EMS “Live” In-Station Continuing Education

CE Provider:	University of Texas Southwestern Medical Center at Dallas Department of Emergency Medicine Division of Emergency Medical Services
Course Title:	Prescription Medication
Course Approval Number:	UTSW – 02M2017 TDH – 101606
Date:	February 2017
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National Continued Competency Program (NCCP) Content Area and Hours:	Local or Individual Component – 4.0 hours
TDH Content Area and Hours:	Preparatory – 3.0 hours Medical – 1.0 hour
Skills Proficiency Verification:	
Class Location:	_____
Instructor Name:	_____
Student Name:	_____

In order to accrue the CE hours required for recertification, the student must attend and participate in the live CE component represented by this module and complete any required skill demonstrations.

STUDENT VERSION

This form shall serve as a written record of the participant's successful completion of the EMS educational activity as outlined in the Texas Administrative Code, Title 25, Part 1, Chapter 157, Subchapter C and as outlined in CECBEMS Standards and Requirements for Organization Accreditation.

Prescription Medication

Cognitive Objectives: Upon successful completion of this course, the student will be able to:

- Formulate a treatment plan for the patient suffering from opioid toxicity.
- Formulate a treatment plan for the patient suffering side effects or toxicity resulting from cardiovascular medications including ACE inhibitors, antihypertensives, antiarrhythmics, cardiac glycosides, and phosphodiesterase inhibitors.
- Formulate a treatment plan for the patient suffering side effects or toxicity resulting from the use of statins to control serum cholesterol levels.
- Formulate a treatment plan for the patient suffering side effects or toxicity resulting from the use of anticoagulants.
- Formulate a treatment plan for the patient suffering side effects or toxicity resulting from the use of psychoactive agents, including SSRIs, antipsychotics, and mood stabilizers.

Psychomotor Objectives:

- No psychomotor objectives listed for this CE module

Affective Objectives:

- No affective objectives listed for this CE module

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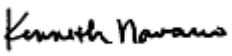
You have participated in a continuing education program that has received CECBEMS approval for continuing education credit. If you have any comments regarding the quality of this program and/or your satisfaction with it, please contact CECBEMS at: CECBEMS -5111 Mill Run Road -Dallas, Texas 75244 - (972) 387-2862 lsibley@cecbems.com. CECBEMS is an organization established to develop and implement policies to standardize the review and approval of EMS continuing education activities. The cosponsoring organizations of CECBEMS are the National Association of Emergency Medical Technicians, the American College of Emergency Physicians, the National Association of Emergency Medical Services Physicians, the National Association of State Emergency Medical Services Directors, the National Council of State Emergency Medical Services Training Coordinators, and the National Registry of Emergency Medical Technicians, and the National Association of EMS Educators.



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For ECG practice or review, visit **www.ecglibrary.com**. To access the latest version of the protocols, for patient care alerts or updates on new medications, visit **www.biotel.ws**. References and bibliographies for all CE modules are on file and available upon request. To comment on this module, good or bad, e-mail **kenneth.navarro@utsouthwestern.edu**

Prescription Medication

In the United States, almost 60% of adults report taking a prescription medication within the prior 30 days (Kantor, Rehm, Haas, Chan, & Giovannucci, 2015). Almost 40% of adults over the age of 65 years report taking five or more prescription medications each day (Kantor, Rehm, Haas, Chan, & Giovannucci, 2015). For individuals over the age of 65 years, there is a 3% to 4% increase in likelihood of emergency department visit for each medication taken compared to individuals who are not prescribed any medications (Allin, Rudoler, & Laporte, 2016). Patients who take both prescription and natural health products (e.g., mineral, herbal, homeopathic, or traditional medicine) are about six times more likely to experience an adverse event when compared to individuals who take prescription medications alone (Necyk et al., 2014).

Top 10 Prescriptions Filled in the United States		
	WebMD (2015)	**LowestMed.com (2016)**
1	Levothyroxine (generic for Synthroid) Used to treat hypothyroidism (low thyroid hormone) and to treat or prevent goiter (enlarged thyroid gland)	Atorvastatin Calcium (generic for Lipitor) Used to lower low-density lipoprotein (LDL) cholesterol, reduce risk for cardiac events and slow the progression of heart disease
2	Rosuvastatin (generic for Crestor) Used to lower low-density lipoprotein (LDL) cholesterol, reduce risk for cardiac events and slow the progression of heart disease	Levothyroxine (generic for Synthroid) Used to treat hypothyroidism (low thyroid hormone) and to treat or prevent goiter (enlarged thyroid gland)
3	Albuterol (generic for Ventolin) Used to treat or prevent bronchospasm in people with reversible obstructive airway disease	Lisinopril (generic for Prinivil) Used to treat high blood pressure or CHF
4	Esomeprazole (generic for Nexium) Used to treat symptoms of gastroesophageal reflux disease (GERD) and other conditions caused by excess stomach acid	Omeprazole (generic for Prilosec) Used to treat symptoms of gastroesophageal reflux disease (GERD) and other conditions caused by excess stomach acid
5	Fluticasone (generic for Advair Diskus) Corticosteroid used to relieve seasonal and year-round allergic and non-allergic nasal symptoms	Metformin (generic for Glucophage) Used to improve blood sugar control in people with type 2 diabetes
6	Insulin glargine (generic for Lantus Solostar) Long-acting insulin used in combination with other medications to improve blood sugar control in patients with either type 1 or type 2 diabetes	Amlodipine (generic for Norvasc) Used to treat hypertension, angina, or other conditions caused by coronary artery disease
7	Lisdexamfetamine (generic for Vyvanse) Central nervous system stimulant used to control symptoms of attention deficit hyperactivity disorder (ADHD) and to treat binge-eating disorders	Simvastatin (generic for Zocor) Used to lower cholesterol and triglycerides (types of fat) in the blood
8	Pregabalin (generic for Lyrica) Used to relieve neuropathic pain (pain from damaged nerves) resulting from diabetes or shingles, used to treat fibromyalgia, and may be used with other medications to treat certain types of seizures	Hydrocodone/Acetaminophen (generic for Lortab) Used to relieve moderate to moderately severe pain
9	Tiotropium (generic for Spiriva Handihaler) Used to prevent wheezing and other respiratory symptoms in patients with chronic obstructive pulmonary disease (not used as a rescue inhaler)	Metoprolol ER (generic for Toprol XL) Used to treat angina, hypertension, or to treat or prevent heart attack
10	Sitagliptin (generic for Januvia) Used to improve blood sugar control in people with type 2 diabetes	Losartan (generic for Cozaar) Used to treat hypertension or to lower the risk of stroke

Analgesics

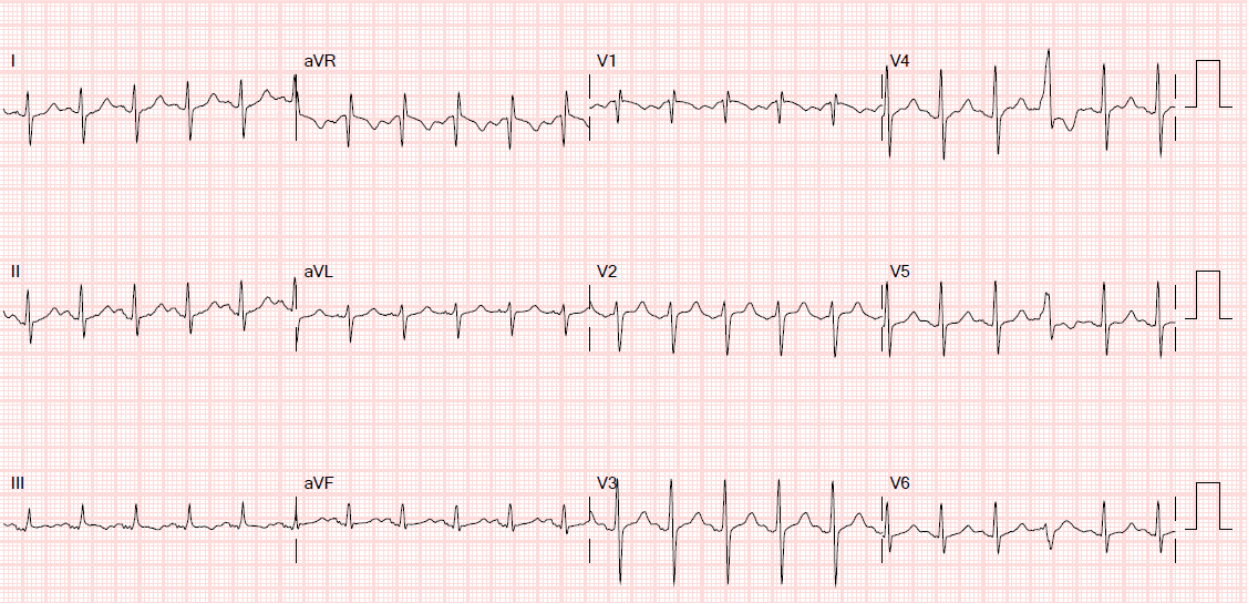
60% of all deaths related to drug overdose involved the use of an opioid (Rudd, Aleshire, Zibbell, & Gladden, 2016). Hospitals emergency departments have significantly reduced narcotic prescription distribution following implementation of an opioid prescription policy (Osborn, Yu, Williams, Vasilyadis, & Blackmore, 2017).

Case Presentation

You respond to a report of an unconscious person at a local residence. You arrive to find a 20 year old male in significant respiratory distress. The patient has an increased work of breathing and is producing pink, frothy sputum. The patient's initial set of vital signs are:

Pulse	B/P	Respiration	Temp	RASpO_2	POC Glucose	GCS
130	142/86	36	37.3°C (99.1°F)	86%	88 mg/dL	15

This is the patient's first 12 lead.



The patient was seen in the emergency department two days ago after being assaulted at a nightclub very early in the morning. The patient was admitted with a maxillary sinus fracture and left orbital wall fractures. The patient received a CT scan, which did not show any evidence in intracranial bleeding. He was admitted to the hospital for observation and was discharged home yesterday afternoon with a prescription for 30 Percocet® (acetaminophen/oxycodone) for a severe headache and instructions to see a specialist tomorrow.

The patient reported a severe headache since hospital discharge. The shortness of breath began suddenly about thirty minutes ago. The spouse reports the patient has a history of anxiety disorder and polysubstance abuse, including IV drug abuse.

Before getting to the ambulance, the patient becomes unresponsive. The patient rapidly deteriorates into cardiac arrest with PEA on the monitor.

Prehospital Diagnosis:

Prehospital Treatment:

Case presentation adapted from Galante, Ahmad, Albers, and Sena (2012).

Narcotic Analgesics

It is possible the recent increased use of heroin in this country can be traced back to the use of prescription narcotics. At the beginning of the last decade, the Joint Commission on the Accreditation of Healthcare Organizations (JAHCO) issued a scathing report describing failure of the medical community to adequately treat pain. One of the report's conclusions was the underuse of narcotics resulted from unfounded fears about facilitating drug addiction. JAHCO reasoned that historically, few patients abused prescription narcotics, which was likely true at the time.

Also around the same time, Purdue Pharma introduced a time-released form of oxycodone and began aggressively marking the drug as an effective and safe analgesic for non-malignant forms of pain (Van Zee, 2009). The company downplayed the risk of addiction by claiming addicts and other seeking to get high wanted immediate action rather than time-released medications. Years later, the company and three executive pled guilty to criminal charges of misrepresenting the potential harm from use of their drug (Van Zee, 2009).

As a result of the JAHCO report and subsequent push for effective pain management, the sale and use of prescription narcotics rapidly increased (Gregg, 2015). An emphasis on pain management combined with the widespread availability and complacent safety attitudes surrounding prescription narcotics created a perfect storm for an epidemic of narcotic addiction and overdose (Maxwell, 2011). Since 1999, deaths associated with prescription opioid use have more than quadrupled (CDC, 2016). Sixty percent of all drug-overdose deaths in the United States today involve the use of narcotics (Rudd, Seth, David, & Scholl, 2016).

Early in this decade, physicians began writing fewer narcotic prescriptions (Dart et al., 2015) and heroin use increased to fill the gap (Cicero & Kuehn, 2014). Heroin moved from an inner-city, minority-centered problem to the suburbs, involving primarily white men and women in their late 20s (Cicero, Ellis, Surratt, & Kurtz, 2014).

There are three major types of opioid receptors in the body, each one corresponding to one of three types of opioid chemicals created naturally by cells in the central and peripheral nervous system. All ingested narcotics must pass out of the blood stream and bind to one of those receptors, a process that initiates a series of chemical reactions that eventually produces the desired effects (Cicero, 2015). Increased receptor stimulation produces increased effects.

All of the major narcotics have similar characteristics, such as metabolism into active metabolites by the liver, elimination through the kidneys and urine, and the ability to remove the drugs from the body by hemodialysis. One major difference between the types of narcotics is a wide variation in serum half-life for therapeutic dosing, ranging from about 2 hours for morphine to 27 hours for methadone (Stolbach & Hoffman, 2016). In overdose especially with tablets, these half-life intervals increase as a result of increased dissolution and absorption.

History

Although difficult in some cases, paramedics should attempt to identify the specific drug(s) (including formulation) ingested, the presence of any co-ingestants, and the patient's prior experience with opioids. Many opioid-related deaths involve the use of more than one opioid (Rudd, Seth, David, & Scholl, 2016).

Physical Examination

The classic signs of opioid intoxication include

- Depressed mental status - This is a common sign but can be masked by the presence of coingestants.
- Decreased respiratory rate and tidal volume - One of the strongest predictors of opioid intoxication in a respiratory rate below 12 breaths per minute, which predicted response to naloxone in all but one patient is a case series (Hoffman, Schriger, & Luo, 1991). Decreases in tidal volume are easy to overlook initially, but become more pronounced with time. Pulse oximetry values can be normal, especially if the patient is breathing supplemental oxygen. However, the decreased rate and tidal volume will produce elevated carbon dioxide levels and should alert you to the developing problem. Carefully monitor the patient's respiratory status and intervene early.

- Decreased bowel sounds
- Miotic (constricted) pupils - The presence of normal pupil size does not rule out opioid intoxication. Patients who use meperidine can present with normal pupils while coingestants (such as sympathomimetics or anticholinergics) can make pupils appear normal or large.

With the exception of a decreased respiratory rate, vital signs abnormalities are not common in the early stages of the intoxication period. Pulse rates may be normal to low, although any bradycardia present is usually mild and may not initially trigger concern. In some cases, normal opioid action triggers a histamine release, which can lower the patient's blood pressure.

During the secondary survey, assess for any evidence of trauma, especially to the head. While opioid abuse predisposes patients to falls and associated injury, it is easy to attribute mental status changes to suspicions of drug intoxication when the patient may have actually traumatic brain injury. Examination of the skin may reveal the presence of track marks or medication patches.

Treatment of Narcotic Toxicity

- Basic Level
  - Assess and support ABCs.
  - Place the patient in a position of comfort or in the left lateral position. If there is evidence of shock, place the patient supine with the feet elevated and closely monitor the airway.
  - Administer oxygen, as needed, to maintain SpO2 of at least 94%.
  - Perform a POC glucose analysis and treat hypoglycemia, if present
- Advanced Level
  - Consider establishing IV access at a TKO rate or use a saline lock. If the patient is hypotensive, treat according to SHOCK Guidelines.
  - All patients treated under the AMS guideline must have continuous cardiac monitoring. If a dysrhythmia develops, treat accordingly under its specific guidelines. Patients with continued altered mentation should also have ETCO2 monitoring.
  - If there is evidence of opioid narcotic use, with altered mental status, hypoventilation and/or hypoxia, AND pinpoint pupils, administer Naloxone 0.4 mg every 5 minutes via IN or SLOW IVP or IO until the respiratory rate improves and the patient can maintain a SpO2 of at least 94%, OR until 2 mg have been given.

Important Treatment Consideration

The use of naloxone should be restricted to patients suspected of opioid narcotic overdose AND hypoventilation and/or hypoxia, AND pinpoint pupils. Its use outside of these indications may cause undesirable narcotic withdrawal. The endpoint for naloxone administration is an improvement in respiratory function, not full consciousness. Do not attempt to restore full consciousness in patients with evidence of narcotic use. In most situations, nothing useful will come from attempts to restore full consciousness in narcotic overdose patients who are breathing adequately. Titrate naloxone administration to restore adequate ventilatory status, or to a SpO2 of at least 94%.

Naloxone has a mean average half-life of about one hour. This is much shorter than the half-life of morphine (3 hours), oxycodone (4.5 hours), and fentanyl patches (17 hours). Although the half-life of heroin is relatively short (about 2-6 minutes), the body converts heroin into morphine, which has a much longer half-life (Naloxone (narcan) nasal spray for opioid overdose, 2016). In some cases, the effects of naloxone will wear off long before the effects of the opioid will. For this reason, every patient suspected of opioid toxicity must be bought to the emergency department.

Case Resolution:

The patient never achieved ROSC in the back of the ambulance. Because the patient had a history of recent trauma, the trauma team was waiting in the ED when you arrived. The trauma team performed bilateral chest decompression to exclude tension pneumothorax. The Surgeon also performed a focused assessment with sonography for trauma (FAST) exam but did not find any fluid in the peritoneum of pericardium. After about 30 minutes of pulselessness, the physician terminated at resuscitation attempts and pronounced the patient dead.

The postmortem toxicology report indicated the patient had a toxic level of oxycodone in his system. Faint needle tracks were found in the right antecubital fossa along with evidence of polarizable foreign material

A postmortem examination was performed. The patient's oxycodone level was 330 ng/mL, which is higher than the toxic level of 200 ng/mL. Needle track marks were identified in the patient's right antecubital fossa, with associated hemorrhage and polarizable foreign material within the subcutaneous tissue. Further examination found similar material in lung tissue, which completely occluded several pulmonary artery arterioles.

The pathologist reported the probable cause of death was multiple pulmonary micro-thromboemboli resulting from probable injection of oral prescription medications. There was no evidence that prior traumatic injuries contributed to his death.

Cardiovascular System Medications

There is a wide variety of medications prescribed for problems associated with the cardiovascular system. These can include medications that act directly on the conduction or pumping function of the heart or act on the blood vessels themselves. This section of the module will provide general information about some of the more commonly prescribed cardiovascular system medications.

Case Presentation

Your ambulance responds to a report of respiratory distress. You arrive to find a 9 year-old female in mild distress with periorbital and lingual swelling (Image 1).

Image 1: Periorbital and lingual swelling at arrival in the ED. Image retrieved from Bukhari, E., Safdar, O. Y., Shalaby, M., Al Sharif, S. M., Alsufiany, K., & Kari, J. A. (2015). Potentially lethal ACE-inhibitor-induced angioedema in a child. Clinical Case Reports, 3(6), 427-430. doi:10.1002/ccr3.265

The patient's mother says the girl experienced fever and cough for the past three days and woke up this morning with some swelling of her tongue that increased over the past four hours. Her initial set of vital signs are:

Pulse	B/P	Respiration	Temp	RASpO_2	POC Glucose	GCS
90	112/65	16	38.5°C (101.3°F)	95%	92 mg/dL	15

Six months ago, the girl was diagnosed with end-stage renal disease and receives hemodialysis three times per week. Her last treatment was yesterday. The mother also reports that four months ago she started developing blood clots in legs and the doctor says the girl has a "leaky heart valve" and "her heart doesn't pump very well." She takes the following medications: warfarin, captopril, atenolol, calcium carbonate, amlodipine, oral sodium bicarbonate, alfacalcidol, and folic acid. She also receives IV erythropoietin three times per week. The girl is compliant with medications and is not allergic to anything. The girl does not remember any recent insect bites.

Upon further examination, you hear fine crackles over both lung fields and note that her abdomen is distended and non-tender. There is pitting edema of both lower extremities that extends to her thighs. There is no evidence of a rash or inflammation.

Prehospital Diagnosis:

Prehospital Treatment:

ACE Inhibitors

Medications belonging to the group known as angiotensin-converting-enzyme (ACE) inhibitors are prescribed primarily for the treatment of hypertension (HTN) and congestive heart failure (CHF). However, these drugs are also used for long-term patient management following an acute myocardial infarction and for kidney complications related to diabetes.

How ACE Inhibitors Work

The kidneys play a major role in the regulation of blood pressure. On any given day, blood pressure rises and falls depending on a variety of activities. During periods when the blood pressure is below normal, the kidneys release an enzyme called renin into the bloodstream. During periods when the pressure is elevated, the kidneys do not release as much. Renin reacts with a circulating protein made in the liver (angiotensinogen) to create a new protein hormone called angiotensin I, which then circulates throughout the body.

At the same time, cells that form the capillary beds in the lungs constantly create and release a protein enzyme called angiotensin-converting enzyme (ACE). This enzyme transforms angiotensin I into another hormone called angiotensin II, which then attaches to specific receptor sites in the brain, kidney, adrenal, vascular wall, and the heart. Stimulation of these receptors will produce vasoconstriction and cause the kidneys to reabsorb greater amounts of water from newly forming urine thus increasing intravascular volume. Collectively, these actions help to bring the blood pressure back to a normal range.

Chronic hypertension essentially resets the normal range. The same renin-angiotensin system (RAS) continues to function and the body works to maintain an elevated blood pressure. Interruptions in the system somewhere along the RAS pathway will reduce the patient's blood pressure to acceptable levels. This is where ACE inhibitors play a role.

Drugs in this class act by preventing the conversion of angiotensin I into angiotensin II. Without angiotensin II to stimulate the receptor sites, vasoconstriction is not as profound and the kidneys allow more water to escape from plasma into urine. These actions reduce the patient's blood pressure.

Adverse Effects Your Patient May Experience

Understanding how the medication works provides clues as to the types of adverse reactions you might expect to see. Since the medication lowers blood pressure, some patients will experience symptoms related to hypotension, such as dizziness, fatigue, and nausea.

ACE inhibitors also decrease aldosterone levels, resulting in greater potassium retention in the kidneys. In some patients, this can lead to hyperkalemia and impaired impulse conduction in nerves and muscle, including the myocardium. With increasing levels of potassium, the patient may experience cardiac dysfunction, paresthesia (burning or prickling sensation usually felt in the extremities), nausea, and vomiting. Patients with any of these symptoms who are also taking an ACE inhibitor should be placed on a cardiac monitor.

ACE inhibitors also increase the production of specific inflammatory mediators, which can result in dry cough, rash, and generalized aches and pains. These same mediators can also cause angioedema, such as in our case presentation (Mahoney & Devaiah, 2008; Tai, Mascaro, & Goldstein, 2010). It is relatively rare with a reported incidence range of 0.68 to 11% (Rasmussen, Mey, & Bygum, 2014; Zingale et al., 2006).

The most dangerous aspect of angioedema is complete airway obstruction. Patients who develop symptoms such as drooling, stridor, hoarseness of the voice, or aphonia (loss of ability to speak) are at extreme risk of airway obstruction. You should be prepared to take immediate and aggressive action.

Although both anaphylaxis and ACE inhibitor use can produce angioedema, they do not both respond in the same way to drug therapy. Epinephrine and steroids are the drugs of choice for treating angioedema caused by anaphylaxis. However, angioedema caused by ACE inhibitors does not respond to these drugs (Cicardi et al., 2014). The reason lies in the fact that ACE inhibitor induced angioedema is not mast cell mediated, as is the case with anaphylaxis.

Case Resolution:

The hospital diagnosis was angioedema secondary to captopril use, which was discontinued. The family provided consent for emergency airway procedures in the event her condition began to deteriorate. She was admitted into a pediatric intensive care unit where she received IV epinephrine 0.01 mL/kg (1:1000) and dexamethasone 0.5 mg/Kg every six hours. The ICU staff covered her tongue with saline soaked gauze and her condition rapidly improved over the next 48 hours. Eventually, all symptoms disappeared and she was released on the seventh day of hospitalization.

While obtaining a history, we learned the patient had fever and cough for three days before developing signs of angioedema. Bacterial and viral infections can trigger angioedema regardless of the presence of ACE inhibitors, especially in children (Wedi, Raap, Wieczorek, & Kapp, 2008).

There are a number of risk factors for the development of ACE inhibitor-induced angioedema including female gender and African-American race (Sanchez-Borges & Gonzalez-Aveledo, 2010). It is also more common within the first week of use (Sanchez-Borges & Gonzalez-Aveledo, 2010).

Antihypertensives

This term describes a variety of medications used to control hypertension. Some of the medications act by helping the body to eliminate excess fluid (diuretics). Others act by reducing the heart rate, the heart's workload and the heart's output of blood (beta-blockers). Still others work by blocking receptor sites on blood vessels, which permit the vessels to stay dilated rather than to constrict (Angiotensin II receptor blockers - ARBS).

Diuretics

This class of antihypertensive medications helps the body eliminate excess fluid. Doctors often prescribe diuretics along with other medications. In some cases, the diuretic and another medication exist in the same pill.

There are three major types of diuretics. The thiazide diuretics are probably the most commonly prescribed of the three. These medications help to lower blood pressure in two ways. They work by causing the kidneys to decrease reabsorption of salt and water from the newly formed urine, which results in greater quantities of urine. Since the drugs do not exert a strong effect on the kidneys, the patient may not really notice the increased urine. The drugs also act to dilate blood vessels. Widening of the blood vessels along with a decrease of fluid in the vessels helps to lower the patient’s blood pressure. An example of a thiazide diuretic is hydrochlorothiazide, or simply HCT or HCTZ.

The second type of diuretics is the loop diuretics. These drugs work similar to the thiazide diuretics except in a different section of the kidney called the loop of Henle (hence, the name). Loop diuretics are much stronger than thiazide diuretics and can produce noticeable volumes of urine, especially in the first few hours after ingestion. An example of a loop diuretic is furosemide.

Finally, there are the potassium-sparing diuretics. These drugs block the actions of a hormone that triggers reabsorption of sodium from the urine. Blocking this action increases sodium concentration in the urine and since water follows sodium, the drugs also increase urine production. However, a hallmark of these drugs is they also block channels in the kidneys that potassium normally uses to exit the blood stream and collect in the urine. Thus, these drugs spare potassium from being lost in large quantities. An example of a potassium-spariing diuretic is spironolactone, sold under the brand name Aldactone.

Severe side effects caused by diuretics are uncommon. In the first few days or even weeks of therapy, the patient may experience dizziness when rising to a standing position. This should disappear and the patient's body acclimates to the physical changes produced by the drugs.

The drugs can also increase blood sugar levels above normal. For non-diabetics, this rarely causes a problem. However, patients with diabetes may need tighter diabetes control to counteract the interference cause by the diuretic.

Similarly, the drugs can also increase the amount of uric acid in the bloodstream and tissue fluids of the body. Uric acid is a byproduct of the metabolism of certain foods and drinks, such as liver, seafood, dried beans, peas, and beer. Normally, uric acid is removed by the kidneys. However, diuretics can impede uric acid removal and result is an abnormal accumulation. In some cases, this can lead to the development of urate (uric acid) crystals in the fluid surrounding a joint. This condition is called gout.

Finally, diuretics can interfere with the normal electrolyte balance of the body and result in low levels of potassium (except for the potassium-sparing diuretics), sodium, and magnesium while increasing calcium levels. This imbalance can result in a variety of problems including weakness, confusion, muscle cramps, and occasionally abnormal heart rhythms.

Beta-blockers

These are some of the most commonly prescribed medications for the treatment of hypertension (9th most commonly prescribed drug in the United States according to LowestMed.com (2016)). These medications help to lower blood pressure by blocking the action of the naturally occurring hormone called epinephrine. By doing so, beta-blockers help the heart beat more slowly and with less force. In addition, the drugs increase the diameter of blood vessels, which reduces the

pressure of the flowing blood. Certain beta-blockers work primarily on the heart while others work on both the heart and the blood vessels. Some examples of beta-blockers include atenolol sold under the brand name Tenormin, metoprolol sold as Lopressor, and propranolol sold as Inderal. A combination hydrochlorothiazide and bisoprolol is sold as Ziac. In the generic form, the names of all beta-blockers end in -lol.

Side effects of beta-blocker use are common, although usually mild. Since the therapeutic action of the drug is to reduce heart rate and lower blood pressure, side effects are generally related to those actions. This can include weakness, dizziness, nausea, and vomiting. Other important side effects include muscle cramps and fatigue.

Angiotensin II Receptor Blockers (ARBS)

Whereas the ACE inhibitors act by preventing the conversion of angiotensin I into angiotensin II, ARBS work by blocking the receptor sites used by the angiotensin II molecules. Without stimulation of those receptor sites, vasoconstriction is less profound and the pressure inside those vessels falls. An example of an ARB is losartan sold under the brand name Cozaar, which appears on in 10th place on the top ten prescriptions filled on Low LowestMed.com (2016). In the generic form, the names of all ARBS end in -tan.

As with the other antihypertensives, this medication has the potential to lower the patient's blood pressure and cause dizziness. As with ACE inhibitors, these drugs can also produce a cough, although this is not as common with ARBS and it is with ACE inhibitors.

Antiarrhythmics

Another major group of cardiovascular system medications is the antiarrhythmics. Physicians prescribe these medications to help control the electrical activity than can produce abnormal heart rhythms. Most paramedics are familiar with antiarrhythmics as the BioTel system carries a two. Some common prescription antiarrhythmics include amiodarone sold as Cordarone and flecainide sold as Tambocor.

Antiarrhythmic medications work by altering the movement of ions across the membranes surrounding heart cells. This alteration results in impulse conduction changes through the myocardium. Antiarrhythmic medications vary in their chemical composition, cellular structure, and mechanisms of action. Some work primarily on sodium channels, others on potassium channels and others work on multiple ion channels simultaneously.

As one can imagine, altering the movement of ions through these channels has the potential for serious side effects. These can include either significantly increasing or slowing heart rates or

worsening of cardiac arrhythmias. Other significant side effects include chest pain, shortness of breath, and fainting episodes. Patients taking antiarrhythmics and experiencing side effects should always be placed on a cardiac monitor.

Cardiac Glycosides

Another common cardiovascular system medication group is the cardiac glycosides. These medications are primarily used to manage heart failure and for some cardiac arrhythmias. These drugs work by reversing sodium/calcium exchange in heart cells, which allows calcium accumulation in heart muscle. The increased concentration of calcium promotes stronger heart muscle contraction and more efficient pumping function. In addition, cardiac glycosides cause sodium levels to rise inside heart cells, which slow conduction of electrical impulses and helps prevent certain types of arrhythmias. An example of a cardiac glycoside is digoxin sold as Lanoxin.

Patients who take too much digitalis at one time or for a long period of time can develop digitalis toxicity. When toxicity develops with normal dosing, conditions such as kidney problems may prevent normal digitalis elimination and subsequent accumulation in the body. Potassium and magnesium are essential for maintaining proper heart function and rhythm. If levels of these minerals are too low, digitalis sensitivity increases and places the patient at a higher risk for toxicity.

The main symptoms of digitalis toxicity involve the gastrointestinal and respiratory system along with visual disturbances. Patients often lose their appetite and experience nausea, vomiting, and/or diarrhea. The patient may develop either tachycardia or bradycardia or an irregular heartbeat.

Toxicity often results in confusion and although rare, patients might also see bright spots, have blurry vision, or experience blind spots. Urinary changes (increased or decreased) are common. The patient may also notice widespread swelling.

Phosphodiesterase Inhibitors

Finally, a type of medication not normally thought of as a cardiovascular system medication is the group known as phosphodiesterase inhibitors. The drugs can be selective, meaning they target specific phosphodiesterase (enzyme) activity, or they can be non-selective, meaning they target many types of phosphodiesterase activities. Most people are familiar with the selective phosphodiesterase inhibitors that affect the smooth muscle of the vessels serving the corpus cavernosum of the penis, although the drug also works on the smooth muscle of the vessels serving the lungs.

However, for the purposes of this module, we will focus our attention on the non-selective phosphodiesterase inhibitors, which are useful in the treatment of heart failure. These drugs act by

preventing the breakdown of a messenger molecule inside cells. These messenger molecules permit the movement of large molecules such as hormones and glucose into the cell, where they can carry out their functions. When the messenger molecule is destroyed by normal biological processes, those larger molecules cannot get into the cells. Nonselective phosphodiesterase inhibitors prevent (or significantly slow) the degradation of the messenger molecules, which allows the larger molecules to continue to work.

The next effect of the nonselective phosphodiesterase inhibitors is to increase cardiac contractility (inotropy), heart rate (chronotropy) and conduction velocity (dromotropy). The medication also causes vascular smooth muscle relaxation. An example of a nonselective phosphodiesterase inhibitor is theophylline.

There are a number of side effects that can occur with this medication. Most are relatively mild and include gastrointestinal complaints such as stomach pain or diarrhea. The medication can also produce headache, restlessness, and irritability. More serious symptoms include vomiting, irregular heartbeat, and seizures.

Table 1: Common Cardiovascular System Medications

Class	Common Names	Common Side Effects
Beta-blockers • Lowers heart rate • Lowers blood pressure • Softens contraction strength	• Propranolol (Inderal®) • Carvedilol (Coreg®) • Metoprolol (Toprol®) • Labetalol (Normodyne®) • Atenolol (Tenormin®)	• Dizziness • Feeling tired • Worsening of usual symptoms (this might improve over time without changing medicines)
Angiotensin converting enzyme (ACE) inhibitors • reduce heart-damaging hormones • opens blood vessels • lowers blood pressure	• Lisinopril (Zestril®) • Captopril (Capoten®) • Enalapril (Vasotec®) • Quinapril (Acupril®)	• Dizziness • Changes in kidney function • Dry cough that often improves with time • Increased potassium levels
Angiotensin Receptor Blockers (ARB) • similar to ACE inhibitors, but without the cough	• Losartan (Cozar®) • Valsartin (Diovan®) • Digoxin (Lanoxin®)	• Dizziness • Changes in kidney function • Increased potassium level

Cardiac Glycosides • slows heart rate • improves heart's pumping ability	Digoxin (Lanoxin®)	• Nausea • Poor appetite • Digestive problems
Hydralazine and Nitrates • Opens blood vessels	• Hydralazine (Apresoline®) • Nitroglycerin (Nitrobid®) • Isosorbide mononitrate (Imdur®) • Isosorbide dinatrate (Isordil®)	• Dizziness • Headache • Swelling in hands, arms, feet, or legs
Diuretics • remove excess fluid from the body	• Furosemide (Lasix®) • Bumetanide (Bumex®) • Torsemide (Demadex®) • Metolazone (Zaroxolyn®)	• Increased urination • Dizziness • Dehydration • Changes in kidney function • Ringing or buzzing in the ears • Skin rash or hives • Itching • Increased blood sugar levels • Gout

Cholesterol Medications

Some of the most commonly prescribed medications in the United States are the statins. These drugs help lower cholesterol levels in the blood. By doing so, the drugs help prevent heart attacks and stroke. Unfortunately, these medications do come with a risk.

Case Presentation

Your patient is a 63-year-old female who complains of generalized aches and pains. She report the discomfort started about a week ago and began as soreness in her thighs and shoulders, and in the lower back and calves. She described the sensation as feeling as if she had been weightlifting. After a few days, the discomfort began to intensify and is beginning to be worrisome. She called her daughter (who lives in another state), who advised her to call an ambulance and go to the emergency department. Her initial set of vital signs are:

Pulse	B/P	Respiration	Temp	RASpO_2	POC Glucose	GCS
62	122/78	18	37.4°C (99.3°F)	97%	106 mg/dL	15

The patient has a 10 – year history of hypertension and recent history of elevated cholesterol levels. Her takes a combination hydrochlorothiazide and bisoprolol tablet each morning. About six

months ago, her doctor prescribed 20 mg simvastatin, which she also took every morning. About three weeks ago, her doctor raised the simvastatin dose to 40 mg daily because her cholesterol levels were still elevated.

Her breath sounds are clear and equal and she has no evidence of trauma to the trunk, head or extremities. The patient is able to stand but needs some assistance getting to the stretcher.

In the ambulance, the patient reports she thought she was simply becoming dehydrated, although she tries to drink enough water every day. She reports her urine has been getting darker each day and currently has the color as dark as a glass of cola.

A few minutes before arrival at the ED, the patient's ECG was

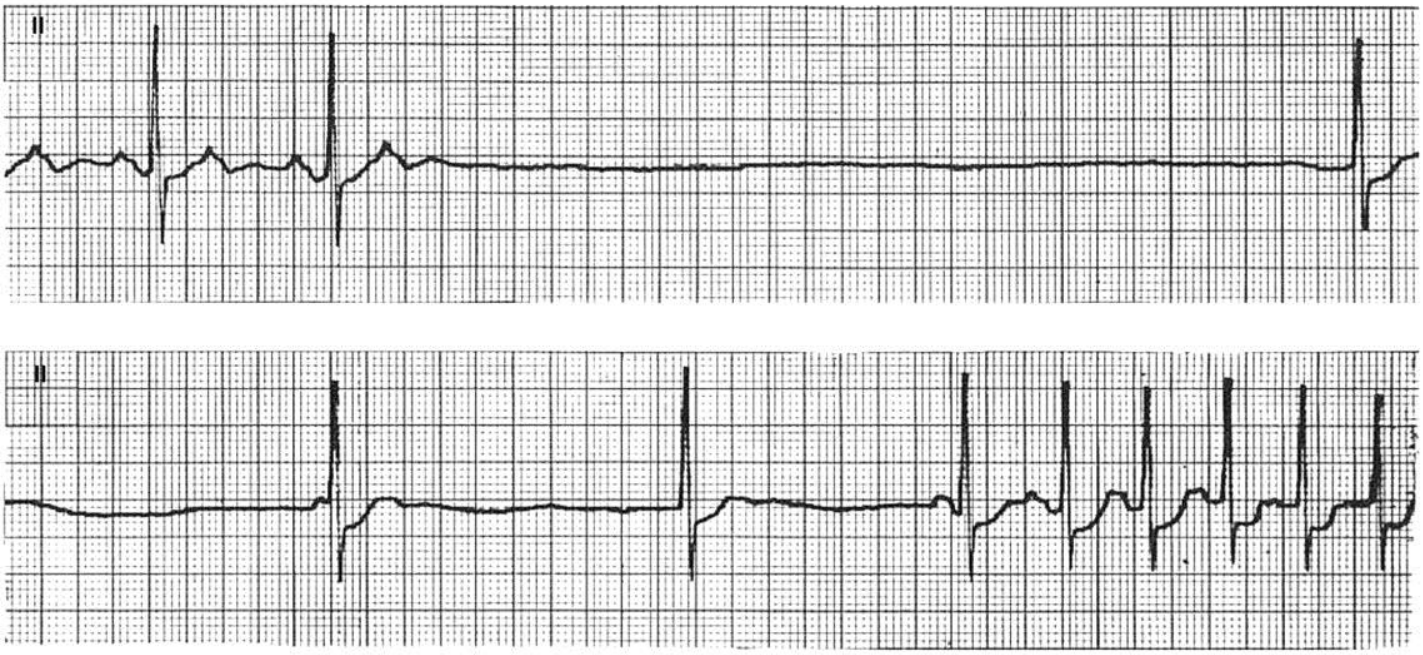


Figure 2. http://ajcc.aacnjournals.org/content/16/3/294/F1.expansion

Her new set of vital signs are:

Pulse	B/P	Respiration	Temp	RASpO$_2$	POC Glucose	GCS
42	86/palp	20	na	93%	na	15

Prehospital Diagnosis:

Prehospital Treatment:

Statins

Medications in the statin class prevent the synthesis of molecules necessary for the liver to produce cholesterol. These drugs are increasing being prescribed to help prevent cardiovascular disease. In fact, several brand names of statins appear in the top ten prescription drugs at two different tracking agencies.

Statin Therapy and Rhabdomyolysis

One of the most serious side effects of statin therapy is the development of rhabdomyolysis, which is a breakdown of muscle cells. The exact mechanism that causes the cells to rupture remains unknown. However, as the cells disintegrate, they release the oxygen storing protein myoglobin into the bloodstream which undergoes a chemical transformation to become particles known as myoglobin casts. The kidneys attempt to filter the casts but become clogged by the sheer volume. This can cause renal tubular obstruction and acute renal failure resulting in death for one out of every ten patients (Law & Rudnicka, 2006).

Patients with rhabdomyolysis classically present with muscle pain, weakness and dark urine. On average, if the symptoms develop, they will appear about one year after beginning statin therapy (Graham et al., 2004).

There are a number of risk factors for the development of statin-induced rhabdomyolysis. As one might expect, the risk increases with increasing age and with the presence of kidney or liver dysfunction (Shek & Ferrill, 2001). Females and those with a low body mass index also have an increased risk for statin-induced rhabdomyolysis (Sathasivam & Lecky, 2008).

The foundation for management of rhabdomyolysis is aggressive fluid administration, which serves to dilute myoglobin in the kidneys. In most cases, normal kidney function returns following early management with IV fluids (Bagley, Yang, & Shah, 2007). Administration of sodium bicarbonate also serves to stabilize the myoglobin casts that are responsible for most of the kidney damage.

Case Resolution:

In the emergency department, the patient continued to experience episodes of an irregular heartbeat. The 12-lead ECG showed no evidence of ischemia or infarction. Cardiology diagnosed sick sinus syndrome and determined the need for a pacemaker implant.

Simultaneously, the patient's lab work revealed blood creatinine level more than 10 times the normal upper limit and a decreased creatinine clearance rate, both of which indicate kidney damage. The recent change in statin dose along with the dark urine and abnormal creatinine levels all

suggested statin-induced rhabdomyolysis. The patient received sodium bicarbonate and crystalloid fluids at 1 liter per hour. Over the next few days, the patient's blood creatinine level continued to rise.

On the 14th hospital day, the blood creatinine level began to fall and the patient received the pacemaker. She was discharged on the 22 hospital day with outpatient follow-up.

Hematologic Medications

Case Presentation

You respond to a residence for a fall. You arrive to an 80-year-old man who suffered a ground level fall on his front porch. Both the patient and the wife denied any loss of consciousness. The patient says he tripped over the dog. The patient says he has some mild pain (2/10) on his forehead where you see a small abrasion over the left eye. There is no active bleeding. His initial vital signs are

Pulse	B/P	Respiration	Temp	RASpO_2	POC Glucose	GCS
64	149/64	14	36.6°C (97.9°F)	99%	88 mg/dL	15

After the patient fell, he was able to get back to his feet and walk into his house. The patient's head to toe exam is unremarkable for trauma, except as indicated. The patient has a history of an irregular heartbeat. He takes digoxin and dabigatran (Pradaxa).

The patient does not want to go to the hospital and will call his doctor for an appointment.

Prehospital Diagnosis:

Prehospital Treatment:

Anticoagulants

Patients often refer to their anticoagulant medication as a blood thinner. These medications help to prevent the formation of blood clots in the bloodstream or heart chambers. A physician prescribed an anticoagulant for our patient because of a history of atrial fibrillation, which could lead

to the formation of small clots in the chambers of the heart. Those clots could escape, travel to the brain, and cause a stroke.

Anticoagulants work by interfering with the protein interactions necessary for clot formation. There are many proteins involved in clot formation, and different anticoagulants act on different proteins.

Most side effects of anticoagulants are related to increased bleeding. Use of these drugs result in increased bruising from even seemingly minor impact. These drugs can be especially dangerous for individuals who suffer trauma.

Case Resolution:

You are concerned about the patient's trauma to the head in light of the fact the patient takes an anticoagulant (Pradaxa) and you recognize the drug name from all the lawyer commercials on television. After some coaching, the patient agrees to go to the hospital. The transport was uneventful.

A CT scan reveals a small subdural hematoma. The patient is transferred to a neurosurgery center as a precaution. Over the next two days, repeat CT scans show no progression of the hematoma and the patient is discharged.

Psychoactive Medication

Psychoactive medications change brain functions and produces alterations in perception, mood, or consciousness. Physicians use these medications to treat a variety of psychological conditions such as anxiety, depression, psychosis, and bipolar affective disorder. Some types of psychoactive substances do not cause physical addiction; however, all have the potential to cause psychological addiction. Co-ingesting more than one type of psychoactive medication (especially alcohol) can be very dangerous.

Case Presentation

You are called to a residence where parents report finding their 20-year-old son with altered mental status. They state they came home from shopping and found the patient in his room very agitated and disoriented. The parents state the patient as a history of depression and anxiety and recently began treatment with escitalopram (Lexapro for depression), qetiapine (Seroquel for depression), and clonezapam (Klonopin for anxiety). He also has a history of cocaine use but they do not believe he had any for over a year.

The patient is non-communicative and becomes agitated when approached. With some effort, you are able to obtain a set of vital signs.

Pulse	B/P	Respiration	Temp	$RASpO_2$	POC Glucose	GCS
133	140/69	10	38.5°C (101.4°F)	93%	102 mg/dL	10

The patient's prescription bottles are all empty on the dresser, including a prescription bottle for acetaminophen/oxycodone (Percocet). There is also evidence of a powder mixed with tiny pill fragments on the dresser. There is also a small glass vial with some white powder residue visible inside.

The patient's breath sounds are shallow, but clear and equal. During chest auscultation, you notice the patient appears to have periodic and sudden twitches in the face and upper exteremities (myoclonus). There is no evidence of trauma. You note diaphoresis and the patient feels warm to the touch. The ECG shows sinus tachycardia in Lead II and there is no ectopy. During movement to the ambulance, the patient's respiratory rate gradually falls and you obtain a new set of vital signs.

Pulse	B/P	Respiration	Temp	$RASpO_2$	POC Glucose	GCS
112	109/52	8	na	88%	na	8

Prehospital Diagnosis:

Prehospital Treatment:

Selective Serotonin Reuptake Inhibitor (SSRI)

This group is the most commonly prescribed medications for the treatment of depression. The drugs can also be used for the treatment of anxiety and mood disorders. Some common members of this group include citalopram (Celexa), fluoxetine (Prozac), paroxetine (Paxil) and sertraline (Zoloft).

How do SSRIs work?

The drugs work by enhancing nerve cell function in areas of the brain that regulate emotion. Serotonin is a chemical messenger that allows nerve cells to communicate with one another in those

areas. When one nerve cell releases the chemical, the other cell will receive some, but not all of the serotonin molecules. Whatever amount is not used may be easily destroyed.

To prevent destruction of the unused portion, the cell that released the serotonin will immediately start collecting or "uptaking" the molecules floating nearby. That way, the nerve cell can use those serotonin molecules again. SSRIs work by preventing the reuptake of the serotonin from the spaces between two adjacent nerve cells. This results in an increased concentration of the chemical in that area, which helps to prevent depression.

However, if those areas accumulate too much serotonin, the nerve cells are over stimulated and the patient begins to experience problems. This is especially true when the patient takes too large a dose of SSRIs or when the patient coingests substances that work in a similar way, such as cocaine or ecstasy. This can lead to a condition called serotonin syndrome that can produce life-threatening elevations in body temperature, seizures, cardiac disturbances and unconsciousness.

Common Side Effects of SSRI Use

One of the reasons the drugs are prescribed so often for these conditions is their safety compared to other medications used for these conditions. Most patients taking the medication experience no side effects at all. However, because of the nervous system stimulation, some patients will have difficulty sleeping (insomnia). Other will experience headaches, rashes, or blurred vision.

Patient's who develop serotonin syndrome often will have alterations in mental status that can include confusion, agitation, lethargy, or even coma. The patient will almost certainly exhibit evidence of autonomic nervous system stimulation (fight-or-flight) that includes tachycardia, hyperthermia, diaphoresis, nausea, vomiting, and dilated pupils. Patients often exhibit involuntary muscle twitching.

Treatment for Serotonin Toxicity (Serotonin Syndrome)

In the acute care setting, management usually involves providing supportive therapies. When patients cannot protect their own airways, paramedics should consider pharmacologically assisted intubation. Severely hyperthermic patients must be aggressively cooled. For agitated patients, benzodiazepine therapy is preferred to the use of physical restraint. If restraint is necessary, sedate the patient as soon as you have control.

Case Resolution:

In the ED, the patient received a chest X-ray and head CT, which showed no abnormalities. He was admitted to the ICU on a ventilator. The Lexapro taken for depression inhibits the removal of

serotonin from the patient's central nervous system. Cocaine works in a similar way and the two medications combined may have produced a type of serotonin toxicity known as serotonin syndrome. Snorting a combination of crushed Percocet, Klonopin, and Seroquel further complicated the mental status changes. Within 24 hours, the patient's mental status improved and the patient was extubated. On the second hospital day, the patient was transferred to a psychiatric ward.

Antipsychotics

Antipsychotics, or neuroleptics, were initially approved for use in the treatment of schizophrenia or bipolar disorder. Increasingly, physicians prescribe these medications for the treatment of major depression, anxiety, and insomnia. Some common antipsychotics include haloperidol (Haldol), chlorpromazine (Thorazine), and thioridazine (Mellaril).

The drugs generally help to reduce confusion, delusions, hallucinations, and psychomotor agitation in psychotic patients. They do this by interfering with nerve cell conduction in the central nervous system, although the exact mechanism of action is unclear.

Side effects of these drugs depend on exactly which drug the patient uses. In general, these side effects can include tachycardia, hyperthermia, movement disorders, seizures, QT prolongation, sedation, and orthostatic hypotension.

One side effect that deserves special attention is called tardive dyskinesia, a movement disorder characterized by repetitive and involuntary movements such as lip smacking, grimacing, or tongue protrusions. This disorder responds favorably to diphenhydramine administration.

Mood Stabilizers (lithium)

Technically, the Food and Drug Administration does not have a drug classification called "mood stabilizer." This is an informal term used by the medical profession to describe medications used to treat mood disorders such as bipolar disorder. One of the most commonly prescribed medications for this disorder is lithium.

Lithium helps to stabilize the patient's mood swings to prevent extreme highs (mania) and extreme lows (depression). Although lithium acts on the central nervous system, the exact mechanism of action is unknown. The drug works best when patients maintain a therapeutic dose in their bloodstream.

Side effects associated with lithium use are common although, many are minor. Some common side effects that paramedics may see are tremors in the hands, increased thirst and urination, and gastrointestinal complaints, such as diarrhea or vomiting.

What happens when you call Poison Control?

When you call the Poison Control number (1-800-222-1222), you will speak to a Certified Specialist in Poison Information (CSPI), who is either a registered nurse or a pharmacist. After completing nursing school or pharmacy training, these individuals send an additional year of training in poison information and must complete pass a national certifying exam before being allowed to manage the number.

Before calling the number, bring the container to the phone when you call. This makes it faster and easier for the specialist to identify the potentially toxic substance and provide an appropriate response. All of the information you provide is considered confidential health information for a patient. It is not shared with people who have no need to know.

You should identify yourself, tell the specialist you are a paramedic, and the name of the agency that employs you. Give the specialist a very brief description of the situation, for example,

> *This is Art Vandelay. I am a paramedic with the Metro Fire Department. I have a kid who may have accidently taken some of his grandmother's blood pressure pills.*

At that point, the poison specialist will begin to ask you specific question in order to determine the best course of action for you to take. It may be more productive for you to collect some of this information.

One of the first questions the specialist will be about your phone number or the phone number of the patient. The information is necessary in the event the line becomes disconnected. The Poison Control Center does not publish a list of incoming phone numbers. The specialist may also ask about the patient's address and zip code. If you have not already provided it, the specialist may also ask about your relationship to the patient. Other questions may include

How old is the patient? Be specific with your response, if you can.

How much does the patient weigh? Do not guess at this information. Instead, ask the patient. For children, ask a parent.

What substance did the patient take? It is helpful to have the medication or substance container handy. The specialist may ask you spell the name of the substance. It is important to be accurate as one or two transposed letter can alter the identity of the substance.

How many pills or how much of the substance did the patient take or come into contact with? Not only is the amount important, but you should also identify the dose of the medications (23 tablets, and each one is 10 milligrams). This will help the specialist determine the total amount of the

poison. The specialist may follow with questions about the size of the container and any dilutions. For some products, you may find this information in the list of active ingredients (this is another reason why you should have the container with you).

What time did the exposure occur? You should try to pinpoint the time.

What symptoms is the patient experiencing? The specialist may start to ask specific questions to establish the severity of the situation. In some cases, symptoms the patient is NOT experiencing may be just as important as symptoms the patient IS experiencing.

What type of medical history does the patient have? Do not forget to tell the specialist if the patient has any allergies. Just as with the symptoms, the specialist may start to ask about specific medical problem (*Does the patient have a history of hypertension?*)

In rare cases, the poison control specialist may put you on hold. This may be because there are several incoming phone calls. Do not hang up. The specialist will gather preliminary information from each caller and begin providing instructions to the caller with the most serious exposure.

Clinical Pearl: One Pill Can Kill

For some drugs or chemicals, exposures to small amount can result in a potentially facial dose, especially for infants and toddlers. Do not underestimate the severity of a single pill exposure in small patients.