions, a few commented that they do obtain cardioplegic solutions from outsourcing facilities. The del Nido formulation was the product most commonly obtained. One participant commented that they compound this formulation in-house because the outsourcing facilities did not offer the volume needed at their institution. Another participant commented that while they do obtain the del Nido formulation from an outsourcing facility they also compound a proprietary formulation in house. This participant observed that “it is complicated to do in-house. We do it on a, Baxa 1200 or 2,400, either one, compounder. Then we send it up to for pH and potassium testing. Obviously, then we're confined to 797 beyond-use-dates versus longer beyond-use-dates that we get from the 503B.” Another participant commented that cardioplegic solutions are managed by the perfusion department, not pharmacy, and they use del Nido solution as well as 3 other formulations.

The participants also discussed challenges with utilizing outsourcing facilities. One participant stated that their facility does not use outsourcing facilities because “it just hasn't been financially, not just the money worth it, but just the lead time for how much time you have to give them and how much you have to... It just isn't worth the dating that they gave us or can give us.” Another commented that they obtain very little product from outsourcing facilities due to the “the amount of work for vetting and continually validating quality of these 503B outsourcing facilities.” The participant stated that they have a robust validation process that takes several months and includes a site visit prior to purchasing from an outsourcing facility, followed by continuous reviewing of quality reports and warning letters. Another challenge has been the reliability of the outsourcing facility. One participant commented that “Traditionally, we've found 503B's to be fairly unreliable, when we have partnered with certain ones, to be able to keep up with the volume. Everybody knows PharMEDium just closed, but we've had some other smaller 503B's where we've had agreements for certain products to take it off our plate, and then

low and behold they're shut down, or closed, or whatever it may be.” Minimum purchase amounts were also reported as a concern with one participant stating that “what we see consistently is the 503Bs, they want us to commit to giving them a certain volume, but then will not give us a reciprocal commitment or at least will not fulfill that reciprocal commitment. That's a huge problem for us making that type of commitment, when we do ultimately have to split our volume in order to make sure that we consistently are able to take care of our patients.” Another challenge was related to outsourcing facilities utilizing API to compound narcotics. One participant commented that this often worsens drug shortages due to the quotas that the Drug Enforcement Administration (DEA) places on the quantity that can be produced. The participant stated that “they [outsourcing facilities] want to buy the product that we're trying to buy to take care of our patients today, to sell us tomorrow. We really need the FDA to say that, especially for controlled substances, that 503Bs can consistently prepare those products so that we don't end up with a shortage year after year, after year and then chasing our tail. Also, we may actually want to tell 503Bs, they can't buy those products or that they're limited in the amount of their ability to buy those products to make what are essentially copies of commercially available products, because it actually induces the shortage in many ways.”

### *Results of survey*

Zero people responded to the survey distributed via professional medical associations and available on the project website.

A prequestionnaire was distributed to participants of the roundtable discussion (refer to Appendix 2.2 for survey instrument).

Forty-three people responded to the prequestionnaire; refer to Table 15 for respondent characteristics. Amongst respondents, 35 (81% of 43 total respondents) utilized outsourcing facilities to obtain drug products, 4 (9%) did not utilize outsourcing facilities, and 4 (9%) did not respond to this question.

Twenty-seven respondents (19% of 143 responses, where respondents were allowed to select multiple reasons) obtained drug products from outsourcing facilities due to a need for ready-to-use products and 20 respondents (14%) obtained drug products from outsourcing facilities due to backorders (refer to Table 16).

Fourteen respondents (31% of 45 total responses, where respondents were allowed to select multiple types) obtained nonsterile products from outsourcing facilities and 31 (69%) obtained sterile products from outsourcing facilities. Refer to Table 17 for the categories of products obtained from outsourcing facilities.

Two respondents (1.9% of 108 responses, where respondents were allowed to select multiple drug products) obtained aluminum phosphate sulfate from a 503B outsourcing facility (refer to Table 18).

Table 11. Characteristics of survey respondents

*No respondents to survey distributed via professional medical associations*

Table 12. Conditions for which aluminum potassium sulfate prescribed or administered

*No respondents to survey distributed via professional medical associations*

Table 13. Reasons for using compounded aluminum potassium sulfate

*No respondents to survey distributed via professional medical associations*

Table 14. Use of non-patient-specific compounded aluminum potassium sulfate

*No respondents to survey distributed via professional medical associations*

Table 15. Demographics of prequestionnaire respondents' facilities

<b>Type of Facility</b>	<b>Responses, n (N=102)<sup>a</sup></b>
Academic medical center	15
Acute care hospital	16
Children's hospital	8
Community hospital	11
Critical access hospital	2
Dialysis center	2
Federal government hospital	4
Health system	15
Inpatient rehabilitation center	4
Long-term acute care hospital	3
Outpatient surgery center	6
Rural hospital	2
Skilled nursing facility	0
Specialty hospital <sup>b</sup>	4
Trauma center	5
Urban hospital	5
<b>Number of Beds</b>	<b>Responses, n (N=38)</b>
< 50	4
50-99	3
100-199	1

200-299	3
300-399	5
400-599	3
> 600	18

<sup>a</sup>Respondents allowed to select more than one type of facility.

<sup>b</sup>Specialties provided include cardiology, pulmonary, vascular, home infusion, neurology, psychiatry, oncology.

Table 16. Reasons for obtaining products from outsourcing facilities

<b>Categories</b>	<b>Responses, n (N=143)<sup>a</sup></b>
Backorders	20
Convenience	19
Cost	10
Need for concentrations not commercially available	19
Need for multi-ingredient products not commercially available	10
Need for preservative-free products	3
Need for ready-to-use products	27
No FDA-approved product available	7
No onsite compounding facility	1
Onsite compounding facility not equipped to compound all necessary products	19
Other <sup>b</sup>	6

<sup>a</sup>Respondents allowed to select multiple categories.

<sup>b</sup>Respondents reported staffing shortages, need for extended dating, volume of product used, standardization projects as additional reasons for utilizing outsourcing facilities.

Table 17. Categories of products obtained from outsourcing facilities

<b>Categories</b>	<b>Responses, n (N=142)<sup>a</sup></b>
Cardioplegic solutions	14
Dermatologic preparations	6

Dialysate solutions	0
Fluids	8
Ophthalmic preparations	10
Patient-controlled analgesia	20
Ready-to-use anesthesia syringes	25
Ready-to-use antibiotic syringes and/or bags	14
Ready-to-use electrolyte solutions	5
Ready-to-use vasopressor solutions	18
Total parenteral nutrition solutions	16
Other <sup>b</sup>	6

<sup>a</sup>Respondents allowed to select multiple categories.

<sup>b</sup>Respondents reported obtaining alum for bladder irrigation, oxytocin, anticoagulant sodium citrate solution, narcotic drips, high-cost anti-seizure medications, antiviral medications, topical pain, and oral tablets/capsules.

Table 18. Products obtained from an outsourcing facility

<b>Product</b>	<b>Responses, n (N=108)<sup>a</sup></b>
Acetylcysteine	1
Adenosine	2
Aluminum potassium sulfate	2
Aspartic acid	0
Atenolol	0
Atropine	9
Baclofen	4
Betamethasone	0
Biotin	0
Bupivacaine	8
Calcium chloride	1
Caffeine sodium benzoate	0



Cholecalciferol	1
Chromium chloride	0
Clonidine	0
Dexamethasone sodium phosphate	0
Diclofenac	0
Gentamicin	0
Glycerin	1
Hydroxyzine	0
Ketamine	14
Levocarnitine	0
Lidocaine	8
Lorazepam	2
Magnesium sulfate	4
Manganese chloride	0
Methylprednisolone	0
Midazolam	15
Mupirocin	1
Norepinephrine	15
Ondansetron	0
Phytonadione	0
Potassium chloride	0
Potassium phosphate	0
Prilocaine	0
Proline	0
Propranolol	1
Ropivacaine	6

Sodium chloride	0
Sodium citrate	3
Sodium phosphate	0
Tetracaine	2
Triamcinolone acetonide	0
Tropicamide	0
None of the above	8

<sup>a</sup>Respondents were allowed to select multiple products.

## **CONCLUSION**

Aluminum potassium sulfate was nominated for inclusion on the 503B Bulks List as a 1% irrigation solution to non-invasively treat hemorrhages. Aluminum potassium sulfate is not available in the nominated dosage form and ROA in any of the countries searched.

From the literature review and interviews, aluminum potassium sulfate is used to treat bladder hemorrhage as a continuous infusion. According to the SME it is used infrequently in refractory cases of bladder hemorrhage but without this as an option there would not be any alternatives. A few participants from the hospital pharmacy roundtable had obtained aluminum potassium sulfate from outsourcing facilities, however, some reported compounding this in-house.

Zero people responded to the survey distributed via professional medical associations and available on the project website. Two people responded to the prequestionnaire stating that they obtain aluminum potassium sulfate from an outsourcing facility.

## REFERENCES

1. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology: Theory and Practice*. 2005;8(1):19-32.
2. Colquhoun HL, Levac D, O'Brien KK, et al. Scoping reviews: time for clarity in definition, methods, and reporting. *J Clin Epidemiol*. 2014;67(12):1291-1294.
3. Levac D, Colquhoun H, O'Brien KK. Scoping studies: Advancing the methodology. *Implementation Science*. 2010;5(1).
4. Peters MDJ, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *International Journal of Evidence-Based Healthcare*. 2015;13(3):141-146.
5. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018;18(1):143-143.
6. Goel AK, Rao MS, Bhagwat AG, Vaidyanathan S, Goswami AK, Sen TK. Intravesical irrigation with alum for the control of massive bladder hemorrhage. *J Urol*. 1985;133(6):956-957.
7. Ho CC, Zainuddin Z. Alum irrigation for the treatment of intractable haematuria. *Malays J Med Sci*. 2009;16(4):66-68.
8. Mallick S, Madan R, Julka PK, Rath GK. Radiation induced cystitis and proctitis - prediction, assessment and management. *Asian Pac J Cancer Prev*. 2015;16(14):5589-5594.
9. Modi KB, Paterson PJ. Alum irrigation in massive bladder hemorrhage in severe renal failure. *Am J Kidney Dis*. 1988;12(3):233-235.
10. Nurmi M, Puntala P, Torniainen K. Alum irrigation in the treatment of severe haemorrhage from the bladder. *Ann Chir Gynaecol*. 1987;76(3):173-175.
11. Octavio Castillo A, Buizza C. [Bladder irrigation with aluminum solution for the control of massive hematuria]. *Arch Ital Urol Nefrol Androl*. 1989;61(1):59-62.
12. Schootstra R, van Driel MF, Hassankhan R, et al. The use of an alum irrigation in the treatment of massive bladder haemorrhage. *Pharm Weekbl Sci*. 1989;11(5):175-178.
13. Serrano Frago P, Allepuz Losa C, Gil Martínez P, et al. [Treatment of hemorrhagic cystitis secondary to cyclophosphamide. Literature review with regard to a case]. *Actas Urol Esp*. 2005;29(2):230-233.
14. Takashi M, Kondo A, Kato K, Murase T, Miyake K. Evaluation of intravesical alum irrigation for massive bladder hemorrhage. *Urol Int*. 1988;43(5):286-288.
15. Tomiki Y, Ono S, Aoki J, et al. Treatment of internal hemorrhoids by endoscopic sclerotherapy with aluminum potassium sulfate and tannic acid. *Diagn Ther Endosc*. 2015;2015:517690.
16. Egan J, Vranic G, Ghasemian SR. Alum irrigation for the treatment of adenovirus induced hemorrhagic cystitis in a kidney transplant recipient. *Urology Case Reports*. 2020;30.
17. Mukamel E, Lupu A, DeKernion JB. Alum irrigation for severe bladder hemorrhage. *Journal of Urology*. 1986;135(4):784-785.
18. Ostroff EB, Chenault Jr OW. Alum irrigation for the control of massive bladder hemorrhage. *Journal of Urology*. 1982;128(5):929-930.
19. Thompson IM, Teague JL, Mueller EJ, Rodriguez FR. Intravesical alum irrigation for intractable bleeding secondary to adenocarcinoma of the prostate. *Journal of Urology*. 1987;137(3):525-526.

20. Westerman ME, Boorjian SA, Linder BJ. Safety and efficacy of intravesical alum for intractable hemorrhagic cystitis: A contemporary evaluation. *Int Braz J Urol.* 2016;42(6):1144-1149.
21. Efros MD, Ahmed T, Coombe N, Choudhury MS. Urologic complications of high-dose chemotherapy and bone marrow transplantation. *Urology.* 1994;43(3):355-360.
22. Praveen BV, Sankaranarayanan A, Vaidyanathan S. A comparative study of intravesical instillation of 15(s) 15 Me $\alpha$  and alum in the management of persistent hematuria of vesical origin. *International Journal of Clinical Pharmacology Therapy and Toxicology.* 1992;30(1):7-12.
23. Ostroff EB, Chenault Jr OW. Re: Alum irrigation for the control of massive bladder hemorrhage. *J Urol.* 1983;130(5):986.
24. Westerman ME, Boorjian SA, Linder BJ. Safety and efficacy of intravesical alum for intractable hemorrhagic cystitis: A contemporary evaluation. *Journal of Urology.* 2015;193(4):e231.

## APPENDICES

### *Appendix 1. Search strategies for bibliographic databases*

#### MEDLINE search strategy

- Platform: Ovid
- Years searched: Ovid MEDLINE and epub ahead of print, in-process, and other non-indexed citations and daily 1946 to February 1, 2021
- Date last searched: February 2, 2021
- Limits: Humans (search hedge); English language
- Number of results: 66

1	(alum\$ adj2 (potash or potassium)).tw.	318
2	administration, intravesical/	4072
3	instillation, drug/	1463
4	therapeutic irrigation/	17635
5	lavage\$.tw.	51583
6	instill\$.tw.	28210
7	irrigat\$.tw.	35099
8	intravesical\$.tw.	9964
9	intra vesical\$.tw.	132
10	exp hemorrhage/	334080
11	exp hemostasis/	114613
12	hemostatic techniques/	4184
13	exp hemostatics/	140524
14	hemorrhoids/	5209
15	ad.fs.	1438648
16	de.fs.	3033844
17	dt.fs.	2274458
18	tu.fs.	2263257
19	pc.fs.	1317446
20	bleed\$.tw.	216074

21	h?emorrhag\$.tw.	260615
22	h?ematur\$.tw.	21681
23	h?emosta\$.tw.	53051
24	h?emorrhoid\$.tw.	6199
25	or/2-24	7241305
26	and/1,25	110
27	exp animals/ not humans/	4782772
28	26 not 27	71
29	limit 28 to english language	66

## Embase search strategy

- Platform: Elsevier
- Years searched: 1947 to present
- Date last searched: February 2, 2021
- Limits: Humans (search hedge); English language
- Number of results: 172

1	'aluminum potassium sulfate'/mj	1002
2	(alum* NEAR/2 (potash OR potassium)):ti,ab,tn	451
3	#1 OR #2	1374
4	'intravesical drug administration'/de	2828
5	'lavage'/de	17648
6	'bladder irrigation'/de	2431
7	'drug instillation'/de	1843
8	'lavage*':ti,ab	74825
9	'instill*':ti,ab	41628
10	'intravesical*':ti,ab	15101
11	'intra vesical*':ti,ab	288
12	'bleeding'/exp	1045721
13	'hemostasis'/de	78177
14	'hemostatic agent'/de	10563
15	'hemorrhoid'/de	10445
16	'drug administration':lnk	1793228
17	'drug therapy':lnk	4010396
18	'prevention':lnk	1197135
19	'bleed*':ti,ab	366923
20	'h\$emorrhag*':ti,ab	398778
21	'h\$ematur*':ti,ab	36839
22	'h\$emosta*':ti,ab	85377



23	'h\$emorrhoid*':ti,ab	10184
24	#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23	6223157
25	#3 AND #24	341
26	[animals]/lim NOT [humans]/lim	6160195
27	#25 NOT #26	200
28	#25 NOT #26 AND [english]/lim	172

*Appendix 2.1. Survey instrument for professional medical associations*

1. How familiar are you with the following terms?

	Very familiar	Somewhat familiar	Not familiar
Compounded drugs (medications prepared to meet a patient-specific need)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
503A Compounding pharmacy (a pharmacy that prepares compounded medications prescribed by practitioners to meet a patient-specific need)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
503B Outsourcing facility (a facility that compounds larger quantities without the receipt of a patient-specific prescription)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. Do you prescribe or administer aluminum potassium sulfate to your patients?

- Yes
- No

3. Do you prescribe or administer aluminum potassium sulfate by any of the following dosage forms and/or routes of administration? (check all that apply)

- Irrigation solution
- None of the above

4. I prescribe or administer aluminum potassium sulfate for the following conditions or diseases: (check all that apply)

- Non-invasive option for treating hemorrhage
- Other (please explain) \_\_\_\_\_

5. I use compounded aluminum potassium sulfate because: (check all that apply)

- Commercial products are not available in the dosage form, strength, or combination I need (please explain) \_\_\_\_\_
- Patient allergies prevent me from using commercially available products (please explain) \_\_\_\_\_
- Patient conditions prevent me from using commercially available products (please explain) \_\_\_\_\_
- I am not aware of any commercially available products containing aluminum potassium sulfate
- Other (please explain) \_\_\_\_\_

6. Do you stock non-patient-specific compounded aluminum potassium sulfate at your practice?

- Yes
- No
- I'm not sure

7. I obtain compounded aluminum potassium sulfate from the following: (check all that apply)

- Compound myself at my practice
- Have the product compounded by an in-house pharmacy
- Purchase, or have a patient purchase, from a compounding pharmacy
- Purchase, or have a patient purchase, from an outsourcing facility
- Other (please explain) \_\_\_\_\_

8. What is your practice setting? (check all that apply)
- Physician office/private practice
  - Outpatient clinic
  - Hospital/health system
  - Academic medical center
  - Emergency room
  - Operating room
  - Other (please describe) \_\_\_\_\_
9. What degree do you hold? (check all that apply)
- Doctor of Medicine (MD)
  - Doctor of Osteopathic Medicine (DO)
  - Doctor of Medicine in Dentistry (DMD/DDS)
  - Doctor of Pharmacy (PharmD) or Bachelor of Science in Pharmacy (BS Pharm)
  - Naturopathic Doctor (ND)
  - Nurse Practitioner (NP)
  - Physician Assistant (PA)
  - Other (please describe) \_\_\_\_\_

*Appendix 2.2. Survey instrument for pharmacy roundtable prequestionnaire*

1. Please select all that apply regarding the facility with which you are affiliated.
  - Academic medical center
  - Acute care hospital
  - Children's hospital
  - Community hospital
  - Critical access hospital
  - Dialysis center
  - Federal government hospital
  - Health system
  - Inpatient rehabilitation center
  - Long-term acute care hospital
  - Outpatient surgery center
  - Rural hospital
  - Skilled nursing facility
  - Specialty hospital, please identify specialtiy(ies)
  - Trauma center
  - Urban hospital
2. Please select the number of beds in the facility with which you are affiliated.
  - < 50
  - 50-99
  - 100-199
  - 200-299
  - 300-399
  - 400-599
  - > 600
3. Do you use an outsourcing facility (503b facility) to obtain any products used in your facility? A list of FDA registered outsourcing facilities can be found at <https://www.fda.gov/drugs/human-drug-compounding/registered-outsourcing-facilites>.
  - Yes
  - No
4. Why do you use an outsourcing facility to obtain product(s)? Please select all that apply
  - Backorders
  - Convenience
  - Cost
  - Need for concentrations not commercially available
  - Need for preservative-free products
  - Need for ready-to-use products
  - No FDA-approved products available
  - No onsite compounding facility
  - Onsite compounding facility not equipped to compound all necessary products
  - Other, please explain \_\_\_\_\_
5. Please select the type(s) of products obtained from an outsourcing facility.
  - Nonsterile products
  - Sterile products
6. Please select the category(ies) of products obtained from an outsourcing facility.
  - Cardioplegic solutions
  - Dermatologic preparations

- Dialysate solutions
  - Fluids
  - Ophthalmic preparations
  - Patient-controlled analgesia
  - Ready-to-use anesthesia syringes
  - Ready-to-use antibiotic syringes and/or bags
  - Ready-to-use electrolyte solutions
  - Ready-to-use vasopressor solutions
  - Total parenteral nutrition solutions
  - Other, please identify \_\_\_\_\_
7. From the list below, please select the drug(s) that you obtain as either a single ingredient or multi-ingredient product from an outsourcing facility.
- Acetylcysteine
  - Adenosine
  - Aluminum potassium sulfate
  - Aspartic acid
  - Atenolol
  - Atropine
  - Baclofen
  - Betamethasone
  - Biotin
  - Bupivacaine
  - Calcium chloride
  - Caffeine sodium benzoate
  - Cholecalciferol
  - Chromium chloride
  - Clonidine
  - Dexamethasone sodium phosphate
  - Diclofenac
  - Gentamicin
  - Glycerin
  - Hydroxyzine
  - Ketamine
  - Levocarnitine
  - Lidocaine
  - Lorazepam
  - Magnesium sulfate
  - Manganese chloride
  - Methylprednisolone
  - Midazolam
  - Mupirocin
  - Norepinephrine
  - Ondansetron
  - Phytonadione
  - Potassium chloride
  - Potassium phosphate
  - Prilocaine
  - Proline
  - Propranolol
  - Ropivacaine
  - Sodium chloride

- Sodium citrate
- Sodium phosphate
- Tetracaine
- Triamcinolone acetonide
- Tropicamide
- None of the above

*Appendix 3. Survey distribution to professional associations*

<b>Specialty</b>	<b>Association<sup>a</sup></b>	<b>Agreed/Declined, Reason for Declining</b>
Anesthesiology	Society of Cardiovascular Anesthesiologists	Declined – failed to respond
Cardiology	American Academy of Cardiovascular Perfusion	Declined
	American Board of Cardiovascular Perfusion	Declined – failed to respond
	American Society of Extracorporeal Technology	Declined – failed to respond
Dermatology	American Academy of Dermatology	Declined – failed to respond
Naturopathy	American Association of Naturopathic Physicians	Agreed
Nephrology	American Society of Diagnostic and Interventional Nephrology	Declined
Ophthalmology	American Academy of Ophthalmology	Declined – failed to respond
	American Society of Cataract and Refractive Surgery	Agreed
	American Society of Retina Specialists	Declined
Podiatry	American Podiatric Medical Association	Agreed
Psychiatry	The International Society for Electroconvulsive Therapy and Neurostimulation	Agreed
Rheumatology	American College of Rheumatology	Agreed
Surgery	American Association of Neurological Surgeons	Declined – failed to respond
	American Association for Thoracic Surgery	Declined – failed to respond
	American College of Surgeons	Declined – failed to respond
	American Society for Reconstructive Microsurgery	Declined – failed to respond
Urology	Society of Urodynamics, Female Pelvic Medicine & Urogenital Reconstruction	Declined
Wound Care	Association for the Advancement of Wound Care	Declined – failed to respond

<sup>a</sup>Associations that declined in Year 1 and/or Year 2 were not contacted in Year 3.