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AHC Media

Gynecologic Complaints in the Adolescent Female

Have you ever had parents bring their teenage daughter into the ED to be "checked out?" So, how do you approach this? There are conflicting imperatives. Some are possibly your personal feelings if you are a parent yourself. Then there is your duty as a physician to provide the best care to the patient, the adolescent female. But also, there are the state laws and regulations that apply to this situation, especially if the patient is refusing an evaluation. The issues of sexual activity and parental authority are controversial and potentially divisive issues in society. In the best of circumstances, the patient will be forthcoming in the history and will cooperate with examination and testing, the parents will allow a confidential evaluation of the patient, if desired, and treatment for potential conditions will be readily accepted. Sometimes, ideal circumstances are not present. In this case, use of counselors and social workers may facilitate evaluation and treatment. In extreme cases, child protective services and law enforcement involvement may be useful if there is concern regarding the safety of the patient in her current circumstances. This issue will address three of the more common gynecologic issues seen in adolescent females who come to the ED — abnormal vaginal bleeding, possible sexually transmitted infections, and emergency contraception.

— J. Stephan Stapczynski, MD, Editor

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Introduction

Adolescent girls may not be straightforward about gynecologic issues, and the emergency practitioner should specifically and in a sensitive manner ask about the patient's gynecologic history. Young women in this age group are the most likely to have irregular menstrual cycles, with abnormal vaginal bleeding being a very common emergency department complaint. The adolescent patient is also at greater risk than an adult for sexually transmitted infections, which must be diagnosed and treated by emergency physicians. Another vital topic is emergency contraception that may be requested by the adolescent female patient or her parent.

General Approach to the Adolescent Female Patient

Taking an Adolescent History. The teenage patient may not be forthcoming about her true chief complaint. She may feel embarrassed, be afraid of disapproval, or require confirmation of confidentiality prior to discussion. Vague abdominal complaints or nonspecific chief complaints may be the adolescent's attempt to seek care for genitourinary complaints.

The provider should focus on the adolescent as the patient and address her directly. After the emergency practitioner has elicited past medical and family history and the parents' chief complaint, consideration should be given to having the parents excused from the room to allow the adolescent the opportunity

Executive Summary

- While the specifics vary, most state laws do not allow parents to force their under 18-year-old child to undergo a pelvic examination or pregnancy test.
- Most states allow parents to force their child to undergo a urine drug test.
- In adolescents, abnormal vaginal bleeding is most commonly due to anovulatory dysfunctional uterine bleeding.
- The adolescent population has the highest rates of gonorrhea and chlamydia infection.
- Emergency contraception is effective up to 120 hours after unprotected intercourse.

to discuss concerns and complete the examination in private. Using a nonjudgmental tone of voice and explicitly telling the patient that she has the right to confidential reproductive health care will encourage disclosure. Seeing the patient without her parent/guardian also provides an important opportunity to ask the patient whether she is sexually experienced, using drugs, or being pressured into these or any other high-risk activities. Drug and alcohol abuse have been associated with higher-risk sexual behaviors, including earlier sexual debut, multiple partners, and inconsistent use of contraception.[1] Answers to the questions in Table 1 will allow the emergency provider to gauge the patient's risk for abusive relationships, pregnancy, and sexually transmitted infections. The provider can choose which questions are the most applicable for a given patient.

This history should not take more than a few minutes for a busy practitioner to complete. Furthermore, this interaction provides a unique opportunity for the emergency medicine practitioner to provide education and anticipatory guidance to the patient. Although traditionally preventative medicine has been considered outside the scope of emergency medicine, emergency physicians have become a source of primary care for patients who have barriers to regular care. About 75% of adolescents utilize the health care system each year, and many of these visits are in the emergency department or urgent care facility. If the emergency physician does not provide education to the high-risk adolescent, that patient may be at preventable risk for sexually transmitted infections, abuse, or unplanned pregnancy.[3,4]

The Adolescent Gynecologic Exam

Frequently, young female patients in the emergency department have not had a prior pelvic exam. If the current complaint necessitates a gynecologic exam, consent is required from the patient. Reassurance and answering all questions prior to the exam should reduce patient and parental stress. Again, the parents should be excused from the room if the adolescent prefers, and a chaperone should accompany the provider. After the patient dons a gown, removes her undergarments, and is provided with a sheet to cover her lap, describe each step of the exam before you start the exam and again as you perform the exam. Use appropriately sized (e.g., small) specula to minimize discomfort. First, an external exam should be performed, looking for infectious lesions, signs of vaginitis, and also any signs of abuse (note that in the majority of exams, even if there is abuse, there are no signs). Second, a speculum exam is performed to inspect the cervix and vaginal vault for bleeding, discharge from the cervical os, cervical lesions, or other abnormalities. Finally, a bimanual exam should be performed to detect any adnexal tenderness, masses, or cervical motion tenderness.

Updates on Issues of Confidentiality

Confidentiality is paramount in this age group. A teenage patient will want to know that certain services can be provided confidentially (i.e., without parental consent or notification), including the diagnosis and treatment of sexually transmitted infections or pregnancy. While there is variation in state law, most states do not allow parents to force their child to undergo a pelvic examination or pregnancy test. The situation is different regarding drug testing; most states allow parents to require their child to undergo a drug test if they suspect the child is using illegal drugs. Issues of force are minimal, provided the test is not considered intrusive (e.g., a urine sample). In a recalcitrant patient, a court order can be obtained by the parent. However, confidentiality has limits that should be explained to the adolescent patient. Specifically, sexual and physical abuse are not protected under minor consent laws, and they require parental notification for the safety of the minor unless the parent is the one suspected of abusing the patient.

Vaginal Bleeding

Overview. Vaginal bleeding is a common complaint in the emergency department. In adults, the differential diagnosis of vaginal bleeding in the non-pregnant patient includes fibroids, polyps, or malignancy. However, in the adolescent patient, this complaint is most commonly due to dysfunctional uterine bleeding with anovulation (95%) and, much less frequently, due to pathologies such as bleeding dyscrasias, endocrine disorders, or malignancy.[5-7] Although it is outside the scope of this review, it is also important to consider complications of pregnancy,

Table 1. Key Components of the Adolescent History

1. "Have you ever had oral, vaginal, or anal sex?" Oral/vaginal/anal sex may need to be defined for the adolescent patient. Avoid slang terms, but ask specifics to determine risk.
2. "How many partners have you had in your lifetime?" Follow this by distinguishing male/female partners. "Have you had sexual relationships with males, females, or both?" Avoid presumptive terms like "boyfriend."
3. "Have you ever been exposed to sexually transmitted infections?" (Remind the patient of risk factors, including IV drug use, high-risk sexual partners, multiple partners, unprotected sex.)[1]
4. "Have you ever been treated for, diagnosed with, or tested for a sexually transmitted infection such as gonorrhea, chlamydia, syphilis, trichomonas, or warts?"
5. "What methods are you using to protect yourself against a sexually transmitted infection? Do you have any questions about how to protect yourself against sexually transmitted infections?"
6. Similarly, "What methods are you using to protect yourself against pregnancy? Do you have any questions about how to prevent pregnancy?"
7. "Are you and/or your partner using any substances or devices while having sex?" This may identify risk factors for vaginal infections/irritations, dyspareunia, as well as abuse or nonconsensual sex acts.[2] This question should be followed with a screen for inter-partner violence: "Has anyone touched you sexually in a way you didn't want?" "Has anyone hit you or hurt you?"

such as spontaneous abortion or ectopic pregnancy, in the differential diagnosis of irregular vaginal bleeding in the adolescent patient. A negative pregnancy test is critical prior to consideration of other etiologies of vaginal bleeding.

Pathophysiology and Differential Diagnosis of Vaginal Bleeding. Dysfunctional uterine bleeding (DUB), the most common cause of abnormal vaginal bleeding in the adolescent, is defined as irregular uterine bleeding not due to structural lesions or systemic diseases. In adolescents, anovulatory cycles are responsible for the majority of DUB. Anovulation is caused by the relative immaturity of the hypothalamic-pituitary-ovarian axis in this age group. During the first two years after menarche, 55-80% of cycles are anovulatory; by year four or five of menstruation, only 20% of cycles are anovulatory.[4-7]

Polycystic ovarian syndrome (PCOS) is the most common endocrine cause of anovulatory cycles and resulting DUB. The syndrome is diagnosed clinically by symptoms including hirsutism and irregular menstrual cycles. PCOS is associated with insulin resistance and obesity, although 10% of PCOS patients are normal or under weight. The finding of polycystic ovaries on a transvaginal ultrasound supports the diagnosis, although it is not required for the clinical diagnosis of PCOS. The suspicion of this syndrome warrants referral to gynecology, adolescent medicine, or a family practitioner for further workup.[7,8]

In the differential of adolescent abnormal uterine bleeding, another etiology for the emergency physician to consider, though much less common, is a bleeding dyscrasia. The emergency provider may be the first physician to encounter patients with an underlying bleeding disorder, as heavy menstrual bleeding is the most commonly experienced sequela. In a series of studies, patients requiring hospitalization for menstrual bleeding had a 5-28% prevalence of bleeding disorders. Many of these patients will enter the hospital through the emergency department.[9,10] While it is not crucial that the emergency provider make the final diagnosis of the particular bleeding disorder, it is imperative to include a bleeding disorder in the differential, especially in those patients with a positive family history, patients with heavy bleeding at menarche, or those requiring transfusion and admission. Also, once hormonal treatments are started, it is much more difficult to make a diagnosis of a blood dyscrasia.

Clinical Features and History of Vaginal Bleeding. The evaluation of vaginal bleeding should start with an assessment of the patient's hemodynamic stability. Unstable or potentially unstable patients should have two large-bore IVs established and volume replacement with isotonic saline and packed red blood cells, if indicated.

The initial history of this complaint should include the onset and timing of the bleeding, including timing in relation to the last normal menstrual cycle and duration of bleeding. Inquire about regularity and duration of cycles and the age of menarche. The patient should try to quantify the bleeding, which may be difficult; ask specifically how frequently she is changing pads/tampons. Also ask specifically if she saw any clots with the bleeding.

In addition to the above general historical questions, further questions may help narrow the differential diagnosis of vaginal bleeding. For example, ovulatory cycle bleeding should be preceded by premenstrual symptoms (breast tenderness, bloating, mood swings, or cramping). Heavy, irregular bleeding without these preceding complaints is often triggered by an anovulatory cycle.[5,8] Ask about a history of excessive bleeding (such as after dental procedures or prolonged nosebleeds) to screen for bleeding disorders, and similarly ask about family history of bleeding disorders and gynecologic

Table 2. Management of Dysfunctional Uterine Bleeding[6,9,22]

Categories of Bleeding	Treatment Guidelines
Mild (duration of bleeding < 3 months, normal hemoglobin)	• Watch and wait • Track cycle with menstrual calendar • NSAIDs for cramps and to decrease blood flow
Moderate (heavy menses or increased frequency of cycle, mild anemia with hemoglobin 8-10 g/dL)	• If not bleeding now: Start cyclic OCP, medroxyprogesterone acetate, or norethindrone acetate • If bleeding now: Start taper method of monophasic OCPs (30 µg ethinyl estradiol/0.3 mg norgestrel) – One pill Q6h for 2 days, then – One pill Q8h for 2 days, then – One pill Q12h for 2 days, then – One pill daily for 3 days to complete the 21-pill pack – Then start new 21-day pack and take one per day, continue OCPs for 3-6 months, skipping any placebos – Make sure to prescribe anti-emetic to prevent nausea associated with higher estrogen doses – If contraindication to estrogen: – Norethindrone acetate 5-10 mg daily
Severe (hemoglobin < 7 g/dL, hemoglobin < 10 g/dL in patient with heavy bleeding or who is orthostatic)	Should admit and send extended workup. Start treatment with either OCPs (30-50 µg ethinyl estradiol/0.3 mg norgestrel) • One pill Q4h until bleeding stops, then • One pill Q6h for 2 days, then • One pill Q8h for 2 days, then • One pill Q12h for 2 days, then • One pill daily for 3 days to complete the 21-pill pack • Then start new 21-day pack and take one per day, continue OCPs for 3-6 months, skipping any placebos OR Premarin 25 mg IV Q4h until bleeding stops and then start OCPs 1 pill PO QD to provide progesterone to stabilize the endometrium. • Also prescribe: iron supplementation, nausea prophylaxis
Special Considerations	• For patients who cannot tolerate oral medicines, use Premarin 25 mg IV Q4h until bleeding stops, then prescribe OCPs • In patients where estrogen contraindicated, use norethindrone acetate 5-10 mg Q4h, followed by taper

Adapted from Hettler J. Pediatric and Adolescent Gynecology. *Textbook of Pediatric Emergency Medicine.* Lippincott Williams & Wilkins; 2010, and Emans SJ, et al. Delayed puberty and menstrual irregularities. *Pediatric and Adolescent Gynecology* Lippincott Williams & Wilkins; 2005.

issues.[11] As always with the complaint of vaginal bleeding, ask about the potential of pregnancy, while keeping in consideration that patients are not always truthful about their sexual history and that a pregnancy test should be performed regardless.

Diagnostic Studies. Emergency department laboratory investigation for vaginal bleeding should always include a pregnancy test and a complete blood count. In patients requiring transfusion, with suspected bleeding disorder, or being considered for admission, order a coagulation panel and type and cross. In the pregnant patient, a pelvic ultrasound should be obtained to evaluate for possible ectopic pregnancy and for viability of the pregnancy. It would be helpful to draw LH, FSH, and TSH levels and a von Willebrand's panel (VWP) because initiation of hormone therapy (to blunt bleeding) will invalidate LH and FSH results, while blood transfusion will alter the accuracy of the VWP test.

Treatment. The treatment choice for dysfunctional uterine bleeding will be guided by the volume of

bleeding and by the results of the lab work obtained. Mild bleeding may be followed expectantly, for example, while moderate bleeding may prompt the emergency physician to start medication to slow bleeding. The patient should always be instructed to follow up with her primary care physician in case long-term OCPs are required to control bleeding, or in case further workup is needed to discover the etiology.[12] In Table 2, the specifics of treatment plans and the levels of bleeding or anemia for which they are indicated are outlined in detail.

Sexually Transmitted Infections

Scope of Problem: The Rise of Sexually Transmitted Infections in Adolescents. Adolescents have the highest rates of sexually transmitted infections (STIs) in the United States.[13] The CDC's Division of Reproductive Health tracks the nationwide trends in sexually transmitted infections. The major findings in the 2002-2007 data included a rise in the prevalence of HIV in adolescents as well as in rates of syphilis. From 1996 to 2006, the rate of HIV in males aged 15-19 years nearly doubled. Many EDs are now using rapid HIV testing and some are even piloting universal testing in high prevalence areas such as Washington, DC.[14,15] Similarly, the incidence of syphilis, which had been steadily declining between 1997-2005, has risen again, affecting 2.2 individuals per 100,000 in 2006, versus only 1.5 per 100,000 in 2004.[14-16] Chlamydial infections in 15- to 19-year-old women occur at the highest age-specific rate in the United States, and their incidence in this population is slowly increasing, up 3% in 2011 compared to the previous year.[13] Women 15 to 19 years old have the second highest rates of gonorrhea infection in the United States, an incidence that has plateaued in the past few years.[13] Adolescents have the lowest age-specific infection rates for herpes type II infections, and the reported incidence has not been increasing.[13]

Risk Factors for Sexually Transmitted Infections (STIs) in Adolescents. Multiple factors place this age group at risk for higher rates of all STIs. It is important, even in the often hectic environment of the emergency department, to screen higher-risk adolescents, including those with early sexual debut, multiple partners, inconsistent use of condoms, limited health care access, drug use, and men having sex with men. Remember that minors have the right in all states to confidential care for sexually transmitted infections.

Some physiologic features place the teenage patient at higher risk for contraction of STIs. The adolescent-aged host frequently has a more naïve immune system to sexually transmitted infections. Other anatomic differences in this age group place the patient at higher risk. Adolescent women have a larger cervical ectropion than adults, thus increasing the STI risk because these cells have greater susceptibility to infection than other types of cervical cells.

History Taking for Patients with Suspected Sexually Transmitted Infection. The complaints that bring an adolescent patient to the emergency department for an STI may include vaginal discharge, pruritis, dysuria, dyspareunia, abdominal pain, or even just a request for STI testing with fears of an exposure. Gonorrhea produces symptoms an average of 10 days after exposure, and may include urinary discomfort, vaginal discharge, dyspareunia, and also pelvic pain — remember to consider pelvic inflammatory disease and related sequelae, including tubo-ovarian abscesses. Another manifestation of this STI may be Bartholin's gland abscesses, so when treating a gland abscess, screen for STI risk factors and consider empiric treatment. On the other hand, chlamydia is frequently asymptomatic. Up to 42% of patients affected by gonorrhea have a concomitant infection with chlamydia, necessitating testing and treatment for both, as addressed in Table 3.[16]

Treatment and Follow-up for Suspected Sexually Transmitted Infections. Because the adolescent patient may be difficult to contact for follow-up culture results, empiric treatment is indicated if the suspicion of disease is moderately high. Remember that given confidentiality laws, the minor herself, rather than the parents, must be contacted with follow-up cultures. It may be useful to send test results to the primary care physician in order to ensure the results are delivered confidentially and in a setting in which that provider can initiate treatment and counseling.

Other Considerations in Gonorrhea and Chlamydia Testing: New Testing Modalities and Follow-up Testing. Gonorrhea and chlamydia can be tested for routinely in the emergency department with endocervical or self- or physician-administered vaginal swabs. These infections can also be tested by urine testing, but require a first void or "dirty" urine sample, while another common test collected during workup for abdominal complaints, a urinalysis for bacterial infection, is done mid-stream. However, mid-stream urine testing for chlamydia has been shown to be sensitive, making simultaneous collection for both STIs and urinary tract infections in the emergency department much simpler.[19]

All patients with gonorrhea or chlamydia require retesting to ensure clearance of the disease, given its potential for long-term harm, including infertility and pelvic inflammatory disease. If the infection is present at this follow-up, it is more likely to be due to re-infection rather than resistant infection. Proper education to the adolescent patient is imperative, including notification of all partners from the 60 days prior to diagnosis and instructions to abstain from sexual activity until 7 days after initiation of treatment of both partners. Patients should be advised to follow up with their primary care provider to initiate partner treatment/notification if tests come back positive.[16,22]

Table 3. Diagnosis and Management of Common Gynecologic Infections[17-20]

Disease	Symptoms	Signs	Testing	Treatment**	Clinical Considerations
Bacterial Vaginosis (BV)*	Thin, gray discharge with fishy odor, especially after sex	Gray discharge coating vaginal walls	• Positive whiff amine test • Vaginal pH > 4.5 • Clue cells > 20%	• Oral (500 mg BID for 7 days) OR vaginal metronidazole • Oral OR vaginal clindamycin	Risk factor for STI infection/transmission
Genital HSV	• Primary: Painful genital lesions, dysuria, fever, malaise • Recurrent: Less severe, genital lesions only	Multiple shallow, erythematous, painful ulcers	• Viral culture and PCR (most sensitive) from base of ruptured ulcer • Serology, less useful in acute period	• Treat all primary infections due to severity of symptoms and to shorten duration of primary infection • CDC's 2010 recommendations, all 10-day courses: — Acyclovir 400 mg PO TID — Famciclovir 250 mg PO TID — Valacyclovir 1000 mg PO BID	• To treat or not treat recurrence left to patient/doctor discretion Recurrent: • CDC's 2010 recommendations: — Acyclovir 800 mg PO TID x 2 days OR 800 mg PO BID x 5 days — Famciclovir 1000 mg PO BID x 1 day OR 125 mg PO BID x 5 days — Valacyclovir 500 mg PO BID x 3 days OR 1 g once daily x 5 days
Yeast Infection*	"Cottage cheese" discharge, vaginal pruritis, dysuria	Vulvar and vaginal erythema, edema	• KOH with budding yeast and hyphae • pH 4-4.5 (BV has pH > 4.5) • Amine test negative (versus BV)	• Topical azoles available • Single dose oral fluconazole 150 mg often more desirable	• Complicated infections (pregnant, immunocompromised, diabetes) require 2 fluconazole 150 mg doses, taken 3 days apart. • LFT testing not required for either single or two-dose regimens
Trichomonas	• Classic (in 10-30%) green-yellow frothy discharge, pruritus, dysuria • Common: Purulent, thin discharge • Dyspareunia, post-coital bleeding	• Green-yellow frothy discharge • Punctate hemorrhages of vagina and cervix ("strawberry cervix" seen only in 20% of patients)	• Motile trichomonads on wet mount (only in 50-70%) • If not seen, culture or rapid nucleic acid tests	Single-dose oral metronidazole 2000 mg	• Treat sexual partner

*Bacterial vaginosis is not clearly established as sexually transmitted, but rather an imbalance in vaginal flora common in females of child-bearing age. Yeast infections are also not sexually transmitted. Risk factors include pregnancy, diabetes, and antibiotic use.[21]
**For all regimens, please check safety and specialized dosing for treatment in the pregnant patient.

The presence of one sexually transmitted infection portends the risk for other concomitant infections, including human immunodeficiency virus (HIV). The emergency physician evaluating a patient for gonorrhea and chlamydia should consider ordering testing for syphilis and HIV to do a complete STI workup. Alternatively, if the emergency physician can ensure reliable follow-up, these additional screening tests may be performed by the primary care provider.[23]

Alternative Treatment Options in Gonorrhea/Chlamydia. Treatment regimens for gonorrhea and chlamydia are found in Table 3. If the adolescent patient refuses

Table 3. Diagnosis and Management of Common Gynecologic Infections[17-20] (*continued*)

Disease	Symptoms	Signs	Testing	Treatment**	Clinical Considerations
Chlamydia	• 50% asymptomatic • Vaginal discharge, dysuria, bleeding • Symptoms of PID: Low abdominal pain or RUQ pain + lower GU symptoms	• Mucopurulent cervical discharge • Friable, edematous cervix	• Urine, vaginal, or cervical nucleic acid amplification (becoming gold standard) • Cervical culture • Rapid immunoassays (available soon) • Imaging if indicated in PID	• Single dose oral azithromycin 1000 mg OR 7 days oral doxycycline 100 mg twice daily • PID may necessitate admit for IV antibiotics	• Untreated cervicitis can lead to PID, causing infertility or future ectopic pregnancies • Consider partner testing and expedited partner treatment
Gonorrhea	• 50% asymptomatic • Similar to chlamydia with discharge, pruritis, or, if PID, abdominal pain	• Mucopurulent cervical discharge • Friable, edematous cervix	• Urine or vaginal nucleic acid amplification most sensitive and specific • Culture is the test of choice in suspected extragenital infection, plus gives antibiotic sensitivity	• CDC recommendation: Single IM dose ceftriaxone 250 mg • AND single dose oral azithromycin 1 g or 7 days of oral doxycycline 100 mg twice daily	• PID, infertility, ectopic pregnancy • Disseminated gonococcal infection • Pharyngeal infections • Consider partner testing and treatment
Syphilis	• Primary: Painless papule then chancre • Secondary: Constitutional symptoms, rash of palms/soles, alopecia, CNS infection • Latent: CNS, cardiovascular	• Primary: Raised ulceration, inguinal lymphadenopathy • Secondary: Rash is discrete reddish-brown, scaly lesions, or condyloma lata. Lymph nodes, hard and rubbery, especially epitrochlear	• Initial (sensitive) serology testing for ED: VDRL, RPR • Follow-up testing if above positive, more specific treponemal serology testing such as FTA-ABS	• Primary, secondary, or early latent: benzathine penicillin G • Latent: 3 weekly doses benzathine penicillin G	• Infection raises risk of HIV acquisition and transmission • Treatment may provoke Jarisch-Herxheimer reaction • Consider partner testing and treatment
HIV	• Consider acute infection in the differential for flu or mononucleosis-like illness	• Rash • Lymph nodes • Mucocutaneous ulcers	• HIV rapid antibody test BUT may be initially negative • Also send RNA viral load, as acute HIV associated with high levels of viremia (even with negative antibody test)	• Urgent referral for workup and initiation of HAART treatment	• Partner notification, testing • Key is level of suspicion; opportunity to catch the HIV infection in the acute phase

**For all regimens, please check safety and specialized dosing in the treatment in the pregnant patient.

Table 4. Indications for Emergency Contraception

- Unprotected sex
- Sexual assault
- Failure of a contraceptive (i.e., contraceptive vaginal ring in place for more than 5 weeks, contraceptive vaginal ring out for more than 3 hours, broken condom, missed doses of oral/vaginal/injection contraceptives)

an intramuscular injection, there are oral-only regimens, although these are not recommended by the CDC as first line because of quinolone resistance by *Neisseria gonorrhoeae*. However, if local gonorrhea resistance is low and the patient is also at low risk, the provider could alternatively prescribe:

- single dose cefixime 400 mg PO; or
- levofloxacin 500 mg PO daily for 7 days; or
- ofloxacin 300 mg PO BID for 7 days; or
- erythromycin base 500 mg PO QID for 7 days.

This should be prescribed in addition to the single dose of azithromycin 1 g PO, or doxycycline 100 mg PO BID for 7 days, to prevent resistance.[22]

The Possibility of Resistant *Neisseria Gonorrhoeae*. There has been growing concern about cephalosporin-resistant *Neisseria gonorrhoeae*. The 2010 CDC recommendations continue to support the regimen of ceftriaxone 250 mg IM once *plus* azithromycin 1 g orally once or doxycycline 100 mg PO BID for 7 days.[22] Laboratories are identifying small, although notable rates of resistance in both gonorrhea and chlamydia cultures. However, there is insufficient prevalence of resistant strains to warrant significant changes to the current treatment recommendations. The recommendation is ceftriaxone plus azithromycin for dual coverage against gonorrhea to prevent further resistance.[18,23]

The emergency practitioner should watch for any future updates in CDC recommendations as concerns for resistance grow.

Emergency Contraception

Background and Epidemiology. Teen pregnancy in the United States had been decreasing annually during 1991-2005, but subsequently increased again from 2005-2007, at a rate now of approximately 42.5 affected young women per 1,000.[16,25] The emergency provider's role in prevention of unplanned pregnancy is limited to the provision of emergency contraception. Patients presenting to the emergency department for a pregnancy test who have had unprotected vaginal sex or contraceptive failure in the past 120 hours are candidates for emergency contraception.

Indications for Emergency Contraception. The main indications to prescribe this class of medications are: unprotected sex, sexual assault, or failure of a contraceptive. Failures of prescribed contraceptives may include: a contraceptive vaginal ring in place for more than 5 weeks, contraceptive vaginal ring out for more than 3 hours, broken condoms, or missed doses of oral/vaginal/injection contraceptives. (*See Table 4.*)

Treatment Regimens in Emergency Contraception. Originally, two main categories of emergency contraception existed: combination pills, sometimes referred to as the Yuzpe regimen, and progesterone-only pills.[26,27] The Yuzpe regimen's use is limited by severe nausea and vomiting as side effects and lower efficacy compared to other emergency contraception options. Only 57% of pregnancies are prevented by Yuzpe method, versus 85% with levonorgestrel-only pills. Many brands of regular oral contraceptive pills can be used, in combinations unique to each brand, to provide emergency contraception. (*See Table 5.*) A complete list of approved pills is available at the Emergency Contraception website: http://ec.princeton.edu/questions/dose.html.

Levonorgestrel (trade name Plan B/Next Choice) is approved for use within 72 hours of unprotected sex, although the World Health Organization has shown efficacy up to 120 hours.

In 2010, the FDA approved ulipristal acetate (UPA, trade name Ella), a progesterone receptor modulator. Its efficacy is proven up to 120 hours after unprotected sex, taken in a single 30-mg dose. In fact, if taken within 72 hours, UPA had a 42% lower pregnancy rate than levonorgestrel. If taken within 24 hours, UPA had a 65% lower pregnancy rate compared to levonorgestrel.[11,28] However, the provider must keep in mind that UPA is not yet widely available in U.S. pharmacies.

Finally, another option, although it requires training for placement or immediate referral to a gynecologist/family practitioner, is the copper intrauterine device. If the patient has guaranteed follow-up with a provider who can place a copper IUD, this device may prevent up to 99.9% of pregnancies if it can be inserted within 5 days of unprotected sex.

In summary, the emergency provider's options include (in increasing order of efficacy): traditional OCP packs in regimens particular to each brand; levonorgestrel only (trade names Plan B or Next Choice); a new medication called ulipristal acetate (trade name Ella); or the patient may be referred for emergency copper IUD.

It is imperative to counsel the patient on the following issues: close follow-up, the possibility of emergency contraception failure, and

Table 5. Oral Contraceptives that Can Be Used for Emergency Contraception in the United States*

Brand	Company	First Dose**	Second Dose (12 hours later)**	Ulipristal acetate per dose (mg)	Ethinyl estradiol per dose (μg)	Levonorgestrel per dose (mg)***
Ulipristal Acetate Pills						
Ella	Watson	1 white pill	None**	30	—	—
Progestin-only Pills						
Levonorgestrel tablets	Perrigo	2 white pills	None**	—	—	1.5
Next Choice	Watson	2 peach pills	None**	—	—	1.5
Next Choice One Dose	Watson	1 peach pill	None	—	—	1.5
Plan B One-Step	Teva	1 white pill	None	—	—	1.5
Combination Progestin and Estrogen Pills						
Altavera	Sandoz	4 peach pills	4 peach pills	—	120	0.60
Amethia	Watson	4 white pills	4 white pills	—	120	0.60
Amethia Lo	Watson	5 white pills	5 white pills	—	100	0.50
Amethyst	Watson	6 white pills	6 white pills	—	120	0.54
Lessina	Teva	5 pink pills	5 pink pills	—	100	0.50
Levora	Watson	4 white pills	4 white pills	—	120	0.60
Lo/Ovral	Akrimax	4 white pills	4 white pills	—	120	0.60
Low-Ogestrel	Watson	4 white pills	4 white pills	—	120	0.60
Nordette	Teva	4 light orange pills	4 light orange pills	—	120	0.60
Ogestrel	Watson	2 white pills	2 white pills	—	100	0.50
Seasonale	Teva	4 pink pills	4 pink pills	—	120	0.60
Seasonique	Teva	4 light blue-green pills	4 light blue-green pills	—	120	0.60

Adapted from http://ec.princeton.edu/questions/dose.html. A complete list can be found at the web site.

* ella, Plan B One-Step, Next Choice One Dose, Next Choice, and levonorgestrel tablets are the only dedicated products specifically marketed for emergency contraception. The regular oral contraceptives listed above have been declared safe and effective for use as ECPs by the United States Food and Drug Administration. Outside the United States, about 100 emergency contraceptive products are specifically packaged, labeled, and marketed. Levonorgestrel-only ECPs are available either over-the-counter or from a pharmacist without having to see a clinician in 60 countries. In the U.S., Plan B One-Step, Next Choice One Dose, Next Choice, and levonorgestrel pills are available over-the counter to women and men aged 17 and older. Younger patients can purchase these pills with a prescription. ella is available by prescription only.

** The labels for Next Choice and levonorgestrel tablets say to take one pill within 72 hours after unprotected intercourse, and another pill 12 hours later. However, recent research has found that both pills can be taken at the same time. All of the brands listed here may be effective when used within 120 hours after unprotected sex, but should be taken as soon as possible.

*** The progestin in Lo/Ovral, Low-Ogestrel, and Ogestrel is norgestrel, which contains two isomers, only one of which (levonorgestrel) is bioactive; the amount of norgestrel in each tablet is twice the amount of levonorgestrel.

future contraceptive plans. Teens may ask the provider if emergency contraception will terminate an existing pregnancy. They should be educated that emergency contraception is not an abortive agent. Levonorgestrel works by delaying ovulation, and UPA may prevent ovulation, thus neither will disrupt an already fertilized and implanted pregnancy.[11] Possible side effects to be communicated to the patient can include nausea/vomiting, headaches, and menstrual-like cramping. All patients should have a negative pregnancy test in the emergency department before UPA is prescribed.

Contraindications to Use of Emergency Contraception. For both the Yuzpe method and levonorgestrel emergency contraceptives, the only contraindications to use are allergy to the drugs or current pregnancy (only due to fact that emergency contraception will not be effective in case of confirmed pregnancy).

Legal and Confidentiality Considerations for Emergency Contraception. A physician can prescribe and also provide the so-called "morning-after pill" to the adolescent patient without parental consent or notification.[20,29] In 17 states, it is now required that health care facilities must offer emergency contraception to sexual assault patients.[27] As of 2009, levonorgestrel-only emergency contraception pills are available "behind the counter" with a form of identification for men and women aged 17 years and older in all 50 states. Patients 16 years of age and younger require a prescription from the physician, except in nine states where laws have been passed to allow pharmacists to dispense emergency contraception pills without a prescription. These pharmacists must work in collaboration with a physician or have undergone specialized training to female patients of any age.[11,20,29]

Conclusion

In this review, the important considerations for the adolescent patient with a gynecologic complaint and subjects that are unique to this age group have been discussed. The emergency provider should obtain a complete and confidential history and physical exam. Many chief complaints warrant a consideration of the genitourinary system, as teenage patients are not always forthcoming with gynecologic complaints. This is meant as an overview of the unique issues in treating the adolescent female patient in the emergency department and as an update to the provider on the current topics in the gynecologic health of this population.

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Physician CME Questions

1. What is the most likely cause of recurrent symptoms of chlamydia 3 months after treatment?
   A. re-infection
   B. resistant strain of *Chlamydia*
   C. misdiagnosis at first presentation
   D. insufficient duration of therapy

2. What is the recommended treatment in the non-pregnant teenager with green-yellow discharge and motile pathogens on wet mount?
   A. 7 days of oral metronidazole twice daily
   B. oral fluconazole single dose
   C. IM ceftriaxone single dose
   D. oral metronidazole single dose

3. The most common cause for dysfunctional uterine bleeding in the adolescent patient is anovulatory cycles. Of the endocrine causes for these, the most common cause is:
   A. pituitary adenoma
   B. hypothyroidism
   C. PCOS
   D. congenital adrenal hyperplasia

4. The FDA-approved time frame from unprotected sex to use of levonorgestrel-only emergency contraception is ___ hours, while WHO has shown efficacy up to ___ hours.
   A. 48, 72
   B. 72, 96
   C. 120, 148
   D. 72, 120

5. A 26-year-old woman is seen in your emergency department complaining of vaginal pruritis and thick white discharge. Her exam shows vulvar edema and erythema. Microscopy shows hyphae and vaginal pH is 4.0. The treatment of choice for this patient is:
   A. azithromycin 2 g PO single dose
   B. fluconazole 150 mg PO single dose
   C. metronidazole 2000 mg PO single dose
   D. ceftriaxone 250 mg IM single dose

6. By years 4-5 after menarche, what percentage of menstrual cycles are still anovulatory?
   A. 55%
   B. 75%
   C. 5%
   D. 20%

7. What would be an acceptable treatment of uncomplicated gonorrhea/chlamydia, according to current recommendations by the CDC?
   A. single IM ceftriaxone dose
   B. single IM ceftriaxone dose + single oral azithromycin dose
   C. IV cefepime for resistant pathogen
   D. oral doxycycline 7-day course

8. Which of the following is the most effective method of emergency contraception?
   A. Yuzpe method (estrogen/progesterone)
   B. levonorgestrel 1.5 mg PO ASAP
   C. ulipristal acetate (UPA) 30 mg PO ASAP after negative pregnancy test
   D. copper IUD

9. Which of the following is a major drawback to Yuzpe regimen of emergency contraception versus progesterone-only regimens?
   A. abdominal cramping
   B. infertility
   C. higher rate of treatment failure
   D. vaginal bleeding

10. Which patient likely warrants initiation of OCPs in the ED for irregular vaginal bleeding and outpatient follow-up only?
    A. a patient with a heavier period this month, hemoglobin 7 mg/dL
    B. a patient with hemoglobin 9 mg/dL, orthostatic symptoms
    C. a patient with hemoglobin 11 mg/dL, heavier bleeding for the past 4 periods in a row, with normal vital signs
    D. a patient with a spotting episode in between two normal periods

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Emergency Medicine Reports

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- discuss the differential diagnosis of the particular medical problems discussed in the publication;
- explain both the likely and rare complications that may be associated with the particular medical problems discussed in the publication.

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Gynecologic Complaints in the Adolescent Female

Key Components of the Adolescent History

1. "Have you ever had oral, vaginal, or anal sex?" Oral/vaginal/anal sex may need to be defined for the adolescent patient. Avoid slang terms, but ask specifics to determine risk.
2. "How many partners have you had in your lifetime?" Follow this by distinguishing male/female partners. "Have you had sexual relationships with males, females, or both?" Avoid presumptive terms like "boyfriend."
3. "Have you ever been exposed to sexually transmitted infections?" (Remind the patient of risk factors, including IV drug use, high-risk sexual partners, multiple partners, unprotected sex.)
4. "Have you ever been treated for, diagnosed with, or tested for a sexually transmitted infection such as gonorrhea, chlamydia, syphilis, trichomonas, or warts?"
5. "What methods are you using to protect yourself against a sexually transmitted infection? Do you have any questions about how to protect yourself against sexually transmitted infections?"
6. Similarly, "What methods are you using to protect yourself against pregnancy? Do you have any questions about how to prevent pregnancy?"
7. "Are you and/or your partner using any substances or devices while having sex?" This may identify risk factors for vaginal infections/irritations, dyspareunia, as well as abuse or nonconsensual sex acts. This question should be followed with a screen for inter-partner violence: "Has anyone touched you sexually in a way you didn't want?" "Has anyone hit you or hurt you?"

Management of Dysfunctional Uterine Bleeding

Categories of Bleeding	Treatment Guidelines
Mild (duration of bleeding < 3 months, normal hemoglobin)	• Watch and wait • Track cycle with menstrual calendar • NSAIDs for cramps and to decrease blood flow
Moderate (heavy menses or increased frequency of cycle, mild anemia with hemoglobin 8-10 g/dL)	• If not bleeding now: Start cyclic OCP, medroxyprogesterone acetate, or norethindrone acetate • If bleeding now: Start taper method of monophasic OCPs (30 µg ethinyl estradiol/0.3 mg norgestrel) – One pill Q6h for 2 days, then – One pill Q8h for 2 days, then – One pill Q12h for 2 days, then – One pill daily for 3 days to complete the 21-pill pack – Then start new 21-day pack and take one per day, continue OCPs for 3-6 months, skipping any placebos – Make sure to prescribe anti-emetic to prevent nausea associated with higher estrogen doses – If contraindication to estrogen: – Norethindrone acetate 5-10 mg daily
Severe (hemoglobin < 7 g/dL, hemoglobin < 10 g/dL in patient with heavy bleeding or who is orthostatic)	Should admit and send extended workup. Start treatment with either OCPs (30-50 µg ethinyl estradiol/0.3 mg norgestrel) • One pill Q4h until bleeding stops, then • One pill Q6h for 2 days, then • One pill Q8h for 2 days, then • One pill Q12h for 2 days, then • One pill daily for 3 days to complete the 21-pill pack • Then start new 21-day pack and take one per day, continue OCPs for 3-6 months, skipping any placebos OR Premarin 25 mg IV Q4h until bleeding stops and then start OCPs 1 pill PO QD to provide progesterone to stabilize the endometrium. • Also prescribe: iron supplementation, nausea prophylaxis
Special Considerations	• For patients who cannot tolerate oral medicines, use Premarin 25 mg IV Q4h until bleeding stops, then prescribe OCPs • In patients where estrogen contraindicated, use norethindrone acetate 5-10 mg Q4h, followed by taper

Adapted from Hettler J. Pediatric and Adolescent Gynecology. *Textbook of Pediatric Emergency Medicine.* Lippincott Williams & Wilkins; 2010, and Emans SJ, et al. Delayed puberty and menstrual irregularities. *Pediatric and Adolescent Gynecology* Lippincott Williams & Wilkins; 2005.

Indications for Emergency Contraception

- Unprotected sex
- Sexual assault
- Failure of a contraceptive (i.e., contraceptive vaginal ring in place for more than 5 weeks, contraceptive vaginal ring out for more than 3 hours, broken condom, missed doses of oral/vaginal/injection contraceptives)

Diagnosis and Management of Common Gynecologic Infections

Disease	Symptoms	Signs	Testing	Treatment**	Clinical Considerations
Bacterial Vaginosis (BV)*	Thin, gray discharge with fishy odor, especially after sex	Gray discharge coating vaginal walls	• Positive whiff amine test • Vaginal pH > 4.5 • Clue cells > 20%	• Oral (500 mg BID for 7 days) OR vaginal metronidazole • Oral OR vaginal clindamycin	Risk factor for STI infection/transmission
Genital HSV	• Primary: Painful genital lesions, dysuria, fever, malaise • Recurrent: Less severe, genital lesions only	Multiple shallow, erythematous, painful ulcers	• Viral culture and PCR (most sensitive) from base of ruptured ulcer • Serology, less useful in acute period	• Treat all primary infections due to severity of symptoms and to shorten duration of primary infection • CDC's 2010 recommendations, all 10-day courses: — Acyclovir 400 mg PO TID — Famciclovir 250 mg PO TID — Valacyclovir 1000 mg PO BID	• To treat or not treat recurrence left to patient/doctor discretion Recurrent: • CDC's 2010 recommendations: — Acyclovir 800 mg PO TID x 2 days OR 800 mg PO BID x 5 days — Famciclovir 1000 mg PO BID x 1 day OR 125 mg PO BID x 5 days — Valacyclovir 500 mg PO BID x 3 days OR 1 g once daily x 5 days
Yeast Infection*	"Cottage cheese" discharge, vaginal pruritis, dysuria	Vulvar and vaginal erythema, edema	• KOH with budding yeast and hyphae • pH 4-4.5 (BV has pH > 4.5) • Amine test negative (versus BV)	• Topical azoles available • Single dose oral fluconazole 150 mg often more desirable	• Complicated infections (pregnant, immunocompromised, diabetes) require 2 fluconazole 150 mg doses, taken 3 days apart. • LFT testing not required for either single or two-dose regimens
Trichomonas	• Classic (in 10-30%) green-yellow frothy discharge, pruritus, dysuria • Common: Purulent, thin discharge • Dyspareunia, post-coital bleeding	• Green-yellow frothy discharge • Punctate hemorrhages of vagina and cervix ("strawberry cervix" seen only in 20% of patients)	• Motile trichomonads on wet mount (only in 50-70%) • If not seen, culture or rapid nucleic acid tests	Single-dose oral metronidazole 2000 mg	• Treat sexual partner

*Bacterial vaginosis is not clearly established as sexually transmitted, but rather an imbalance in vaginal flora common in females of child-bearing age. Yeast infections are also not sexually transmitted. Risk factors include pregnancy, diabetes, and antibiotic use.
**For all regimens, please check safety and specialized dosing for treatment in the pregnant patient.

Disease	Symptoms	Signs	Testing	Treatment**	Clinical Considerations
Chlamydia	• 50% asymptomatic • Vaginal discharge, dysuria, bleeding • Symptoms of PID: Low abdominal pain or RUQ pain + lower GU symptoms	• Mucopurulent cervical discharge • Friable, edematous cervix	• Urine, vaginal, or cervical nucleic acid amplification (becoming gold standard) • Cervical culture • Rapid immunoassays (available soon) • Imaging if indicated in PID	• Single dose oral azithromycin 1000 mg OR 7 days oral doxycycline 100 mg twice daily • PID may necessitate admit for IV antibiotics	• Untreated cervicitis can lead to PID, causing infertility or future ectopic pregnancies • Consider partner testing and expedited partner treatment
Gonorrhea	• 50% asymptomatic • Similar to chlamydia with discharge, pruritis, or, if PID, abdominal pain	• Mucopurulent cervical discharge • Friable, edematous cervix	• Urine or vaginal nucleic acid amplification most sensitive and specific • Culture is the test of choice in suspected extragenital infection, plus gives antibiotic sensitivity	• CDC recommendation: Single IM dose ceftriaxone 250 mg • AND single dose oral azithromycin 1 g or 7 days of oral doxycycline 100 mg twice daily	• PID, infertility, ectopic pregnancy • Disseminated gonococcal infection • Pharyngeal infections • Consider partner testing and treatment
Syphilis	• Primary: Painless papule then chancre • Secondary: Constitutional symptoms, rash of palms/soles, alopecia, CNS infection • Latent: CNS, cardiovascular	• Primary: Raised ulceration, inguinal lymphadenopathy • Secondary: Rash is discrete reddish-brown, scaly lesions, or condyloma lata. Lymph nodes, hard and rubbery, especially epitrochlear	• Initial (sensitive) serology testing for ED: VDRL, RPR • Follow-up testing if above positive, more specific treponemal serology testing such as FTA-ABS	• Primary, secondary, or early latent: benzathine penicillin G • Latent: 3 weekly doses benzathine penicillin G	• Infection raises risk of HIV acquisition and transmission • Treatment may provoke Jarisch-Herxheimer reaction • Consider partner testing and treatment
HIV	• Consider acute infection in the differential for flu or mononucleosis-like illness	• Rash • Lymph nodes • Mucocutaneous ulcers	• HIV rapid antibody test BUT may be initially negative • Also send RNA viral load, as acute HIV associated with high levels of viremia (even with negative antibody test)	• Urgent referral for workup and initiation of HAART treatment	• Partner notification, testing • Key is level of suspicion; opportunity to catch the HIV infection in the acute phase

**For all regimens, please check safety and specialized dosing in the treatment in the pregnant patient.

Supplement to *Emergency Medicine Reports*, July 14, 2013: "Gynecologic Complaints in the Adolescent Female." *Authors:* **Brianne Jo Steele, MD**, Stanford Kaiser Emergency Medicine Residency. **Sophia Yen, MD, MPH**, Assistant Professor, Division of Adolescent Medicine, Department of Pediatrics, Lucile Packard Children's Hospital/Stanford University Medical School. **N. Ewen Wang, MD**, Associate Director of Pediatric Emergency Medicine, Division of Emergency Medicine, Department of Surgery, Stanford University Medical School.

Trauma Reports

PRACTICAL, EVIDENCE-BASED REVIEWS IN TRAUMA CARE

Volume 14, Number 4 **July/Aug 2013**

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AHC Media

Pediatric Burns: Current Standard for Assessment and Management

Pediatric burns, with all of their challenging aspects, are a common injury faced by emergency medicine physicians. Burn injuries are painful for the patient, distressing to the parent, and often raise some difficult questions for the physician in regard to recognition and assessment of non-accidental trauma and the clinical dilemma of disposition. The authors review the current standard for recognition, evaluation, and management of pediatric burn injuries.

— Ann M. Dietrich, MD, Editor

Introduction

The purpose of this article is to review the epidemiology, pathophysiology, evaluation, differential diagnosis, management, and complications associated with pediatric burns. The article identifies risk factors for pediatric patients affected by burns, the mechanism of burn injury, and the morbidity and mortality associated with pediatric burns. Additionally, this article discusses basic physiology and definitions of the various subclasses of burns, as well as the unique pathophysiology of the pediatric population. A systemized approach to the initial evaluation of the pediatric burn patient is presented, with a discussion of other less common but potentially life-threatening diseases that present in a manner similar to burn injuries. The authors address the key laboratory studies necessary when managing the pediatric burn patient. In addition, the article discusses the various components of pediatric burn treatment, from the initial stabilization and basic management to considerations of fluid administration, use of blood products, antibiotics, nutrition and, ultimately, of surgical care. The authors address potential complications of burn injuries and provide a brief discussion on their management. Finally, the article discusses disposition of the pediatric burn patient, including criteria for admission and transfer.

Epidemiology

Burns are a significant cause of morbidity and mortality throughout the world. Children comprise 29% of all burn victims.[1,2] Burns are a leading cause of accidental death in the pediatric population; they are the third leading cause of accidental death after motor vehicle deaths and drowning.[1] Burn injuries account for nearly 120,000 ED visits for patients younger than the age of 20.[1,3] Although potentially life-threatening, the majority of pediatric burns are minor and do not require admission.[4] One large study cited an overall mortality of less than 3% for burn injuries.[5] However, mortality rates are higher for children younger than 4 years of age.[6]

Burns are defined as caused by a variety of sources, including heat, electricity, chemicals, radiation, and friction. This article will focus primarily on assessment and management of thermal burns.

Children typically develop their motor skills before abstract thinking and reasoning. Thus, as they become more mobile and explore their environment, they often put themselves in danger from many sources that can lead to burns.

Executive Summary

- Young children require as little as 15% total body surface area (TBSA) to trigger a systemic response. As they age, the percentage needed to trigger an inflammatory response increases.
- Children involved in closed-space fires are more likely to sustain inhalation injury as the result of their relative immobility and impaired ability to escape.
- First-degree burns are typically moist, red, painful, and without blistering and are not included in BSA calculations.
- The practitioner must maintain a suspicion for nonaccidental trauma (NAT) when the history and physical exam do not correlate with findings, when there is a delay in seeking care, when there is concern for neglect or lack of supervision, or when specific burn patterns are present.

Common mechanisms for burn injuries in children often include biting electric cords, exposure to hot bath water, and spilling of hot liquids. Among pediatric burn injuries, scalds are the most common form of burns worldwide.[4,7,8] These frequently occur in the home, primarily in the kitchen and bathroom, and most commonly affect children younger than the age of 5 years. In addition to age, crowded homes, unsupervised play, low socioeconomic status, younger unmarried mothers, and lack of maternal education all are associated with increased risk for scald injuries.[9] Among children older than the age of 5 years, flame and fire-related injuries become more prominent. In the pediatric population, as with adults, males tend to be more commonly affected than females.[1]

Table 1. Temperature/Time Exposure Relationships

Temperature Moritz (°F/°C)	Time to achieve third-degree burn (seconds)
155/68	1
140/60	5
127/52	60
124/51	180
120/48	300
100/37	Safe for bathing

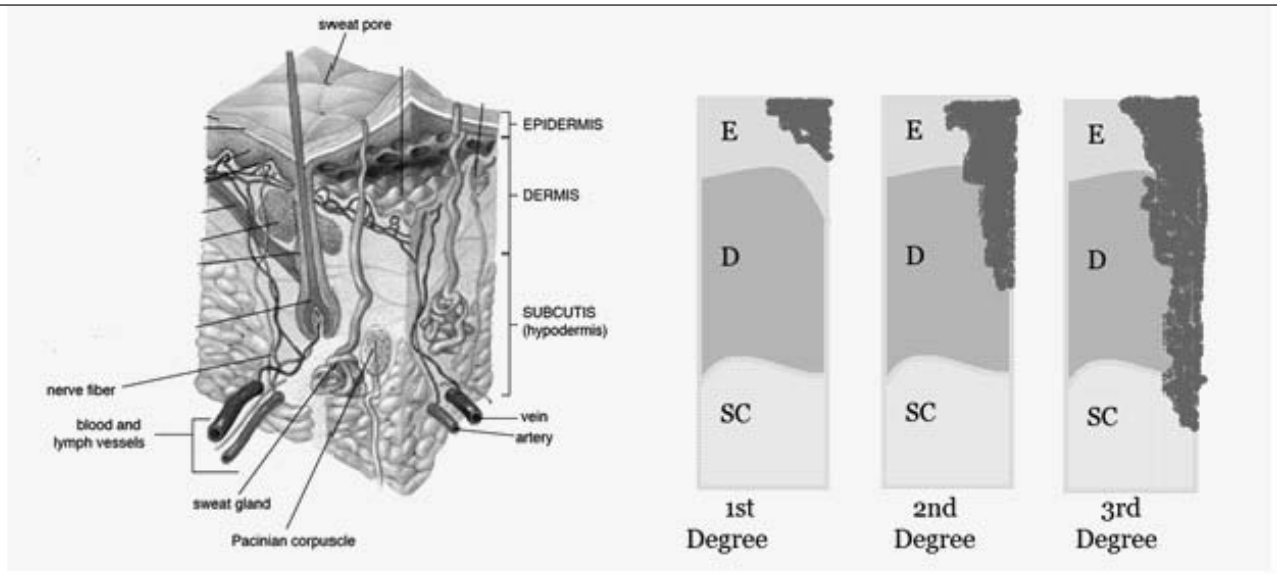
Pathophysiology

A common truth in medicine is that "children are not little adults." This principle applies to pediatric burn injuries as well. Children have thinner skin and less developed mechanisms of thermoregulation than adults; this is especially true for infants. As a result, children tend to get deeper burns, lose heat more rapidly, have more insensible fluid loss, and require less exposure time to produce significant damage. In addition, children have higher overall fluid requirements than their adult counterparts. They also have more volatile immune systems that allow them to mount a greater systemic inflammatory response to burn injuries. In children, even small burns can trigger this diffuse immune response.

Young children require as little as 15% total body surface area (TBSA) to trigger a systemic response. As they age, the percentage needed to trigger an inflammatory response increases.[10] This response usually occurs in the latter portion of the first 24 hours and can manifest as shock or systemic inflammatory response syndrome (SIRS). Components of the inflammatory response include tissue release of cytokines, free radicals, and prostaglandins. As a result of this release of chemical mediators and inflammatory markers, the capillary bed becomes "leaky," resulting in decreased intravascular volume and local edema. Secondly, this massive release of chemicals results in neutropenia, malfunctioning T-cells, and subsequent suppression of the immune system. The hematologic system is also affected, with red blood cells (RBCs) being destroyed by free radicals, direct thermal injury, and formation of microthrombi at the site of the burn. Several other organ systems are affected by the systemic response. The gastrointestinal system responds with increased permeability of the gut and decreased motility. The cardiovascular system is impacted by increasing catecholamine output, producing hypermetabolic state and subsequent myocardial depression.[11,12]

The systemic response to burns occurs in a relatively predictable manner. The "ebb" occurs in the first 48 hours and usually includes decreases in cardiac output (CO), decreased oxygen consumption, and hyperglycemia secondary to impaired glucose tolerance. Over the next five days or so is a state referred to as "flow." In the flow state, the previously depressed functions gradually rise to a catabolic state, then plateau throughout wound healing and recovery. This catabolic state can

Figure 1. Burn Depth



Key:
E = epidermis; D = dermis; SC = subcutis

persist long beyond the initial recovery, resulting in muscle loss, growth delay, and poor wound healing.[13,14]

The skin is the body's first line of defense. Burns occur when the skin comes into contact with hot or caustic material. Temperatures as low at 40° Celsius can cause significant injury to pediatric patients secondary to the thin nature of their skin. In addition, damage to the tissue can continue even after the source of the burn is removed. As a result of the burn injury, the tissues coagulate and have decreased blood flow, leading to hypoxia, accumulation of toxins, and further tissue damage.

The depth of the burn is determined by several factors, including the source of the burn, time exposed to the source, pressure of the source, and the temperature. Exposure to higher temperature under significant pressure over a longer period of time will likely cause a deeper, more severe burn. In 1947, Moritz established temperature/time exposure relationships.[15] These experiments were conducted in normal adults and, to this day, remain the reference standard for all burn injuries. One must take into account that given the unique feature of the pediatric integument system, these exposure times may be markedly reduced in this population. Diller et al attempted to address this in 2006 and came to the conclusion that a correction factor should be applied to children. These authors suggested a proposed correction of 3-4°F reduction in temperature from Moritz's original work.[16] In addition, Moritz's exposure times are in regard to third-degree burns, and one must consider that deep second-degree burns have comparable severity.[15] (*See Table 1.*)

The nomenclature for describing burns has changed in the last several years and will be addressed and defined here. (*See Figure 1.*)

The least invasive class of burns is first degree. This type of burn does not go deeper than the epidermis. First-degree burns, also referred to as superficial burns, are typically moist, red, painful, and without blistering. These rarely require medical treatment. Calculations of body surface area affected should not include first-degree burns. Second-degree burns can be further subdivided into partial and full thickness burns. Partial-thickness second-degree burns, also known as superficial partial-thickness burns, extend beyond the epidermis but only involve the top layers of the dermis. These burns are moist, red, and painful with blistering. A classic example of this type of injury is a blistering sunburn. These burns typically do not involve the vasculature or nerves, so they have intact sensation and will blanch. Full-thickness second-degree burns, also known as deep partial thickness burns, involve the dermis but extend into much deeper levels. They are often moist, red, hemorrhagic, blistering, and painful. Deep partial-thickness burns typically have diminished sensation secondary to nerve damage and often have delayed capillary refill secondary to vascular damage. Depending on the extent of surface area involved, deep second-degree burns may be treated surgically like third-degree burns. Second-degree burns are included in BSA estimates for the purpose of triage and fluid resuscitation. Third-degree burns, also known as full-thickness burns, extend beyond the dermis into the subcutaneous tissue. In contrast to superficial and partial-thickness burns, these burns are insensate and dry. The skin will often have a

Table 2. Lund-Browder Method

	0-1 year	1-4 years	5-9 Years	10-14 years	15-Adult
Head	19	17	13	11	9
Thigh (each)	5.5	6.5	8	8.5	9
Leg (each)	5	5	5.5	6	6.5
Torso	26	26	26	26	26
Arm (each)	4	4	4	4	4
Forearm	3	3	3	3	3
Hand	3	3	3	3	3
Buttock	5	5	5	5	5
Genitalia	1	1	1	1	1
Foot (each)	3.5	3.5	3.5	3.5	3.5
Neck	1	1	1	1	1
Numbers presented as percentage TBSA					

Table 3. Rule of Nines

	Adult	Child
Head	9	18
Torso (front and back)	18	28
Arm (each)	9	9
Leg (each)	18	14
Genitalia	1	1
Numbers presented as percentage TBSA		

black or white, waxy appearance. Treatment of these burn injuries often requires surgical debridement and grafting. The final class of burns is fourth degree. These burns extend beyond the subcutaneous tissue into the deep bone and muscle. These burns appear very similar to third-degree burns on clinical examination.

Deeper burns have predictable patterns of injury. The center of the burn is referred to as the zone of coagulation. This area sustains irreversible damage and consists of non-viable tissue. The zone of ischemia is the layer adjacent to the zone of coagulation. Tissue in this region is subject to reversible microvascular injury. This zone is the most responsive to resuscitation. If adequately resuscitated, tissue in this area may be recoverable; if not, it can become necrotic and devitalized. The outermost zone is the zone of hyperemia. This area is subject to vasodilatation in response to the local inflammatory changes. The tissue in this area does not suffer irreversible injury and is usually viable. If inadequate fluid resuscitation is given, any of these zones are prone to expand.

The depth of the burn and structures affected allows the physician to classify the burn as mild, moderate, or severe. This, unfortunately, allows for a discrepancy between physicians and doesn't account for the dynamic nature of the burn.

In addition to the burn injury, the physician must consider whether an inhalation injury is present. Inhalation injuries should be suspected if the burn occurred in a closed space, especially when there are clinical findings of stridor, hoarseness, drooling, facial burns, soot in the sputum or airway, or singed nasal hair. As the heat from closed-space fires circulates through the airway, it causes edema to the tissue. The amount of edema can be potentiated by any concomitant toxins released from the burning material. Toxins may also produce direct damage to the tissue from their chemical properties. In response to this insult, the body mounts an inflammatory response, which includes neutrophils, cytokines, and free radicals. After the acute injury, the vasculature becomes leaky, producing an acute respiratory distress syndrome-like (ARDS) picture; the patient develops hypoxia and has bilateral infiltrates on chest radiograph. This reaction, in addition to the systemic effects of the burn, makes the patient prone to develop pneumonia. In the early stage, *Staphylococcus aureus* is the most common culprit, whereas later

Pseudomonas predominates. Since children more commonly suffer from scald injuries, they have a lower incidence of inhalation injury than their adult counterparts. Despite this fact, the incidence of inhalation injury is still about 30% in pediatric burn patients.[5,17,18] However, children involved in closed-space fires are more likely to sustain an inhalation injury as the result of their relative immobility and impaired ability to escape. When they sustain inhalation injuries, pediatric patients suffer more extensive damage because of their higher minute ventilation and smaller airways. Almost 50% of deaths from burn injuries can be attributed to inhalation injury. These deaths are usually the result of carbon monoxide toxicity and hypoxia.[19]

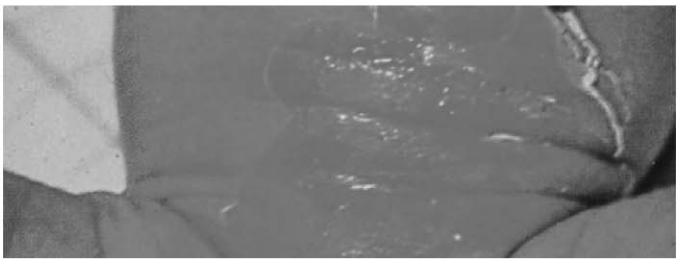
In addition to the increase in morbidity and mortality, inhalation injuries also can significantly alter management. When inhalation injury is present, the managing physician must increase the volume of fluids administered.[20] The details of evaluation and management of these injuries will be discussed in subsequent sections.

Differential Diagnosis

Typically, a history of fire or exposure to a source (chemical, electrical, thermal, or radiation) is available upon patient presentation. However, in the rare occurrence it is not available, other conditions should be considered that may appear similar to a burn. Some of these conditions are staphylococcal scalded skin syndrome (*see Figure 2*), toxic shock syndrome, Kawasaki's disease, Stevens-Johnson syndrome, and toxic epidermal necrolysis. While an extensive discussion of these diseases is beyond the scope of this paper, the authors mention them as a consideration in evaluation of the patient with a burn-like picture if history is unavailable.

Additionally, the practitioner must maintain a suspicion for non-accidental trauma (NAT) when the history and physical exam do not correlate with findings, when there is a delay in seeking care, when there is concern for neglect or lack of supervision, or when specific burn patterns are present (these will be discussed in the next section). The incidence of abuse and neglect as a cause of pediatric burns varies from almost 2-25%. The true incidence is likely higher since the reported numbers were generated using data collected with varying methods. Standard definitions of abuse often exclude neglect.[21,22,23] If the practitioner suspects abuse, social workers and the local department of family and children's services need to be contacted, as suspicion of child abuse falls under the mandatory reporting laws in the United States. The specifics of these laws vary slightly by state. It is vital that the practitioner be aware of his or her state's policies. Specific state policies can be found online at www.childwelfare.gov.

Figure 2. Staphylococcal Scalded Skin Syndrome



Initial Evaluation

When evaluating the pediatric burn patient, a thorough history is critical. Components of the history should include time of occurrence, source of burn, duration of exposure, situation leading up to exposure, as well as methods of treatment prior to arrival. In addition, a thorough past medical history is essential, including tetanus status, co-morbidities such as respiratory disease, immune compromising diseases, diabetes, and cardiovascular problems. These historical components are essential because they portend a higher morbidity and mortality and may help guide treatment and the decision to transfer.

As with any critically ill or injured patient, it is imperative to proceed in a methodical and organized manner when assessing a pediatric burn patient. The American College of Surgeons (ACS) and American Burn Association (ABA) suggest following the primary and secondary surveys as described in the Advanced Trauma Life Support (ATLS) course.[24]

Begin with an assessment of the airway. In doing so, the practitioner must not only consider current airway compromise, but also should take note of concerning findings and anticipate a possible decline in airway patency. Emergent and immediate control of the airway with endotracheal intubation should be performed if any of the following are present: altered mental status, hypoxia, stridor, drooling, oropharyngeal edema, marked tachypnea, or apnea. Additional concerning findings include hoarse voice, oropharyngeal erythema and edema, singed facial hairs and soot in oropharynx, or carbonaceous sputum. These should prompt frequent repeated assessments of the child's airway. Methods of airway control will be discussed further in the management section.

Once the airway is assessed, the practitioner should assess the quality and quantity of respirations. One should note the presence of wheezing, rales, or stridor, as well as tachypnea and increased work of breathing, including the use of accessory muscles. Assess for burns on the chest and neck. Large burns to the chest and neck, especially those that are circumferential, may be

Figure 3. Grill Burn

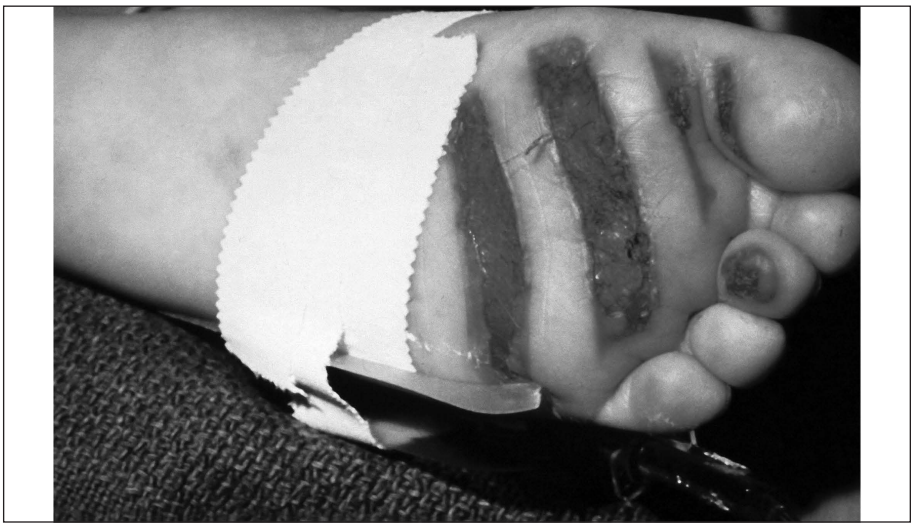


Table 4. Grades of Ocular Burns

Grade	Appearance	Prognosis
I	Corneal ulceration, no limbal ischemia	Good
II	Steamy cornea with some limbal ischemia and injection of conjunctiva	Good
III	Corneal opacification, loss of iris detail, moderate amount of limbal ischemia	Guarded
IV	Cornea opaque, iris and pupil obscured, large amount of limbal ischemia	Poor*
*Improving prognosis with current day therapies		

constrictive and significantly compromise ventilation. If significant burns involving the chest are present, one may need to progress to escharotomy, which will be discussed under management.

The next area to be addressed is the circulatory system. Assessment of the circulation includes checking pulses and capillary refill, especially in extremities affected by the burn. If pulses are absent or there is a marked delay in capillary refill, one should again consider escharotomy to restore perfusion to the affected limb. Another means of assessing circulation is by measuring blood pressure. Most burn patients do not initially present with hypotension. It should be noted, however, that early in the course of a burn, hypotension is rare and should prompt good fluid resuscitation as well as an assessment for internal bleeding. SIRS and sepsis are later findings. The appropriate manner of resuscitation and fluid administration will be discussed later, but is similar to other trauma assessments. Until the airway, breathing, circulation, disability, and exposure, including removal of all clothing and a thorough inspection of the skin (i.e., primary survey), are assessed, managed, and stabilized, one should not proceed. After full exposure, one should do a thorough assessment of the burn. This will be described in more detail below with the secondary survey.

Evaluation of the Burn

The next step of assessment is an estimation of the extent of burn injury. This is important in guiding therapeutic interventions and triage decisions and often correlates with the potential morbidity and mortality. There are several validated methods for estimating the extent of burns in the pediatric population. Two commonly used methods are the Lund-Browder method and rule of nines. (*See Tables 2 and 3.*) As a result of their disproportionately large heads, children cannot accurately be assessed using the same means as adults. As a general rule, the pediatric patient's palm, including fingers, provides an estimate equivalent of about 1% TBSA. While all burns need be documented, only superficial partial thickness burns and those that are deeper second-, third-, and fourth-degree burns are included in calculations for fluid administration. In general, the initial estimation of TBSA involvement is often incorrect secondary to inexperience with burn estimation and failure to fully clean and expose the patient. Also burns can often evolve in the first 24 hours.[25]

When assessing burn injuries, the practitioner should pay special attention to the shape and extent of the burn. Specific patterns should raise concern for NAT and neglect. Some of these patterns include burns in the shape of a hot object, such as the imprint of a utensil or curling iron, as well as cigarette burns and lighter burns. (*See Figure 3.*) A stocking glove distribution of burns arises from the child being forcefully placed into hot water. This pattern should raise suspicion for submersion injury and abuse. Finally, genital burns should cause the practitioner to consider NAT, as previously mentioned.

Following full burn assessment, one should proceed with a complete secondary survey of the patient. This should include palpation of all bony surfaces as well as an assessment of pelvic stability. In addition, one

should assess the abdomen for distention and tenderness and carefully examine the genitourinary region. Concomitant trauma is not uncommon in burn patients and can be missed if a thorough survey is not performed.

Special consideration should be given to the eye examination, especially in chemical and flash burns. Ocular burns can be broken down into four categories. Grades 1 and 2 are minor with small ulceration, chemosis, and conjunctival erythema. Grades 3 and 4 affect the deeper structures and appear often with corneal opacification, dark thrombosed vasculature, and iridocyclitis. (*See Table 4.*) To fully assess for ocular involvement, one should stain the eyes with fluorescein and look with a slit lamp or Wood's lamp. Increased uptake suggests corneal involvement. When ocular injury is suspected, one should begin with copious irrigation of the eye using 500-1000 mL of normal saline, clean water, or other irrigation fluid for at least 15 minutes to a goal of neutral pH of 7. If ocular involvement is discovered, one should treat with a topical ocular antibiotic and arrange close follow-up within 24 hours with an ophthalmologist. The use of ocular steroids should be discussed. More severe eye injuries (grades 3 and 4) require emergent ophthalmology consultation and often result in surgical exploration and debridement.[26]

Diagnostic Testing

After a full assessment of the burn victim is complete, the practitioner should consider further diagnostic testing. This may include chest radiographs, imaging of any injured areas, and CT scan of the head in patients with an altered mental status. Laboratory studies to consider include carboxyhemoglobin, cyanide levels, type and cross, complete blood count, chemistries, urinalysis, urine myoglobin, creatinine kinase, coagulation studies, and blood gases.

Early Management

Airway Management. Management of the burned pediatric patient proceeds in a stepwise progression, beginning with management of the airway. The physician must be aware of the dynamic nature of the airway in a burned child. Failure to consider inhalation injury and improper or delayed management of the critical airway is one of the most frequent causes of adverse events in the pediatric burn patient.[27] The presence of inhalational injury dramatically increases mortality in burn victims,[28,29] and in the acute setting, burn-specific insults can result in abrupt airway collapse. External injuries can also complicate the airway with eschar formation of the chest or circumferential burns of the neck constricting the airway and impeding ventilation mechanics.[30,31]

If there is concern for impending airway collapse, a definitive airway should be established. Conventional induction and paralyzing agents are acceptable, with the caveat that succinylcholine should be avoided in the patient who presents 48 hours after injury, as severe burns can result in delayed onset hyperkalemia.[32] (*See Table 5.*) In the pediatric patient who does not require intubation, there is still a role for sedation and analgesia, particularly in the acute phase of decontamination, cleaning, and debridement of burns. The effectiveness of ketamine or various opioids in concert with benzodiazepines has been well demonstrated.[33,34] (*See Table 5.*) There is also increasing evidence that dexmedetomidine can serve as an effective replacement for benzodiazepines.[35,36]

Approximately 80% of fire-related deaths are due not to the injury itself, but to the inhalation of toxic products[28], most notably carbon monoxide (CO) and hydrogen cyanide gases (CN). Various toxins have a profound effect on lung parenchyma, both via direct alveolar

Table 5. Analgesics, Sedatives, and Paralytics for Pediatric Burn Patients

Drug	Intravenous Dosages
Analgesics	
Morphine	0.1-0.2 mg/kg
Fentanyl	1.0-3.0 ug/kg
Ketorolac	0.5 mg/kg (max dose 30 mg)
Hydromorphone	0.015 mg/kg
Sedatives	
Midazolam	0.05-0.10 mg/kg
Diazepam	0.2 mg/kg (max dose 10 mg)
Lorazepam	0.05 mg/kg (max dose 2 mg)
Diprivan	1.0-2.0 mg/kg (loading), 50-100 ug/kg/min (infusion)
Etomidate	0.15 mg/kg (sedation); 0.3 mg/kg (induction)
Dexmetomidine[37]	0.5-2 ug/kg (sedation); 0.1-2 ug/kg/hr (infusion)
Other	
Ketamine	0.5-2.0 mg/kg
Paralytics	
Succinylcholine	1.0-2.0 mg/kg
Vecuronium	0.1-0.2 mg/kg
Rocuronium	0.5-1.0 mg/kg

Table 6. Common Antidotes for Cyanide Toxicity

Antidote	Pediatric Dosing
Hydroxocobalamin	70 mg/kg up to adult dose of 5 g, administered IV over 15 minutes, then a second dose of the same given over 15-120 minutes, as clinically indicated
Sodium thiosulfate	500 mg/kg up to the adult dose of 12.5 g, administered IV over 10-30 minutes, then a second administration of half the initial dose given at 2 hours if symptoms persist
Sodium nitrite	Administer 0.2 mL/kg of 3% sodium nitrite solution intravenously, not to exceed 300 mg; repeated at half the initial dose if symptoms of cyanide toxicity persist/reappear

destruction and impedance of ciliary function. Exposure to smoke triggers an inflammatory cascade that increases bronchial vessel permeability and leads to pulmonary edema. This localized destruction, in combination with the subsequent sloughing of necrotized respiratory epithelium and interstitial congestion, results in hypoxia.

In addition to direct alveolar and bronchial effects, compounds such as CO and CN are absorbed and produce systemic toxicity. The increased affinity of CO for hemoglobin shifts the oxygen dissociation curve to the left, impairing diffusion of oxygen into the tissues. Management of CO toxicity involves initial supportive care, primarily through the administration of 100% humidified, normobaric oxygen, which reduces the elimination half-life of CO from 5 to 6 hours to approximately 30 to 90 minutes. Further reduction in half-life to 30 minutes is possible with the utilization of hyperbaric oxygen therapy (HBOT).[38] The goal of HBOT is to prevent delayed neuropsychological sequelae in the form of cognitive impairments and affective disorders that manifest days to months after exposure.

There are limited data to indicate exactly when HBOT is indicated in pediatric patients.[39,40] Studies in adult populations suggest benefits in patients with acute CO exposure in patients with loss of consciousness, and those with higher COHb levels at presentation.

CN uncouples oxidative phosphorylation within mitochondria, derailing aerobic metabolism and resulting in formation of lactic acid. CN is managed with high-flow oxygen as well as concomitant administration of one of the four classes of antidote. These include hydroxocobalamin, sodium thiosulfate, dicobalt edetate, and methemoglobin-forming compounds.[41] (*See Table 6.*)

The mainstay for refractory hypoxia from inhalational injury-related pulmonary edema is ventilator support. The goal is to improve oxygenation while minimizing ventilator-induced lung injury. Unfortunately, limited data exist to suggest which settings lead to the best outcomes in the pediatric population. One 2004 survey produced no consensus among pediatric burn centers regarding the application of various ventilator modes in the setting of acute respiratory failure, as well as the use of cuffed endotracheal tubes and the timing of tracheostomy.[42]

Small studies have demonstrated the effectiveness of less conventional ventilator therapies, including high-frequency percussive ventilation, high-frequency oscillatory ventilation,[43] extracorporeal membrane oxygenation (ECMO) in refractory patients,[44] and even the use of surfactant as an adjunct,[45] but further study is needed to elucidate the effectiveness of these alternative therapies. A full discussion of these therapies is beyond the scope of this article.

Fluid Resuscitation

As with adults, adequate fluid resuscitation and maintenance of euvolemia is a critical component in the management of pediatric burns. The causes of hypotension in burn patients are multifactorial and include evaporative fluid losses, extravascular fluid shifts, and inflammatory responses related to the burn itself, as well as from subsequent infection. Inadequate resuscitation leads to renal and hepatic dysfunction.[46,47] Restoring and maintaining adequate perfusion can prevent late complications, including multisystem organ failure. The efficacy of fluid resuscitation in burned children is dependent on time to intervention. Prompt initiation is associated with a lower incidence of sepsis and renal failure, fewer deaths with cardiac arrest, and lower overall mortality.[48]

The Parkland formula provides an early estimate for 24-hour fluid volume requirements for resuscitation. Fluid requirements are calculated by multiplying 4 milliliters per kilogram body mass (ml/kg) by the estimated percentage total body surface area (TBSA) of second- and third-degree burns for the first 24 hours (4 mL/kg/% BSA). Half of the calculated volume is administered in the first 8 hours following injury and the remainder during the subsequent 16 hours.

Although the Parkland formula is well established as a guideline for fluid resuscitation, it has been recently challenged.[49] Multiple studies have demonstrated a subset

of patients in which the Parkland Formula inaccurately estimates necessary replacement.[50,51] Identification of these specific populations in which high fluid volumes have produced poor outcomes has changed the basis of concern from inadequate resuscitation of burn patients to over-resuscitation.[52]

The clinical consequences of over resuscitation, first described by Pruitt[53] as "fluid creep" are manifest in the form of ARDS, pneumonia, bloodstream infections, multiple organ failure, compartment syndromes of both the abdomen and non-traumatic limbs, and death.[54,55] Recognition of this complication has led to the utilization of alternative products for initial resuscitation, including hypertonic fluids and colloids,[56,57] the clinical effectiveness of which has not yet been conclusively demonstrated. Despite this, a number of burn centers use colloid replacement therapy in pediatric patients in whom isotonic crystalloid replacement does not prove adequate. Colloids have not demonstrated a survival benefit in these patients.[58,59,60] Limited data suggest that using invasive hemodynamic monitoring to guide fluid resuscitation results in a lower incidence of sepsis and mortality at a similar infection rate, and that using such monitoring achieves similar rates of urine output in critically burned patient with less volume.[61]

As most severe burns are complicated by anemia, blood products are viewed as an often necessary supplement to intravenous crystalloids for volume replacement. However, blood transfusions are not a benign therapy, and associated complications may occur. Some studies have demonstrated a correlation between increased transfusion products in trauma and increased mortality[62] and, as such, the current trend is to minimize transfused blood products.[63] The details of transfusion ratios and techniques are beyond the scope of this article.

Escharotomy

Escharotomy is the surgical release of restrictive, inelastic tissue when such tissue begins to compromise physiological function (e.g., neurovascular function in an extremity, tracheal obstruction, or severely limited chest wall motion). Prior to commencing, the patient should receive proper analgesia, either local

Figure 4. Large Second- and Third-Degree Burns to Torso and Extremities with Escharotomy

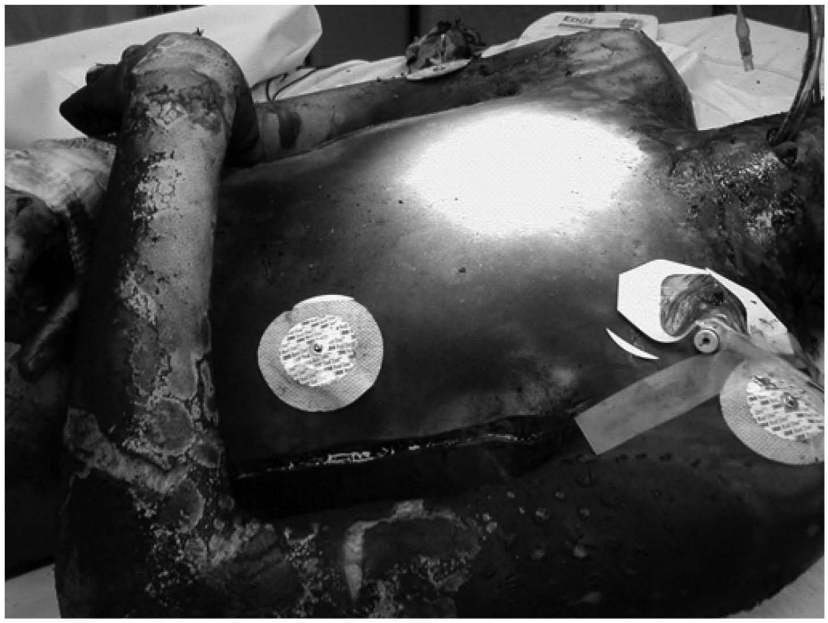


Photo courtesy of Dr. Colin Kaide

Figure 5. Close-up of Escharotomy Incision

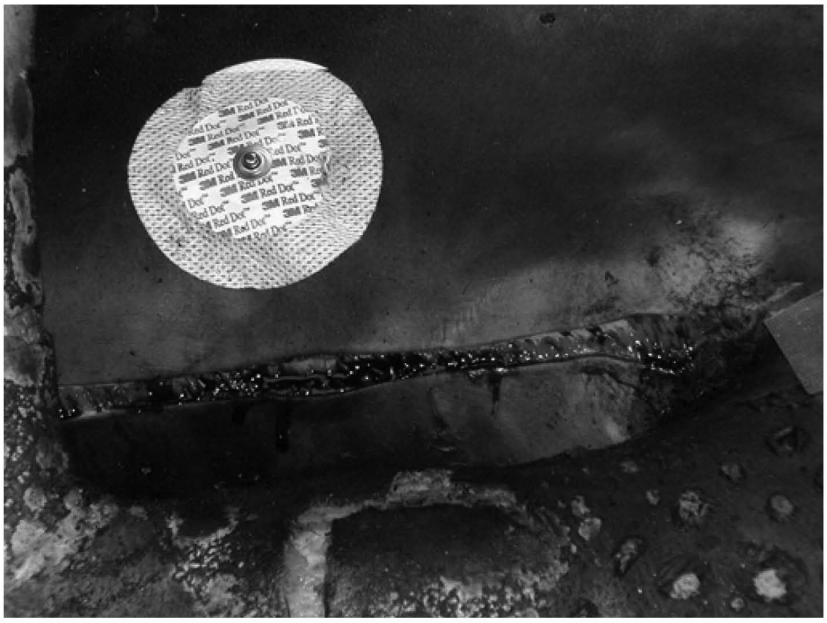


Photo courtesy of Dr. Colin Kaide

Table 7. ABA Indications for Transfer to a Burn Center

- Second-degree burns (partial thickness) of greater than 10% of the body surface area (BSA)
- Third-degree burns (full thickness) in any age group
- Burns involving:
  - Signs or symptoms of inhalation injury
  - Respiratory distress
  - The face
  - The ears (serious full-thickness burns or burns involving the ear canal or drums)
  - The mouth and throat
  - Deep or excessive burns of the hands, feet, genitalia, major joints, or perineum
- Electrical injury or burn (including lightning)
- Burns associated with trauma or complicating medical conditions
- Chemical burns
- Burn injury in patients who will require special social, emotional, or rehabilitative intervention
- Burned children in hospitals without qualified personnel or equipment for the care of children

or systemic, as time allows. For the physician unfamiliar with the technique, the incision should be made to the depth of the subcutaneous fat.

For limbs, the lateral and medial aspects of the involved extremity are incised with a scalpel 1 cm proximal to the burned area, extending 1 cm distal to the burn. Neck escharotomy should be performed longitudinally along the lateral posterior aspect of the neck to avoid the critical vascular structures. In the case of full-thickness circumferential chest burns, the incision should extend from the clavicle to the costal margin bilaterally and link transverse incisions as dictated by the area of the burn.[68] (*See Figures 4 and 5.*)

Wound

The primary early complications of burn wounds are volume losses and infection secondary to interruption of the dermal barrier. Later, there is disruption of mechanical function related to contracture formation. Once the injured area has been cleared of obstructive debris and/or any chemical agents that might augment injury, efforts should be directed at cleansing the wound and debriding necrotic tissue. These steps allow for better visualization of the wound, identification of wound margins, and the removal of devitalized tissue that has the potential to serve as a nidus for infection. Cleaning typically consists of gentle mechanical scrubbing with soap and water. When blisters are encountered, the practitioner should attempt to leave them intact, since unroofing them may lead to slightly higher infection rates and more patient discomfort.

Tetanus vaccination status should be addressed and updated as necessary. Before the advent of effective tetanus prophylaxis, 20% of the patients sustaining major thermal injury died of tetanus infection.[69]

Burns with an intact epidermis do not require antimicrobial prophylaxis or complex dressings, but for patients with deeper burns, consideration should be given to dressing type and antimicrobial agents. Maintaining wounds at low colonization levels reduces the frequency and duration of septic episodes caused by wound contamination from skin flora.[70] Systemic antimicrobial agents do not reach burn wounds in sufficient concentrations due to thrombosis of capillaries and wound edema, which compresses local vasculature. Therefore, their use is not routinely recommended. However, topical agents do successfully delay colonization of organisms and keep wound flora to a minimum. When preparing a patient for transfer to a burn center, a clean or sterile dry towel/sheet should be placed over the burned area without any additional medications or dressings.

Historically, application of antimicrobial agents such as mafenide acetate, 1% silver sulfadiazine, or bacitracin in combination with synthetic bandages has been the standard of care,[71] but these agents are slowly being replaced by more advanced artificial skin and biosynthetic dressings.

Biosynthetic dressings such as Mepilex, Biobrane, beta-glucagon collagen, and hydrocolloid improve wound healing by promoting early epithelialization. Occasionally, the application of these will be requested by the burn specialist. Some, such as Mepilex Ag, have the added benefit of intrinsic antimicrobial properties and can be used independently of topical antibiotics. Early studies suggest they provide a wide range of benefits in the form of less-frequent dressing changes, facilitation of outpatient versus inpatient therapy, increased patient comfort, and decreased incidence of operative intervention.[72,73,74] Studies have not consistently demonstrated a benefit of one dressing type over another, and practice varies from institution to institution.

Ultimately, those burns that are too extensive or complicated to be managed with dressings require definitive surgical management in the form of excision and reconstruction using skin grafts. Early excision has consistently been shown to decrease hospital length of stay and mortality.[75,76,77]

Nutrition

Nutrition is of critical importance

following a severe burn. The goal is to provide nutritional supplementation within 48 hours of injury. Extensive burn trauma leads to both a hypermetabolic and catabolic state, in which the patient is at risk for malnutrition and progressive weight loss for an interval extending for at least 9–12 months after injury.[78] This discrepancy between protein/energy supply and demand manifests clinically with delayed wound healing, muscle wasting, and immunocompromise during recovery. A number of regulatory molecules contribute to this consumptive state, and future therapies will likely attempt to combat muscle breakdown via a combination of anabolic proteins, anabolic steroids, and anti-catabolic agents.[79] The details of the complex caloric needs of the pediatric burn patient are beyond the scope of this article.

Psychological Support

In the pediatric patient, the physical damage of a severe burn injury is often accompanied by psychological stress. Acutely, this presents as internalizing behaviors such as anxiety and withdrawal, and externalizing behaviors, such as those characterized by oppositional defiant disorder. These represent healthy coping mechanisms, which may help children deal with their situation.[87]

More concerning is the potential to develop behaviors or attitudes that are dysfunctional. Children must deal with a host of complications. In addition to anxiety and post-traumatic stress disorder (PTSD) symptoms, they may have difficulty with social interaction, self-esteem issues, or problems with body image (related to scarring).[88] This is compounded by whatever functional deficits they have acquired as a result of the burn injury itself. The authors of one study concluded that 15–20% of children developed a negative psychosocial outcome as a result of burn trauma.[89]

An increasing body of literature reveals extensive psychosocial and familial challenges and suggests that there is utility in recruiting professional psychological help for pediatric trauma survivors and their families in the aftermath of a burn injury.[90]

Complications

Infection is the most common complication of pediatric burns.[91,92] Infectious complications include urinary tract infection, pneumonia, wound infection, and line infection. The practitioner should have a high suspicion for infection in the pediatric burn patient with fever, leukocytosis, malaise, rash, or altered mental status. Urinary tract infections (UTIs) due to prolonged Foley catheter use are more common in pediatric burn patients than adults and are the leading complication of burns in children younger than age 16 years.[2,92] Cellulitis closely follows UTIs in rates of complication.[2] In addition to the common pathogens *Staphylococcus* and *Streptococcus*, one should be aware of pathogens unique to burn patients, such as *Pseudomonas*, yeast, and fungus. As with other hospitalized and immune-compromised patients, providers should be cognizant of the potential for resistant organisms when choosing antimicrobials.[93,94] The third most common infection is pneumonia. As with non-burned patients, the risk of pneumonia is increased with mechanical ventilation.[93] In addition, inhalation injury alone also increases the risk of pneumonia.[95]

Pediatric burn victims are also prone to septicemia and fungemia, with sepsis being the leading cause of mortality in pediatric burn patients.[94,95]

As expected, larger, deeper burns and indwelling lines increase the risk for nosocomial infection.[96] Treatment for these conditions includes antibiotics and supportive care. Prophylactic antibiotics are not indicated.[93] Prevention consists of early wound closure, infection control programs, minimizing ventilator days, and meticulous catheter care. In addition, the use of central lines should be reserved to the ICU setting or in cases in which peripheral access cannot be obtained.

Renal failure is a less common and often less severe complication of pediatric burns. The etiology is often secondary to inadequate resuscitation of the burn patient. Given the fact that most children do not have underlying kidney disease, renal function tends to recover well with fluid resuscitation.[97]

In contrast to renal failure, abdominal compartment syndrome (ACS) is a phenomenon that develops in burn patients as a result of adequate or over-resuscitation. ACS is present when intra-abdominal pressure consistently measures greater than 20 mm Hg and there are signs of end organ damage. Burns induce ABS through several mechanisms, including over-resuscitation, direct compression due to circumferential burns, and increased mesenteric vascular resistance and subsequent inflammatory cascades. Early recognition and prompt treatment of ACS is essential to minimizing end organ damage, restoring perfusion, and improving outcomes.[98,99]

Disposition

The decision to discharge, admit, or transfer the pediatric burn patient is one that is not always clear. To assist in this, the ABA has established guidelines for transfer to a tertiary burn center. (*See Table 7.*)

The majority of pediatric burns are minor, as previously discussed. Admission rates for pediatric burns are relatively low, ranging from 4-10%. Most first-degree burns and burns less than 10% often can be sent home with close outpatient follow-up. Social work should be involved in burns suspicious for NAT or the patient should be admitted for further investigation to prevent exposing the child to further abuse and injury.[7,100-104]

Prevention

The prevention of pediatric burns by making parents and children aware of environmental contributors is as important as the recognition and evidence-based management of burn injuries. The ABA has made a concerted effort in the area of burn prevention, as have many pediatric advocacy groups and local burn

Table 8. Pearls of Pediatric Burns

- Consider NAT as a cause of burn.
- Early, aggressive airway control is essential.
- Use the rule of 9s to assess TBSA of second-, third-, and fourth-degree burns. If unable to remember rule of 9s, the patient's palm equals 1% TBSA.
- Resuscitate using Parkland formula
  - 4 mL/kg/% TBSA
  - half of this volume over first 8 hours, and second half over the next 16 hours
- Be knowledgeable about transfer criteria and transfer early and appropriately.

centers. Efforts include suggesting a lower temperature setting of 120°F on residential water heaters to reduce the incidence of scald injuries. Simple measures such as teaching parents to turn pot handles to the back, being cognizant of electrical cord location, using non-slip mats, not heating infant bottles in a microwave, applying outlet covers, and never leaving children unsupervised in the kitchen are being employed to reduce burn injuries. As practitioners, it is important to review and reinforce these concepts when one encounters parents with a child, especially one with a burn, to prevent future injury.

Conclusion

Burns are a significant problem affecting the pediatric population. In addition to the physical disfigurement of burn injuries, they carry a psychological burden that can leave a lifelong impact on the child and family. Pediatric burn patients can be very complex. An organized approach to the assessment and management of the pediatric burn patient assures the best outcome. Early control of the airway and appropriate fluid management are critical determinants of good outcomes for this population. Proper assessment and evaluation of the burn injury ensures patients are dispositioned to the adequate level of care. It is crucial that the physician understand the unique medical and psychological complications of pediatric burns, enabling early recognition and intervention to minimize long-term disability. (*See Table 8.*)

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CME/CNE Objectives

Upon completing this program, the participants will be able to:

- discuss conditions that should increase suspicion for traumatic injuries;
- describe the various modalities used to identify different traumatic conditions;
- cite methods of quickly stabilizing and managing patients; and
- identify possible complications that may occur with traumatic injuries.

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CME/CNE Questions

1. A burn that involves the dermis and epidermis is classified as:
   A. first degree
   B. second degree
   C. third degree
   D. fourth degree

2. A burn that is insensate is classified as:
   A. first degree
   B. second degree
   C. third degree
   D. fourth degree

3. Which of the following *does not* require transfer to a burn center?
   A. a child with genital burns
   B. a child with second-degree burns over the entire anterior chest and right anterior thigh
   C. a child with circumferential second-degree burns of a finger
   D. All of the above should be sent to a pediatric burn center.

4. A 5-year-old child has a second-degree splash burn to the anterior chest, anterior right thigh, and anterior right upper extremity. What is the TBSA?
   A. 10%
   B. 15%
   C. 20%
   D. 25%

5. If the previously mentioned 5-year-old weighs 20 kg, what is the total amount of fluids the child should receive in the first 24 hours?
   A. 800 mL
   B. 1000 mL
   C. 1600 mL
   D. 2000 mL

6. Which of the following is an indication for early intubation?
   A. hoarse voice
   B. carbonaceous sputum
   C. drooling
   D. all of the above
7. Which of the following is an indication for escharotomy?
   A. circumferential extremity burn
   B. poor ventilatory compliance with significant chest wall burn
   C. abdominal wall burn
   D. all of the above
8. Children involved in closed-space fires are more likely to sustain inhalation injury as the result of their relative immobility and impaired ability to escape.
   A. true
   B. false
9. Young children require as little as what percentage total body surface area (TBSA) to trigger a systemic response?
   A. 1%
   B. 5%
   C. 25%
   D. 15%
10. Which of the following statements is true regarding nutritional needs of burn patients?
   A. Patients are only at risk for malnutrition and progressive weight loss for the first three months after injury.
   B. Patients may experience symptoms such as delayed wound healing, muscle wasting, and immunocompromise during recovery.
   C. Extensive burn trauma leads to a hypermetabolic state, but not a catabolic state.
   D. Extensive burn trauma leads to a catabolic state, but not a hypermetabolic state.
11. Which of the following factors in the history and physical exam of burn injuries should cause the practitioner to maintain suspicion of non-accidental trauma?
   A. when the history and physical exam do not correlate with findings
   B. when there is a delay in seeking care
   C. when there is concern for neglect or lack of supervision
   D. when specific burn patterns are present
   E. all of the above
12. Which of the following is the leading complication of burns in children younger than 16 years of age?
   A. urinary tract infection from prolonged Foley catheter use
   B. wound infection
   C. pneumonia
   D. line infection

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Upon completion of this educational activity, participants should be able to:

- discuss conditions that should increase suspicion for traumatic injuries;
- describe the various modalities used to identify different traumatic conditions;
- cite methods of quickly stabilizing and managing patients; and
- identify possible complications that may occur with traumatic injuries.

The American Medical Association, which oversees the Physician's Recognition Award and credit system and allows AHC Media to award *AMA PRA Category 1 Credit ™*, has changed its requirements for awarding *AMA PRA Category 1 Credit ™*. Enduring materials, like this newsletter, are now required to include an assessment of the learner's performance; the activity provider can award credit only if a minimum performance level is met. AHC Media considered several ways of meeting these new AMA requirements and chose the most expedient method for our learners.

HERE ARE THE STEPS YOU NEED TO TAKE TO EARN CREDIT FOR THIS ACTIVITY:

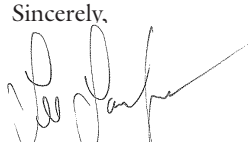
1. Read and study the activity, using the provided references for further research.
2. Log on to **www.cmecity.com** to take a post-test; tests can be taken after each issue or collectively at the end of the semester. *First-time users will have to register on the site using the 8-digit subscriber number printed on their mailing label, invoice, or renewal notice.*
3. Pass the online tests with a score of 100%; you will be allowed to answer the questions as many times as needed to achieve a score of 100%.
4. After successfully completing the last test of the semester, your browser will be automatically directed to the activity evaluation form, which you will submit online.
5. **Once the completed evaluation is received, a credit letter will be e-mailed to you instantly.** You will not have to wait to receive your credit letter!

This activity is valid 24 months from the date of publication. The target audience for this activity includes emergency medicine and family physicians.

If you have any questions about the process, please call us at (800) 688-2421, or outside the U.S. at (404) 262-5476. You can also fax us at (800) 284-3291, or outside the U.S. at (404) 262-5560. You can also email us at: customerservice@ahcmedia.com.

On behalf of AHC Media, we thank you for your trust and look forward to a continuing education partnership.

Sincerely,



Lee Landenberger
Continuing Education Director
AHC Media