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The Toxiscap Hunt: An Escape Room-Scavenger Hunt for Toxicology Education

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ABSTRACT:

Audience: This scavenger hunt/escape room is a didactic activity for emergency medicine residents or fourth-year medical students rotating in emergency medicine.

Introduction: Between 2008-2011, 1.1 million patients presented to U.S. emergency departments each year for poisonings,¹ including acute ingestions, envenomations, occupational exposures, and overdoses. Toxicologic exposures are considered part of the core curriculum for emergency medicine (EM) residents, who must understand the presentation and treatment of such patients.² Educating residents in a unique, engaging format such as an “escape room” activity provides an alternative to the didactic format of teaching this material, which may build medical knowledge and team rapport amongst residents.³

Objectives: By the end of the activity, learners should be able to:

1. Calculate an anion and osmolal gap.
2. Recognize poisonings amenable to hemodialysis.
3. Interpret electrocardiogram (ECG) changes related to a variety of ingestions, including beta-blockers and calcium channel blockers, digitalis, and tricyclic antidepressants.
4. Recognize poisonous plants and their clinical toxidromes.
5. Calculate loading dose of N-acetylcysteine as antidote for acute acetaminophen ingestion.
6. Collaborate as a team to arrive at solutions of problems.
7. Recognize poisons that have available antidotes
8. Know the clinical effect of various types of snake envenomations.
9. Recognize the toxicity associated with at least four household chemicals.
10. Know the antidotes for six common poisonings.

Methods: This didactic exercise is a small group activity, utilizing puzzles to apply toxicology knowledge.

SMALLgroups

Topics: Toxicology, small-group activity, team-building exercise, acetaminophen overdose, N-acetylcysteine, overdose, toxicology, anion gap, osmolal gap, toxic alcohols, ethylene glycol, fomepizole, poisonous plants, poisonous animals, mushroom toxicity, hemodialysis in the poisoned patient, tricyclic antidepressant overdose, digitalis toxicity.



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Learner Audience:

Medical students, interns, junior residents, senior residents

Time Required for Implementation:

The instructor may order supplies in advance (one to two weeks) of the session. The setup of the Toxiscap Hunt will take 1-2 hours on the day of the session; in addition, advanced preparation will be needed to adjust puzzles to be institution specific, print clues, and set locks before setup. As an alternative, the session may be done without lockboxes and just use envelopes with clues, which is much less time- and cost-intensive.

The actual Toxiscap Hunt will run for approximately 1.5 hours: 1 hour for learners to complete all stations, 30 minutes for wrap-up didactic session.

Recommended Number of Learners per Instructor:

One instructor should oversee the entire exercise. Ideally, there should be five other volunteers (staff, students, faculty, fellows, chief residents) to oversee stations, ensure participants are following rules, relock boxes (or hand out clues, if using envelopes), and retape clues. These additional volunteers do not need background knowledge in toxicology.

Topics:

Toxicology, small-group activity, team-building exercise, acetaminophen overdose, N-acetylcysteine, overdose, toxicology, anion gap, osmolal gap, toxic alcohols, ethylene glycol, fomepizole, poisonous plants, poisonous animals, mushroom toxicity, hemodialysis in the poisoned patient, tricyclic antidepressant overdose, digitalis toxicity.

Objectives:

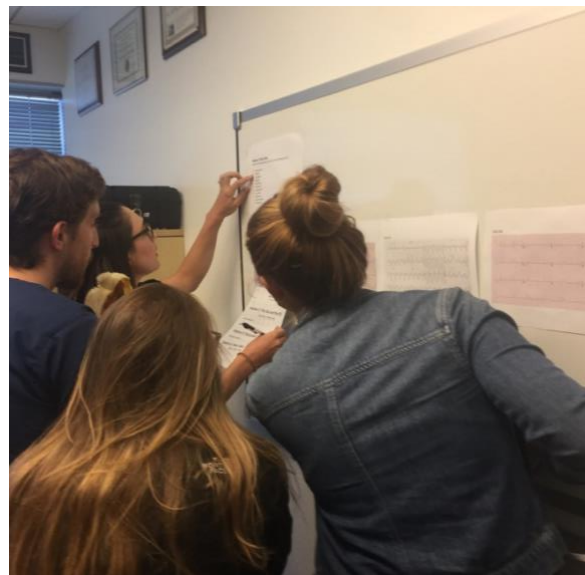
By the end of the activity, learners should be able to:

1. Calculate an anion and osmolal gap.
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3. Interpret ECG changes related to a variety of ingestions, including beta-blockers and calcium channel blockers, digitalis, and tricyclic antidepressants.
4. Recognize poisonous plants and their clinical toxidromes.

5. Calculate loading dose of N-acetylcysteine as antidote for acute acetaminophen ingestion.
6. Collaborate as a team to arrive at solutions of problems.
7. Recognize poisons that have available antidotes
8. Know the clinical effect of various types of snake envenomations.
9. Recognize the toxicity associated with at least four household chemicals.
10. Know the antidotes for six common poisonings.

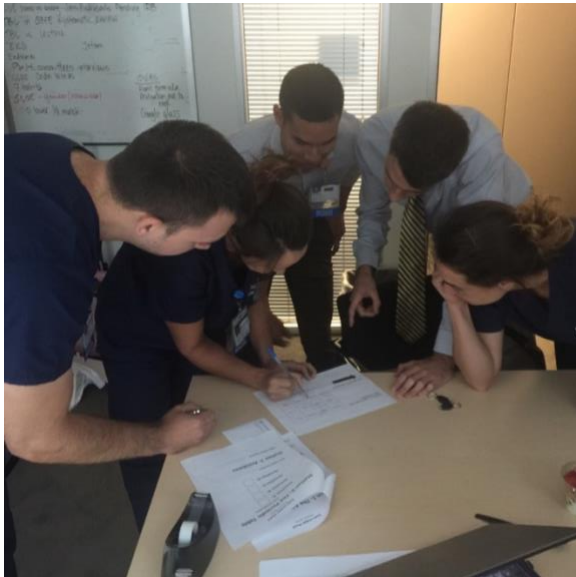
Linked objectives and methods:

Objective six (collaborate) is evident throughout the activity. Team members must use each other's knowledge and resourcefulness to arrive at solutions to each problem. Team collaboration was very apparent during the pilot of this didactic activity (Figures 1 and 2). Each of the remaining objectives (1-5, 7-10) are achieved in each respective station of the toxiscap hunt (ie, Objective 1 is achieved in station 1). Knowledge is solidified during the answer and explanation session following the hunt.





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Figures 1 & 2: Learners working as a team to problem solve on stations #3 and #8

Recommended pre-reading for instructor:

The instructor should have moderate background knowledge in toxicology (toxicologist, toxicology fellow, or board-certified emergency physician). The instructor should be familiar with the explanations/answers for each station in the PowerPoint file. The instructor may also benefit from reading:

- Audi J, Belson M, Patel M, Schier J, Osterloh J. Ricin poisoning: a comprehensive review. *JAMA*. 2005;294(18):2342-2351. doi: 10.1001/jama.294.18.2342
- Burns E. Digoxin toxicity. *Life in the Fastlane*. <https://lifeinthefastlane.com/ecg-library/basics/digoxin-toxicity/>. Updated April 4, 2017. Accessed August 14, 2017.
- Garlich FM, Goldfarb DS. Have advances in extracorporeal removal techniques changed the indications for their use in poisonings? *Adv in Chron Kid Dis*. 2011;18(3):172-179. doi: 10.1053/j.ackd.2011.01.009
- Long, H. Acetaminophen, aspirin, and NSAIDs. In: Adams JG, Barton ED, Collings JL, DeBlieux PMC, Gisondi MA, Nadel ES, eds. *Emergency Medicine: Clinical Essentials*. 2nd ed. Philadelphia, PA: Elsevier; 2014:1231-1238.
- Mycyk MB. Toxic alcohols. In: Adams JG, Barton ED, Collings JL, DeBlieux PMC, Gisondi MA, Nadel ES, eds. *Emergency Medicine: Clinical Essentials*. 2nd ed. Philadelphia, PA: Elsevier; 2014:1292-1298.
- Minns A. Anticholinergic plants. *California Poison Control System Newsletter*. 2008;6(4).

<http://toxicology.ucsd.edu/Newsletters/CPCS%20Newsletter%20Anticholinergic%20Plants.pdf>. Accessed August 14, 2017.

- Minns A. Naturally occurring cardiac glycoside poisoning 2017;15(1). <https://www.calpoison.org/hcp/2017/callusvol15no1.htm>. Accessed August 14, 2017.
- Nickson C. Tricyclic antidepressant toxicity. *Life in the Fastlane*. <https://lifeinthefastlane.com/toxicology-conundrum-022/>. Published October 30, 2009. Accessed August 14, 2017.
- Nickson C. Antidotes. *Life in the Fastlane*. <https://lifeinthefastlane.com/ccc/antidote-summary/>. Published May 20, 2016. Accessed August 14, 2017.
- Slim J. CDEM curriculum: snake bites. <https://cdemcurriculum.com/snake-bites/>. Accessed on August 14, 2017.
- Vo KT. Amanita phalloides mushroom poisoning-- Northern California, December 2016. *Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention*. <https://www.cdc.gov/mmwr/volumes/66/wr/mm6621a1.htm>. Published June 2, 2017. Accessed August 14, 2017.

Learner responsible content (LRC):

Learners may be in the middle of a toxicology block or have previous exposure to toxicology content, so should be up to date with their reading in various toxicology topics.

Results and tips for successful implementation:

We tested the toxiscap hunt on 25 learners. Learners formed five groups of five. This was an ideal number of groups, allowing for at least one station in between each group at the time of start.

Each group should be started at a different station. For example, one group begins the hunt at station one, while another group begins at station three. We suggest having at least two sets of clues for each station, in opposite ends of the room; this allows for multiple groups to complete the station at once, in case one group catches up with another. Station rooms should be big enough to accommodate 10-15 people (our academic offices were an appropriate size). For a total group size larger than 30, we strongly recommend two to three sets of clues at each station (with faculty member to quickly relock box in between groups) and larger rooms.

We recommend buying all materials at least two weeks in advance to allow for shipping.



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Evaluation:

Twenty-one participants completed the post-hunt survey. Overall, the hunt was rated as “outstanding” (Likert 5/5) by 19 and “good” (Likert 4/5) by 2. All participants agreed with the statement, “I learned something” and all participants wanted to repeat the activity in the future. The lowest ranked stations were the toxic snakes (station #8, Likert average 4.5/5) and periodic table (station #6, Likert average 4.3/5) (Scale: 5, “Awesome”; 4, “Good”; 3, “Okay”; 2, “Meh”; 1, “Lame”) stations. As a result of feedback for these two stations, we made modifications to each station question to make it more straightforward. The highest rated stations (all Likert average greater than 4.8/5) were toxic ECGs (station #3), antidotes (station #7), and toxword puzzle (station #10).

Content:

- Toxiscap Hunt In-Class Power Point
 - Introduction Slides and Answers for discussion and wrap up
- Toxiscap Stations and Set-Up Power Point
 - Slides to print for setting up the escape rooms
- Toxiscap Learner Answer Sheet
 - For learners to fill out while engaging in the Toxiscap Room

Small group application exercise (sGAE)

Station Setup: As there are multiple stations this is explained in detail below.

Materials list:

Of note, we used multiple unique materials to increase the “game” aspect of this activity. However, many of the materials listed below can be modified to create a less costly activity. For example, instead of toolboxes and locks, envelopes could be used and the station moderator would only give the envelope with the next “clue” when the group arrives at the correct answer. In addition, black lights need not be purchased; as an alternative, “try again” may be written in regular pencil on the back of the paper. Lastly, instead of actually purchasing household chemicals, a print-off photo could be used of these chemicals.

1. Six small (14- or 16-inch) toolboxes: We used: (Waterloo brand)
<https://www.amazon.com/gp/product/B00Y3I224W/r ef=oh aui detailpage o04 s02?ie=UTF8&psc=1> or (Stack On Brand)
<https://www.amazon.com/gp/product/B000KKWJTK/r ef=oh aui detailpage o04 s04?ie=UTF8&psc=1>.
2. Make your own combination (letter) locks. We used Masterlock brand:
<https://www.amazon.com/gp/product/B003HC7U1U/r ef=oh aui detailpage o04 s04?ie=UTF8&psc=1>
3. Make your own combination (number) locks. We used ORIA brand:
<https://www.amazon.com/gp/product/B01ISJSTRK/ref =oh aui detailpage o02 s00?ie=UTF8&psc=1>
4. Set of invisible ink (black light) markers. Our set also came with three UV black light keychains. We used:
<https://www.amazon.com/gp/product/B00IMMRDHQ/ ref=oh aui detailpage o05 s00?ie=UTF8&psc=1>
5. Two UV black lights (keychains or flashlight). We used both the keychains (above) and a flashlight. If using the black light flashlight, we recommend UV safety goggles (below)
<https://www.amazon.com/gp/product/B008133KB4/r ef=oh aui detailpage o05 s01?ie=UTF8&psc=1>
6. Six pairs of UV safety goggles (one for instructor and five for group members). We used:
<https://www.amazon.com/gp/product/B003OBZ64M/r ef=oh aui detailpage o03 s00?ie=UTF8&psc=1>
7. The following products may be purchased for the household chemicals station (station #9). As an alternative to reduce cost or time, a picture of chemicals could be used.
 - a. A product containing zinc phosphide; we used “Sweeney’s Mole and Gopher Poison Peanuts”:
<https://www.amazon.com/Sweeneys-Gopher-Poison-Peanuts-S6006/dp/B000GRNOTQ>
 - b. A product containing methanol; we used “Krystal Kleer Windshield Washer Fluid”:
<http://www.homedepot.com/p/Krystal-Kleer-1-Gallon-Windshield-Washer-Fluid-111205/202259351>
 - c. A product containing caustic lye; we used “Drano Crystals”:
<http://www.homedepot.com/p/Drano-18-oz-Kitchen-Crystals-Clog-Remover-020113/100147144>
 - d. Isopropanol (purchase at any drug store or
<https://www.amazon.com/Isopropyl-Alcohol-Solution-16-Ounce/dp/B000P158X8?th=1>)
 - e. Purchase at least 6 other “distractor” products. The following are good distractors: D-Con rodent control, Prestone antifreeze, Harris roach tablets, Terro Spider Killer, Roundup Weed Killer, TomCat Mouse Killer, Vicks VapoRub.
8. Color printer to print clues, scissors, scotch tape.
9. Ten offices or spaces (we used faculty member’s individual offices). If office spaces are not available, stations could be set up throughout various areas of a room or building.



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Instructions:

1. Purchase/secure all items listed above or secure alternative option.
2. Adjust slides for your institution:
 - a. See “Station slides” PowerPoint (slides 69-75). Two stations’ clues (stations #9 and #10) require you to adjust the clues for your institution.
 - i. Station #9, Household Chemicals: The clues lead our learners to spell out “MJEN.” Therefore, the next clue was located at Dr. Maxwell Jen’s office (station #10). For the station that follows station #9 (station #10), you will need to choose an office that corresponds to any four-letter code (letters cannot repeat, i.e. you cannot have more than one of the same letter in the code).
 - ii. Station #10, Toxword Puzzle: For our hunt, the final clue in the Toxword Puzzle spelled out “AWRAY,” which corresponded to the office of faculty member, Dr. Alisa Wray. Therefore, Dr. Wray’s office was the location of the next station (station #1, stations make a loop). You will need to adjust this clue to your hunt and choose a code that corresponds to the location of station #1. You will choose a five-letter code. The following letters are available in the Toxword Puzzle: A, B, D, E, F, H, I, L, M, N, O, P, R, S, T, W, X, Y. You will then move the symbols (pentagon, circle, etc.) on the toxword puzzle slide to correspond to your five-letter code (see “Station Slides” PowerPoint, slides 74-75).
3. Print out all PowerPoint slides in color (“Station Slides”).
4. Print and cut out tickets (“Station Slides,” slide #76-77). The tickets will need to have the locations of stations 2, 4, 5, 6, 7, and 9. You will need at least one ticket per group, per station.
5. Set up each station per the instructions below.
6. Print out answer sheets (“Answer Sheet,” one per group).
7. Setup PowerPoint (“In Class PowerPoint”).

Divide learners into groups of four to five and start the hunt!

Stations:

Station 1: The AG and the OG

Station Materials: Instructions slide (“Station Slides” Powerpoint, slide 4), scratch paper, paper “tickets” (“Station Slides” PowerPoint, slides 76-77), pens; either one number lock and one small toolbox or envelope with station number listed.

1. Choose the location for station #1 based on your final clue in station #10, as it is a loop. The location of station #1 should correspond to a five-letter code that can be spelled out by the available letters in the toxword puzzle, station #10 (see setup instructions 2ii for further explanation).
2. Print and cut out “tickets” which have the location of station #2 (for example, “Dr. Smith’s office,” need at least one ticket per group) and place inside toolbox (see Figure 3) or envelope.
3. If using a number lock, set the number lock combination to 3235 (the answer to the puzzles: AG: 32; OG: 35) and lock the toolbox. If using an envelope, simply place the next clue in the envelope to distribute to learners when they arrive at correct answer.
4. Tape the station instructions to a desk; also place scratch paper and pens on the desk.



Figure 3: Toolbox with “tickets” inside

Station 2: Dialyzable Toxins

Station materials: Station Slides (slides 7-23), markers or pencils; optional: UV black lights x2, UV safety goggles, extra tape.

1. Print the station slides (slides #7-23).
2. Print several copies of the station slide (slide #8, at least one per group).
3. The first slide (Slide #7) is the correct slide. On the back of printed slide #7, write “Your next station is located in Dr. _____’s office” with either light pencil or invisible ink/black light markers (Figure 4).



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4. On the back of the remaining 15 slides, write "Try again" in light pencil or invisible ink.
5. Tape the 16 slides (in random order) onto a wall, such that groups can remove the paper easily from the wall (Figure 5).
6. Have extra tape at station 2 in order to re-tape sheets between groups.
7. Place several copies of the station slide (slide #8, at least one per group) on top of a desk, with a few markers.
8. Optional: Place a blacklight/UV light next to the station slides (arrow pointing to them).
9. Optional: Place UV goggles with the UV/blacklight.



Figure 4: Location for next station is written in "invisible" ink on back of correct pattern at station #2.

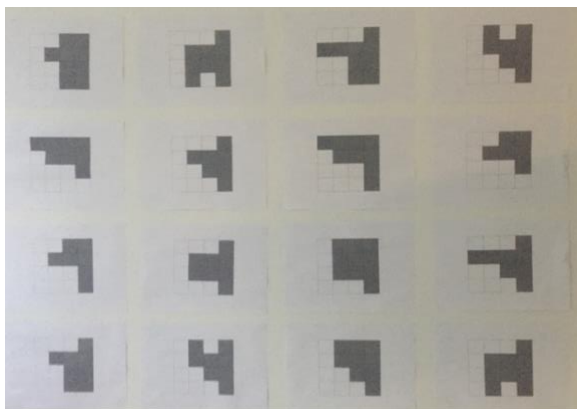


Figure 5: Station #2 setup

Station 3: Toxic ECGs

Station materials: Instructions for station 3 ("Station Slides" PowerPoint, slide 25), scratch paper, paper "tickets" (slides 76-77, "Station Slides"), pens, and either one letter lock and one small toolbox OR envelope.

1. Print the station slides (Slides #25-29, "Station Slides").
2. Print out tickets (at least one per group) with the location of station 4 and place the tickets in a lock box (Figure 3) or envelope.
3. If using lockbox, set a lock with the combination: BADK and lock the lockbox.

Station 4: Toxic Plants and Fungi

Station materials: Station slides (slides 31-34), scratch paper, paper "tickets" (slides 76-77 of "Station Slides"), pens, one number lock, and one small toolbox.

1. Print the station slides in color (Slides #31-34).
2. Print out tickets (at least one per group) with the location of station 5 and place the tickets in a lock box (figure 3) or envelope.
3. If using lockbox, set a lock with the combination: 4223 and lock the lockbox.

Station 5: Acetaminophen toxicity, N-acetylcysteine dosing

Station materials: Station slide (slide 36), paper "tickets" (slides 76-66 of "Station Slides" file), pens, either one number lock and one small toolbox OR envelope.

1. Print the station slide (Slide #36).
2. Print out tickets (at least one per group) with the location of station 6 and place the tickets in a lock box (figure 3) or envelope.
3. If using a lockbox, set a lock with the combination: 4223 and lock the lockbox.

Station 6: The Periodic Table

Station materials: Station slides (slides 38-42), scratch paper, paper "tickets" (slides 76-77 of "Station Slides" file), pens, either one number lock and one small toolbox OR envelope.

1. Print the station slides in color (Slides #38-42).
2. Print out tickets (at least one per group) with the location of station 7 and place the tickets in a lock box (figure 3) or envelope.
3. If using a lockbox, set a lock with the combination: 2906 and lock the lockbox.

Station 7: Antidotes

Station materials: Station slides (slides #45-61), extra tape, markers or pencils; optional: UV black lights x2, UV safety goggles.

1. Print the station slides ("Station Slides," #45-61).
2. Print several copies of the instructions slide (slide #46, at least one per group).



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3. The first slide (slide #45) is the correct slide. On the back of printed slide #45, write "Your next station is located in Dr. _____'s office" with invisible ink/black light markers (Figure 4) or with light pencil.
4. On the remaining 15 slides, write "Try again" in invisible ink or light pencil.
5. Tape the 16 slides (in random order) onto a wall, such that groups can remove the paper easily from the wall (Figure 6).
6. Have extra tape at station 7 in order to re-tape sheets between groups.
7. Place the instruction slides (slide #46) on top of a desk, with a few markers.
8. Optional: Place a UV/blacklight next to the station slides (arrow pointing to them).
9. Optional: Place UV goggles next to the UV/blacklight.

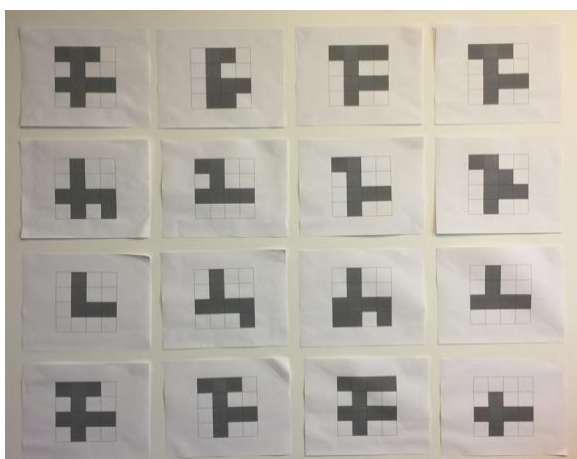


Figure 6: Example setup for station #7

Station 8: Venomous Snake ID

Station materials: Station slides (slides #63-68), scratch paper, paper "tickets" (slides 76-77 of "Station Slides"), pens, and either one letter lock and one small toolbox OR envelope.

1. Print the station slides in color (Slides #63-58).
2. Print out tickets (at least one per group) with the location of station 9 and place the tickets in a lock box (figure 3) or envelope.
3. If using lockbox, set a lock with the combination: BACR and lock the lockbox.

Station 9: Household Chemicals

Station Materials: Instructions for station 9 (slide #72), cut out letters (slide #71) and either picture or bottles of chemicals listed under #7 on materials list (zinc phosphide, methanol, caustic lye, isopropanol, and at least five other chemicals).

1. Cut out the letters from slide #71 of the "Station Slides" PowerPoint.
2. Print the instructions slide (slide #72).
3. Decide on a location for station #10, which should correspond to a four-letter code (for example, Dr. Maxwell Jen's office is "MJEN").
4. Place all the chemicals or photo on a shelf in station #9 (Figure 7).



Figure 7: Station #9, Household Chemicals

5. Place the first letter of your four-letter code on the zinc phosphide containing product (Sweeney's Gophers and Moles).
6. Place the second letter of your four-letter code on the methanol containing product (Krystal Kleer Washer Fluid, Figure 8).
7. Place the third letter of your code on the caustic lye containing product (Drano Crystals).
8. Place the last letter of your code on isopropanol.
9. Place remaining letters on your remaining household chemicals (may not use all letters).



Figure 8: Letter taped to methanol containing product



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Station 10: Toxword Puzzle

Station Materials: Station slide (slide #74), pens/pencils

1. Format the station slide:
 - a. Choose a five-letter code that corresponds to the location of station #1. For example, our station #1 was in Dr. Alisa Wray's office. Therefore, the five-letter code on the toxword puzzle was "AWRAY." The following letters are available for this five-letter code: A, A, A, A, A, B, D, D, E, E, E, E, F, H, I, I, I, I, I, I, L, L, L, M, N, N, N, N, N, N, O, O, P, R, R, R, R, R, R, S, T, T, W, X, Y, Y.
 - b. Move the symbols on PowerPoint slide #74 so that the symbols are placed on the corresponding letters from your five-letter code in the following order: pentagon, triangle, hexagon, diamond, circle (see slide #75 for example; for our station, the pentagon was on the A in "atropine," the triangle was over the W in "warfarin," the hexagon was over the R in "pyridoxine," the diamond was over the A in "intralipid" and the circle was over the Y in "methylene blue.")
2. Print out multiple copies of station slide (slide #74, at least one for each group).
3. Place station slides (slide #74) and pens in the room.

After the toxscape hunt is set up, walk through all stations to ensure that stations are set up correctly, with clues leading learners in the correct order, and with the correct codes in each lock box or envelope.

sGAE Answers: Please find the answers and explanations in the PowerPoint file "Toxscape In Class PowerPoint"

Brief wrap up (optional): See PowerPoint file "In Class PowerPoint"

Pearls:

PEARL #1: ANION GAP & OSMOLAR GAP

ANION GAP

$Na - (Cl + HCO_3^-)$

OSMOLAR GAP

$2*Na + (BUN/2.8) + (glucose/18) + (eth/3.7 - 4.6)$

- Elevated anion gap + osmolar gap = consider **ethylene glycol** or **methanol** toxicity
- Ethylene glycol= toxic metabolite is oxalic acid, may produce renal failure

- Methanol= toxic metabolite is formic acid, may produce optic nerve toxicity

PEARL #2: DIALYZABLE TOXINS

- Properties of toxins that are amenable to hemodialysis:
 - Smaller molecular weight (although now larger molecules are possible)
 - Less protein bound
 - Small volume of distribution (more water soluble)
- The EXTRIP guidelines are systematic reviews/guidelines for hemodialysis in poisonings

PEARL #3: TOXIC ECGs

Certain ingestions tend to have pathognomonic ECG patterns:

- Figure 1: Bidirectional ventricular tachycardia = think **Digoxin toxicity**
- Figure 2: Wide QRS, terminal R wave in lead aVR >3mm, increased R: S ratio in aVR = think **TCA overdose**

PEARL #4: TOXIC PLANTS AND FUNGI

Plants and fungi may contain toxic ingredients that have clinical effects:

- Nightshade (*Atropa belladonna*): Anticholinergic syndrome
- Ricin (*Ricinus communis*): Beans from the castor oil plant, if ingested, may be deadly or cause cytotoxic effects on GI tract
- Foxglove (*Digitalis purpurea*) Cardiac glycoside with effects similar to that of digoxin toxicity: bradycardia, dysrhythmias, nausea, vomiting, and xanthopsia (yellow color change to vision)
- *Amanita phalloides* mushroom: "Death cap" mushroom responsible for most mushroom related deaths, which can lead to gastrointestinal symptoms and hepatotoxicity

PEARL #5: ACETAMINOPHEN ANTIDOTE DOSING

- N-acetylcysteine (NAC) is 100% hepatoprotective when it is given within 8 hours after an acute acetaminophen ingestion.
 - Dosing
- Oral: 140 mg/kg initial dose, followed by 70 mg/kg every 4 hours
- I.V.: Loading dose: 150 mg/kg IV; mix in 200 mL of 5% dextrose in water (D5W) and infuse over 1 h
 - Dose 2: 50 mg/kg IV in 500 mL D5W over 4 h
 - Dose 3: 100 mg/kg IV in 1000 mL D5W over 16 h



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PEARLS #6 & #7: ANTIDOTES

It is important to recognize common toxidromes and their antidotes

Drug or Toxin	Antidote
Acetaminophen	N-acetylcysteine
Cyanide	Hydroxycobalamin
Digoxin	Digoxin immune Fab (Digibind)
Morphine (opiates)	Naloxone
Ethylene glycol, methanol	Fomepizole
Methotrexate	Folinic acid/leucovorin
Isoniazid	Pyridoxine (Vitamin B6)
Iron	Supportive care, deferoxamine
Rattlesnake	Crotalidae polyvalent immune Fab (CroFab)

PEARL #8: SNAKE ENVENOMATION

Snakes that produce poisonous venom:

- Coral Snake: "Red on yellow, kill a fellow." Contains a neurotoxic venom.
- Western Diamondback rattlesnake, Cottonmouth rattlesnake: Cytotoxic and hemotoxic venom.

PEARL #9: HOUSEHOLD CHEMICALS

A number of household chemicals may produce a poisoning if ingested:

- **Zinc phosphide:** converted to phosphine gas, inhibiting oxidative phosphorylation (cyanide-like effect).
- **Washer fluid:** Contains methanol. Toxic metabolic byproduct is formic acid which may affect the optic nerve to produce blindness.
- **Caustic Lye, drain cleaner:** Caustic base which is highly corrosive to tissues.
- **Isopropyl alcohol, ie, rubbing alcohol:** Causes elevated osmolal gap but normal anion gap; also produces ketones.

PEARL #10: MISCELLANEOUS TOXINS

- **Sarin gas (nerve gas):** Produces cholinergic syndrome (bronchorrhea, respiratory distress, sweating, miosis, altered mental status). Treated with atropine and pralidoxime.

- **Diphacinone:** commonly found in rat poison, similar mechanism of action to warfarin.
- **Pyridoxine:** antidote to isoniazid ingestion.
- **Local anesthetic toxicity:** No readily available antidote; however, may consider use of intralipid if unstable patient with dysrhythmia.
- **Beta-blocker or calcium channel blocker overdose:** consider high dose insulin in severe toxicity.

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