Critical decisions in emergency medicine

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Brainchild

External and internal stressors can quickly overwhelm a young person's ability to cope, a problem that can result in anxiety, depression, personality changes, aggression, or even hallucinations. Although emergency clinicians are frequently challenged to differentiate medical etiologies from underlying psychiatric disorders, this can be particularly difficult when assessing pediatric patients, whose normal moods can sometimes mimic potentially abnormal behavior.

High Life

Synthetic drugs of abuse are more popular and widely available than ever before; in 2017, more than half of opioid-related deaths in the US were attributed to synthetic varieties. Dangerous and hard to detect, these xenobiotics can have unpredictable physiological effects. This is especially true of synthetic cannabinoids and cathinones, which can lead to a variety of potentially dangerous symptoms, ranging from tachycardia and agitation to stroke and acute coronary syndrome.

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IN THIS ISSUE

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This educational activity consists of two lessons, a post-test, and evaluation questions; as designed, the activity should take approximately 5 hours to complete. The participant should, in order, review the learning objectives, read the lessons as published in the print or online version, and complete the online post-test (a minimum score of 75% is required) and evaluation questions. Release date March 1, 2021. Expiration date February 29, 2024.

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Brainchild

Pediatric Psychiatric Emergencies

LESSON **5**


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Reviewed by **Sharon E. Mace, MD, FACEP**

OBJECTIVES

On completion of this lesson, you should be able to:

1. Approach and stabilize pediatric patients with psychiatric emergencies.
2. Evaluate common psychiatric diagnoses.
3. Use diagnostic adjuncts available in the emergency department.
4. Administer pharmacological treatment for pediatric psychiatric patients.
5. Discuss medicolegal issues involving pediatric patients.

FROM THE EM MODEL

19.0 Procedures and Skills Integral to the Practice of Emergency Medicine

19.4.9 Psychobehavioral

CRITICAL DECISIONS

- How should pediatric psychiatric patients be evaluated in the emergency department?
- What is the best way to differentiate a medical condition from a psychiatric disorder?
- How should suicidal pediatric patients be managed?
- When are physical or chemical restraints appropriate?
- What medicolegal issues must be considered when managing pediatric psychiatric patients?

External and internal stressors can quickly overwhelm a young person's ability to cope, a problem that can result in anxiety, depression, personality changes, aggression, or even hallucinations. Although emergency clinicians are frequently challenged to differentiate medical etiologies from underlying psychiatric disorders, this can be particularly difficult when assessing pediatric patients, whose normal moods can sometimes mimic potentially abnormal behavior.

CASE PRESENTATIONS

CASE ONE

A 9-year-old boy presents via ambulance in 4-point leather restraints after an outburst in school. The teaching staff reports that after recess — where no untoward incidents were reported — the boy began banging his head against the table, resulting in a forehead bleed. When staff attempted first aid, he attacked them, scratching one teacher in the face and bending another's finger to the point of deformity.

The child was subsequently restrained and transported the emergency department, where he is now growling and spitting at the medical staff. He has a history of attention deficit hyperactivity disorder for which he takes methylphenidate. He is tachycardic and tachypneic; his blood pressure cannot be obtained.

CASE TWO

A 16-year-old girl is sent to the emergency department after disclosing to her counselor that she has thoughts of hurting herself. She was hospitalized 2 months ago after deliberately slitting her wrists. She says she was diagnosed with depression 3 years ago after her father committed suicide. The patient also confides that she been using a razor to cut herself and has been smoking marijuana daily to cope with her feelings. She reports further "spiraling" after breaking up with her boyfriend last week. Her vital signs are within normal range, and the physical examination is unremarkable.

After a discussion with the hospital psychiatrist, the emergency physician recommends admitting the girl to the psychiatric unit. However, her mother refuses and threatens to take her home, insisting the patient's suicidal thoughts are a fabricated bid for attention.

National trends demonstrate an increase (up to 5%) in emergency department visits for pediatric mental health issues.[1,2] In spite of the nationwide demand for mental health services, there is a shortage of trained pediatric psychiatry personnel and limited accessibility to mental health and community-based services. These deficiencies have forced emergency departments to meet these critical needs.

A psychiatric emergency refers to a relatively sudden situation in which there is an impending risk of harm to oneself or others. The two most common pediatric mental health emergencies are suicidality and aggression. Even when a psychiatric consultant is available, it is vital for emergency physicians to be armed with the knowledge to appropriately screen children and adolescents with mental health complaints and differentiate true psychiatric crises from behavioral issues that can be managed on an outpatient basis.

All pediatric patients should be approached in a culturally and developmentally appropriate manner with consideration for special needs or developmental delays. Unfortunately, family and social issues can further complicate the assessment, treatment, and disposition of pediatric psychiatric patients. The CDC recommends using the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) to help diagnose mental health disorders in children.

CRITICAL DECISION

How should pediatric psychiatric patients be evaluated in the emergency department?

Ensuring a safe environment for patients, their parents or guardians, and hospital staff is key (*Figure 1*). Patients must be screened for dangerous weapons prior to evaluation; typically, security personnel use metal detectors or physically search patients and their belongings. In most centers, psychiatric patients are asked to undress and are provided with hospital gowns and socks, and their belongings are kept in a secure location pending disposition. Dedicated rooms for mental health patients should be devoid of objects that can be used as weapons, including cutlery, medical tubes, electrical cords, and bandages.

A serene setting, preferably separate from the hectic environment of the main emergency department, is ideal; patients who are exposed to as little stimulus as possible are more likely to cooperate with treatment. These rooms should be easily accessible to medical and security staff, and high-risk patients must be constantly observed by sitters or continuous video monitoring. "Panic buttons" have been introduced by many hospitals to help with safety as situations warrant.

Clinicians should attempt to gain rapport with the patient, interacting in a developmentally appropriate manner and explaining the evaluation process (unless the child is uncooperative). A parent or guardian can be an invaluable resource in calming a pediatric psychiatric patient; however, they may also be a trigger. Read the room carefully and observe the interaction between children and their caregivers.

The evaluation of pediatric psychiatric patients involves obtaining a medical history, performing a physical examination, and conducting a brief but comprehensive interview of the child and their parents or guardians. Psychiatric evaluations of children and adolescents tend to take longer than those of adults, as the process typically involves additional interviews with collateral contacts.

Speaking with parents or guardians provides an opportunity to collect valuable information about a child's history, behavioral changes, potential risk factors, and any treatments that have been tried in the past. These discussions can help clarify whether the patient may be a risk to themselves or others, if there are any available resources in the community that can be used in the patient's care, and whether

the parent or guardian is willing and able to supervise the child and follow-up with recommendations.

A complete physical examination includes a mental status assessment and thorough neurologic exam. Routine lab tests have shown limited utility and are not recommended unless there is suspicion for a specific medical illness; however, some mental health facilities require lab work prior to accepting transferred patients.

CRITICAL DECISION

What is the best way to differentiate a medical condition from a psychiatric disorder?

All patients presenting with mental health complaints should be medically evaluated for possible underlying or comorbid pathologies. Clues to the possibility of an organic (medical) etiology include abnormal vital signs or physical examination findings, a history of substance abuse, and an acute change in baseline neurologic or psychiatric status. A broad range of medical illnesses can manifest psychiatric symptoms, including endocrine, neurologic, systemic, toxicologic, and metabolic conditions. Furthermore, it can be difficult to differentiate between manipulative behaviors and true psychiatric disorders when managing these cases. Pediatric patients often present with dissociative disorders, which occur most commonly in girls; sexual abuse as a common original trauma.

Psychosis

Psychosis is characterized by delusions, hallucinations, and disorganized thoughts and speech. Although it is a common manifestation of schizophrenia, psychosis can be present in other psychiatric conditions, including depression and bipolar disorder. It is also a symptom of a broad range of medical conditions, so a thorough history must be obtained to rule out life-threatening causes like hypoglycemia, hypoxia, central nervous system abnormalities, infection, endocrine and metabolic disease, lupus, medication toxicity, and drug overdose.

Acute-onset psychosis is more likely have a medical etiology than a psychiatric origin, but the presence of subacute or chronic symptoms (known psychiatric diagnosis) or a family history of mental illness should raise suspicion for the latter. Managing an acute psychotic episode due to psychiatric illness involves the administration of antipsychotic medication. In cases of chronic psychosis, inpatient management is warranted if the patient is suicidal, homicidal, or unable to sustain activities of daily living.

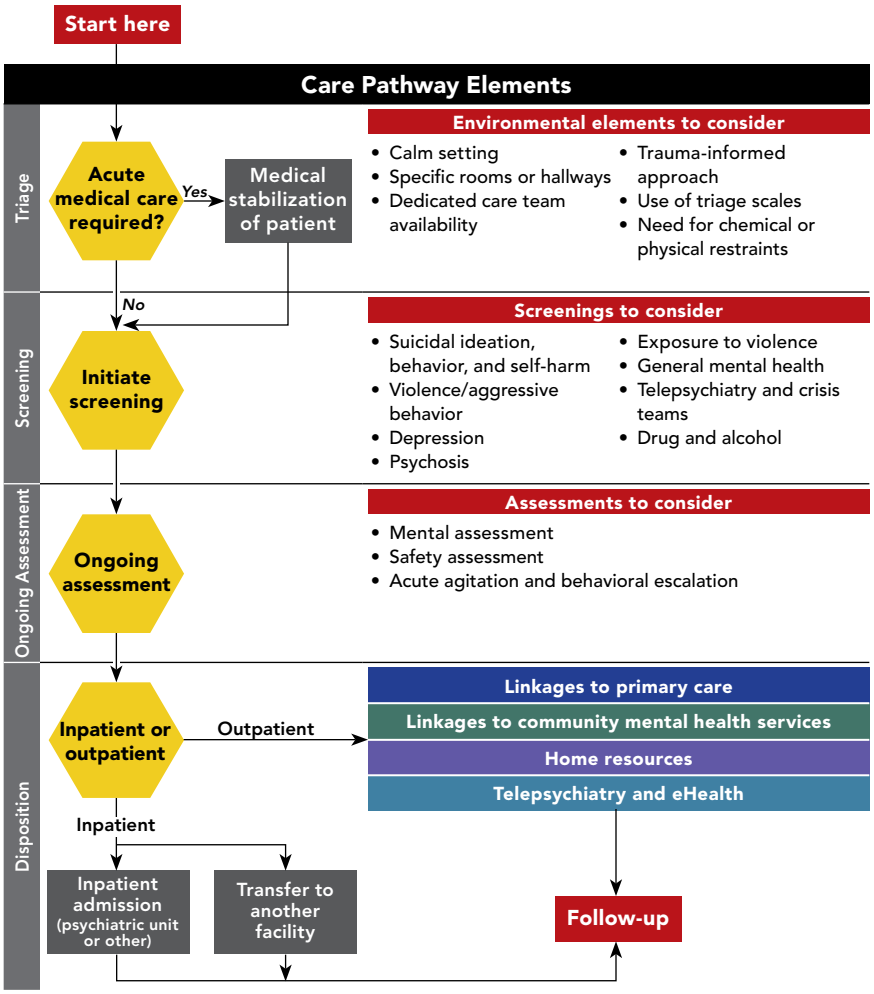
CRITICAL DECISION

How should suicidal pediatric patients be managed?

Suicide is one of the leading causes of death in the adolescent population.[3] In the emergency setting, the main objectives when managing a suicidal child are to keep the patient safe, recognize and manage any possible medical complications, and decide upon a suitable disposition. The physical examination may reveal signs of self-injury, such as cuts or ligature marks, and the presence of altered mental status warrants a toxicology screening, including ethanol measurements. An organic etiology should also be ruled out.

The greatest risk factor for suicide in an adolescent is a previous attempt. Other risk factors include a recent psychiatric admission, dysphoric mood, hopelessness, impulsive behavior, substance abuse, access to lethal means, recent stressors (eg, personal, relational, etc), homosexual or transgender identity, and a family history of suicide. A thorough medical history includes an inquiry about these risk factors, as well as further discussion about the reason

FIGURE 1. Assessing Pediatric Psychiatric Emergencies



ADAPTED FROM THE US DEPARTMENT OF HEALTH AND HUMAN SERVICES

for current suicidal thoughts and any plan of carrying out a suicide attempt.

The age and cognitive ability of the patient influences the concept of suicide. Younger children, for example, may not understand the finality of death, and some patients may not necessarily want to die but express suicidal ideation due to overwhelming sadness or hopelessness.

The emergency physician must work with mental health clinicians to arrange a disposition that is beneficial to the patient. When managing these cases, it is imperative to avoid dismissing the need for a psychiatry consultation if the patient or parent denies or downplays thoughts of suicide. Criteria for inpatient psychiatry management include a persistent desire to die, severe hopelessness, a failure to establish safety plans, a poor support system with unreliable monitoring and follow-up, and a suicide attempt using a highly lethal means.

Low-risk children and adolescents who have appropriate supervision at home and adequate access to mental health care may be managed on an outpatient basis. Although safety contracts are sometimes employed, their usefulness is debatable. If the patient is to be discharged home, a discussion must be had with caregivers regarding restricting their means to self-harm (eg, limiting access to potentially dangerous instruments like knives, firearms, and medications).

CRITICAL DECISION

When are physical or chemical restraints appropriate?

Agitation or violent behavior may be the result of a medical, toxicological, or psychiatric condition — or a combination of any. It is important to ascertain the etiology of each patient's symptoms to inform the management strategy. Manifestations of agitation may range from restlessness or verbal assaults to the destruction of property, self-harm, or physical violence. Identified triggers amenable to intervention (eg, the presence of a specific family member) should be addressed. The goals of managing an agitated child include ensuring the safety of everyone involved, helping the patient manage their emotions, averting physical or chemical restraints whenever possible, and avoiding interventions that might increase agitation.[4]

When an acutely agitated patient is at risk of harming themselves or others, the use of restraints may be necessary. Verbal restraints and de-escalation should be attempted first: Patients should be approached in a reassuring, nonhostile manner, and the physician should stay more than an arm's length away to avoid harm and appear less threatening. While giving patients some autonomy helps with cooperation, it is necessary to set limits in a firm but respectful tone and avoid bargaining.

TABLE 1. Pediatric Chemical Restraint Medications

Medication	Initial Dose
Haloperidol	0.05–0.15 mg/kg Teen: 2–5mg
Lorazepam	0.05–0.1 mg/kg Teen: 2–4 mg
Midazolam	0.05–0.15 mg/kg Teen: 2–4mg
Olanzapine	<12 years: 2.5 mg Teen: 5–10 mg
Diphenhydramine	1.25 mg/kg Teen: 50 mg
Risperidone (oral)	<12 years: 0.5 mg Teen: 1 mg
Ziprasidone	<12 years: 5 mg Teen: 10–20 mg
Aripiprazole	<12 years: 1–2 mg Teen: 2–5 mg

Chemical Restraints

If this fails, the next step typically involves the use of medications (chemical restraints), including antipsychotic agents, benzodiazepines, or a combination of both (*Table 1*). Patients already taking any of these medications should be given their usual or an increased dose of the same drug. All cooperative patients should be given the option to take the medication orally.

Keep in mind the respective adverse effects of these medications: first-generation antipsychotics (haloperidol) and second-generation antipsychotics (olanzapine, risperidone, and ziprasidone) can cause cardiac arrhythmias, hypoventilation, CNS depression, and extrapyramidal symptoms. Neuroleptic malignant syndrome. a rare adverse effect of antipsychotic agents, is characterized by fever and muscle rigidity. Benzodiazepines can cause respiratory depression, and paradoxical reactions can occur between benzodiazepines and antihistamines.

Physical Restraints

Physical restraints can result in both physical and psychological harm. Such tools are only indicated in cases of severe disruptiveness with an impending risk of harm — and only after other, less-restrictive de-escalation measures have failed. The Joint Commission and the Centers for Medicare and Medicaid Services have both developed guidelines and regulations regarding the use of physical restraints.[5,6] Notable safety considerations include involving enough personnel to immobilize the patient, using safe restraint material, securing

Pearls

- A parent or guardian can be an invaluable resource for calming a pediatric psychiatric patient; however, they may also be a trigger. Read the room carefully, and observe the interaction between the patient and guardian.
- Pediatric patients often present with dissociative disorders, which occur most commonly in girls who have suffered sexual abuse.
- Work to gain rapport with the child or adolescent, interacting in a developmentally appropriate manner while explaining the evaluation process.

CASE RESOLUTIONS

CASE ONE

The restrained boy received a dose of midazolam; within 30 minutes, he was calm. The restraints were promptly removed, and he was placed under continuous observation. Head CT was negative for any acute intracranial process, and his blood work was clinically insignificant.

The patient said that he began banging his head after "a voice" told him he was "stupid and bad." He further explained that the school staff's attempt to administer first aid had angered and frustrated him.

The patient had not previously shared anything about hearing voices with his family, who expressed great concern. He was admitted to the inpatient psychiatric unit for further treatment and assessment.

CASE TWO

The teenage girl was determined to be at a particularly high risk of self-harm based on her previous suicide attempt and family history. Concerned about the patient's welfare and her mother's refusal to allow inpatient treatment, the emergency physician reported the case to Child Protective Services.

After several long conversations with the emergency clinician and case worker, the mother acquiesced. The girl was admitted to the psychiatry unit, where she received a comprehensive evaluation and long-term treatment plan.

restraints to the bed frame to avoid falls, and reducing the risk of aspiration by placing the patient in a supine position. Pillows should be avoided to avoid the risk of suffocation. The medical team should include at least five members, including a designated leader who can explain the process to the patient in clear language. It is crucial to continuously monitor patients in chemical or physical restraints for the development of possible side effects.

CRITICAL DECISION

What medicolegal issues must be considered when managing pediatric psychiatric patients?

Consent to treat should be obtained prior to the initial evaluation. Unless the patient has a life-threatening condition requiring medical stabilization, waived consent is not applicable. Consent is typically obtained from a parent or guardian; however, some states do allow children to provide consent for mental health treatment without the involvement of a legal custodian. In some instances, a patient may meet the criteria for psychiatric hospitalization despite the objection of their patients or guardians. The laws on involuntary hospitalization vary from state to state, thus familiarity with state laws is prudent.

Attention should be paid to the interaction between the patient and their parents or guardians, and a report must be made to the appropriate authorities whenever child abuse or neglect is suspected or witnessed. Furthermore, if a parent or guardian refuses treatment for a child who is in imminent danger, Child Protective Services must be consulted. As mandated reporters, it is important that physicians understand how to recognize child abuse and make comprehensive, accurate reports in a timely manner. Similarly, if it is determined that a patient poses a danger to another individual, the clinician is obligated to warn the intended victim against violence.

Pitfalls

- Dismissing the need for psychiatry consultation if the patient denies or downplays thoughts of suicide.
- Neglecting to consider organic causes of mental status changes.
- Failing to attempt low-risk de-escalation measures before implementing chemical or physical restraints.

Summary

The rate of emergency department cases for pediatric mental health complaints has significantly increased, and the evaluation of these patients can be taxing. Nevertheless, it is imperative for emergency physicians to be adept in conducting basic interviews and pursuing the best level of care. The acute evaluation of pediatric psychiatric patients incorporates triage and medical clearance, observance of safety measures, a thorough medical history, involvement of the family and caregivers, a mental health consultation, and disposition planning. It is crucial that final treatment plans include input and approval from members of the hospital's psychiatry team prior to discharge.

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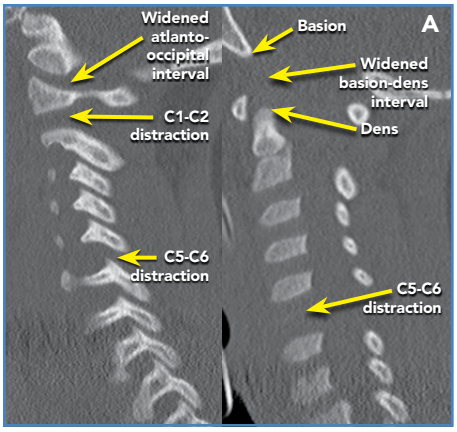
The Critical Image

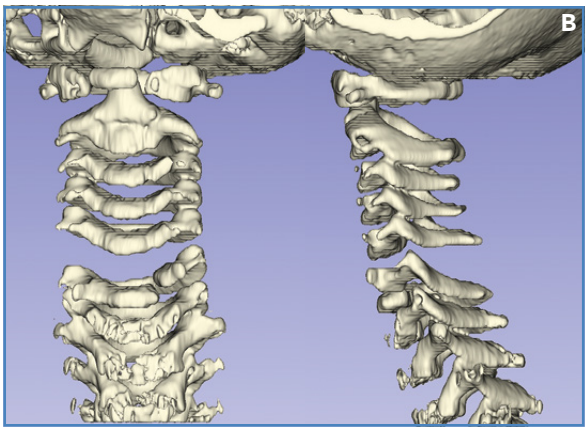
By **Joshua S. Broder, MD, FACEP**
Dr. Broder is a professor and the residency program director in the Division of Emergency Medicine at Duke University Medical Center in Durham, North Carolina.
Case contributor: **John Hoff, MD**

A 12-kg girl (estimated age, 1 year) presents via ambulance following a high-speed, head-on motor vehicle collision. EMS found the child restrained in a rear-row infant seat; she was pulseless and asystolic, and CPR was initiated. Paramedics placed a supraglottic airway and tibial intraosseous catheter and achieved return of spontaneous circulation before transport.

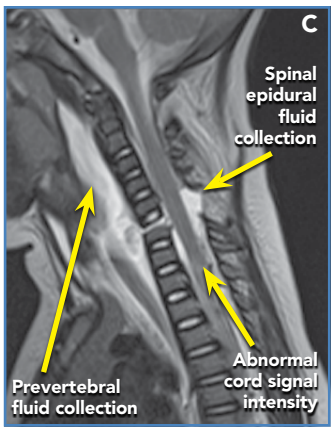
On arrival, the infant's vital signs are blood pressure 107/65, heart rate 114, respiratory rate 28 via bag-valve-mask, temperature 37°C (98.6°F), and SpO_2 97% on 100% FiO_2. No visible or palpable traumatic findings are found on the physical exam, but the patient is neurologically unresponsive and apneic. Her supraglottic airway is replaced with an endotracheal tube. Axial CT images reveal no injuries, and she is transferred to the pediatric ICU.



A. Sagittal CT reconstruction demonstrating a multilevel distraction injury of the cervical spine. Axial images alone (not shown) missed the injury, which is evident only as an unexpectedly large interval between bony structures. In addition to a widened C5-C6 intervertebral space, the distances between the occipital condyles and atlas (C1) and the basion (anterior aspect of the foramen magnum) and dens are increased.



B. 3D CT reconstructions viewed from anterior and lateral perspectives demonstrate a distraction injury at the C5-C6 level.



C. T2-weighted MRI demonstrating distraction of the vertebral bodies at C5-C6 and an associated spinal cord injury with an increased T2 signal within the cord. The large prevertebral and epidural fluid collections are additional clues to the spinal injury.

KEY POINTS

- Pediatric cervical spine injuries are rare (0.66%-0.98%), and injuries in young children and infants are even rarer (0.1% in patients <9 years).[1,2]
- The ACR Appropriateness Criteria rate plain radiography as usually appropriate and CT as usually ***inappropriate*** as the initial imaging modality for children younger than 3 years who meet high-risk criteria for cervical spine trauma.[3] However, in cases of polytrauma with abnormal neurologic status, CT is the pragmatic choice because of its ability to rapidly assess for multi-system trauma. When performed, multiple CT planes should be reviewed to enable the detection of subluxation and distraction injuries.
- While attention should be directed to common areas of injury, subtle clues like increased intervals between bony landmarks and increased prevertebral soft-tissue distances may reveal subtle and rare injuries. The basion-dens interval (distance between the tip of the dens of C2 and the basion, or anterior-most midline point of the foramen magnum) is increased in atlanto-occipital injuries. The normal value on CT is reported to be below 8.5 mm in adults; in the patient above, the value was 11 mm.[4] The normal atlanto-occipital interval is less than 1.4 mm in adults and varies in children, with a value less than 1.7 mm in children under 12 months of age.[5] In this patient, it was 2.8 mm.

CASE RESOLUTION

The patient remained neurologically unresponsive. Brain death criteria were met, and she died after life support was withdrawn.

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The Critical Procedure

Ultrasound-Guided Serratus Anterior Plane Block

By **Lauren Karsh, MD**
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Reviewed by **Steven J. Warrington, MD, MEd**

The effective management of pain associated with acute chest wall pathologies, such as rib fractures, postoperative conditions, and herpes zoster, is vital for patient comfort. A serratus anterior plane block with ultrasound guidance provides optimal analgesia for localized pain control in the emergency department.

Contraindications

- Overlying infection
- Allergy to the anesthetic

Benefits and Risks

Serratus anterior plane blocks provide both localized and prolonged analgesia (when used continuously); this approach is an ideal alternative or adjunct to systemic narcotic analgesia. Additionally, the procedure may provide relief when traditional regimens have failed, as in patients with intractable herpes zoster pain. The technique can be used in both children and adults.

In addition to the potential complications associated with the anesthetic used, risks of the technique include pneumothorax, hematoma formation, infection, inadvertent intravascular injection, nerve injury, and procedure failure.

Alternatives

Alternative approaches include erector spinae plane, paravertebral, and intercostal blocks. Consider the location of the injury when determining which procedure would be most effective to help control the patient's symptoms. Clinicans may also consider placing a catheter to provide a continuous infusion of medication, but this approach is generally used for ongoing management in collaboration with other departments (eg, anesthesia). Other alternatives include systemic and topical medications.

Special Considerations

Ultrasound guidance may reduce the risk of complications like pneumothorax and vascular injury. Potential risks may be mitigated by closely monitoring the patient's breathing and movement when manipulating the needle. Discomfort during the procedure can be reduced by warming or buffering the anesthetic; topical or superficial anesthesia should be considered prior to the procedure.

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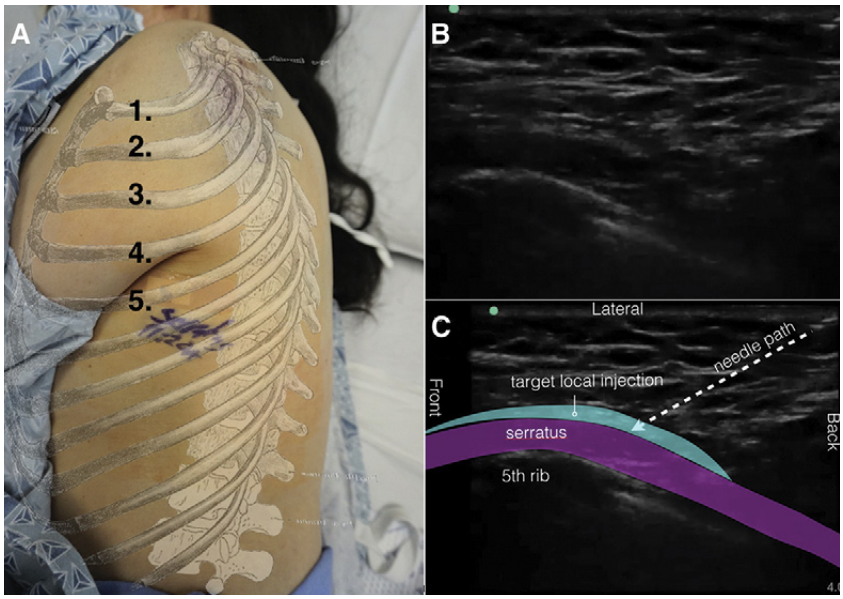
TECHNIQUE



1. **Place** the patient in either the supine position (with the arm on the affected side raised) or lateral decubitus position (with the arm out of the way) (*Figure A*).
2. **Identify** the planned injection site using a linear high-frequency ultrasound transducer in the sagittal position at the midaxillary line (*Figure B*). Slowly move the transducer posteriorly to identify the latissimus dorsi and serratus anterior muscles and the fascial plane.
3. **Prepare** the site after identifying the pertinent structures.
4. **Introduce** and advance the needle until it is underneath the fascial plane (*Figure C*). Carefully aspirate and inject a small amount of solution under real-time ultrasound, using hydrodissection to confirm the position of the needle tip.
5. **Inject** the anesthetic solution slowly, readjusting the location of the needle tip if necessary.
6. **Remove** the needle and apply dressing to the site; consider applying an ice pack as well.

Critical Pediatrics

Primary Spontaneous Pneumothorax

By **David Foster, MD, MS**
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Reviewed by Sharon E. Mace, MD, FACEPH

An otherwise healthy 16-year-old boy presents with sudden-onset chest pain and shortness of breath. He describes 5 hours of constant, mild "stabbing" pain in his left chest, which began while he was getting dressed and is worse with deep inspiration. Breath sounds are present on examination but are decreased in the left chest compared to the right. His vital signs are blood pressure 110/75, heart rate 110, respiratory rate 24, temperature 37°C (98.6°F), and SpO_2 97% on room air. He has no other symptoms, and his vaccinations are up to date. He denies smoking, alcohol or drug use, and sexual activity. His parents are healthy with no history of connective tissue disorders or pulmonary disease.

The emergency physician orders upright periapical and lateral x-rays of the patient's chest, which reveal a moderate-sized pneumothorax of the left lung (*Figure 1*).

Case Discussion

A spontaneous pneumothorax occurs without an inciting event like trauma or an iatrogenic complication. Spontaneous pneumothoraces can be subdivided based on the presence of underlying pulmonary disease. Primary spontaneous pneumothoraces (PSPs) occur in the absence of pulmonary disease, whereas secondary spontaneous pneumothoraces (SSPs) are associated with underlying lung conditions like asthma, pneumonia, cystic fibrosis, and connective tissue disorders. For example, vaping is associated with PSP, and status asthmaticus is associated with SSP.

Pathophysiology

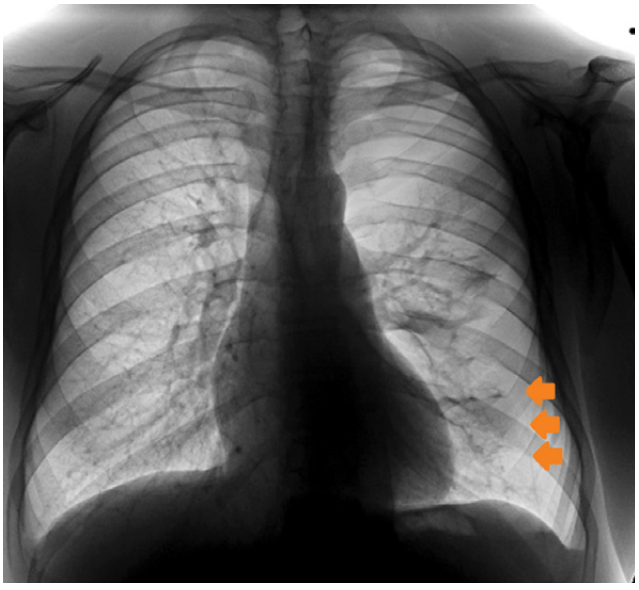
Alveolar rupture can cause air to enter the pleural space and lead to lung collapse. Increased alveolar and transpulmonary pressures are the basis for alveolar rupture in patients with PSP. Underlying pulmonary disease leading to weakness and the disruption of visceral pleural is associated with gas leaking into the pleural space in children with SSP. PSP is two to four times more common in males than females, with an annual incidence of 4 per 100,000 children.

Complications

Tension pneumothorax is a life-threatening complication of PSP and SSP in which increasing positing pressure in the pleural space compromises the patient's cardiopulmonary function. Initial signs of the disorder include hypotension, tachycardia, jugular venous distension, and tracheal deviation away from the pneumothorax side. Immediate decompression of the pneumothorax is a critical action to precent cardiovascular collapse and death.

FIGURE 1. Left-Sided Pneumothorax, Moderately Sized

FIGURE 2. Pleural Line (Orange Arrows)



Diagnosis

Pneumothorax is both a clinical and radiographic diagnosis. The presentation of sudden-onset pleuritic chest pain, dyspnea, or abnormal vital signs should prompt further investigation. Clinical context, associated symptoms, and underlying disease help prompt the evaluation for SSP. Patients with signs and symptoms of a tension pneumothorax warrant immediate treatment, often before imaging studies are obtained.

Plain chest radiographs are the imaging modality of choice for diagnosing pneumothorax. In such cases, a thin pleural line can typically be observed (*Figure 2*). In addition, there will be an absence of lung marking between the pleural line and the chest wall. Ultrasound (US) has a sensitivity of 94% and a specificity of 100% for diagnosing pneumothorax. Diagnostic findings include the absence of lung sliding and presence of a lung point.

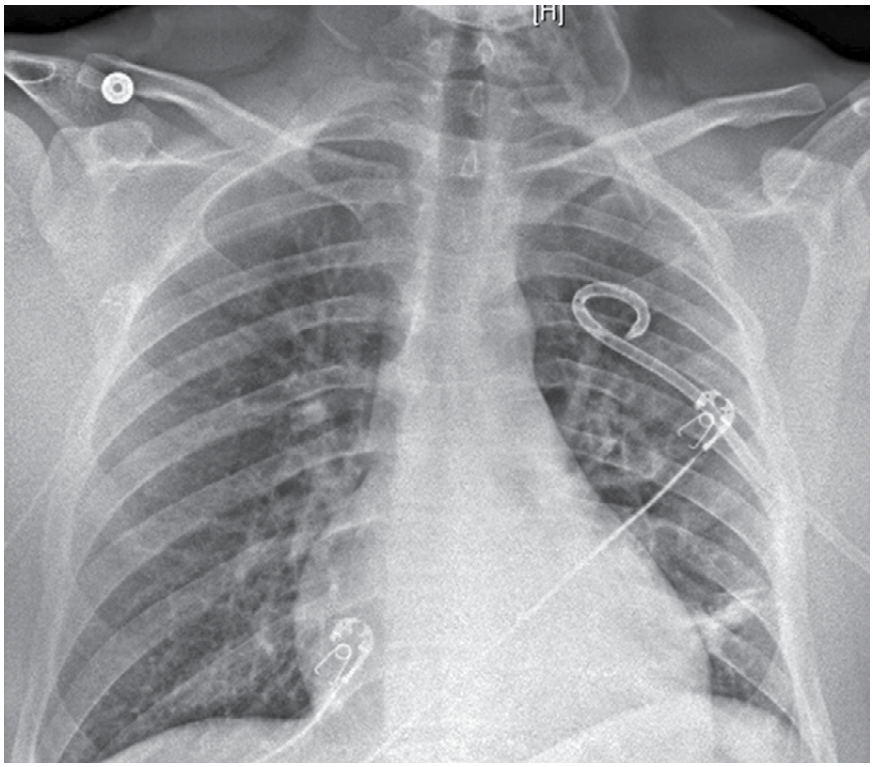
Chest CT is extremely sensitive and specific for diagnosing and evaluating the size of a pneumothorax. However, the exposure to ionizing radiation and detection of radiographically present but clinically insignificant diagnoses should factor into imaging decisions. Laboratory studies are generally unhelpful for diagnosing pneumothorax.

Management

There is no standardized policy for managing pneumothorax in pediatric patients. Many treatment strategies are adapted from the adult literature and policy guidelines. Factors that guide management include the size of the pneumothorax, stability of the patient, any associated conditions, and presence of an underlying pathology. Success is defined as positive lung re-expansion. Secondary outcomes of success can be measured by hospital admission and length of stay, future recurrence, and ultimate need for surgical intervention.

The least-invasive treatment for a clinically stable pediatric patient with a small or moderately sized pneumothorax is oxygen therapy. Oxygen is often administered via a nonrebreather mask and is thought to increase the reabsorption of air in the pleural space. Oxygen therapy should be paired with observation and monitoring, and repeat radiographs should be obtained after 6 to 12 hours.

FIGURE 3. Left-Sided Pigtail Catheter



Invasive treatment for pneumothorax is a continuum that begins with needle aspiration and includes small pigtail catheter insertion, larger thoracostomy (chest) tube insertion, and finally surgical intervention.

Chest tube insertion, either with a small pigtail catheter (*Figure 3*) or larger thoracostomy tube, allows for prolonged active suction and continuous monitoring for air leaks. If no air leak is found after 12 hours of continuous low suction or water seal and the patient is stable with improved lung expansion on repeat radiographs, the chest tube can be clamped and turned off. Additional observation for continued stability and no signs of complications or re-expansion should be performed prior to chest tube removal and discharge.

Surgical intervention includes pleurodesis, video-assisted thoracoscopic surgery, and open thoracotomy; the need for these treatments is determined by surgery, the patient's history and presentation, and the success or failure of other treatment modalities.

CASE RESOLUTION

A pigtail catheter was inserted into the patient's left chest, and he was admitted for close monitoring and repeat imaging. The catheter was transitioned from suction to water seal after 12 hours and removed after 24 hours, as repeat radiographs showed complete resolution of the pneumothorax.

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Critical Cases in Orthopedics and Trauma

Sternoclavicular Joint Dislocation

By Jeremy Riekena, MD; and Victor Huang, MD, CAQ-SM
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Reviewed by John Kiel, DO, MPH

A 23-year-old woman presents with right shoulder pain. She explains that she fell onto the affected shoulder while playing soccer and has taken ibuprofen for pain with minimal relief. A physical examination reveals tenderness over the medial aspect of her right clavicle. Her vital signs are stable, and her respiratory, cardiovascular, and neurological exams are normal.

The sternoclavicular (SC) joint is the only joint that directly articulates between the upper extremities and torso. This saddle-type structure has inherent stability and flexibility due to its articulating surfaces and four ligamentous attachments: the anterior and posterior SC ligaments, interclavicular ligament, and costoclavicular ligament.[1]

SC joint dislocations are rare, comprising less than 1% of all dislocations and 3% of shoulder girdle injuries. Injuries to the joint can be categorized as sprains (grade I), subluxations (grade II), and dislocations (grade III).[2] Anterior SC joint dislocations are the most common of these injuries and can be caused by lateral compression of the anterolateral shoulder with force transmitted medially.[2] Posterior SC dislocations represent about 10% of SC dislocations and may occur from direct force to the medial clavicle or posterolateral compression of the shoulder.[3]

The associated risk of injury to the subclavian vasculature, trachea, esophagus, and brachial plexus makes posterior dislocations a true orthopedic emergency. As many as 30% of posterior dislocations are associated with a life-threatening concomitant complication, and 3% to 4% of these cases result in death.[2,3]

Presentation

Patients with SC dislocations commonly present after a traumatic event with complaints of chest or shoulder pain that is exacerbated when supine and with arm movement.[4,5] It is critical to perform thorough neurovascular, pulmonary, cardiac, and GI exams to assess for trauma to underlying structures.

In such cases, the SC joint demonstrates localized swelling with tenderness; pain may be worsened with glenohumeral or scapulothoracic movement. An anterior dislocation is evidenced by a prominent, anteriorly displaced medial clavicle, while a posterior dislocation demonstrates a depressed medial clavicle relative to the sternum.[2] Posterior dislocations are more subtle and may be missed without a high index of suspicion and thorough evaluation. Diagnostic imaging is recommended, as the physical exam may be hindered by a delayed presentation.[6]

FIGURE 1. Axial CT, Posterior Dislocation of the Right SC Joint

Imaging

Due to overlying bony structures and soft tissues, standard radiographs of the shoulder and clavicle may be inadequate for evaluating the SC joint; notably, the serendipity view, which is taken with a 40° cephalic tilt, can be used to perform a more thorough assessment.[4] X-ray findings may demonstrate widening of the SC joint space and displacement of the affected clavicle above or below the contralateral clavicle. Chest x-rays can be useful when evaluating for associated hemo- and pneumothorax.

Bedside ultrasound can help expedite diagnosis and treatment. By comparing the contralateral side, ultrasonography may demonstrate the direction of the injury and reveal a posterior dislocation that would be difficult to detect based on physical findings alone.

The ability of CT to illuminate the relationship between the sternum and clavicle makes it the gold standard for assessing suspected SC joint and associated thoracic injuries.[5] CT angiography has the added advantage of identifying vascular injuries associated with posterior dislocations.[6]

FIGURE 2. AP View of the Right Clavicle

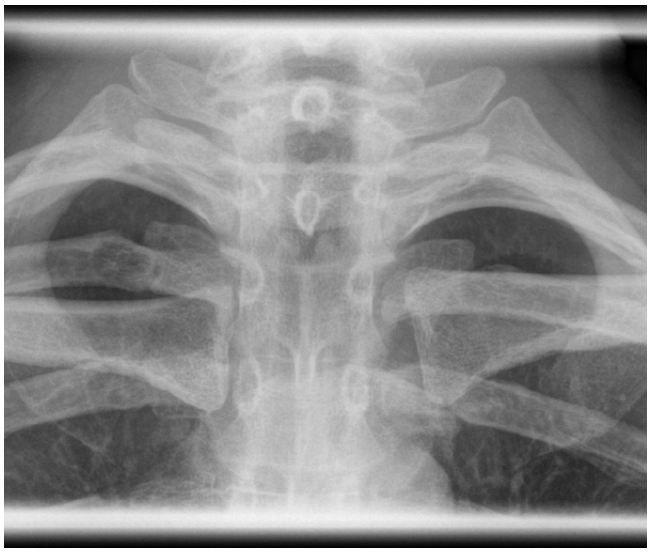
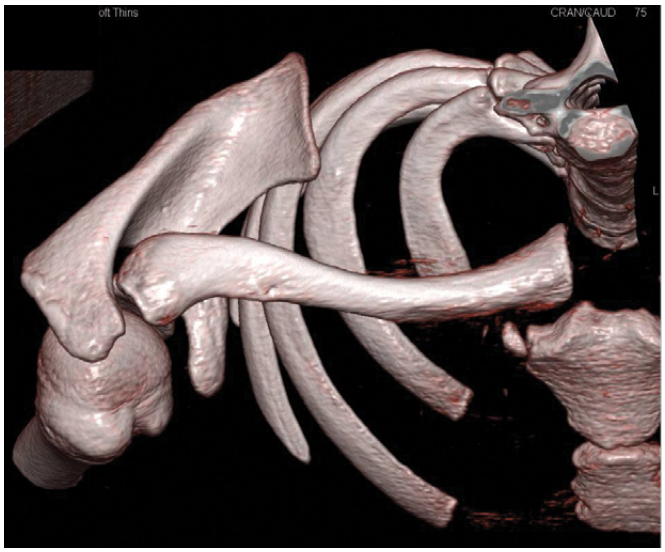


FIGURE 3. 3D CT, Posterior Dislocation/Right SC Joint



Anterior Dislocation

Grade I and II anterior dislocations are not typically associated with significant morbidity, and patients can routinely be discharged without complications. These injuries are sufficiently treated with analgesia, rest, immobilization with a sling or figure-of-eight splint, and outpatient orthopedic follow-up.[2,5]

An orthopedic surgeon should be consulted about patients with grade III anterior dislocations.[5] Closed reduction in the emergency department or operating room (OR) may be required for these cases and can be performed within 7 to 10 days of the inciting event. To perform the reduction, the patient should be placed in the supine position with a sandbag or rolled-up towel between their scapulae. The affected arm should be abducted to 90˚ and extended to 15˚ with inline traction applied. Additional anterior-to-posterior pressure may need to be applied to the medial clavicle.[2,6]

Reduced joints should be stabilized with a figure-of-eight brace, sling support, or a Velpeau bandage.[5,6] Return precautions and appropriate follow-up should be clearly explained to the patient, as up to 50% of these injuries re-dislocate. Pain typically resolves within 2 to 3 weeks, and most patients can return to full physical activity after 3 months.[3,5]

Posterior Dislocation

Indications for the emergent closed reduction of a posterior dislocation include airway obstruction, stridor, labored breathing, dysphagia, and neurovascular compromise.[2,6] Orthopedic surgery should be consulted regarding closed vs open reduction in the OR. Thoracic and vascular surgery should also be made available, as reduction can damage the surrounding neurovascular and aerodigestive structures.[5] When performing a closed reduction, there are several techniques to consider:

- **Classic:** The affected arm is abducted and extended with inline traction, and anterior traction is applied to the medial clavicle.[2]
- **Towel clip:** If the classic technique is unsuccessful, the skin over the clavicle should be prepared under sterile conditions. Using a metal towel clip, the medial clavicle is grasped percutaneously and placed in anterolateral traction.[2,6]
- **Buckerfield and Castle:** The ipsilateral arm is adducted with caudal traction while an assistant places posterior pressure on the bilateral shoulders.[3]

All patients with posterior SC dislocations should be admitted for operative management and kept for observation, as vascular injuries may occur after reduction.[7]

CASE RESOLUTION

X-rays revealed that the patient's right clavicle was inferior to the left clavicle, and CT angiography confirmed a posterior SC dislocation without associated intrathoracic injuries. Orthopedic and vascular surgery were consulted, and she was admitted for open reduction and internal fixation. The procedure was successful, and the patient was discharged after an observation period with clavicular splinting and orthopedic follow-up.

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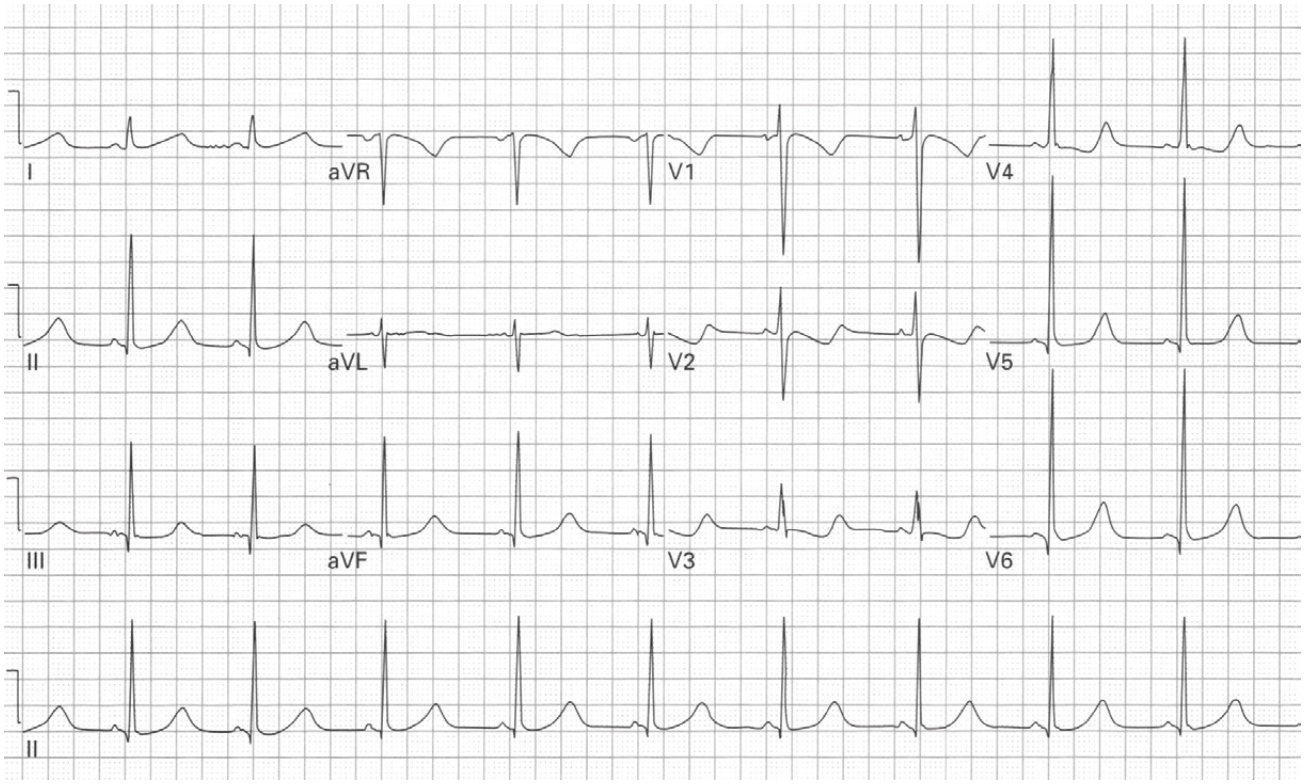

A 20-year-old pregnant woman with 12 hours of persistent nausea and vomiting.

The Critical ECG

Sinus rhythm, rate 60, T-wave abnormality suggestive of hypokalemia. ECG findings typically associated with hypokalemia include U waves, ventricular ectopy, ST-segment depression, and T-wave flattening. In the author's experience, moderate-to-severe hypokalemia often induces an unusual biphasic T-wave appearance in the mid-precordial leads as noted in this example. The ST segment sags downward, often producing frank ST-segment depression, then rises into an upright T wave with a slightly prolonged overall QT interval.

It may be that this upright T wave is actually a U wave following an inverted T wave. Regardless, this biphasic complex is characteristic of hypokalemia and resolves with appropriate treatment. This patient's serum potassium level was 2.9 mEq/L (normal 3.5-5.3 mEq/L). The biphasic T wave of hypokalemia should not be confused with the biphasic T wave found in Wellen syndrome, in which the initial portion of the T wave rises and the terminal portion inverts. Essentially, they are mirror images of each other.

By Amal Mattu, MD, FACEP

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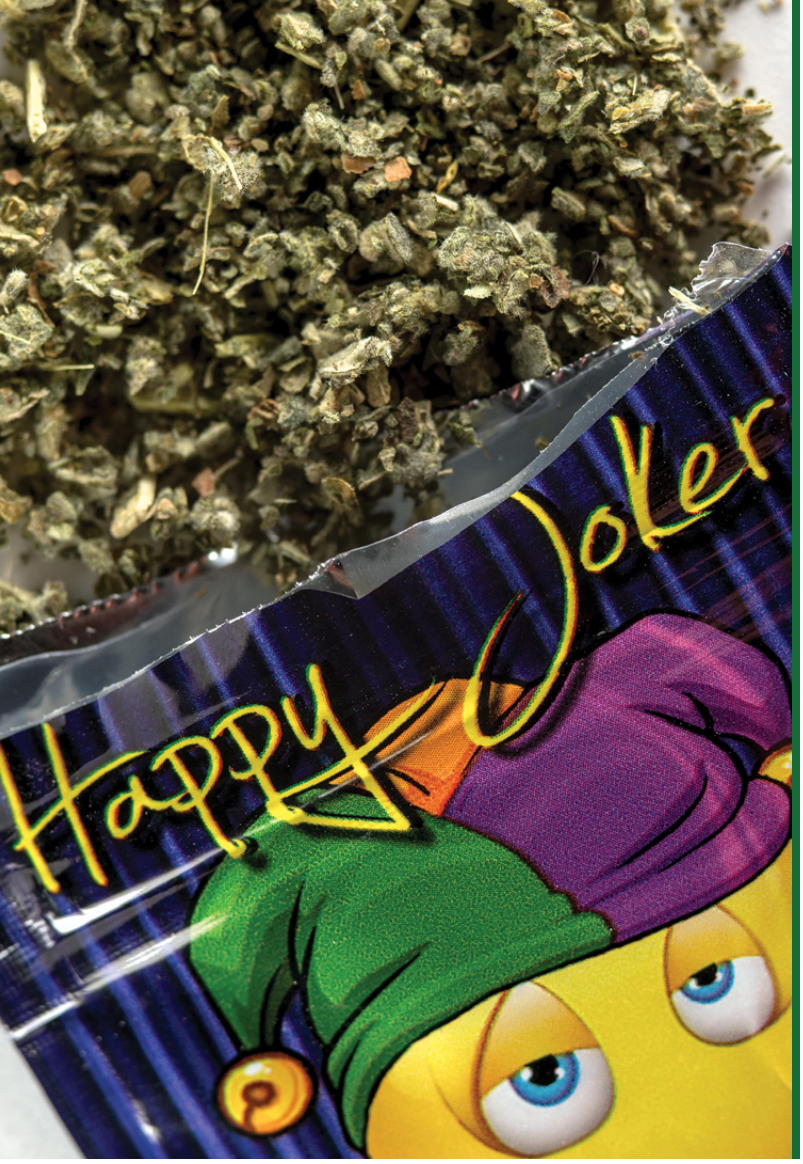
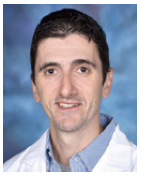
From **Mattu A, Brady W.** *ECGs for the Emergency Physician 2.* BMJ Publishing; 2008. Reprinted with permission.



High Life

Synthetic Drugs of Abuse

LESSON 6


By **Aaron Trautmann, DO; Bradford E Schwartz, MD;** and **Anthony J. Hackett, DO, FAAEM, FACEP**

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Reviewed by **George Sternbach, MD, FACEP**

OBJECTIVES

On completion of this lesson, you should be able to:

1. Identify two common classes of synthetic drugs of abuse.
2. Identify the common physiologic effects of each of these drug classes.
3. Identify the warning signs and symptoms of patients suffering the effects of synthetic drugs of abuse.
4. Discuss the management of synthetic drugs of abuse.
5. Describe treatment resources for patients suffering from drug dependency.

FROM THE EM MODEL

17.0 Toxicologic disorders

17.1.24 Recreational drugs

CRITICAL DECISIONS

- What unique dangers are posed by synthetic cannabinoids?
- How should a patient who has abused SCs be assessed?
- What treatments should be employed for patients who have ingested SCs?
- What unique dangers are posed by synthetic cathinones?
- How should synthetic cathinone ingestions be evaluated and managed?

Synthetic drugs of abuse are more popular and widely available than ever before; in 2017, more than half of opioid-related deaths in the US were attributed to synthetic varieties.[1] Dangerous and hard to detect, these xenobiotics can have unpredictable physiological effects. This is especially true of synthetic cannabinoids and cathinones, which can lead to a variety of potentially dangerous symptoms, ranging from tachycardia and agitation to stroke and acute coronary syndrome.

CASE PRESENTATIONS

CASE ONE

A 48-year-old woman arrives via ambulance with agitation and altered mental status (AMS). A neighbor called 911 after seeing her pounding on car windows in the parking lot of her apartment complex while screaming incoherently about being "chased by cats." EMS notes finding "incense paraphernalia" at the scene.

Once the patient has been chemically and physically restrained, her vital signs are obtained: blood pressure 150/90, heart rate 150, respiratory rate 25, and SpO_2 98% on room air. She has prominent bruising over both wrists and ankles from the restraints and seems to have bitten her tongue in the struggle, as evidenced by profuse bleeding from her mouth.

CASE TWO

A 24-year-old man presents via ambulance as a "danger to the public." He is agitated, hallucinating, and acting erratically. Paramedics were called to the scene after a bystander found him wandering down the middle of the highway naked, covered in blood, and waving a knife. When EMS and police arrived on scene, the patient refused to follow police orders and was tased. Paramedics were able to administer 5 mg of droperidol and 5 mg of midazolam intramuscularly, and the patient was transferred to the stretcher, where physical restraints were placed.

Upon arrival, he is appropriately sedated and maintaining his airway. Intravenous (IV) access is established, and the patient is placed on a cardiac monitor. He is tachycardic with vital signs that include blood pressure 180/90, respiratory rate 145, rectal temperature 39.4°C (103°F), and SpO_2 98%. The physical exam is significant for lacerations and dried blood across his forearms and thighs.

CRITICAL DECISION

What unique dangers are posed by synthetic cannabinoids?

Synthetic cannabinoids (SCs) generate much more potent effects than their natural counterparts. These exacerbated reactions are often attributed to the direct binding of CB1 (central cannabinoid) and CB2 (peripheral cannabinoid) receptors, which have 5 and 10 times the binding affinity, respectively, of marijuana.[1] By slightly altering the chemical structure of the SC compound, clandestine chemists have generated a range of similar chemicals that can enumerate a variety of different clinical symptoms.

Many users believe SCs (or "synthetic marijuana") produce a legal high, as these substances are often packaged, rebranded, and sold as nonillicit items like incense. Additionally, the constantly evolving chemical structure of these compounds makes it difficult for them to be identified by urine drug screening assays, thus providing users a way to avoid detection.[2]

Since initially hitting the market as "spice" in the UK and Europe and "K2" in the US, the popularity of SCs has exploded. Although JWH-018 was the first compound to be widely abused, it was quickly outlawed after being discovered by German authorities. Much to the dismay of law enforcement, another variant (JWH-073) rapidly took its place. The subsequent development of second- and third-generation SCs, such as AM-2201 and XLR-11, soon followed. Most recently, fourth-generation "indazole" SCs have emerged. These agents use an indazole ring containing a fused benzene and pyrene ring — a modification of the indole backbone found in earlier generations.[3]

Largely due to the variety of chemical compounds that can be synthesized and the quandary it creates for law enforcement, SC variants have become particularly difficult to track and criminalize. In July of 2012, the federal government took stricter measures to outlaw SC use by passing the Synthetic Drug Abuse Prevention Act, which permanently placed 26 synthetic cannabinoids and cathinones into Schedule I of the Controlled Substances Act.

Often marketed as incense or potpourri and labeled "not for human consumption," SCs can commonly be found in head shops and gas stations (*Figure 1*). The burgeoning problem of these substances is evidenced by increased calls to the poison center: In 2015, the number of these calls related to SCs over a period of three months was four times that of *all* calls placed to poison control in 2014.

CRITICAL DECISION

How should a patient who has abused SCs be assessed?

The effects of SCs differ from those of naturally occurring marijuana. While marijuana use typically causes tachycardia, conjunctival irritation, and sometimes slurred speech, the effects of SCs can be more alarming and variable (*Table 1*). Patients who have used SCs may present with severe mood changes (eg, euphoria, anxiety, agitation), cognition changes (eg, psychosis, delusions, confusion), and physiologic effects (eg, tachycardia, hypertension, vomiting, and seizures).[4]

Small modifications in the chemical structure of the cannabinoid during synthesis can produce drastic differences in its clinical effects; for example, while one package of "spice" may produce agitation, delirium, and tachycardia, another may cause lethargy and vomiting.[5] Two users smoking from the same package may even experience different clinical effects. The production of SCs involves dissolving the substance in a solvent — often acetone — and allowing the solution to dry on plant material. The amount of solvent left on the plant material is highly variable, a factor that causes significant disparities in the potencies of each product.[6]

Additionally, SCs contain a variety of active metabolites that may have other, higher-affinity binding properties to the CB receptors. Although agitation, tachycardia, and sympathomimetic effects dominate SC generations one through three, fourth-generation SCs often have central-depressant effects and can cause bradycardia. Possible mechanisms for the cardiotoxicity and neurotoxicity of SCs include binding to cardiac potassium channels and central serotonergic and dopaminergic activity, respectively.[7,8]

Fourth-generation indazole SCs were recently reported to have caused an outbreak of "zombie" intoxications in New York City characterized by a blank stare, groaning, and purposeless gestures. The culprit was a synthetic cannabinoid called "AK 47 Karat Gold," which was found to contain a fourth-generation SC known as AMB-FUBINACA, a parent compound that was developed by Pfizer for use as a novel analgesic.

A similar compound was described in Georgia in 2013, and in 2020, another fourth-generation SC (5F-MDMB-PINACA) was discovered as an adulterant in heroin.[9] The toxidrome reported in this case is of clinical importance, as these patients received naloxone and developed a paradoxical syndrome of anticholinergic symptoms and severe agitation. Analysis of the confiscated drugs revealed that the heroin was laced with the aforementioned SC.[10]

The primary assessment of patients with suspected SC intoxication should include a thorough history and evaluation for specific clinical toxidromes (eg, sympathomimetic, anticholinergic, cholinergic, etc). SC abuse is often strongly suggested by the patient's history or found paraphernalia. In addition to the dangers intrinsic to these drugs and their variable potency, SCs are often adulterated with other dangerous substances. In March 2018, there was an outbreak of coagulopathies noted in SC users due to the adulteration of the drug with brodifacoum, a potent anticoagulant ingredient found in rat poison. In an early case series of 34 patients who ingested these laced SCs, the most common manifestations included mucocutaneous bleeding, hematuria, and bruising.[11]

Adulteration with brodifacoum is not unique to this drug class; it was reported as early as 1997 in a 21-year-old man who developed a year-long coagulopathy after smoking laced marijuana.[12] The rationale behind the adulteration is unclear, but it is likely an attempt to prolong the high; additionally, superwarfarin may act as a CB-receptor modulator.

CRITICAL DECISION

What treatments should be employed for patients who have ingested SCs?

There are no antidotes for SC ingestion; the management of these cases is supportive. Patients with unexplained bleeding abnormalities after suspected SC use should be evaluated for coagulopathy due to the adulterant brodifacoum: a long-acting, vitamin K-dependent antagonist.[13]

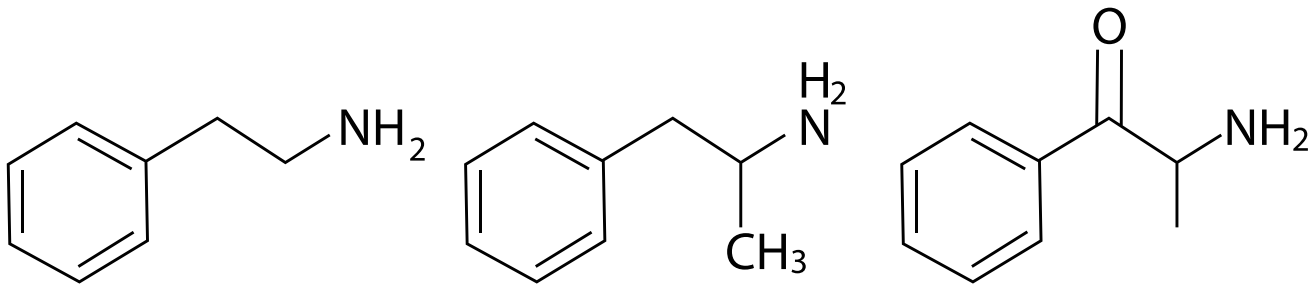
Benzodiazepines are useful for the treatment of anxiety and agitation and can be used to resolve seizures associated with sympathomimetic, agitated states. Rarely, a more aggressive sedation regimen that warrants propofol and dexmedetomidine may be required; in such cases, intubation should be considered. Hyperthermia can be treated with evaporative cooling; there is no role

TABLE 1. Signs and Symptoms of SC and Cathinone Toxicity

Physical exam findings	• Tremor • Cold extremities • Dry mouth • Dry skin • Conjunctival injection • Nystagmus • Sweating • Dilated pupils • Mydriasis • Hypertonia • Myoclonus • Muscle jerking • Shortness of breath
Vital signs	• Hyperpyrexia • Hypertension • Tachycardia • Tachypnea
Lab findings	• Metabolic acidosis • Hypokalemia • Hyponatremia • Hypermagnesemia • Elevated creatinine kinase
Cardiovascular	• Chest pain • Palpitations • Ventricular tachycardia • Ventricular fibrillation
Hallucinations	11%
Delusions	11%
Seizures	4%
Headaches	3%

FIGURE 1. Common Synthetic Cannabinoid Packaging

FIGURE 2. Structural Similarity of Cathinone and Amphetamine



Phenylethylamine | Amphetamine | Cathinone

for antipyretic agents, as the source of drug-induced hyperthermia is unrelated to the hypothalamic set point.

Rhabdomyolysis may occur and is treated supportively with aggressive IV hydration. Seizures should be managed with benzodiazepines as a first-line treatment, and those who require second-line medications should receive phenobarbital. Sodium channel-blocking agents like phenytoin should be avoided due to their potential for worsening complications associated with polypharmacy overdose.

Discharge Decisions

Most patients can be discharged once symptoms resolve, typically within 6 hours of arrival. Patients with more complex symptoms may require admission. Emergency clinicians should also consider consulting the poison control center (1-800-222-1222), which can offer valuable guidance for managing these cases.

CRITICAL DECISION

What unique dangers are posed by synthetic cathinones?

Synthetic cathinones have burst onto the drug scene in the past decade as a new "legal" designer drug class. These products are chemically related to their parent compound, cathinone, which is structurally similar to amphetamine with one exception: Synthetic cathinones contain a ketone moiety (*Figure 2*).[14] Cathinone is a phenylethylamine alkaloid that was originally obtained from the leaves of the *Catha Edulis* plant, also called "qat" or "khat." The plant, which is predominantly found in East Africa, has been used for its stimulant properties for centuries.[15]

Cathinone derivatives have been developed into numerous illicit drugs, resulting in an ever-evolving milieu of novel substances that are difficult to detect on drug screening. Cathinones are actually part of a larger family of substituted phenylethylamines. Mescaline (from the peyote cactus) is an example of a currently abused natural substituted phenylethylamine, and synthetic substituted phenylethylamines include well-known drugs like amphetamine, methamphetamine, and 3,4-methylene-dioxymethamphetamine (MDMA).

Although it is difficult to catalog the present number of cathinone derivatives currently in use, a 2018 analysis documented at least 30 different variants, and a more recent DEA report identified six new cathinone substances in 2019 alone. These substances have many street names, including "Flakka," "Meow Meow," "Vanilla Sky," and "Bloom" — each with different pharmacokinetic properties that can produce unpredictable results.[16] Some of the earliest synthetic cathinones included mephedrone, methylone, and 3,4-methylenedioxypyrovalerone (MDPV). Like many synthetic drugs, these substances initially emerged as either experimental medicinal compounds or obscure synthetic products in the early- to mid-20th century and were later rediscovered.[17]

Although their mechanism is not completely understood, model cathinones like methylone and mephedrone are monoamine oxidase inhibitors, which likely modulate the reuptake of biogenic amines and produce various mixtures of serotonergic and stimulant effects. As with other amphetamines, the effects of the drug can be somewhat predicted by the substitution of the phenylethylamine itself.[18]

In contrast to the typical cathinone, MDPV use tends to result in more adrenergic effects, causing experiences more closely related to cocaine abuse; in fact, MDPV is estimated to be about 10 times more powerful than cocaine.[19] Given their structural similarity to other

Pearls

- SCs can cause various clinical symptoms, the most common being tachycardia and agitation; less-common symptoms include seizures, kidney injury, and even stroke and acute coronary syndrome.
- Synthetic cathinones like methedrone and methylone cause agitation, sympathomimetic symptoms, and various serotonergic effects.
- Cathinones like MDPV, *N*-ethylpentylone, and eutylone have effects similar to cocaine and can cause significant, dangerous psychiatric symptoms.
- The management of patients who have ingested synthetic drugs of abuse is largely supportive.

forms of abused stimulants, synthetic cathinones are often used in illicit drug manufacturing to dilute the product. In more recent years, two predominant formulations have become abused — *N*-ethylpentylone (MDEVP, bk-EPDP, bk-EBDP) and eutylone (bk-EBDB) — both of which were initially discovered on the illicit market in 2014.

Like MDPV, the effects of *N*-ethylpentylone are similar to those of cocaine; the drug is sometimes misrepresented as MDMA in club culture.[20] Although drugs like methylone and mephedrone are designated Schedule I substances, many novel agents and analogues are advertised and sold as "plant foods" or "bath salts" with explicit warnings that they are not for human consumption.

It should be noted that not all synthetic cathinones are illicit. One of the most widespread synthetic cathinone pharmaceuticals is bupropion, which has a similar structure to MDPV and other phenylethylamine derivatives. Due to these similarities, bupropion has recently found a niche as drug of abuse that can be insufflated and even injected by users. As expected of other cathinones, its stimulant effects have led some to call it "poor man's cocaine." Unlike the other nonpharmaceutical cathinones, bupropion can lead to seizures and QTc prolongation. Arrhythmias associated with overdose can be difficult to treat with traditional means.[21]

Much like the adulterants found in SC products, cathinones can also contain unwanted byproducts of illicit production techniques. Tragic consequences from the contamination of methcathinone resulted in a Parkinsonian syndrome that was described in Europe in 2008. These patients demonstrated stereotypical Parkinsonian movements that were refractory to traditional treatments.[22]

Astute researchers recognized that the unique symptoms that developed in these patients mimicked those seen in cases of heavy metal toxicity, specifically manganese toxicity in welders. Thus, this syndrome was determined to be due to the toxic buildup of manganese in the synthetic product rather than the cathinone itself. Unfortunately, the neurotoxicity of the contaminating manganese was likely exacerbated by the cathinone itself.[23]

TABLE 2. Common Adverse Neuropsychiatric Effects of SC and Cathinone Intoxication

Psychiatric symptoms	Estimated prevalence of SC reactions	Estimated prevalence of synthetic cathinone reactions
Agitation/irritability	25%	40%
Lethargy	14%	7%
Altered mental status	12%	13%
Hallucinations	11%	18%
Delusions	11%	18%
Seizures	4%	3%
Headaches	3%	3%

CRITICAL DECISION

How should synthetic cathinone ingestions be evaluated and managed?

Patients who have ingested synthetic cathinones can present with a wide spectrum of symptoms, ranging from minor complaints like nausea, vomiting, hypertension, and hyperthermia to more serious complications, including renal insufficiency, rhabdomyolysis, significant acidosis, seizures, acute psychosis, and suicidal or homicidal ideation (*Table 2*). The initial assessment of these patients should be focused on addressing any signs of hemodynamic instability (eg, hypotension, significant hypertension, tachycardia, and hyperpyrexia). Changes in temperature have been found to be dose dependent and are associated with the chronicity of use.

Acute cathinone use primarily causes hyperthermia, agitation, and adrenergic symptoms. A thorough neurologic exam should include an evaluation for clonus, a finding that suggests serotonin syndrome. In a potentially undifferentiated toxic ingestion, it is important to obtain an ECG early to evaluate the QRS and QT intervals for evidence of arrhythmia and ischemia. A detailed laboratory evaluation should be undertaken to look for end-organ damage, evidence of rhabdomyolysis, and other possible ingestions.

Patient Management

Supportive management is the main treatment for synthetic cathinone ingestion. Benzodiazepines should be used for acute agitation secondary to a sympathetic surge from overdose and are also the first-line treatment for patients with acute seizures. Second-line antiepileptic agents should be employed for refractory seizures; however, phenytoin should be avoided due to the increased risk of sodium-channel blockade it poses in patients with other possible ingestions.

Pitfalls

- Believing the same clinical effects apply to all patients who have abused SCs; these presentations vary, even across the same batch of drug.
- Failing to consider coagulopathy due to adulteration with brodifacoum or other anticoagulants.
- Neglecting to consider synthetic cathinones in any "club drug" overdose. It is important to remember that these substances are popular party drugs.
- Failing to recognize that synthetic drugs of abuse can be used to "cut" other substances with similar effects, thus obscuring the parent drug's toxidrome.

CASE RESOLUTIONS

CASE ONE

The agitated woman required additional sedation with 10 mg of midazolam before she became calm. An ECG and basic lab tests, including a CBC, CK, and a basic metabolic panel, were ordered. Aggressive IV fluid hydration was initiated using 3 L of lactated Ringer's solution, and the patient's CK level decreased from 15,000 to 10,000. Her creatinine level was 0.5, and no acute kidney injury was noted.

Based on her profuse bleeding and scattered bruising, a coagulation workup was ordered, which revealed a PTT level above 50, an INR of 6, and a hemoglobin of 10. The emergency physician ordered 10 units of IV vitamin K and consulted poison control, which recommended treating the patient with prothrombin complex concentrate. She was admitted to the hospital under telemetry status and discharged 2 days later after her hemoglobin, INR, and creatinine level stabilized. She was referred to an outpatient substance abuse program.

CASE TWO

The man suspected of synthetic cathinone abuse received ziprasidone for continued sedation. His lab tests were remarkable for leukocytosis, a CK of 47,500, and a lactate of 3.2. The patient was given 2 L of lactated Ringer's solution, which improved his CK and lactate levels, and cooled via evaporative measures.

His vital signs improved, and his ECG was unremarkable. A drug screen was negative for all tested substances, including alcohol. He was admitted to the intermediate care unit, where he remained hemodynamically stable and showed improvement in his mental status via a psychiatric evaluation.

Atypical antipsychotic agents can also be used to manage agitation and have been found to be effective for treating acute psychosis related to the ingestion of cathinones and other substituted phenylethylamines. Hyperpyrexia is a concern that should be managed with cooling measures as opposed to antipyretic agents. Aggressive fluid resuscitation should be employed in cases of rhabdomyolysis from agitated delirium secondary to overdose.

A widened QRS detected on ECG is likely due to a mixed ingestion and may not be solely blamed on the cathinone. A widened QRS or QT interval can be treated with sodium bicarbonate and magnesium, respectively.

Discharge Decisions

Given the wide variety of synthetic cathinones available, the effects of these substances are variable and can potentially last for days. Observation in the emergency department is reasonable for minor symptoms. If the patient shows improvement in mental status and is not deemed a danger to themselves or others, discharge may be reasonable. Admission to the hospital is necessary for those with signs of more significant symptoms, including renal insufficiency, seizures, rhabdomyolysis, serotonin syndrome, acute psychosis, and suicidal or homicidal ideation.

Summary

Synthetic drugs of abuse are more widely available than ever before. These xenobiotics are dangerous, hard to detect, and have unpredictable effects on patient physiology. Due to the explosion of xenobiotic abuse, emergency physicians must have an understanding of the effects and presenting symptoms these potential lethal drugs.

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The LLSA Literature Review

Bag-Valve-Mask Ventilation

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Casey JD, Janz DR, Russell DW, et al; PreVent Investigators and the Pragmatic Critical Care Research Group. Bag-mask ventilation during tracheal intubation of critically ill adults. *N Engl J Med.* 2019 Feb 28;380(9):811-821.

Hypoxemia during tracheal intubation is a common but serious complication that can lead to poor patient outcomes and even death. During rapid-sequence intubation, there is typically a delay of 45 to 90 seconds between medication administration and laryngoscopy. The use of bag-valve-mask (BVM) ventilation after induction and prior to laryngoscopy has remained controversial, and the risks of aspiration associated with this approach are widely debated.

The multicenter PreVent trial studied adults (18+ years) undergoing induction and tracheal intubation in participating ICUs. Patients were split into two groups: those who received ventilation with a BVM device between induction and laryngoscopy, and those who received none.

Researchers focused on two outcomes: the lowest oxygen saturation observed during the interval between induction and 2 minutes after tracheal intubation, and the incidence of hypoxemia (oxygen saturation <80%) during the period between induction and 2 minutes after intubation. Additional outcomes included new opacities on chest x-ray within 48 hours after intubation and operator-reported aspiration events.

For participants in the "no-ventilation" group, BVM ventilation could be used only after a failed attempt at laryngoscopy as a treatment for hypoxemia. Noninvasive ventilation was not allowed in either group during the interval between induction and intubation; however, preoxygenation using any method, including noninvasive ventilation, was permitted prior to induction in both groups.

The two groups were analyzed using an intention-to-treat comparison. The median lowest oxygen saturation was 96% in the BVM ventilation cohort and 93% in the no-ventilation group. The mean difference in the lowest oxygen saturation between the two groups was 4.7%, and the difference in lowest oxygen saturation was greater for participants with a lower oxygen saturation at induction (P=0.01).

In addition, 10.9% of patients in the BVM ventilation group and 22.8% in the no-ventilation group had an oxygen saturation less than 80%; furthermore, 29.5% of those in the BVM ventilation group and 40.1% of those in the no-ventilation cohort had an oxygen saturation less than 90%. There was no significant difference in the presence of new opacities on chest x-ray in the 48 hours after intubation in either group and no significant difference when looking at operator-reported aspiration.

Overall, the study illustrates the benefit of BVM ventilation for preventing hypoxemia in patients undergoing tracheal intubation. A larger study population is needed to fully evaluate for operator-reported aspiration, as the incidence was low in this trial. Further research is needed before these results can be generalized to patients in the emergency department.

KEY POINTS

- Critically ill adults undergoing intubation who receive BVM ventilation after induction appear to have higher oxygen saturations and lower rates of severe hypoxemia than those who do not.
- The incidence of operator-reported aspiration was lower in the BVM ventilation group than in the no-ventilation group.

Critical Decisions in Emergency Medicine's series of LLSA reviews features articles from ABEM's 2021 Lifelong Learning and Self-Assessment Reading List. Available online at acep.org/moc/llsa and on the ABEM website.

CME QUESTIONS

Reviewed by Lynn Roppolo, MD, FACEP

Qualified, paid subscribers to *Critical Decisions in Emergency Medicine* may receive CME certificates for up to 5 ACEP Category I credits, 5 *AMA PRA Category 1 Credits*™, and 5 AOA Category 2-B credits for completing this activity in its entirety. Submit your answers online at acep.org/cdem; a score of 75% or better is required. You may receive credit for completing the CME activity any time within 3 years of its publication date. Answers to this month's questions will be published in next month's issue.

1 While waiting in the triage area, a 15-year-old girl threatens the staff with profanity and physical violence. Security is held up in another part of the hospital and is unable to attend immediately. What should be your first step?

A. Administer oral olanzapine
B. Establish authority by engaging her with similar "street" language
C. Obtain a detailed history, including any gang affiliations
D. Use de-escalation techniques, speak calmly, and maintain a safe distance from the patient

2 What is a criterion for inpatient psychiatric management?

A. All acute psychiatric conditions in children warrant inpatient admission
B. Consent of the parent or guardian
C. Failure to establish a safety plan
D. General feelings of sadness

3 What measure should be taken when discharging a pediatric patient with suicidal ideation?

A. Consult Child Protective Services so the agency can provide ongoing monitoring
B. Counsel parents and caregivers to restrict the child's access to instruments that can be used for self-harm
C. Encourage the child to return to the emergency department if their "sad thoughts" persist
D. No pediatric patient with suicidal ideation should be discharged

4 A 17-year-old boy with a history of schizophrenia is brought in by his parents after rambling nonsensically at home. In the emergency department, he continues to yell and appears frantic. His parents report that he has had similar episodes in the past. He is otherwise healthy and is compliant with his daily dose of olanzapine. He is alert and well groomed, and his vital signs and physical exam are normal. What is the best medication to administer next?

A. Intramuscular lorazepam
B. Intramuscular risperidone
C. Oral benztropine
D. Oral olanzapine

5 Which life-threatening medical condition can manifest signs of psychosis?

A. Alcohol poisoning
B. Attention deficit disorder
C. Hyperglycemia
D. Hypoxia

6 A 14-year-old girl presents with thoughts of hurting herself following a fight at home. She confides that she has been having suicidal thoughts for several months and has also been cutting herself with a razor blade. After a discussion with the psychiatrist, you recommend inpatient psychiatric admission, but her father refuses and threatens to take her home. What is your next best step?

A. Allow the patient to go home after instructing her to return if suicidal thoughts persist
B. Consult local Child Protective Services
C. Enter a mental capacity note in the patient's chart and refuse to discharge
D. Prescribe an antidepressant and discharge her

7 Which life-threatening complication of antipsychotic use is characterized by severe rigidity?

A. Cardiac arrhythmia
B. Neuroleptic malignant syndrome
C. Overdose
D. Serotonin syndrome

8 What potential side effect should be considered when prescribing a first- or second-generation antipsychotic?

A. CNS depression
B. Hyperventilation
C. Paradoxical reactions
D. Worsening psychosis

9 Which factor places an adolescent at greatest risk for suicide?

A. Family history of suicide
B. History of depression
C. Marijuana use
D. Previous suicide attempt

10 Which action is appropriate when managing a patient with physical restraints?

A. Ensure that at least three trained staff members are available to help
B. Ensure that the patient's head is supported by a pillow
C. Monitor the patient in 30- to 45-minute intervals
D. Place the patient in the supine position to reduce the likelihood of airway obstruction

11 Which effect of SC use can be predicted by the substance's chemical structure?

A. Psychosis is determined by the drug's ability to bind to the CB1 and CB2 receptors
B. SCs have variable effects that can be unpredictable based on each formulation and user
C. Sedation is the most common effect
D. The effects of these drugs are similar to those of marijuana

12 What is the most common method of SC ingestion?

A. Any plant-like material can be used
B. Marijuana bud
C. Package labeled "Scooby Snacks"
D. Powder that can be snorted or smoked

13 What unique complication of recreational bupropion overdose can be particularly difficult to treat?

A. Acute urinary retention
B. QRS and QTc prolongation that cannot be attributed to sodium-channel blockade
C. Severe aggression and agitation with acute psychosis
D. Significant vomiting and hemorrhagic gastritis

14 What change in the chemical structure of synthetic cathinones can cause sympathomimetic peripheral effects like tachycardia and hypertension?

A. Methylation on the benzene ring
B. The addition of a ketone group
C. The addition of a methyl group to the terminal amine portion of the structure
D. The addition of a sulfur group

15 Which treatment should be avoided in patients with SC ingestion?

A. Benzodiazepines
B. Dexmedetomidine
C. Phenytoin
D. Propofol

16 What is the first-line agent for managing the blood pressure of an agitated, hypertensive patient with an acute ingestion of a synthetic cathinone?

A. Hydralazine 10 mg IV
B. Metoprolol 10 mg IV
C. Midazolam 5 mg IV
D. Therapy is unnecessary if the patient has no chest pain

17 EMS responds to a 24-year-old man who appears to be in a state of excited delirium. He is aggressive and fighting with the police officers on scene. What is the best way to manage his agitation?

A. Lorazepam 4 mg IV
B. Midazolam 10 mg IM
C. Use physical four-point restraints to secure the patient to the gurney during transport to the hospital
D. Ziprasidone 10 mg IM

18 A patient presents with paranoia after using "bath salts." What would you expect to see on his drug screen?

A. It is impossible to predict the results
B. Negative results
C. Positive for cannabinoids
D. Positive for cocaine

19 What is the natural origin of cathinone?

A. Castor bean
B. Khat plant
C. Peyote cactus
D. Psilocybin mushrooms

20 A 27-year-old man presents after smoking an unknown substance. He is hypotensive and vomiting blood. What is the likely etiology of his symptoms?

A. Bath salts
B. MDMA adulterated with *N*-ethylpentalone
C. Opioids adulterated with fentanyl
D. SCs adulterated with brodifacoum anticoagulants

ANSWER KEY FOR FEBRUARY 2021, VOLUME 35, NUMBER 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	D	B	B	A	A	B	B	C	B	D	C	B	C	B	C	C	C	D	D

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Drug Box

DELAFLOXACIN

By Frank LoVecchio, DO, MPH, FACEP
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Delafloxacin is an intravenous and oral fluoroquinolone indicated for the treatment of acute skin and skin-structure infections caused by susceptible bacteria. It is the only oral antibiotic with in-vitro activity against methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, and most Gram-positive pathogens, including quinolone-resistant strains.

Mechanism of Action

Inhibition of both bacterial topoisomerase IV and DNA gyrase (topoisomerase II) enzymes, which are required for bacterial DNA replication, transcription, repair, and recombination

Susceptible Organisms

Gram-positive organisms: *S. aureus* (including MRSA and methicillin-susceptible isolates), *S. haemolyticus, S. lugdunensis, Streptococcus agalactiae, S. anginosus* group (including *S. anginosus, S. intermedius*, and *S. constellatus*), *S. pyogenes*, and *Enterococcus faecalis*.
Gram-negative organisms: *Escherichia coli, Enterobacter cloacae, Klebsiella pneumoniae*, and *P. aeruginosa*.

Adult Dosing

- 300 mg every 12 hours over 60 minutes via IV infusion for 5 to 14 days, ***OR***
- 300 mg every 12 hours over 60 minutes via IV infusion, then switch to an oral 450-mg delafloxacin tablet every 12 hours for a total of 5 to 14 days, ***OR***
- 450-mg tablet given orally every 12 hours for a total of 5 to 14 days

Dosage adjustment is required for patients with severe renal impairment (eGFR 15-29 mL/min/1.73m^2). Delafloxacin is not recommended in patients with end-stage renal disease.

Precautions

The most common side effects are nausea, vomiting, headache, and diarrhea. Serious adverse reactions include tendonitis, tendon rupture, peripheral neuropathy, CNS alteration, and seizures. Fluoroquinolones may exacerbate muscle weakness in patients with myasthenia gravis and should be avoided. As with other fluoroquinolones, QTc prolongation and *Clostridium difficile*-associated diarrhea may occur.

Pregnancy and lactation risks are not well studied.

Tox Box

CYCLOPEPTIDE MUSHROOMS

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Cyclopeptide-containing mushrooms are found throughout the US, mainly in northern bicoastal regions. Thousands of exposures are reported annually, usually due to mushroom misidentification, some of which may result in liver failure or death. Late GI symptoms can be followed by terminal hepatic failure.

Pathophysiology

- Species
  - — *Amanita phalloides, A. virosa, A. verna*
  - — *Galerina* species
  - — *Lepiota* species
- Amatoxins (cyclic peptides)
  - — Heat stable
  - — High oral bioavailability
  - — Suppress protein synthesis by inhibiting RNA polymerase II

Clinical Effects

- ***Phase I:*** (5-24 hours post ingestion)
  - — GI: diarrhea
  - — Nausea and vomiting
- ***Phase II:*** (12-36 hours post ingestion)
  - — Liver injury (LFTs↑, INR↑)
- ***Phase III:*** (2-6 days post ingestion)
  - — Hypoglycemia
  - — Jaundice
  - — Kidney failure
  - — Hepatic coma

Treatment

- Decontamination with oral activated charcoal (1 gm/kg) to absorb amatoxins
- Fluid and electrolyte repletion
- No proven antidote
  - — *N*-acetylcysteine 150 mg/kg IV — potential hepatic protection
  - — Benzylpenicillin 0.5-1.0 MU/kg/day IV — no consistent data
  - — Silymarin (milk thistle extract) — investigational agent
- Liver transplantation if prognosis is dire