When the Antidote Causes Harm

Preventing Errors with Intravenous Acetylcysteine

March 18th, 2025
CSHP National Webinar

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1300-1400 PM EST

ZERO Preventable Harm From Medications
Institute for Safe Medication Practices Canada

Land Acknowledgment

We acknowledge we are hosted on the lands of the Mississaugas of the Anishinaabe, the Haudenosaunee Confederacy and the Wendat. We also recognize the enduring presence of all First Nations, Métis and the Inuit peoples.[1] We are grateful to live, work and play on this land and we want to contribute to the implementation of the Truth and Reconciliation Commission's eight health-related Calls to Action.

Nous tenons à souligner que nous sommes accueillis sur le territoire traditionel des Mississaugas, des Anichinabés, des Haudenosaunees et des Wendats. Nous voulons également reconnaître la pérennité de la présence des Premières Nations, des Métis et des Inuits. Nous sommes reconnaissants de vivre, de travailler et de jouer sur ce territoire et nous voulons contribuer à la mise en œuvre des huit appels à l'action de la Commission de vérité et de réconciliation en matière de santé.

Find your land acknowledgement at https://native-land.ca/

1. https://www.tdsb.on.ca/Community/Indigenous-Education/Resources/Land-Acknowledgementc

Objectives

1. Learn about the reported incidents related to acetylcysteine infusion overdoses that have caused harm in Canada.
2. Understand the methodology that ISMP Canada and HIROC undertook to analyze the incidents using human factors principles.
3. Determine what recommendations from the analysis could be applied locally into practice.
4. Consider strategies for enhancing reporting, learning and acting following medication incidents.

Poll #1 Questions – Role and attendees

My role within the health care team is…

- ❑ Patient/Family Advisor
- ❑ Nurse
- ❑ Pharmacist
- ❑ Physician
- ❑ Nurse Practitioner
- ❑ Pharmacy Technician
- ❑ Manager/Director
- ❑ Clinical Educator
- ❑ QI/Risk Management Consultant
- ❑ Other (please share in the Chat)

How many attendees are in the room altogether?

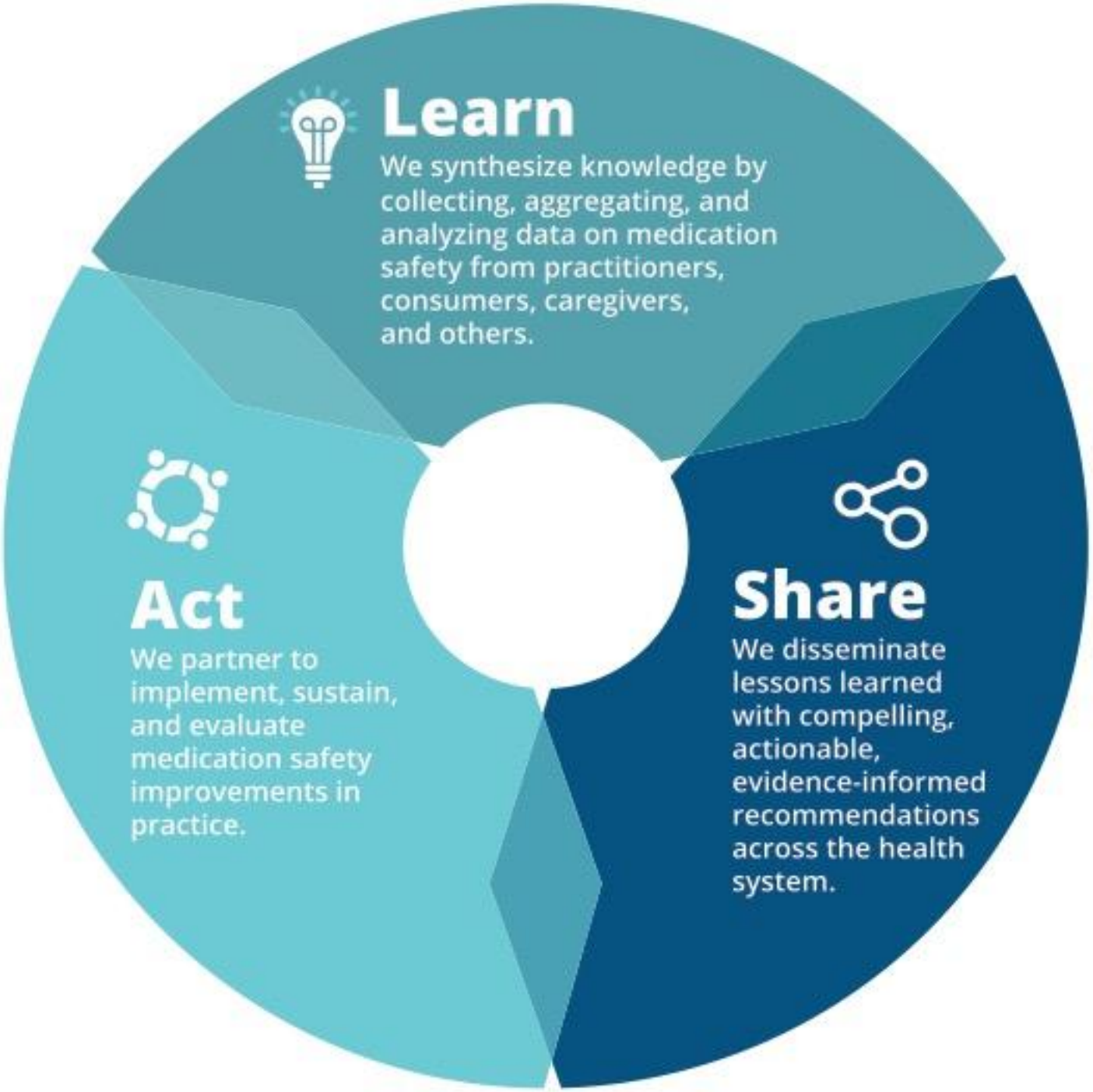
- ❑ 1-4
- ❑ 5-10
- ❑ 11-20
- ❑ 20+

A Trusted Partner

Strengthening medication safety through timely learning, sharing, and acting to improve health care.

ISMP Canada is a national, independent, not-for-profit organization that purposefully partners with organizations, practitioners, consumers, and caregivers to advance medication safety in all healthcare settings.

ismp CANADA



About HIROC

- HIROC is Canada's leading provider of healthcare liability insurance.
- HIROC is a not-for-profit organization with over 800 Subscribers.
- HIROC partners with healthcare organizations to provide insurance and risk management solutions that help reduce risk, prevent losses, and improve patient safety.

HIROC

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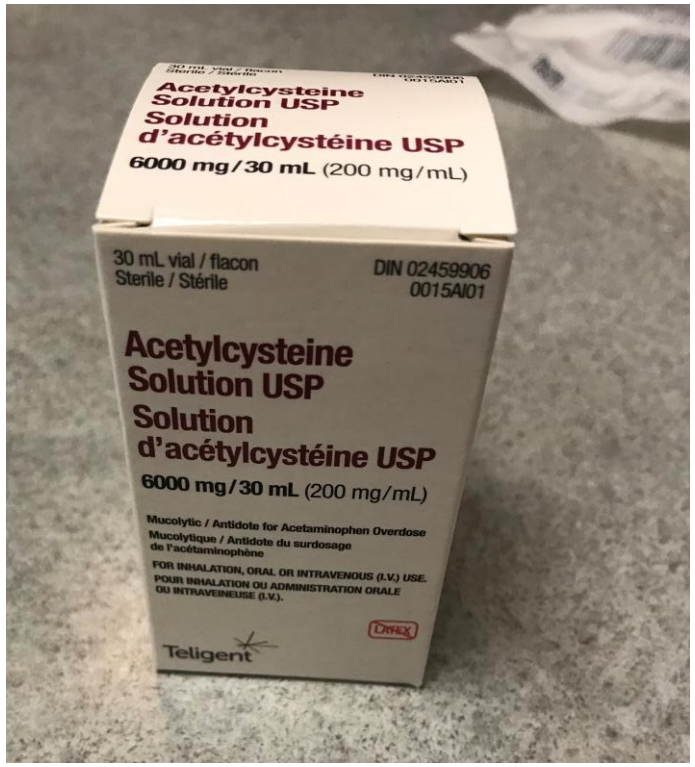
What is Acetylcysteine?

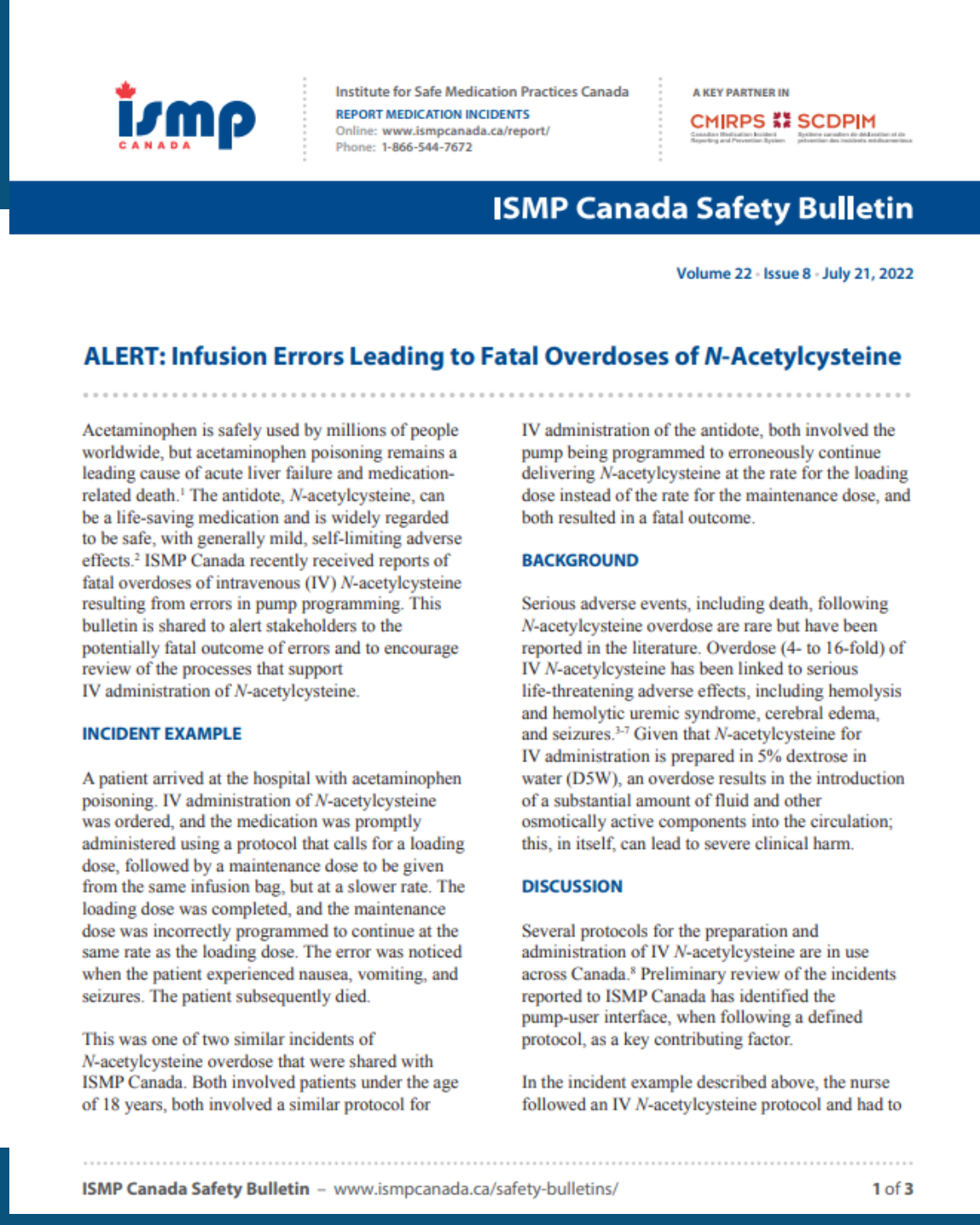
Acetylcysteine (also referred to as N-acetylcysteine or NAC) is effective as an antidote for acetaminophen poisoning.

Acetylcysteine is indicated to prevent or lessen hepatic injury which may occur following the ingestion of a potentially hepatotoxic quantity of acetaminophen.



Alert - July 2022

- Two death cases prompted the analysis team to create an ISMP Canada Safety alert
- The decision was made to do a comprehensive search of acetylcysteine overdose errors reported in the last 5 years.
- Goal to publish findings, contributing factors and recommendations in a subsequent bulletin



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ISMP Canada Safety Bulletin

Volume 22 • Issue 8 • July 21, 2022

ALERT: Infusion Errors Leading to Fatal Overdoses of *N*-Acetylcysteine

Acetaminophen is safely used by millions of people worldwide, but acetaminophen poisoning remains a leading cause of acute liver failure and medication-related death.[1] The antidote, *N*-acetylcysteine, can be a life-saving medication and is widely regarded to be safe, with generally mild, self-limiting adverse effects.[2] ISMP Canada recently received reports of fatal overdoses of intravenous (IV) *N*-acetylcysteine resulting from errors in pump programming. This bulletin is shared to alert stakeholders to the potentially fatal outcome of errors and to encourage review of the processes that support IV administration of *N*-acetylcysteine.

INCIDENT EXAMPLE

A patient arrived at the hospital with acetaminophen poisoning. IV administration of *N*-acetylcysteine was ordered, and the medication was promptly administered using a protocol that calls for a loading dose, followed by a maintenance dose to be given from the same infusion bag, but at a slower rate. The loading dose was completed, and the maintenance dose was incorrectly programmed to continue at the same rate as the loading dose. The error was noticed when the patient experienced nausea, vomiting, and seizures. The patient subsequently died.

This was one of two similar incidents of *N*-acetylcysteine overdose that were shared with ISMP Canada. Both involved patients under the age of 18 years, both involved a similar protocol for IV administration of the antidote, both involved the pump being programmed to erroneously continue delivering *N*-acetylcysteine at the rate for the loading dose instead of the rate for the maintenance dose, and both resulted in a fatal outcome.

BACKGROUND

Serious adverse events, including death, following *N*-acetylcysteine overdose are rare but have been reported in the literature. Overdose (4- to 16-fold) of IV *N*-acetylcysteine has been linked to serious life-threatening adverse effects, including hemolysis and hemolytic uremic syndrome, cerebral edema, and seizures.[3-7] Given that *N*-acetylcysteine for IV administration is prepared in 5% dextrose in water (D5W), an overdose results in the introduction of a substantial amount of fluid and other osmotically active components into the circulation; this, in itself, can lead to severe clinical harm.

DISCUSSION

Several protocols for the preparation and administration of IV *N*-acetylcysteine are in use across Canada.[8] Preliminary review of the incidents reported to ISMP Canada has identified the pump-user interface, when following a defined protocol, as a key contributing factor.

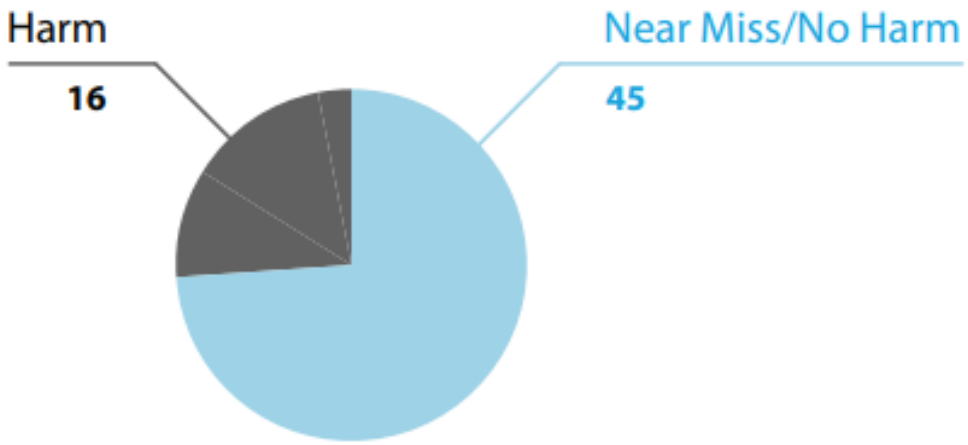
In the incident example described above, the nurse followed an IV *N*-acetylcysteine protocol and had to

Number of Acetylcysteine Incidents Reported

TABLE 1. Results of Database Searches

Database	Number of Reports **Extracted**	Number of Reports **Excluded**	Number of Reports **Included**
ISMP Canada	10	5	5
CIHI NSIR	61	5	56
Canada Vigilance Program	8	8	0
Total	**79**	**18**	**61**

FIGURE 1. Distribution of Incident Outcomes ($n = 61$)



Fatal Acetylcysteine Infusion Overdoses

BOX 4. Database Reports Associated with Fatal Acetylcysteine Infusion Overdoses

Fatal incidents ($n = 4$) related to acetylcysteine infusion overdose involved the following errors:

- administration of the maintenance infusion using the infusion rate of the loading dose (10-fold error), with both doses prepared in the same 1-litre infusion bag of dextrose 5% in water (D5W)
- miscommunication/confusion about the regimen the patient was to receive (e.g., confusing the 3-step "mg/kg" dose and the 2-step "mg/kg/h" dose)
- miscalculation of a concentration or rate of infusion

ISMP Canada has received 3 reports of death or severe harm related to the continuation of the loading dose IV infusion rate instead of reduction to a lower rate for the maintenance dose, resulting in a 10-fold dose error.

Use of a 1-bag, single-concentration regimen was described in all 3 reports.

Poll #2 – Your Experience

Have you experienced any questions or concerns when ordering, preparing and/or administering intravenous acetylcysteine?

- ❑ Yes
- ❑ No
- ❑ Unsure

Please share any comments in the chat

Reporting of Incidents

Thank you to those across Canada that shared information about these incidents so that learning and improvements could occur

It is likely that there are more incidents of preventable harm related to infusing acetylcysteine that were not shared

There are many factors that contribute to under reporting of incidents in healthcare

Just Culture

Culture is a set of shared attitudes, values, goals, and practices that characterize an organization*

A just culture is a small part of a larger healthcare organizational culture – '**the way we do things around here**' – that strives to make care as safe as it can be

When healthcare organizations work within a just culture, there is trust that everyone will be treated fairly when something goes wrong with patient care

*What is a Just Culture -HQCA https://justculture.hqca.ca/what-is-a-just-culture

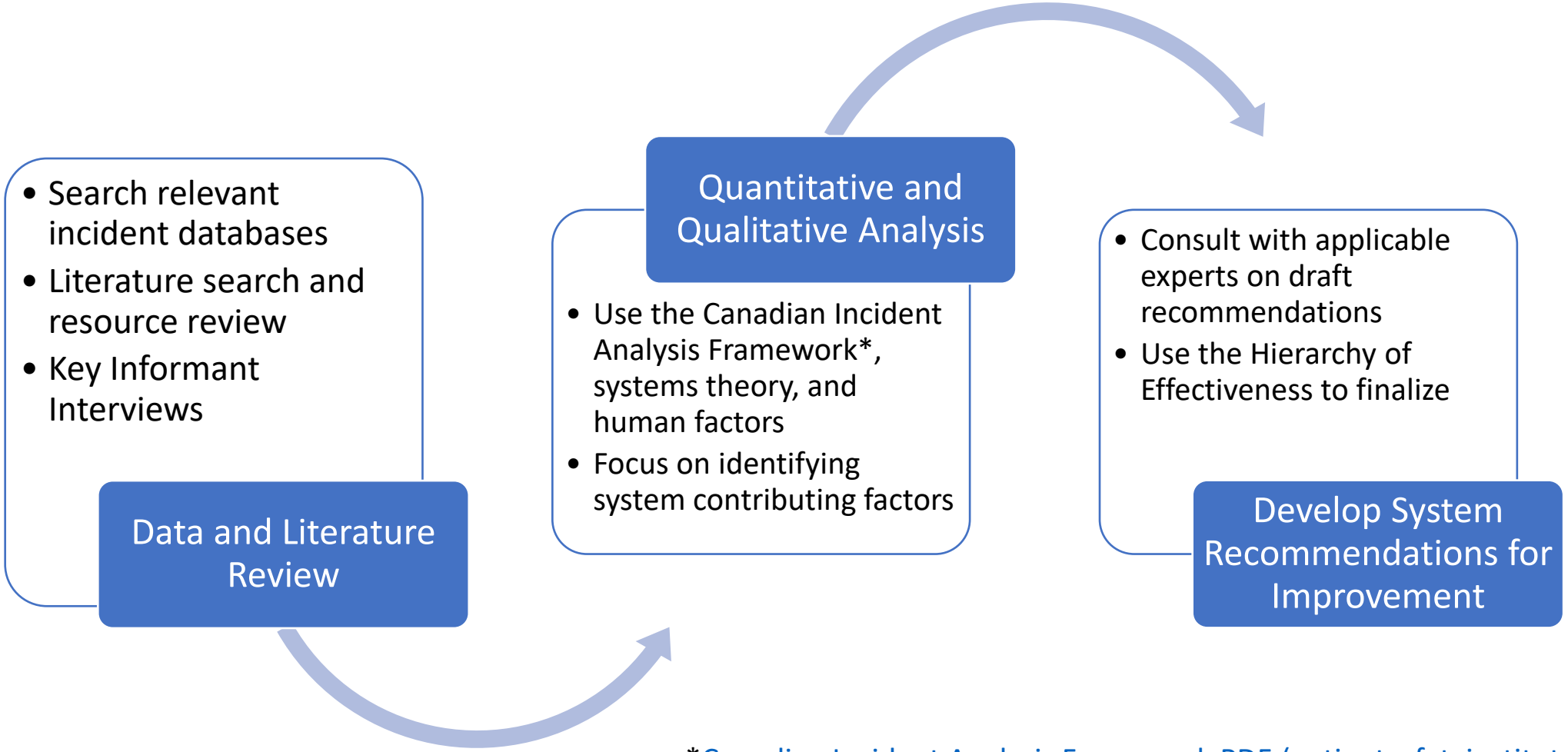
Poll #3 - Just Culture

I feel safe and supported in reporting medication incidents

- ❑ Yes
- ❑ No
- ❑ Unsure

Please share any comments in the chat

Analysis Methodology



*Canadian Incident Analysis Framework.PDF (patientsafetyinstitute.ca)

Literature Review and Collaboration with HIROC

- Jamie Guo, Master of Nursing student, Toronto Metropolitan University, performed a literature search of acetylcysteine protocols and published errors.
- Created a pan-Canadian snapshot of the varying protocols/regimens used in Canada
- Identified the need to update the manufacturer drug monographs
- Asked HIROC to collaborate, including providing Carleene, a Human Factors consultant and expert on IV pumps

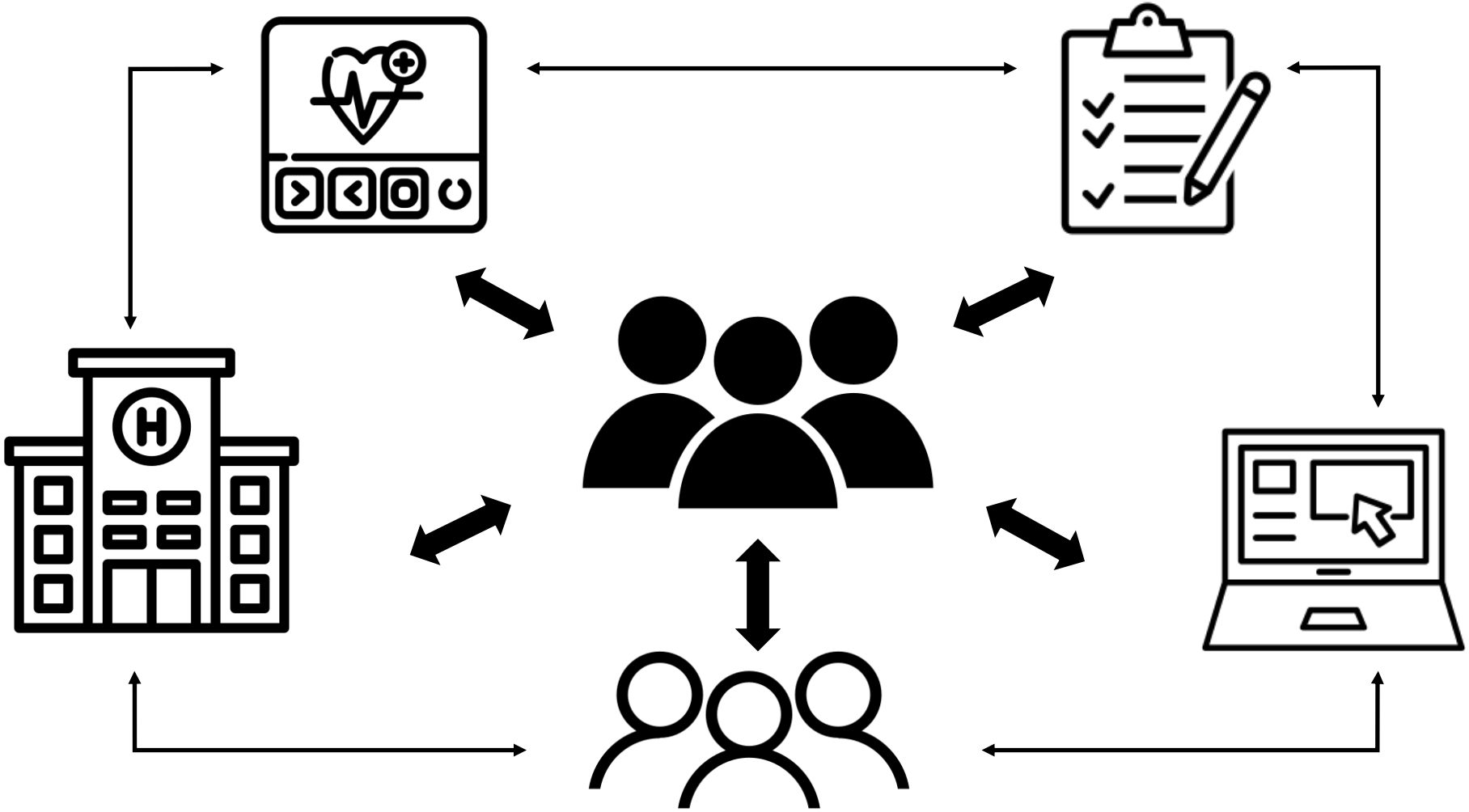
Pan-Canadian Snapshot (2022)

Summary of IV N-Acetylcysteine Protocols for Acetaminophen Toxicity in Canada

Provinces	Ontario	SickKids	UHN	Saskatchewan	Alberta (PADIS)	Quebec (Poison Centre)	Quebec (McGill)	Nova Scotia (Halifax IWK Health Centre), Prince Edward Island & New Brunswick (*NB also uses 3-bag)	Newfoundland and Labrador	British Columbia	Manitoba (Winnipeg) *Also uses single concent. protocol	Drug Monograph (Sandoz)
Overall NAC Infusion Protocol	*Single Concentration Protocol **4-hr loading dose +** Maintenance dose *typically over at least 8 hours until meets criteria to stop ***Typically, at least 12 hours in total. (Total of 288mg/kg over 12 hours)** Dilute in D5W.	*Single Concentration Protocol **4-hr loading dose +** Maintenance dose over a minimum of 8 hours until advised to stop by Poison Centre. ***At least 10-12 hours in total** Dilute in D5W	*Single Concentration Protocol **4-hr loading dose +** Maintenance dose Dilute in D5W	*Single Concentration Protocol ***1-hr loading dose +** 20-hr maintenance dose 21 Hour Protocol: ***Total 450mg/kg** (17.3mL/kg) NAC over 21 hrs. Compatible with D5W, NS or 0.45% NaCl	Single Concentration 2-Step Regimen ***1-hr first dose +** 20-hr second dose 21-Hour Protocol: **Total 450mg/kg** (*15mL/kg) NAC over 21 hrs. Dilution in D5W is preferred, NS if necessary ✦Compatible with D5W, NS and 0.45% NS	*Single Concentration Protocol ***1-hr loading dose** + 20-hr infusion dose 21-Hour Protocol: Total **450 mg/kg** over 21 hours. Compatible with D5W, NS, or 1/2NS	*Single Concentration Protocol ***1-hr loading dose** + 20-hr infusion dose 21-Hour Protocol: Total **450 mg/kg** over 21 hours. Compatible with D5W, NS, or 1/2NS	Single Concentration Protocol ***1-hr loading dose** + 20-hr maintenance dose 21 Hour Protocol: **Total 450mg/kg** (15mL/kg) NAC over 21 hrs. Dilute in dextrose 5% in water (D5W) or sodium chloride 0.9% (NS)	Traditional (*3-Bag) Protocol ***1-hr loading dose+** 4-hr second dose+16-hr third dose 21 Hour Protocol: ***Total 300mg/kg** (10mL/kg) NAC over 21hrs. Dilute in dextrose 5% in water or NS	3-Bag (*Traditional) Protocol ***1-hr loading dose+** 4-hr second dose+16-hr third dose 21-Hour Protocol: ***Total 300mg/kg** NAC over 21 hrs. Dilute in D5W or NS	*Traditional 3-bag Protocol ***1-hr loading dose+** 4-hr second dose+16-hr third dose 21-Hours in Total: **Total 300 mg/kg NAC** over 21 hrs. Compatible with D5W and NaCl 0.45%	*Traditional 3-bag protocol ***15-minutes initial infusion+** 4-hr seco infusion Dilute in D5W
Supplied NAC Concentration and IV Preparation	Supplied as 20% (200mg/mL) NAC solution *Dilute 200mg/mL to **30mg/mL** for IV administration.	Supplied as 20% (200mg/mL) NAC solution *Dilute 200mg/mL to **30mg/mL** for IV administration. **IV Preparation:**	Supplied as 20% (200mg/mL) NAC solution **IV Preparation:** **Loading Dose:** Obtain a	*Supplied as 20% Acetylcysteine solution (mL), 200mg/mL. *Dilute to **26mg/mL** **Standard IV preparation:** **26mg/mL** bag preparation: Add *30,000mg (30g) (150mL) NAC into a 1000mL bag of D5W.	**Standard concentration: 30mg/mL** (adult/children); **40mg/mL** (neonates up to 28 days of age); **50mg/mL** for fluid-restricted patient **IV Preparation for 30mg/mL concentration:** If using a 500mL	Supplied as (20%) solution Dilute to **38.7 mg/mL** **IV Preparation:** **For 5-26kg:** Dilute 12000mg or 60mL NAC 20% in 250mL bag (final volume =310mL)	Supplied as 6000mg/30mL (20%) injectable multidose vial *Dilute to **38.7 mg/mL** **IV Preparation:** Dilute 8 vials (240mL) of NAC 20% (6000 mg/30 mL) in a 1000 mL bag of NS, 1/2NS,	Supplied as NAC 200 mg/mL (20%) solution **Uses one standard concentration:** *N*-Acetylcysteine **30mg/mL** **IV Preparation:** Use 250mL IV bag for patients < 17kg. 500mL IV bag for patients 17-33kg. 1000mL IV bag for patients 34kg and	Supplied as 20% Acetylcysteine solution (mL), 200mg/mL concentration **IV Preparation:** **First Infusion:** Add 0.75mL/kg of NAC to 2.25 mL/kg of IV fluid (D5W). Final Concentration of 50 mg/mL. **Second Infusion**: Add	**IV Preparation:** **Loading Dose:** 150mg/kg NAC in 250mL IV bag	Supplied as 20% NAC solution, 200mg/mL **IV Preparation: (*For Patient more than 40kg):** **Loading dose:** Dilute in 100mL D5W. **Second Infusion:** Dilute in 500mL D5W.	Supplied as 20% solution, Sandoz Standa 200mg/mL **IV Preparation:** NAC solution for IV use should be conside container. Solutions recommended for ea 2nd, 3rd infusions) should be freshly prepa times stated. See **Table I** for Dosage Guid

Acetylcysteine Regimens Used in Canada

Human factors in healthcare

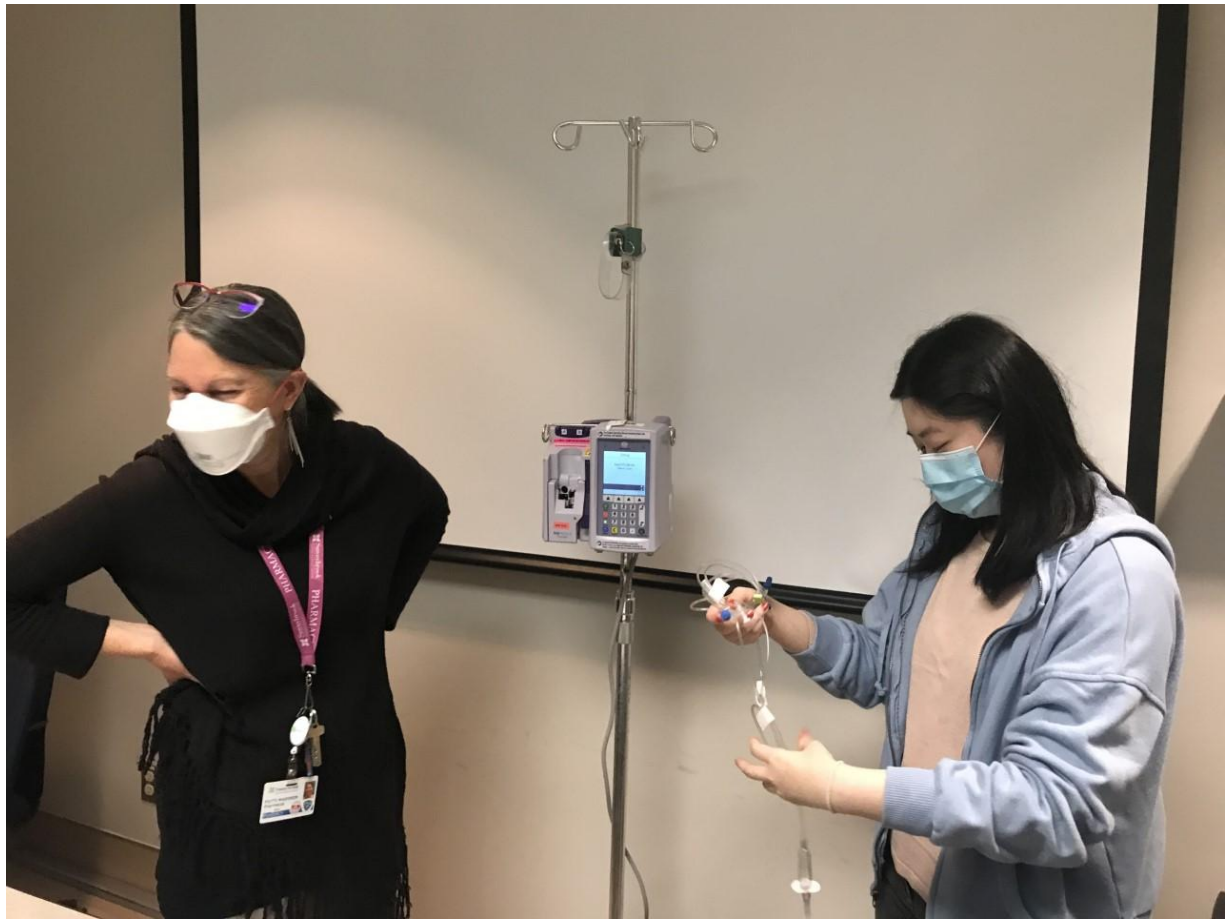


Site Visit – What did we do?

- Met with experts to understand local context for delivering acetylcysteine
- Reviewed hospital's acetylcysteine protocol, order sets, pump programming instructions
- Completed small "simulation" with an infusion pump

From left to right: Carleene Banez, Sylvia Hyland, Jamie Guo, Patti Madorin, Alice Watt, Carolyn Hoffman

Site Visit – Why was it helpful?



- Understand complexities of delivering acetylcysteine infusions within hospitals
- Translating Poison Centre guidelines into practice
- Develop supportive resources based on hospital tools, equipment, etc.
- Human factors perspective to see how components come together

Human factors analysis

Provincial Poison Centre Guidelines

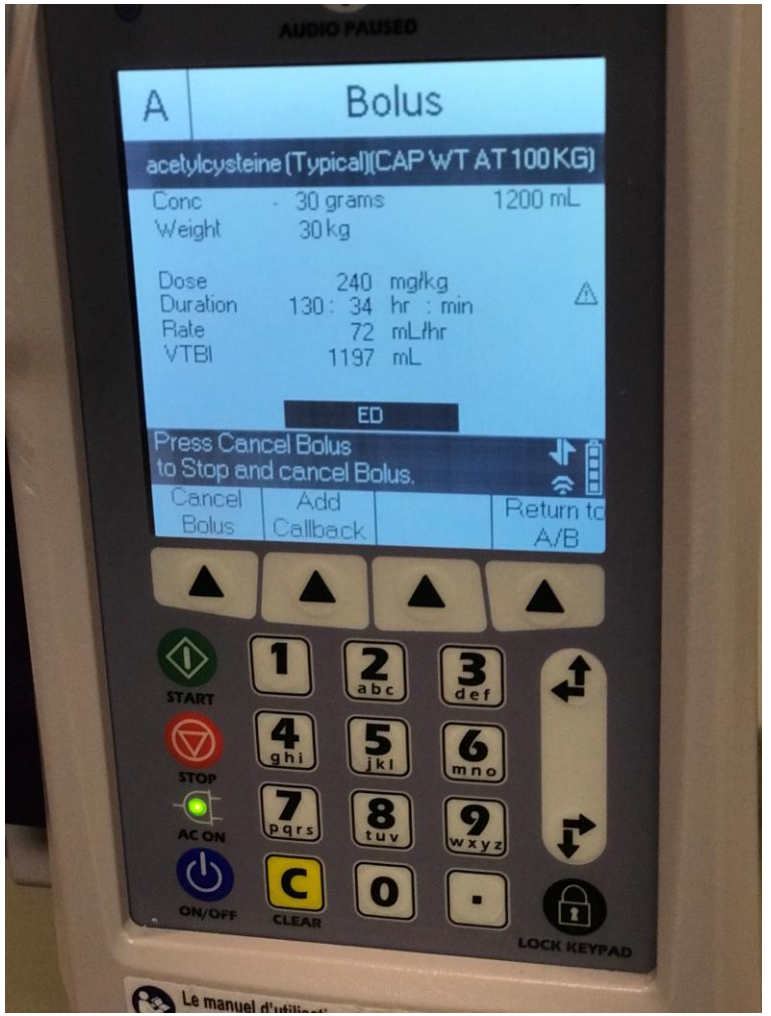
Hospital Protocols and Order Sets

Infusion Pumps

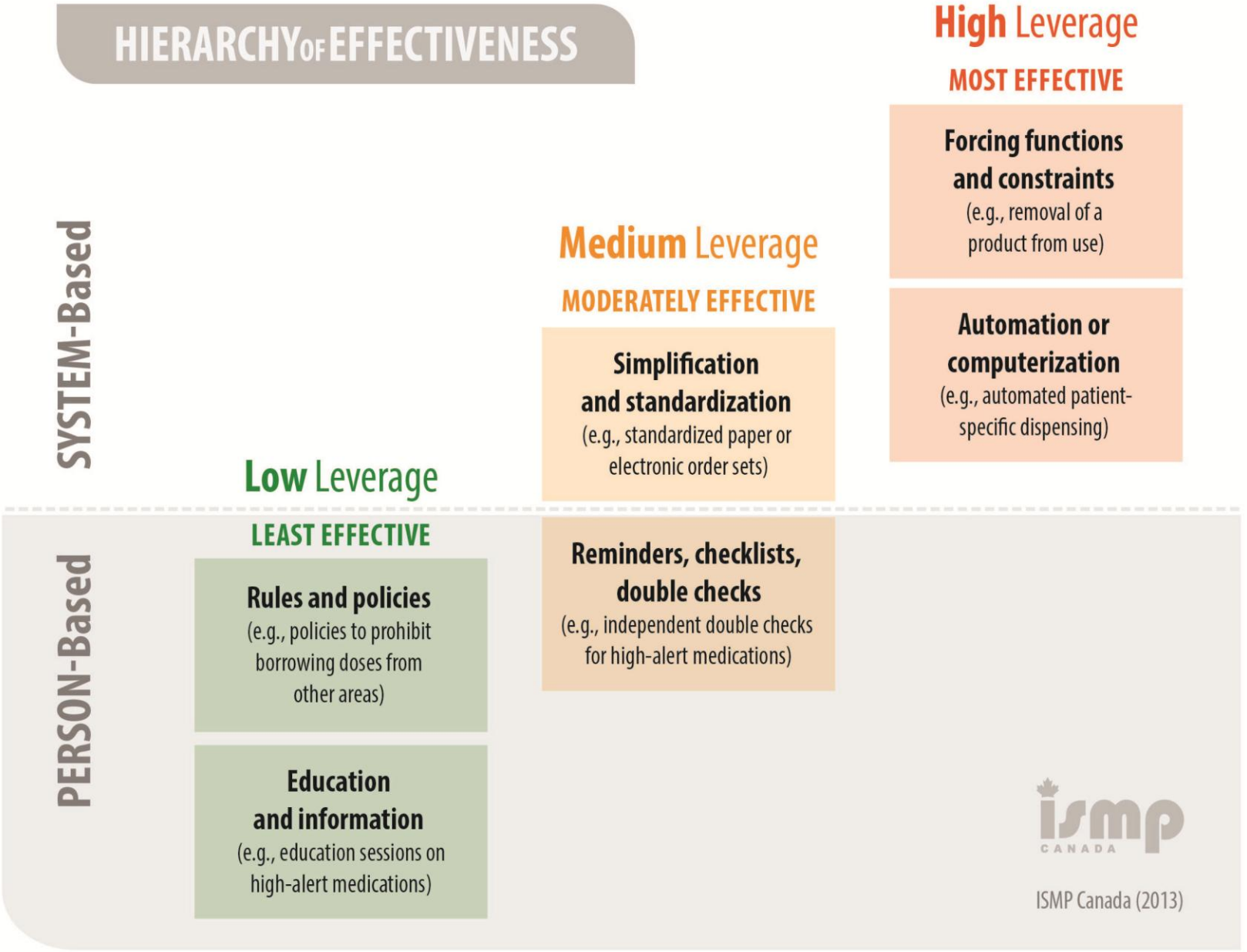
- Onsite visit to tertiary hospital
- Reviewed components individually
- Conducted assessment at a systems level
- Evaluation considered human strengths and capabilities
- Identified opportunities to improve patient safety: standardization, simplification, customization to local context

Potential for error

- Delivering a loading dose and a maintenance dose from the same bag may be confusing for nurses
- Poison Centre guidelines for acetylcysteine infusions are broad and lack specifics that are best provided in hospital order sets
- Drug libraries must be tested and validated to ensure rounded values fall within acceptable limits

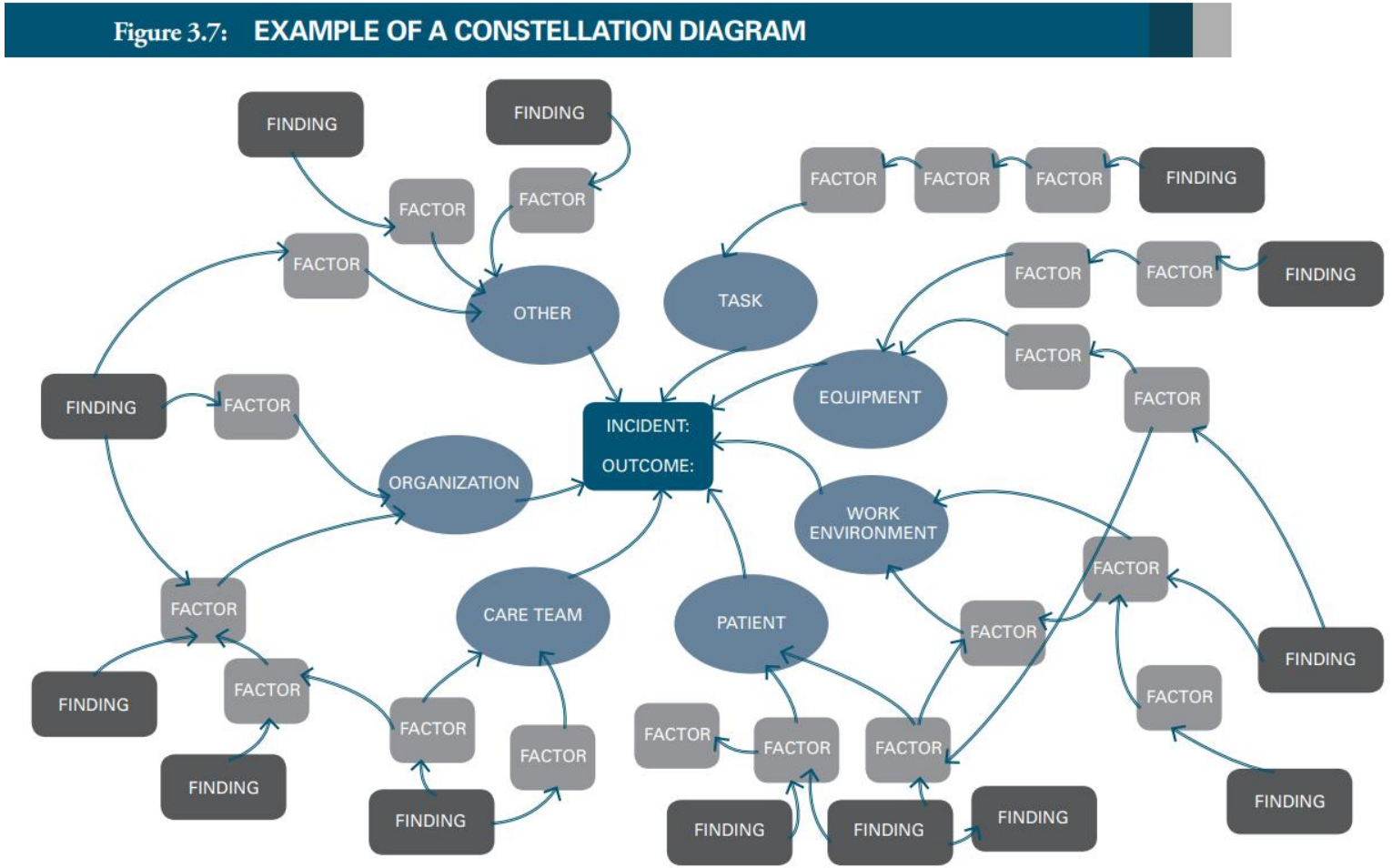


ISMP Canada Hierarchy of Effectiveness



Designing effective recommendations. Toronto (ON): Institute for Safe Medication Practices Canada. Ontario Critical Incident Learning. 2013[cited 2023 Sept 8];4:1-2. Available from: https://www.ismp-canada.org/download/ocil/ISMPCONCIL2013-4_EffectiveRecommendations.pdf

Diagramming Incident Analyses



P.44 Canadian Incident Analysis Framework (2012)

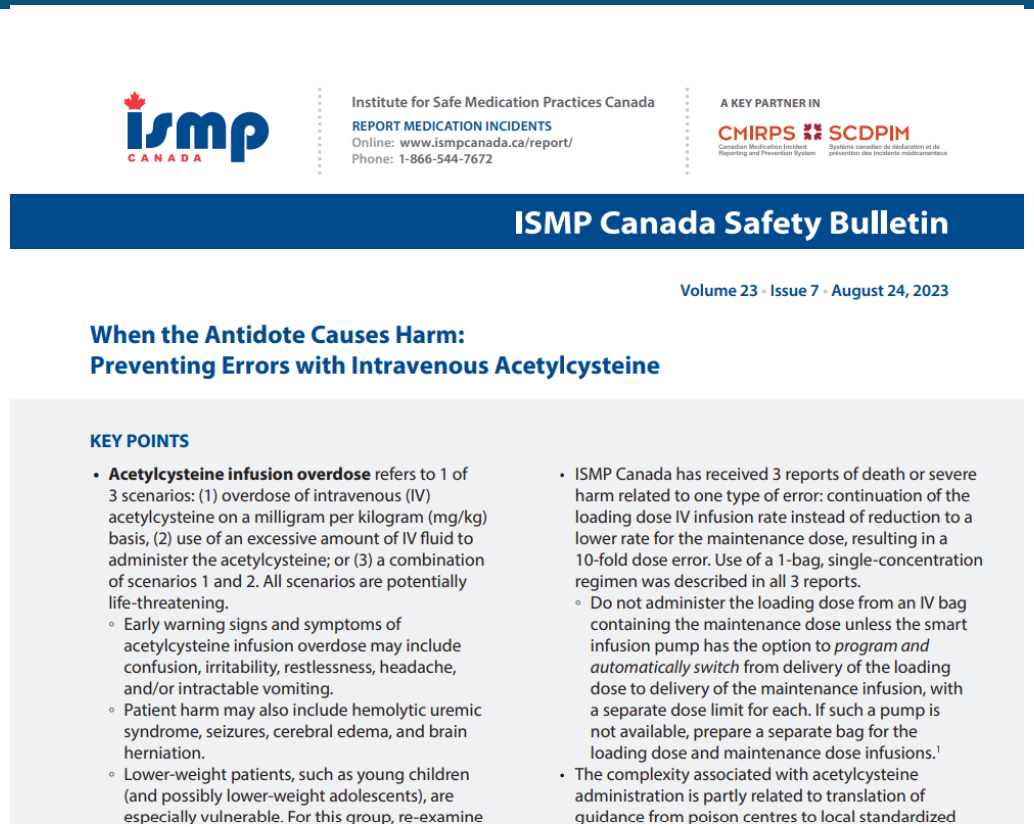
What Did We Learn?

Acetylcysteine infusion overdose refers to 1 of 3 scenarios:

(1) Too much IV acetylcysteine
(2) Too much IV fluid to infuse the acetylcysteine; or
(3) A combination of the two.

All scenarios are potentially life-threatening.

Bulletin Published August 2023



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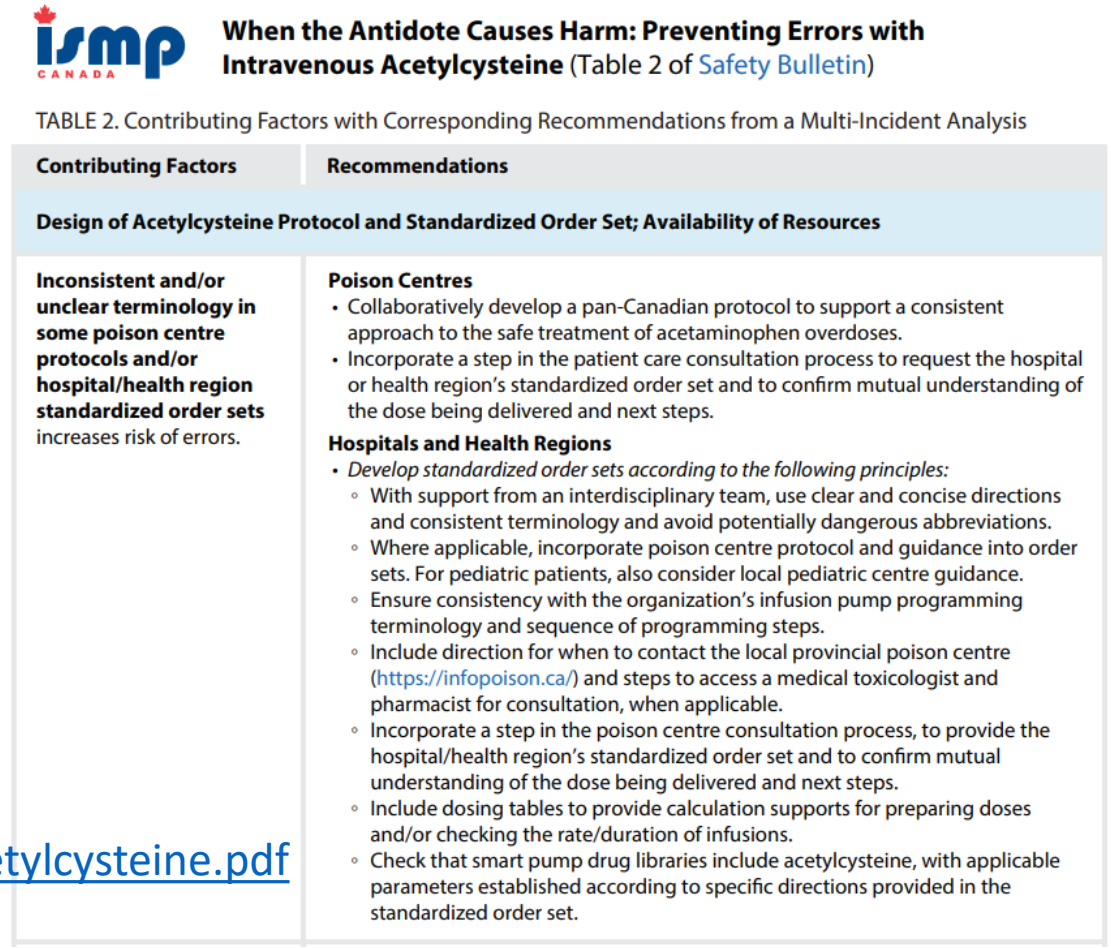
ISMP Canada Safety Bulletin

Volume 23 • Issue 7 • August 24, 2023

When the Antidote Causes Harm: Preventing Errors with Intravenous Acetylcysteine

KEY POINTS

- **Acetylcysteine infusion overdose** refers to 1 of 3 scenarios: (1) overdose of intravenous (IV) acetylcysteine on a milligram per kilogram (mg/kg) basis, (2) use of an excessive amount of IV fluid to administer the acetylcysteine; or (3) a combination of scenarios 1 and 2. All scenarios are potentially life-threatening.
  - Early warning signs and symptoms of acetylcysteine infusion overdose may include confusion, irritability, restlessness, headache, and/or intractable vomiting.
  - Patient harm may also include hemolytic uremic syndrome, seizures, cerebral edema, and brain herniation.
  - Lower-weight patients, such as young children (and possibly lower-weight adolescents), are especially vulnerable. For this group, re-examine
- ISMP Canada has received 3 reports of death or severe harm related to one type of error: continuation of the loading dose IV infusion rate instead of reduction to a lower rate for the maintenance dose, resulting in a 10-fold dose error. Use of a 1-bag, single-concentration regimen was described in all 3 reports.
  - Do not administer the loading dose from an IV bag containing the maintenance dose unless the smart infusion pump has the option to *program and automatically switch* from delivery of the loading dose to delivery of the maintenance infusion, with a separate dose limit for each. If such a pump is not available, prepare a separate bag for the loading dose and maintenance dose infusions.[1]
- The complexity associated with acetylcysteine administration is partly related to translation of guidance from poison centres to local standardized



When the Antidote Causes Harm: Preventing Errors with Intravenous Acetylcysteine (Table 2 of Safety Bulletin)

TABLE 2. Contributing Factors with Corresponding Recommendations from a Multi-Incident Analysis

Contributing Factors	Recommendations
Design of Acetylcysteine Protocol and Standardized Order Set; Availability of Resources	
Inconsistent and/or unclear terminology in some poison centre protocols and/or hospital/health region standardized order sets increases risk of errors.	**Poison Centres** • Collaboratively develop a pan-Canadian protocol to support a consistent approach to the safe treatment of acetaminophen overdoses. • Incorporate a step in the patient care consultation process to request the hospital or health region's standardized order set and to confirm mutual understanding of the dose being delivered and next steps. **Hospitals and Health Regions** • *Develop standardized order sets according to the following principles:* ◦ With support from an interdisciplinary team, use clear and concise directions and consistent terminology and avoid potentially dangerous abbreviations. ◦ Where applicable, incorporate poison centre protocol and guidance into order sets. For pediatric patients, also consider local pediatric centre guidance. ◦ Ensure consistency with the organization's infusion pump programming terminology and sequence of programming steps. ◦ Include direction for when to contact the local provincial poison centre (https://infopoison.ca/) and steps to access a medical toxicologist and pharmacist for consultation, when applicable. ◦ Incorporate a step in the poison centre consultation process, to provide the hospital/health region's standardized order set and to confirm mutual understanding of the dose being delivered and next steps. ◦ Include dosing tables to provide calculation supports for preparing doses and/or checking the rate/duration of infusions. ◦ Check that smart pump drug libraries include acetylcysteine, with applicable parameters established according to specific directions provided in the standardized order set.

https://ismpcanada.ca/wp-content/uploads/ISMPCSB2023-i7-Acetylcysteine.pdf

Table of Contributing Factors and Recommendations:
ISMPCSB2023-i7-Acetylcysteine-Table-2-Only (ismpcanada.ca)

Overview of the Recommendations

- Seven categories of contributing factors/recommendations related to:
  - **Design of Acetylcysteine Protocol and Standard Order Set; Availability of Resources**
  - Canadian Product Monograph
  - Decision to Treat and Prescribing of Acetylcysteine
  - Preparation and Administration of Acetylcysteine for infusion
  - **Infusion Pump Programming**
  - Monitoring of Acetylcysteine infusions
  - **Patient and Family Engagement**

ISMPCSB2023-i7-Acetylcysteine-Table-2-Only (ismpcanada.ca)

Design of Acetylcysteine Protocol and Standard Order Set; Availability of Resources

Use of a 1-litre bag of dextrose 5% in water (D5W) for administration of acetylcysteine in lower-weight patients (e.g., toddlers) increases potential for harm.

Lower-weight patients, such as young children (and possibly lower-weight adolescents), are **especially vulnerable** to harm from fluid overload.

Recommendation:

For this group, **re-examine regimens** that use 1-litre D5W infusion solutions to administer acetylcysteine, and consider use of weight-based infusion volume limits.

Consider the osmolarity, tonicity, and total volume of the IV solution (e.g., D5W becomes hypotonic upon infusion. Compatible with D5W, 0.9% saline, 0.45% saline, and 0.45% saline + 5% dextrose solutions.

N-Acetylcysteine Protocol from Health PEI

-We have a peds and adult antidote library

-Acetylcysteine is only available the antidote library

-Health PEI library entries are very similar to Nova Scotia Health Authority. We have 1 extra weight category.

-Pump library was built so that the loading dose is part of the entry; the infusion automatically flips after complete

- They can't program the loading dose outside of the weight category

-We've done a lot of work on the Health PEI IV manual insert, based on feedback from ED/ICU nursing about the Poison Centre's IV monograph; we took the IWK monograph and put in a table with step by step instructions for each weight category.

Health PEI
One Island Health System

Santé Î.-P.-É.
Un système de santé unique

N-Acetylcysteine (NAC) IV Administration 21 Hour Protocol

Dose is calculated using total body weight up to a maximum of 100 kg. Select appropriate pump entry based on patient's weight (kg) category. **For patients weighing 100 kg or more, it is crucial to use "acetylcysteine 100kg+" IV pump entry.**

This protocol will use one standard concentration: **N-acetylcysteine 30 mg/mL**

Total: 450mg/kg (15 mL/kg) NAC over 21hrs

Prepare bag using below table. Use dextrose 5% in water (most common) or sodium chloride 0.9%.

Patients less than 17 kg **250 mL**	Loading Dose: 150 mg/kg acetylcysteine IV over 60 minutes immediately followed by; Continuous Infusion: 15 mg/kg/h acetylcysteine IV for a minimum of 20 hours 1. Remove 37.5 mL from 250 mL bag 2. Add 37.5 mL of NAC 200 mg/mL (20%) (7,500 mg) to 212.5 mL for a final volume of 250 mL **Use this bag for loading dose and continuous infusion** 3. Choose "acetylcysteine < 17 kg" from antidote library. 4. Program continuous infusion details first. VTBI = 15 mL/kg x patient weight (kg). Do NOT adjust time. Time does not take loading dose into account (programmed in next step). Rate: 15 mg/kg/h 5. Program loading dose: 150 mg/kg acetylcysteine IV over 60 minutes • An additional 250 mL bag may be required if greater than 21-hour NAC therapy required
Patient 17 - 33 kg **500 mL**	Loading Dose: 150 mg/kg acetylcysteine IV over 60 minutes immediately followed by; Continuous Infusion: 15 mg/kg/h acetylcysteine IV for a minimum of 20 hours 1. Remove 75 mL from 500 mL bag 2. Add 75 mL of NAC 200 mg/mL (20%) (15,000 mg) to 425 mL for final volume of 500 mL **Use this bag for loading dose and continuous infusion**

Shared with permission from Health PEI

Atlantic Canada Poison Centre

ADMINISTRATION

Intravenous 21 hour protocol

Choose bag to prepare according to patient weight. The initial bag will be used for the loading dose and the start of the maintenance infusion.

Weight	Initial Bag	Additional Bag to complete the 21 h protocol	Subsequent bag to prepare if treatment required beyond 21 h
less than 17 kg	250 mL **	n/a	250 mL
17 to 33 kg	500 mL **	n/a	250 mL
34 to 66.6 kg	1000 mL **	n/a	500 mL
66.7 to 99 kg	1000 mL	500 mL **	500 mL
100 kg or greater	1000 mL	500 mL	500 mL

** Full volume may not be required to complete the 21 h protocol. To set a total volume for a 21 h protocol, please refer to local pump specific information. Solution remaining can continue to be used if treatment required beyond 21 h.

Prepare bag to a final concentration of 30 mg/mL. Use dextrose 5% in water or sodium chloride 0.9%.

Acetylcysteine New Protocol - Pediatric | Atlantic Canada Poison Centre

Ontario Poison Centre

Poison Centre®
Centre Anti-Poison

PREPARATION OF A 3% INTRAVENOUS *N*-ACETYLCYSTEINE BAG

As part of the Poison Centre's treatment recommendations for the acetaminophen-poisoned patient, a 3% *N*-Acetylcysteine solution will need to be prepared. The following are instructions on how to prepare this solution in **D5W**.

Patient is ≤ 20kg:

Remove 37.5 mL from a 250 mL bag of D5W

Add 37.5 mL of 20% IV *N*-Acetylcysteine to the remaining 212.5 mL in the D5W bag

37.5 mL X 200 mg/mL = 7 500 mg of *N*-Acetylcysteine

7500 mg in 250 mL yields a final solution with 30 mg/mL or 3%

Patient is 21 – 40 kg:

Remove 75 mL from a 500 mL bag of D5W

Add 75 mL of 20% IV *N*-Acetylcysteine to the remaining 425 mL in the D5W bag

75 mL X 200 mg/mL = 15 000 mg of N-Acetylcysteine

15 000 mg in 500 mL yields a final solution with 30 mg/mL or 3%

Patient is ≥ 41 kg:

Remove 150 mL from a 1000 mL bag of D5W

Add 150 mL of 20% IV *N*-Acetylcysteine to the remaining 850 mL in the D5W bag

150 mL X 200 mg/mL = 30 000 mg of *N*-Acetylcysteine

30 000 mg in 1000 mL yields a final solution with 30 mg/mL or 3%

Notes:

1. 20% IV *N*-Acetylcysteine is equivalent to 200 mg/mL.
2. The 3% solution is slightly hyperosmolar but still within the safety margin for administration via a peripheral vein.
3. It is recognized that any particular bag of IV fluid could have excessive fluid more than advertised. It is of little consequence when making this 3% solution. Assume a finished volume as advertised on the bag.
4. Mixing is important to ensure uniform distribution of *N*-Acetylcysteine in the infusion solution.
5. Each bag of 3% N-Acetylcysteine should be changed at 24 hours to guarantee stability of the solution.

REVISED APRIL 2, 2019

https://www.ontariopoisoncentre.ca/siteassets/pdfs/english/78797-how-to-solution.pdf

Infusion Pump Programming

Choosing "no drug selected", "other drug", "drug X", "basic mode", or a generic "IV fluids" setting (depending on the pump model) bypasses a smart pump's drug error reduction software and reduces the likelihood that a programming error will be detected and prevented.

Recommendations:

- Include acetylcysteine in infusion pump drug libraries and build specific regimens for adults and pediatric patients.
- Develop a timely process to support nurses when incorrect or missing drug library settings are identified, as well as a clear process to remedy the concern.
- Review instances of "no drug selected" and pump override reports to identify quality improvement opportunities.

Patient and Family Engagement

Lack of patient/family engagement in the treatment plan, including monitoring parameters, reduces the likelihood that errors will be detected and shared with health care providers.

Recommendation:

Engage the patient/family in the plan of care, including the plan for loading and maintenance dose infusions with anticipated timelines.

During discussion, **describe early warning signs and symptoms** of concern to bring to the attention of a health care provider, including confusion, irritability, restlessness, and intractable vomiting.

ISMPCSB2023-i7-Acetylcysteine-Table-2-Only (ismpcanada.ca)

System Wide Recommendation

- ISMP Canada does not endorse a specific regimen at this time and calls upon applicable **experts from across the country to collaboratively develop a pan-Canadian protocol** to support a consistent approach to the safe treatment of acetaminophen overdoses.

Feedback on the Published Bulletin

"Awesome, just awesome!! Great work everyone, I really appreciate all of the work that went into investigating, assessing, analyzing and developing these recommendations. I hope this will help make meaningful improvements from the tragedies." – Reporter

"Excellent work from Canadian colleagues with learning for the UK" – NHS Patient Safety Team

"Congratulations Team, This is an excellent review and resource, I have already disseminated through SickKids Pharmacy and am proud to have made my small contribution to this work." – Dr. Conor McDonnell, Anesthesiologist

One hospital is reviewing their protocols and forms:

"Based on this we might revise the perfusions labelling on our pre-printed order form to describe more precisely the type of perfusions, revise the labelling in the pump to match the preprinted form, and add a warning in the pump if someone tries to start initially with the maintenance perfusion, and if possible a warning if we try to perfuse the bolus twice in a row. We will also consider adding an independent double verification for at least the pump programing."

Taking Action Locally, Provincially and Nationally

ISMP Canada

- ✓ CACCN Collaboration
- ✓ Two industry partners connected with ISMP Canada to discuss potential collaborative efforts
- ✓ Presenting at a Human Factors conference
- ✓ Call for reduced product sizes for acetaminophen:

  Acetaminophen-Related Harm: A Call for Improved Product Packaging - ISMP Canada

Locally?

- ✓ Any changes to consider at your hospital?

Poll #4 – Take Action

I have learned something today that I will use to improve medication safety

- ❑ Agree
- ❑ Disagree
- ❑ Unsure

Please share any comments in the chat

The Canadian Medication Safety Network

provides a chance to hear from health care providers and consumers about medication safety needs and opportunities from communities across the country.

This valuable mode of communication will facilitate improved medication safety.

Register Today!

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Benefits of Joining this Community

Community-Building: Connect with healthcare providers and fellow consumers.
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Access to Resources: Receive up-to-date and valuable Canadian medication safety information directly from experts in the field.

Click this link to register

or scan this code

SafeMedicationUse.ca

ismp CANADA

Stay tuned! You will also receive an invite to join a webinar in 2025!

https://ismpcanada.ca/canadian-medication-safety-network/

Thank you, CSHP for your collaboration and hosting us today!

Thank you for listening.

Any Questions?

Tell us what you think? Scan the QR code for the evaluation survey!
Contact: Alice.Watt@ismpcanada.ca for more information.

ZERO Preventable Harm From Medications
Institute for Safe Medication Practices Canada