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Approach to the Pediatric Patient with HIV in the Emergency Department

Definition of Problem

During the past 20 years, rates of pediatric human immunodeficiency virus-1 (HIV) and acquired immunodeficiency syndrome (AIDS) have decreased dramatically. With the advent of life-saving combined antiretroviral therapy (cART), HIV-infected infants, children, and adolescents are less likely to present to the emergency department (ED) with HIV-related disease progression, including opportunistic infection and malignancies. As frontline health care providers, ED physicians should be comfortable with recognizing and diagnosing perinatally acquired HIV in infants and children who were missed in the perinatal period, as well as adolescents who may be newly infected with HIV. Familiarity with antiretroviral medications, their associated toxicities, and clinically relevant drug-drug interactions is useful. Lastly, ED physicians are occasionally called on to provide counseling and prophylaxis medications for children and adolescents exposed to HIV inadvertently through needlesticks, mucous membranes, or sexual abuse.

Epidemiology

HIV may be acquired either vertically or horizontally. Vertical, or perinatal, transmission occurs when the virus is transmitted from mother to child in utero, during labor and delivery, or through breastfeeding. Horizontal transmission occurs when the virus is acquired behaviorally through the exchange of bodily fluids, typically through sexual contact or needle sharing.

In 2010, an estimated 10,798 persons younger than 13 years of age with perinatally acquired HIV were living in the United States, approximately half of whom had progressed to AIDS. Perinatally acquired AIDS cases peaked in 1992 and have decreased by more than 95% in the past two decades, with only 334 new cases between 2008 and 2011.[1,2] Of children who are perinatally infected with HIV, most are diagnosed shortly after birth, and the majority are diagnosed within the first 24 months of life.

In contrast to perinatally acquired infections, approximately 39,034 adolescents and young adults aged 13 to 24 were living with HIV in the United States in 2010.[1,3] In 2011, there were approximately 2,317 newly acquired cases of HIV in the United States in patients between 13 and 19 years of age. Of these adolescents, 92.8% of the males acquired HIV through males having sex with males (MSM), while 92.7% of the females acquired HIV through heterosexual contact.[3]

EXECUTIVE SUMMARY

- The incidence of perinatal-acquired HIV infection has substantially declined in the United States due to widespread testing and treatment, along with changes in delivery modes and limitation of breastfeeding.
- The vast majority of acquired HIV infection in adolescents is from males having sex with males.
- Consider acute HIV syndrome in adolescents who present with fever, lymphadenopathy, skin rash, sore throat, myalgias, arthralgias, headache, diarrhea, oral ulcers, leukopenia, thrombocytopenia, transaminase elevation, or aseptic meningitis.
- Use the CD4 count, if available within the past three months, to evaluate the degree of immunosuppression and the potential for an opportunistic infection in the febrile HIV patient.
- Most serious infections in HIV patients are similar to those found in non-HIV-infected patients: pneumonia, urinary tract, and sepsis.

Etiology: Perinatal Transmission

The decrease in perinatal HIV transmission from mother to child is due to a variety of factors, including increased awareness and education, early diagnosis of HIV in pregnant mothers, use of early cART during pregnancy, changes in recommendations for mode of delivery, and recommendations to limit breastfeeding in HIV-positive mothers. With these interventions, the rate of perinatal transmission in non-breastfeeding HIV-infected mothers has dropped from 25-40% to less than 2%.[4-10] The majority of perinatal HIV occurs in women who were poorly adherent to their antiretroviral therapy, received inadequate or no prenatal care, or were infected with HIV late in pregnancy.

Etiology: Behaviorally Acquired Cases

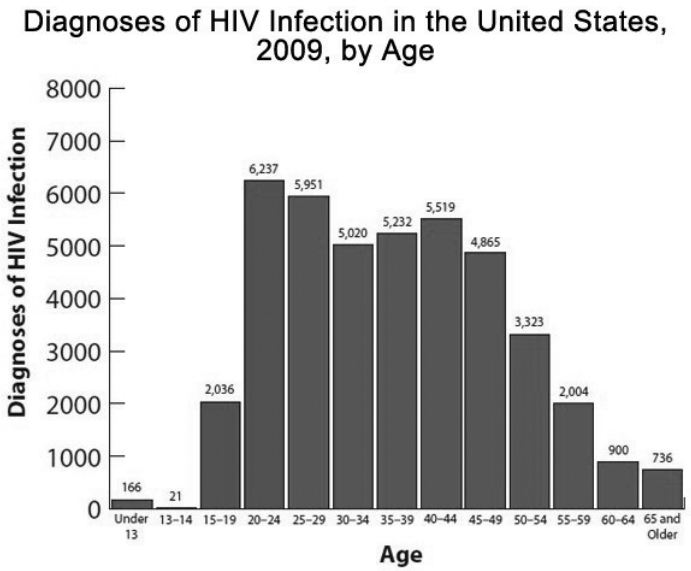
U.S. data from 2010 show that among adults with newly acquired HIV, 25% acquired the virus heterosexually, 63% via MSM, and 11% outside of the setting of sexual contact — typically through intravenous drug use (IVDU). Adolescents and young adults aged 15-24 are at high risk for acquiring HIV infection due increased risk factors and decreased rates of screening. (*See Figure 1.*)[11]

Pathophysiology

After exposure to HIV, CD4 T-cells and Langerhans' cells in the mucosa serve as an initial site of viral replication.[12,13] The virus continues to replicate as the CD4 T-cells migrate to lymphatic tissues throughout the body.[13] During this time, there is rapid viral replication, destruction of reservoirs of CD4 T-cells, and establishment of viral latency.[13]

After the period of acute HIV infection, the amount of HIV-1 viral copies detected in plasma, known as the viral load (VL), stabilizes and then declines to a viral set point. The virus continues to replicate in lymphoid tissues throughout the body, leading to a continued increased rate of turnover of CD4 T-cells.[12] In addition to alteration in the numbers of T-cells, the quality of T-cells is affected as well, leading to alteration in immune response and progression of HIV disease.[12] Antibodies that neutralize the transmitted virus are usually produced within six weeks of initial infection, but in some infected individuals, they may not be produced for at least three months after initial infection.[14] (*See Figure 2.*)

Figure 1. HIV Infection by Age



Reprinted from: CDC. http://www.cdc.gov/hiv/risk/age/youth/index.html

Natural History of HIV in Children

With the advent of antiretroviral therapy in the 1990s and continued advancements during the past two decades, patients with HIV/AIDS in the developed world are now living longer. However, pediatric patients with perinatally acquired HIV still have a mortality rate that is about 30 times higher than the general U.S. pediatric population.[15,16]

As HIV progresses, CD4 T-lymphocytes become depleted, leading to lower CD4 percentages and lower CD4/CD8 ratio, resulting in increased risk for opportunistic infection and AIDS.[17] Without cART, 15-20% of HIV-infected children die before 4 years of age (rapid progressors), and 80-85% have delayed onset of milder symptoms, surviving beyond 5 years of age (slow progressors).[18] In the United States, the

most common AIDS-defining illnesses are *Pneumocystis jirovecii* pneumonia (previously *Pneumocystis carinii* or PCP), lymphocytic interstitial pneumonitis (LIP), recurrent bacterial infections, wasting syndrome, candida esophagitis, HIV encephalopathy, and cytomegalovirus (CMV) disease.

Per the 2008 CDC guidelines, HIV infection in children is classified clinically (*see Table 1*) and immunologically.[19,20] As of 2014, the CDC revised its classification system for surveillance and based it mainly on CD4 T-lymphocyte counts unless the patient has acute HIV infection (now referred to as stage 0) or a stage 3-defining opportunistic illness. (*See Table 2.*)

Children and Adolescents with Previously Diagnosed HIV/AIDS

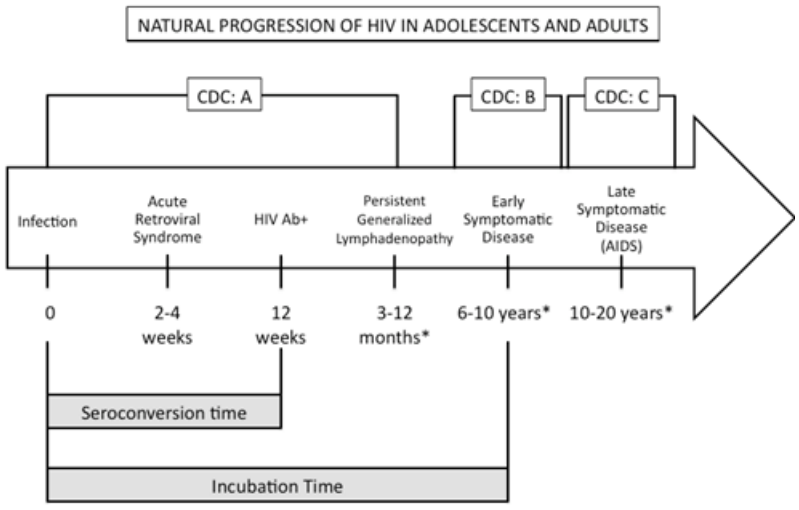
Patients previously diagnosed with HIV/AIDS may or may not be on cART, and compliance is variable. The incidence of opportunistic infections in pediatric patients with HIV/AIDS has dropped since the advent of cART therapy.[21] (*See Table 3.*)

Patients on cART may present with adverse reactions or side effects due to their medications, although current cART is generally well-tolerated. Patients recently initiated on antiretroviral medication may show signs of immune reconstitution inflammatory syndrome (IRIS) (See below: Immune Reconstitution Inflammatory Syndrome). Immunocompromised patients may present with a variety of clinical symptoms, and the differential diagnosis varies based on these presenting complaints and severity of immunosuppression. (See below: Approach to the HIV-infected Patient in the Emergency Department).

Infants and Children with Undiagnosed Perinatally Acquired Infection

For infants and children with undiagnosed perinatally acquired HIV or AIDS, clinical manifestations are often nonspecific. The most common presenting symptoms in the first year of life include lymphadenopathy, unexplained hepatosplenomegaly, oral candidiasis, failure to thrive, and developmental delay. Often, these children and teenagers come to medical attention with recurrent severe or unusual infections. (*See Table 1.*) Children diagnosed late in their childhood are often cared for by families who were unaware of the child's biological mother's HIV diagnosis.

Figure 2. Natural Progression of HIV in Adolescents and Adults



* Timeline varies with individual patients; may be shortened if individual is a rapid progressor.

Adolescents with Acute HIV

The emergency physician should also consider new diagnoses of HIV in the adolescent or adult who may have acute HIV or acute retroviral syndrome (ARS). The diagnosis of ARS should be in the differential for patients who have a high-risk exposure within the previous 2-6 weeks, and are manifesting one or more of the following symptoms: fever, lymphadenopathy, skin rash, sore throat, myalgias, arthralgias, headache, diarrhea, oral ulcers, leukopenia, thrombocytopenia, transaminase elevation, or aseptic meningitis.[22-24] (*See Table 4.*) High-risk exposures include sexual contact with a person with known HIV or at risk for HIV, multiple sexual partners, MSM, exchanging sex for money or drugs, IVDU, and being the sexual partner of an intravenous drug user or someone diagnosed with a new sexually transmitted infection (STI).[23] The other considerations on the differential for these patients include Epstein-Barr virus (EBV) and CMV-related infectious mononucleosis, influenza, viral hepatitis, streptococcal infection, and syphilis.

During this one- to four-week period after HIV infection, the antibodies to the virus may not be detectable in plasma, and HIV screening tests designed to detect HIV antibodies may be negative.[13] (See section: Diagnostic Studies in HIV and AIDS.) During this time, the patient is highly infectious, as the virus is replicating aggressively and the viral load is high.[25,26]

The emergency physician has three responsibilities in cases of acute HIV.[13] First, the ED physician should conduct appropriate testing. Second, there should be counseling for patients with potential acute HIV to prevent continued transmission of the virus and reporting of the infection to the department of health. Third, the ED physician should ensure appropriate outpatient follow up for the patient.

Initiation of antiretroviral medications is typically not an emergency, and requires expert consultation. A clinician may need to start antiretroviral medications in the ED in cases involving post-exposure prophylaxis within 72 hours of exposure to HIV and for prevention of perinatal transmission in pregnant

Table 1. Classification of HIV Infection in Children Younger Than 13 Years of Age

Category N: Not Symptomatic

Children who have no signs or symptoms considered to be the result of HIV infection or who have only one of the conditions listed in Category A.

Category A: Mildly Symptomatic

Children with two or more of the conditions listed below but none of the conditions listed in Categories B and C.

- Lymphadenopathy (≥ 0.5 cm at more than 2 sites; bilateral = one site)
- Hepatomegaly
- Splenomegaly
- Dermatitis
- Parotitis
- Recurrent or persistent upper respiratory infection, sinusitis, or otitis media

Category B: Moderately Symptomatic

Children who have symptomatic conditions other than those listed for Category A or C that are attributed to HIV infection. Examples of conditions in clinical Category B include but are not limited to:

- Anemia (< 8 gm/dL), neutropenia (< 1,000/mm^3), or thrombocytopenia (< 100,000/mm^3) persisting ≥ 30 days
- Bacterial meningitis, pneumonia, or sepsis (single episode)
- Oropharyngeal candidiasis (thrush), persisting > 2 months in children > 6 months of age
- Cardiomyopathy
- Cytomegalovirus (CMV) infection with onset before 1 month of age
- Diarrhea, recurrent or chronic
- Hepatitis
- Herpes simplex virus (HSV) stomatitis, recurrent (> 2 episodes in 1 year)
- HSV bronchitis, pneumonitis, or esophagitis with onset before 1 month of age
- Herpes zoster (shingles) involving at least 2 distinct episodes or more than 1 dermatome
- Leiomyosarcoma
- Lymphoid interstitial pneumonia (LIP) or pulmonary lymphoid hyperplasia complex
- Neuropathy
- Nocardiosis
- Persistent fever (lasting > 1 month)
- Toxoplasmosis, onset before 1 month of age
- Varicella, disseminated

Category C: Severely Symptomatic

Children who have any condition listed in the 1987 surveillance case definition for AIDS, with the exception of LIP.

- Serious bacterial infections, multiple or recurrent (i.e., any combination of at least two culture-confirmed infections within a 2-year period), of the following types: septicemia, pneumonia, meningitis, bone or joint infection, or abscess of an internal organ or body cavity (excluding otitis media, superficial skin or mucosal abscesses, and indwelling catheter-related infections)
- Esophageal or pulmonary candidiasis
- Coccidiomycosis, disseminated (at site other than or in addition to lungs, cervical or hilar lymph nodes)
- Cryptococcosis, extrapulmonary
- Cryptosporidiosis or isosporiasis with diarrhea persisting > 1 month
- Cytomegalovirus disease with onset of symptoms at > 1 month (at a site other than liver, spleen, or lymph nodes)
- Encephalopathy (at least one of the following progressive findings present for at least 2 months in the absence of a concurrent illness other than HIV infection that could explain the findings): failure to attain or loss of developmental milestones or loss of intellectual ability, verified by standard developmental scale or neuropsychological tests; impaired brain growth or acquired microcephaly demonstrated by head circumference measurements or brain atrophy demonstrated by CT or MR imaging (serial imaging is required for children < 2 years of age); acquired symmetric motor deficit manifested by two or more of the following: paresis, pathologic reflexes, ataxia, or gait disturbance
- Herpes simplex virus infection causing a mucocutaneous ulcer that persists for > 1 month; or bronchitis, pneumonitis, or esophagitis for any duration affecting a child > 1 month of age
- Histoplasmosis, disseminated (at a site other than or in addition to lungs or cervical or hilar lymph nodes)
- Kaposi's sarcoma
- Lymphoma, primary, in brain
- Lymphoma, small, noncleaved cell (Burkitt's), or immunoblastic or large cell lymphoma of B-cell or unknown immunologic phenotype
- *Mycobacterium tuberculosis*, disseminated or extrapulmonary
- Mycobacterium, other species or unidentified species, disseminated (at a site other than or in addition to lungs, skin, or cervical or hilar lymph nodes)
- *Mycobacterium avium* complex or *Mycobacterium kansasii*, disseminated (at site other than or in addition to lungs, skin, or cervical or hilar lymph nodes)
- *Pneumocystis jirovecii* pneumonia (PCP)
- Progressive multifocal leukoencephalopathy
- Salmonella (nontyphoid) septicemia, recurrent
- Toxoplasmosis of the brain with onset at > 1 month of age
- Wasting syndrome in the absence of a concurrent illness other than HIV infection that could explain the following findings: a) persistent weight loss > 10% of baseline OR b) downward crossing of at least two of the following percentile lines on the weight-for-age chart (e.g., 95th, 75th, 50th, 25th, 5th) in a child > 1 year of age OR c) < 5 percentile on weight-for-height charge on two consecutive measurements ≥ 30 days apart PLUS a) chronic diarrhea (i.e., at last two loose stools per day for > 30 days) OR b) documented fever for ≥ 30 days, intermittent or constant)

Adapted from: 1994 Revised Classification System for Human Immunodeficiency Virus Infection in Children Less Than 13 Years of Age MMWR. 1994;43:1-10.
Schneider E, Whitmore S, Glynn KM, et al. Revised surveillance case definitions for HIV infection among adults, adolescents, and children aged < 18 months and for HIV infection and AIDS among children aged 18 months to < 13 years — United States, 2008. *MMWR Recomm Rep* 2008;57(RR-10):1-12.

HIV-infected adolescents. In both of these cases, it is prudent to involve experts in the field and hospital protocols to assist with initiation of antiretroviral therapy.

Diagnostic Studies in HIV and AIDS

The appropriate diagnostic studies in patients with suspected or known HIV/AIDS vary depending upon the age of the patient and suspected length of time that the patient has been infected.

Infants Younger than 18 Months of Age. In patients who are younger than 18 months old in whom HIV is suspected, virological testing is recommended.[27,28] Virological testing consists of nucleic acid amplification testing (NAAT) using polymerase chain reaction (PCR) to detect HIV-1 DNA or RNA in serum. Qualitative HIV-1 DNA PCR is typically used in diagnosis, while quantitative HIV-1 RNA PCR assays, also referred to as the viral load (VL), are used for monitoring. Antibody testing is not reliable in this age group due to placental transmission of maternal antibodies. A negative antibody test in a non-breastfed infant older

than 6 months can, however, exclude HIV infection.[17] VL may not be useful in this age group because it may be initially undetectable, even in an infected infant, if mother and infant have been on antiretroviral therapy. If PCR testing is positive, the patient requires repeat confirmatory tests and infectious disease (ID) consultation.[28]

Toddlers Older than 18 Months of Age. In children who are older than 18 months of age and no longer breastfeeding, HIV ELISA antibody testing (first-generation test) is an appropriate screening test. ELISA detects serum IgG antibodies produced against HIV-1 antigens, including p24 (a nucleocapsid protein) and gp 120 and gp 41 (envelope proteins).[28] These antibodies persist for life. Antibody testing may be unreliable during the very late stages of HIV infection, during which there is severe immune suppression.[17] Any positive HIV-1 ELISA requires confirmatory testing with Western blot assays, which are more specific for HIV-1, and, eventually, virological testing with HIV-1 DNA or RNA PCR.

Older Children and Adolescents. In older children, newly developed rapid combined antibody-antigen tests (fourth-generation tests) may be used for screening point-of-care testing.[29] These tests detect both IgG and IgM antibodies and p24 antigen. They may detect HIV p24 antigen during acute infection when antibody formation is not yet detectable. Fourth-generation tests have been shown to have sensitivity and specificity greater than 99%.[29] These tests have not yet been shown to be reliable in infants.[30] Older second-generation tests detect IgG antibodies, while third-generation tests can detect both IgG and IgM, allowing for earlier detection of HIV antibodies. If positive, patients need an ID consult and confirmatory testing.

Acute HIV. In patients for whom there is concern for acute HIV, HIV-1 DNA PCR or p24 antigen testing is appropriate.[13] In this time period immediately after infection, it is too early for antibodies to be present. This is referred to as the "window period," during which the virus is actively replicating, but antibodies cannot be detected. Since fourth-generation HIV tests have combined antibody-antigen testing, they can be useful in detecting acute HIV infection.[31]

Table 2. Immunologic Categories Based on Age-specific CD4+ T-lymphocyte Counts and Percent of Total Lymphocytes

	Age of Child					
	< 12 months		1-5 years		6-12 years	
Immunologic Category	µL	%	µL	%	µL	%
No evidence of suppression (Stage 1)	≥ 1500	≥ 34	≥ 1000	≥ 30	≥ 500	≥ 26
Moderate Suppression (Stage 2)	750-1499	26-33	500-999	22-29	200-499	14-25
Severe Suppression (Stage 3)	< 750	< 26	< 500	< 22	< 200	< 14

Adapted from: Centers for Disease C, Prevention. Revised surveillance case definition for HIV infection — United States, 2014. *MMWR Recomm Rep.* 2014;63(RR-03):1-10.

Monitoring

HIV-infected individuals can be classified through immunologic staging based on their CD4 count or CD4 percentage. In children, the stage is based primarily on the CD4 T-lymphocyte count. The CD4 count takes precedence over the CD4 T-lymphocyte percentage, and the percentage is considered only if the count is unavailable or missing.[32] (*See Table 2.*) Knowing an HIV patient's CD4 count and CD4 percentage is useful to determine their risk for opportunistic infection. VL is also used for monitoring response to antiretroviral therapy and disease progression.

Screening

The CDC, USPSTF, and American Academy of Pediatrics (AAP) all support screening of adolescents for HIV. In the ED setting, this can be accomplished with rapid tests for which results are available in 5-40 minutes.[17] Rapid oral tests are recommended only for children who are 13 years of age or older.

Approach to the HIV-infected Patient in the Emergency Department

When approaching a known HIV-infected patient in the emergency department, it is crucial to establish the patient's level of immune compromise. If the patient has CD4 counts or percentages obtained within the previous three months, these numbers can be used to make this determination (*see Table 2*). If these counts and percentages are not available, the clinician will need a detailed history and physical examination to clinically classify the patient. The clinician should also assess adherence to cART. HIV-infected children and adolescents who have been reliably adherent to their cART therapy likely will not be immunocompromised. Most patients with HIV and AIDS maintain the ability to develop physiologic signs of infection, including localizing symptoms, fever, tachycardia, tachypnea, and hypotension. Profoundly immunocompromised patients, however, may not have the ability to mount a fever or develop localizing symptoms.

Infectious Considerations

As with all patients presenting to the ED with fever or infectious concerns, diagnostic evaluation should begin with a thorough history and physical examination. In patients with a focal source of infection, cultures from that source should be obtained. In patients without a focal source of infection, little evidence exists regarding the most appropriate degree of infectious work-up to pursue. Expert recommendations include obtaining blood cultures for patients

with serious focal infections and those who appear toxic or septic. If severe immune compromise is suspected, obtaining aerobic, anaerobic, and fungal cultures should be considered.

While patients with HIV have a higher incidence of viral and fungal infections than the non-HIV-infected population, HIV-infected patients are more likely to develop and present with bacterial infections. The most common infections in HIV-infected patients are similar to those in patients without HIV, including pneumonia, sepsis, and urinary tract infections, even in the cART era. The incidence of opportunistic infections and other related infections have dropped significantly since the use of cART in children.[21,33] Patients maintained on cART therapy have an incidence of 3.66 serious bacterial infections per 100 person-years, which is similar to that of non-HIV-infected children.[33]

In patients with controlled HIV infection, recommendations for empiric antibiotics are similar to those for uninfected children.[34] For HIV-infected children with severe disease, neutropenia, or nosocomial infection, broader empiric antibiotics are recommended.[34] Patients with HIV have an incidence of neutropenia of 20-34%. This neutropenia is believed to be multifactorial, likely due to both HIV infection and antiretroviral medications. Despite the presence of neutropenia in these patients, it is relatively well-tolerated, and they do not seem to have the same degree of immune compromise as patients who are neutropenic due to oncologic etiologies.[35,36] In patients with severe sepsis or septic shock, there are no clear recommendations regarding whether cART therapy should be continued or temporarily discontinued given the risk of drug interactions, hepatic and cardiac toxicities, pancreatitis, and lactic acidosis associated with various antiretroviral medications.[37]

Respiratory Complaints

When a child with HIV/AIDS and severe immune compromise presents with respiratory complaints, PCP, LIP, and tuberculosis must be high on the differential.

PCP occurs in 40-50% of reported cases of AIDS in children, and is more common in infancy than in older children.[38] Perinatally infected patients often present between 2-6 months of age, and PCP is often the first AIDS-defining illness in children.[39] Patients present with tachypnea, dyspnea, cough, low-grade fever, and a significant degree of hypoxia that is exacerbated with exertion.[38,40] Symptoms worsen over 1-2 weeks prior to presentation. In patients with PCP, chest radiographs typically demonstrate a diffuse interstitial pattern or bilateral opacifications with air bronchograms with "ground-glass" or reticulogranular appearance, but these findings are not always seen.[38,39] Diagnosis is made with nasopharyngeal aspirates, broncho-alveolar lavage samples, or induced sputum samples.[38] Treatment includes supportive therapy with oxygen, high dose trimethoprim/sulfamethoxazole (TMP/SMX), potentially with the addition of steroids. Due to high mortality, especially in infants, when there is a high index of suspicion, PCP therapy should be initiated promptly, along with treatment for bacterial pneumonia, even when investigations are not immediately available. Pentamidine, dapsone, or atovaquone may be used instead of TMP/SMX if the patient is allergic to, or cannot tolerate, the medication. Steroids should be added, and may be life-saving in patients with severe hypoxia or an elevated alveolar-arterial (A-a) gradient.[38,40]

Lymphocytic interstitial pneumonitis occurs in 25-40% of children with perinatally acquired HIV.[38,39] The presentation is insidious, and is particularly common in patients older than 2 years of age. Patients typically present with a nonproductive cough and mild hypoxemia. Generalized lymphadenopathy, bilateral non-tender parotid swelling, and clubbing are also seen. Labs may reveal hypergammaglobulinemia.[39,41] LIP should be considered in children with HIV who have recurrent pneumonias.[38] Definitive diagnosis requires a lung biopsy, which demonstrates diffuse lymphocytic infiltration of the pulmonary interstitium.[38] The CDC criteria for a presumptive diagnosis of LIP in an HIV-infected child require persistence of diffuse, symmetrical, reticulo-nodular or nodular pulmonary opacification with or without mediastinal adenopathy for at least two months. There should be no identifiable pathogen, and no response to antibiotic therapy.[42,43] Treatment of LIP is primarily supportive, but also includes cART therapy and corticosteroids.[44]

Tuberculosis (TB) must also remain in the differential diagnosis for any immunocompromised patient with respiratory symptoms, although TB may also have extrapulmonary manifestations. There is significant overlap between those affected by HIV/AIDS and those affected by TB. Approximately one-third of the world's population is infected with tuberculosis, and it remains a leading killer of people who are HIV-infected.[45] Antiretroviral therapy use is strongly associated with a reduced risk of tuberculosis among HIV-infected children.[46] In the ED, reactivation of LTBI or TB IRIS should remain on the differential for HIV-infected patients with unexplained symptoms (both pulmonary and extrapulmonary), particularly if they have low CD4 counts, high viral loads, have been noncompliant with or recently initiated on cART, come from an area with endemic TB, or were previously incarcerated or homeless.

Neurologic Complaints

Neurologic complaints in children with HIV/AIDS may include headache, seizures, altered mental status, and other unexpected neurologic changes. The two most common opportunistic infections that must be considered are Cryptococcus and Toxoplasmosis.

Cryptococcus neoformans is a ubiquitous encapsulated fungus, and while it is the most common life-threatening fungal infection in HIV-infected adults, it is uncommon in HIV-infected children.[47,48] The most common presentation of cryptococcosis in HIV-infected children is cryptococcal meningitis, which is diagnosed through india ink staining or antigen testing on CSF or antigen testing in the blood.[49] Patients often have indolent courses and prolonged symptoms prior to presentation. Cryptococcal meningitis is treated with extended antifungal therapy, usually amphotericin B with flucytosine.[49,50]

Table 3. Incidence of Opportunistic Infections in the Pre- and Post-HAART Eras in Patients with CD4% < 15

Opportunistic Infection	Pre-cART Incidence Rate Per 100 Person-years	Post-cART Incidence Rate Per 100 Person-years
Herpes zoster	4.8	3.5
Disseminated MAC and other non-TB mycobacteria	5.0	0.9
Pneumocystis jirovecii (PCP)	3.1	0.8
Candidiasis	3.0	0.5

Adapted from: Gona P, Van Dyke RB, Williams PL, et al. Incidence of opportunistic and other infections in HIV-infected children in the HAART era. *JAMA* 2006;296(3):292-300.

Toxoplasma gondii is a single-cell parasite that is found throughout the world.[51] It is acquired through ingestion of contaminated food/water or exposure to cat feces.[51] While more than 80% of healthy infected patients are unaffected, patients with HIV/AIDS are more likely to develop severe disease due to immunosuppression. The risk of infection rises when CD4 counts fall below 100 cells/uL.[51] Toxoplasmosis in patients with HIV/AIDS may be due to a new infection, or reactivation of previously acquired infection. Immunosuppressed patients typically present with fever and encephalitis, characterized by headache, lethargy, impaired coordination, ataxia, dementia, and seizures.[51] The incidence of toxoplasmic encephalitis has decreased since the use of cART.[52,53] Computed tomography (CT) scans of the brain often reveal multiple ring-enhancing lesions. Definitive diagnosis requires tissue biopsy or detection in body fluids, often in combination with serologic testing, especially to differentiate from central nervous system (CNS) lymphoma.[51] Patients with HIV/AIDS and toxoplasmosis should be treated aggressively, as the clinical course may be rapidly fatal.[51] Patients with CD4 counts less than 100 should be on TMP/SMX as prophylaxis against toxoplasmosis (and PCP).[51]

Gastrointestinal Complaints

The most common infectious HIV-related gastrointestinal complaint is oropharyngeal or esophageal candidiasis. Patients with esophageal candidiasis may present with odynophagia, dysphagia, retrosternal chest pain, nausea/vomiting, and/or concomitant oropharyngeal candidiasis.[34] In severely immunocompromised patients or in those with indwelling central venous catheters, candidemia and disseminated candidiasis become risks. Oral candidiasis can be treated with topical antifungal therapy (nystatin suspension or clotrimazole troches), while esophageal or disseminated fungal infection requires systemic therapy.[34]

Other Complications

Patients with long-standing HIV or AIDS may also present with a variety of complaints related to the HIV virus itself. Prior to widespread use of cART therapy, HIV-related neurologic dysfunction was a significant source of morbidity and mortality in HIV-infected children.[54,55] Classically, patients present with cognitive and motor deficits, as well as structural brain damage. Clinical findings in children consist of seizures, headaches, behavioral changes, microcephaly, motor dysfunction, and loss of developmental milestones.[56,57] The most severe manifestation, progressive encephalopathy, is analogous to HIV-associated dementia in adults. Despite these dramatic improvements, HIV-related neurologic changes are still seen in approximately 10% of HIV-infected children and adolescents on neurologic exam and brain imaging.[58]

HIV-associated malignancies include Kaposi's sarcoma (KS), non-Hodgkin's lymphoma, and cervical carcinoma. Approximately 90% of pediatric patients with HIV-associated malignancies have Kaposi's sarcoma.[59] Patients with lower CD4 counts and high viral loads are at higher risk of developing KS.[59,60] Kaposi's sarcoma is a low-grade vascular neoplasm mediated by human herpesvirus-8. Adults with KS typically present with skin findings and generalized lymphadenopathy. Children, on the other hand, typically present without the typical cutaneous findings. Definitive diagnosis requires tissue biopsy.[60]

Table 4. Incidence of Clinical Symptoms Associated with Acute HIV

Clinical Feature	Proportion of Patients (%)
Fever	75
Fatigue	68
Myalgia	49
Skin rash	48
Headache	45
Pharyngitis	40
Cervical lymphadenopathy	39
Arthralgia	30
Night sweats	28
Diarrhea	27

Adapted from: Vanhems P, Dassa C, Lambert J, et al. Comprehensive classification of symptoms and signs reported among 218 patients with acute HIV-1 infection. *J Acquir Immune Defic Syndr* 1999;21(2):99-106.
Daar ES, Pilcher CD, Hecht FM. Clinical presentation and diagnosis of primary HIV-1 infection. *Curr Opin HIV AIDS* 2008;3(1):10-15.

Immune Reconstitution Inflammatory Syndrome

The incidence of pediatric IRIS is 10-20%. In affected patients, it occurs within 12 months after initiation of antiretroviral therapy, usually within one week to three months of starting cART. Risk factors for IRIS include a high pathogen load and a very low CD4 count when antiretroviral therapy is initiated.[61] Patients have acute worsening in clinical condition due to an infectious or inflammatory condition associated with the restoration of their immune system. Clinical deterioration

Table 5. Antiretroviral Medications Used for the Treatment of HIV and AIDS

Protease Inhibitors (PIs)

- Lopinavir
- Atazanavir
- Darunavir
- Ritonavir
- Indinavir
- Saquinavir
- Fosamprenavir
- Tipranavir
- Nelfinavir

Nucleoside/Nucleotide Reverse Transcriptase Inhibitors

- Zidovudine
- Didanosine
- Stavudine
- Lamivudine
- Emtricitabine
- Abacavir
- Tenofovir

Non-nucleoside Reverse Transcriptase Inhibitors

- Efavirenz
- Nevirapine
- Delavirdine
- Etravirine
- Rilpivirine

Fusion Inhibitors

- Maraviroc
- Enfuvirtide

Integrase Inhibitors

- Raltegravir
- Elvitegravir
- Dolutegravir

is due to the unmasking of a subclinical opportunistic infection or the recurrence of a previously treated infection. In these patients, the infectious pathogen is typically easily detectable. The most common causes of IRIS are mycobacterial. BCG (Bacillus Calmette–Guérin) reactivation has also been reported.[62] In order to diagnose IRIS, the patient should have evidence of immunological response to antiviral therapy, clinical worsening due to an infectious or inflammatory condition temporally related to the initiation of ART, and symptoms that are not explained by noncompliance with ART, adverse drug reaction, treatment failure of an opportunistic infection, or an alternative infection/neoplasm.[62] Treatment for IRIS with reactivation of an infection involves antimicrobial treatment as well as supportive care, possibly including anti-inflammatory medications such as nonsteroidal anti-inflammatory medications (NSAIDs) and steroids. While most cases resolve, IRIS may be fatal, especially in younger children.[62]

Medication Adverse Effects and Drug-Drug Interactions

Patients on cART may present with a variety of complaints that are a direct result of their antiretroviral medications. Currently, there are five major categories of medications to control HIV infection. (*See Table 5.*)

Each of these medications has its own potential side effects and adverse effects, and many interact with other medications used on a regular basis.

In general, with the exception of abacavir, all nucleoside reverse transcriptase inhibitors (NRTIs) require dose adjustment in the setting of renal insufficiency.[63] Protease inhibitors (PIs) and non-nucleoside reverse transcriptase inhibitors (NNRTIs) are cleared via the cytochrome P450 system in the liver. Therefore, these medications must be dose-adjusted in the setting of hepatic injury.[64] NRTIs increase a patient's risk of developing pancreatitis, particularly in the setting of low CD4 counts and for those patients with a history of pancreatitis.[65,66] Other potential adverse effects of antiretroviral therapy include bone marrow suppression, lactic acidosis, liver failure, and hypersensitivity reactions. In patients on cART, when clinically indicated, it may be beneficial to obtain a complete blood count with differential, aminotransferase levels, blood urea nitrogen (BUN), serum creatinine, amylase, and lipase to evaluate for medication toxicities.

In addition to medication-specific adverse effects, the clinician should be aware of potential drug-drug interactions. Particular caution should be taken with the use or prescription of antiarrhythmics, ergot medications, various antiepileptic medications, and benzodiazepines. It is prudent to look up each potential drug-drug interaction on websites such as www.drugs.com or the National Institutes of Health (NIH) website.[67,68]

Additional Aspects to Consider

Reporting. HIV is a reportable disease in the United States. All reporting is confidential and name-based. Each state has specific laws and regulations around reporting. They can be found at the CDC website: www.cdc.gov/hiv/policies/law/states/.

Post-Exposure Prophylaxis (PEP). In general, PEP is recommended for any direct exposure of the vagina, anus, penis, mouth, or broken skin with semen, vaginal fluid, or blood — with or without visible injuries, tissue damage, or blood. This includes injuries with exposure to blood from a source either known to be HIV-infected or HIV unknown (for example, sexual abuse, human bites, accidents) and needle-sharing.

Post-exposure prophylaxis has been shown to be most beneficial in the first 72 hours after exposure, and is not recommended outside of this time frame.[69] PEP should be continued for four weeks. If the injured patient is HIV positive at baseline or the source patient is found to be HIV negative, PEP may be discontinued. In addition to starting PEP in appropriate scenarios, follow up should include counseling and testing at baseline and six weeks, three months, and six months after exposure. Patients should also be monitored for PEP toxicities (gastrointestinal disturbances, headache, and fatigue), acute retroviral syndrome, and screened for hepatitis B and C, as well as other STIs.

Low-risk Exposure. Extremely low-risk exposures do not require PEP. Examples include exposure to needles or sharps that have not been in contact with an HIV-infected or at-risk person, human bites not involving blood, kissing, oral sex without ejaculation, or blood exposure or oral-to-oral contact

without mucosal damage. Urine, nasal secretions, saliva, sweat, and tears not visibly contaminated with blood carry a negligible risk for HIV exposure. Most commonly, ED physicians encounter community-acquired needlestick injuries (CA-NSIs). The risk of HIV transmission with such events is very low and typically PEP is not warranted.[70]

Occupational Exposure. The average risk for HIV transmission after a percutaneous exposure to HIV-infected blood is approximately 0.3% (95% CI 0.2-0.5%) and after a mucosal membrane exposure approximately 0.09% (95% CI 0.006-0.5%).[71] Source patients should be tested for HIV infection with either HIV-1 DNA PCR testing or fourth-generation combined antibody-antigen tests. If the fourth-generation (rapid) test is positive, confirmatory testing must be pursued. If testing of the source patient is delayed for any reason, PEP should be started pending test results.[72] A variety of three-drug regimens are appropriate and are given for 28 days. It is prudent to discuss with an occupational health and an ID consultant regarding institution-specific recommendations.

Non-Occupational Exposure. The risk of HIV transmission after non-occupational exposure ranges from 0.005-0.67%, depending on the type of exposure.[69] A variety of two-drug and three-drug regimens exist and are given for 28 days. Consultation with an ID expert regarding institution-specific recommendations is advised.

HIV Testing Consent

As of June 2013, all 50 states and the District of Columbia allow minors to consent to STI services. Of these, 31 states specifically include HIV testing and treatment within the category of STI services. State-specific laws exist regarding verbal and written consent for HIV testing, as well as pre- and post-test counseling. State-specific laws can be found at the CDC website: www.cdc.gov/hiv/policies/law/states/.

Disposition

The ID team should be consulted for any new diagnosis, new opportunistic infection diagnosis, and medication complication or side effect to establish follow up. Antiretroviral therapy should not be discontinued without specific recommendations from an ID or HIV expert.

Summary

Although there has been a decline in pediatric patients with HIV presenting to the emergency department, it remains a complex condition. Fewer patients are presenting with opportunistic infections, but these infections still occur in those who are severely immunocompromised. Additionally, the ED physician should remain alert to recognize patients with undiagnosed perinatal HIV infection, acute retroviral syndrome, and complications of antiretroviral therapy. In general, most pediatric patients with HIV can be approached using the typical emergency department algorithms. Patients with severe immune compromise or advanced HIV/AIDS require consideration of a broader differential diagnosis and lower threshold for diagnostic testing and treatment.

References

1. CDC. Pediatric HIV Surveillance. 2012.
2. Mofenson LM. U.S. Public Health Service Task Force recommendations for use of antiretroviral drugs in pregnant HIV-1-infected women for maternal health and interventions to reduce perinatal HIV-1 transmission in the United States. *MMWR Recomm Rep* 2002;51(RR-18):1-38; quiz CE1-4.
3. CDC. HIV Surveillance in Adolescents and Young Adults. 2012.
4. Cooper ER, Charurat M, Mofenson L, et al. Combination antiretroviral strategies for the treatment of pregnant HIV-1-infected women and prevention of perinatal HIV-1 transmission. *J Acquir Immune Defic Syndr* 2002;29(5):484-494.
5. Forbes JC, Alimenti AM, Singer J, et al. A national review of vertical HIV transmission. *AIDS* 2012;26(6):757-763.
6. Connor EM, Sperling RS, Gelber R, et al. Reduction of maternal-infant transmission of human immunodeficiency virus type 1 with zidovudine treatment. Pediatric AIDS Clinical Trials Group Protocol 076 Study Group. *N Engl J Med* 1994;331(18):1173-1180.
7. ACOG committee opinion scheduled Cesarean delivery and the prevention of vertical transmission of HIV infection. Number 234, May 2000 (replaces number 219, August 1999). *Int J Gynaecol Obstet* 2001;73(3):279-281.
8. Briand N, Jasseron C, Sibiude J, et al. Cesarean section for HIV-infected women in the combination antiretroviral therapies era, 2000-2010. *Am J Obstet Gynecol* 2013;209:335.e1-335.e12.
9. Committee on Pediatric AIDS; Mofenson LM, Flynn PM, Aldrovandi GM, et al. Infant feeding and transmission of human immunodeficiency virus in the United States. *Pediatrics* 2013;131(2):391-396.
10. Nduati R, John G, Mbori-Ngacha D, et al. Effect of breastfeeding and formula feeding on transmission of HIV-1: A randomized clinical trial. *JAMA* 2000;283(9):1167-1174.
11. CDC;Pageshttp://www.cdc.gov/hiv/risk/age/youth/index.html on January 31 2014.
12. Mirza A, Rathore MH. Pediatric HIV infection. *Adv Pediatr* 2012;59(1):9-26.
13. Cohen MS, Shaw GM, McMichael AJ, et al. Acute HIV-1 infection. *N Engl J Med* 2011;364(20):1943-1954.
14. Wei X, Decker JM, Wang S, et al. Antibody neutralization and escape by HIV-1. *Nature* 2003;422(6929):307-312.
15. Brady MT, Oleske JM, Williams PL, et al. Declines in mortality rates and changes in causes of death in HIV-1-infected children during the HAART era. *J Acquir Immune Defic Syndr* 2010;53(1):86-94.
16. Hazra R, Siberry GK, Mofenson LM. Growing up with HIV: Children, adolescents, and young adults with perinatally acquired HIV infection. *Annu Rev Med* 2009;61:169-185.
17. Read JS. Diagnosis of HIV-1 infection in children younger than 18 months in the United States. *Pediatrics* 2007;120(6):e1547-1562.
18. Pickering LK BC, Kimberlin DW, Long SS. *Human Immunodeficiency Virus Infection*. Elk Grove Village, IL: American Academy of Pediatrics; 2012.
19. Centers for Disease Control and Prevention. 1994 Revised Classification System for Human Immunodeficiency Virus Infection in Children Less Than 13 Years of Age *MMWR* 1994;43:1-10.
20. Schneider E, Whitmore S, Glynn KM, et al. Revised surveillance case definitions for HIV infection among adults, adolescents, and children aged < 18 months and for HIV infection and AIDS among children aged 18 months to < 13 years — United States, 2008. *MMWR Recomm Rep* 2008;57(RR-10):1-12.
21. Gona P, Van Dyke RB, Williams PL, et al. Incidence of opportunistic and other infections in HIV-infected children in the HAART era. *JAMA* 2006;296(3):292-300.
22. Vanhems P, Dassa C, Lambert J, et al. Comprehensive classification of symptoms and signs reported among 218 patients

with acute HIV-1 infection. *J Acquir Immune Defic Syndr* 1999;21(2):99-106.

23. Emmanuel PJ, Martinez J. Adolescents and HIV infection: The pediatrician's role in promoting routine testing. *Pediatrics* 2011;128(5):1023-1029.
24. Daar ES, Pilcher CD, Hecht FM. Clinical presentation and diagnosis of primary HIV-1 infection. *Curr Opin HIV AIDS* 2008;3(1):10-15.
25. Eshleman SH, Khaki L, Laeyendecker O, et al. Detection of individuals with acute HIV-1 infection using the ARCHITECT HIV Ag/Ab Combo assay. *J Acquir Immune Defic Syndr* 2009;52(1):121-124.
26. Wawer MJ, Gray RH, Sewankambo NK, et al. Rates of HIV-1 transmission per coital act, by stage of HIV-1 infection, in Rakai, Uganda. *J Infect Dis* 2005;191(9):1403-1409.
27. Camacho-Gonzalez AF, Ross AC, Chakraborty R. The clinical care of the HIV-1-infected infant. *Clin Perinatol* 2010;37(4):873-885, xi.
28. World Health Organization. WHO Recommendations on the Diagnosis of HIV Infection in Infants and Children. 2013/06/07 ed; 2010.
29. Muhlbacher A, Schennach H, van Helden J, et al. Performance evaluation of a new fourth-generation HIV combination antigen-antibody assay. *Med Microbiol Immunol* 2013;202(1):77-86.
30. Bhowan K, Sherman GG. Performance of the first fourth-generation rapid human immunodeficiency virus test in children. *Pediatr Infect Dis J* 2013;32(5):486-488.
31. Detection of acute HIV infection in two evaluations of a new HIV diagnostic testing algorithm — United States, 2011-2013. *MMWR Morb Mortal Wkly Rep* 2013;62(24):489-494.
32. Centers for Disease C, Prevention. Revised surveillance case definition for HIV infection — United States, 2014. *MMWR Recomm Rep* 2014;63(RR-03):1-10.
33. Nachman S, Gona P, Dankner W, et al. The rate of serious bacterial infections among HIV-infected children with immune reconstitution who have discontinued opportunistic infection prophylaxis. *Pediatrics* 2005;115(4):e488-e494.
34. Panel on Opportunistic Infections in HIV-Exposed and HIV-Infected Children. Guidelines for the Prevention and Treatment of Opportunistic Infections in HIV-Exposed and HIV-Infected Children. Department of Health and Human Services. 2013.
35. Moore DA, Benepal T, Portsmouth S, et al. Etiology and natural history of neutropenia in human immunodeficiency virus disease: A prospective study. *Clin Infect Dis* 2001;32(3):469-475.
36. Kuritzkes DR. Neutropenia, neutrophil dysfunction, and bacterial infection in patients with human immunodeficiency virus disease: The role of granulocyte colony-stimulating factor. *Clin Infect Dis* 2000;30(2):256-260.
37. Hatherill M. Sepsis predisposition in children with human immunodeficiency virus. *Pediatr Crit Care Med* 2005;6(3 Suppl):S92-S98.
38. Khare MD, Sharland M. Pulmonary manifestations of pediatric HIV infection. *Indian J Pediatr* 1999;66(6):895-904.
39. Graham SM, Gibb DM. HIV disease and respiratory infection in children. *Br Med Bull* 2002;61:133-150.
40. Saltzman RW, Albin S, Russo P, et al. Clinical conditions associated with PCP in children. *Pediatr Pulmonol* 2012;47(5):510-516.
41. Weber HC, Gie RP, Cotton MF. The challenge of chronic lung disease in HIV-infected children and adolescents. *J Int AIDS Soc* 2013;16:18633.
42. Centers for Disease Control and Prevention. Classification system for human immunodeficiency virus (HIV) infection in children under 13 years of age. *MMWR* 1987;36(15):225-236.
43. Pitcher RD, Beningfield SJ, Zar HJ. Chest radiographic features of lymphocytic interstitial pneumonitis in HIV-infected children. *Clin Radiol* 2010;65(2):150-154.
44. Fan LL, Deterding RR, Langston C. Pediatric interstitial lung disease revisited. *Pediatr Pulmonol* 2004;38(5):369-378.
45. CDC. Reported tuberculosis in the United States, 2012. Department of Health and Human Services. 2013.
46. Li N, Manji KP, Spiegelman D, et al. Incident tuberculosis and risk factors among HIV-infected children in Tanzania. *AIDS* 2013;27(8):1273-1281.
47. Joshi NS, Fisher BT, Prasad PA, et al. Epidemiology of cryptococcal infection in hospitalized children. *Pediatr Infect Dis J* 2010;29(12):e91-e95.
48. Abadi J, Nachman S, Kressel AB, et al. Cryptococcosis in children with AIDS. *Clin Infect Dis* 1999;28(2):309-313.
49. Day JN, Chau TT, Wolbers M, et al. Combination antifungal therapy for cryptococcal meningitis. *N Engl J Med* 2013;368(14):1291-1302.
50. Likasitwattanakul S, Poneprasert B, Sirisanthana V. Cryptococcosis in HIV-infected children. *Southeast Asian J Trop Med Public Health* 2004;35(4):935-939.
51. Robert-Gangneux F, Darde ML. Epidemiology of and diagnostic strategies for toxoplasmosis. *Clin Microbiol Rev* 2012;25(2):264-296.
52. Jones JL, Sehgal M, Maguire JH. Toxoplasmosis-associated deaths among Human Immunodeficiency Virus-infected persons in the United States, 1992-1998. *Clin Infect Dis* 2002;34(8):1161.
53. Abgrall S, Rabaud C, Costagliola D. Incidence and risk factors for toxoplasmic encephalitis in human immunodeficiency virus-infected patients before and during the highly active antiretroviral therapy era. *Clin Infect Dis* 2001;33(10):1747-1755.
54. Gelbard HA, Epstein LG. HIV-1 encephalopathy in children. *Curr Opin Pediatr* 1995;7(6):655-662.
55. Epstein LG, Sharer LR, Oleske JM, et al. Neurologic manifestations of human immunodeficiency virus infection in children. *Pediatrics* 1986;78(4):678-687.
56. van Arnhem LA, Bunders MJ, Scherpbier HJ, et al. Neurologic abnormalities in HIV-1 infected children in the era of combination antiretroviral therapy. *PLoS One* 2013;8(5):e64398.
57. Webb KM, Mactutus CF, Booze RM. The ART of HIV therapies: dopaminergic deficits and future treatments for HIV pediatric encephalopathy. *Expert Rev Anti Infect Ther* 2009;7(2):193-203.
58. Chiriboga CA, Fleishman S, Champion S, et al. Incidence and prevalence of HIV encephalopathy in children with HIV infection receiving highly active antiretroviral therapy (HAART). *J Pediatr* 2005;146(3):402-407.
59. Tukei VJ, Kekitiinwa A, Beasley RP. Prevalence and outcome of HIV-associated malignancies among children. *AIDS* 2011;25(14):1789-1793.
60. Arkin LM, Cox CM, Kovarik CL. Kaposi's sarcoma in the pediatric population: The critical need for a tissue diagnosis. *Pediatr Infect Dis J* 2009;28(5):426-428.
61. Puthanakit T, Aurpibul L, Oberdorfer P, et al. Hospitalization and mortality among HIV-infected children after receiving highly active antiretroviral therapy. *Clin Infect Dis* 2007;44(4):599-604.
62. Boulware DR, Callens S, Pahwa S. Pediatric HIV immune reconstitution inflammatory syndrome. *Curr Opin HIV AIDS* 2008;3(4):461-467.
63. Huang L, Quartin A, Jones D, et al. Intensive care of patients with HIV infection. *N Engl J Med* 2006;355(2):173-181.
64. Akgun KM, Huang L, Morris A, et al. Critical illness in HIV-infected patients in the era of combination antiretroviral therapy. *Proc Am Thorac Soc* 2011;8(3):301-307.
65. Moore RD, Keruly JC, Chaisson RE. Incidence of pancreatitis in HIV-infected

patients receiving nucleoside reverse transcriptase inhibitor drugs. *AIDS* 2001;15(5):617-620.

66. Smith CJ, Olsen CH, Mocroft A, et al. The role of antiretroviral therapy in the incidence of pancreatitis in HIV-positive individuals in the EuroSIDA study. *AIDS* 2008;22(1):47-56.
67. 2014;Pageshttp://www.drugs.com on February 3 2014.
68. NIH;Pageshttp://aidsinfo.nih.gov/guidelines/html/1/adult-and-adolescent-arv-guidelines/32/drug-interactions on February 3 2014.
69. Smith DK, Grohskopf LA, Black RJ, et al. Antiretroviral postexposure prophylaxis after sexual, injection-drug use, or other nonoccupational exposure to HIV in the United States: Recommendations from the U.S. Department of Health and Human Services. *MMWR Recomm Rep* 2005;54(RR-2):1-20.
70. Papenburg J, Blais D, Moore D, et al. Pediatric injuries from needles discarded in the community: Epidemiology and risk of seroconversion. *Pediatrics* 2008;122(2):e487-e492.
71. Panlilio AL, Cardo DM, Grohskopf LA, et al. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for postexposure prophylaxis. *MMWR Recomm Rep* 2005;54(RR-9):1-17.
72. Chin RL. Postexposure prophylaxis for HIV. *Emerg Med Clin North Am* 2010;28(2):421-9, Table of Contents.

CME Questions

1. You are seeing a 3-year-old female with perinatally acquired HIV in your emergency department for cough. She had labwork completed at the infectious disease clinic last week, which demonstrated a CD4 count of 400 and a CD4 percentage of 12%. How immunosuppressed is this patient?
   A. not at all immunosuppressed
   B. mildly immunosuppressed
   C. moderately immunosuppressed
   D. severely immunosuppressed
2. A 15-year-old female presents to your emergency department as a victim of sexual assault. What is the maximum number of hours prior to presentation that the assault could have occurred in which post-exposure prophylaxis would be indicated?
   A. 24 hours
   B. 48 hours
   C. 72 hours
   D. 96 hours
3. A 14-year-old male presents to the emergency department and you are concerned that he has acute retroviral syndrome. What diagnostic test should you send to establish this diagnosis?
   A. HIV DNA PCR
   B. HIV viral culture
   C. CD4 count and percentage
   D. second-generation rapid HIV test
4. You are seeing a 7-month-old female with perinatally acquired HIV who is severely immunocompromised. She presents with fever, cough, and increased work of breathing that has worsened over the past week. Her oxygen saturation on room air is 79%. A chest X-ray demonstrates bilateral ground glass opacities. You start the patient on oxygen and antimicrobials to cover community acquired pneumonia. What additional medications should be started at this time?
   A. multidrug therapy for tuberculosis
   B. trimethoprim-sulfamethoxazole +/- steroids
   C. amphotericin B
   D. fluconazole
5. You are treating a 3-year-old male in the ED for status epilepticus, and his parents tell you that he is taking the following medications: zidovudine, lamivudine, lopinavir/ritonavir, and trimethoprim-sulfamethoxazole. You order a loading dose of phenytoin to control his seizures. Which of his medication levels is most likely to be affected by phenytoin, which is metabolized through the cytochrome P450 system?
   A. zidovudine
   B. lamivudine
   C. lopinavir/ritonavir
   D. trimethoprim-sulfamethoxazole
6. Adolescent males who acquire HIV behaviorally are most like to acquire the virus by which method?
   A. heterosexual activity
   B. sexual activity with another male
   C. intravenous drug use
   D. blood transfusion
7. The most common clinical symptom associated with acute HIV is:
   A. myalgias
   B. pharyngitis
   C. cervical lymphadenopathy
   D. fever
8. A 4-month-old male presents to the ED and you are concerned for perinatally acquired HIV infection. His mother reports she was recently diagnosed with HIV. He is exclusively breastfed. What diagnostic test should you send to establish this diagnosis?
   A. HIV-1 DNA PCR
   B. viral culture
   C. fourth-generation rapid diagnostic test
   D. HIV 1/2 antibody test
   E. CD4 count and percentage
9. Exposure to which of the following bodily fluids carries *more* than a negligible risk for exposure to HIV?
   A. urine
   B. nasal secretions
   C. saliva
   D. vaginal fluid
10. A 16-year-old male with perinatally acquired HIV presents to the ED with cough and nasal congestion for the past 2 days. He has been afebrile, and is compliant with his antiretroviral therapy. He is clinically well appearing. His vital signs are as follows: HR 84; BP 120/72; pOx 99% on RA; RR 14. His lungs are clear and the remainder of his physical exam is unremarkable. A recent CD4 count is 426. Prior to disposition from the ED, this patient needs which of the following?
    A. blood culture
    B. chest X-ray
    C. sputum samples sent for TB
    D. reassurance and follow up with his primary care doctor

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EMERGENCY MEDICINE REPORTS

Approach to the Pediatric Patient with HIV in the Emergency Department

Classification of HIV Infection in Children Younger Than 13 Years of Age

Category N: Not Symptomatic

Children who have no signs or symptoms considered to be the result of HIV infection or who have only one of the conditions listed in Category A.

Category A: Mildly Symptomatic

Children with two or more of the conditions listed below but none of the conditions listed in Categories B and C.

- Lymphadenopathy (≥ 0.5 cm at more than 2 sites; bilateral = one site)
- Hepatomegaly
- Splenomegaly
- Dermatitis
- Parotitis
- Recurrent or persistent upper respiratory infection, sinusitis, or otitis media

Category B: Moderately Symptomatic

Children who have symptomatic conditions other than those listed for Category A or C that are attributed to HIV infection. Examples of conditions in clinical Category B include but are not limited to:

- Anemia (< 8 gm/dL), neutropenia (< 1,000/mm^3), or thrombocytopenia (< 100,000/mm^3) persisting ≥ 30 days
- Bacterial meningitis, pneumonia, or sepsis (single episode)
- Oropharyngeal candidiasis (thrush), persisting > 2 months in children > 6 months of age
- Cardiomyopathy
- Cytomegalovirus (CMV) infection with onset before 1 month of age
- Diarrhea, recurrent or chronic
- Hepatitis
- Herpes simplex virus (HSV) stomatitis, recurrent (> 2 episodes in 1 year)
- HSV bronchitis, pneumonitis, or esophagitis with onset before 1 month of age
- Herpes zoster (shingles) involving at least 2 distinct episodes or more than 1 dermatome
- Leiomyosarcoma
- Lymphoid interstitial pneumonia (LIP) or pulmonary lymphoid hyperplasia complex
- Neuropathy
- Nocardiosis
- Persistent fever (lasting > 1 month)
- Toxoplasmosis, onset before 1 month of age
- Varicella, disseminated

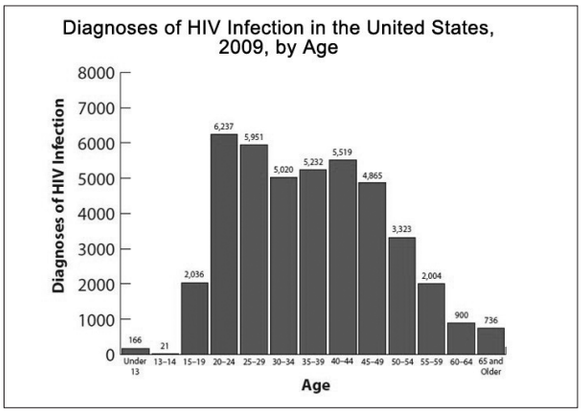
Category C: Severely Symptomatic

Children who have any condition listed in the 1987 surveillance case definition for AIDS, with the exception of LIP.

- Serious bacterial infections, multiple or recurrent (i.e., any combination of at least two culture-confirmed infections within a 2-year period), of the following types: septicemia, pneumonia, meningitis, bone or joint infection, or abscess of an internal organ or body cavity (excluding otitis media, superficial skin or mucosal abscesses, and indwelling catheter-related infections)
- Esophageal or pulmonary candidiasis
- Coccidiomycosis, disseminated (at site other than or in addition to lungs, cervical or hilar lymph nodes)
- Cryptococcosis, extrapulmonary
- Cryptosporidiosis or isosporiasis with diarrhea persisting > 1 month
- Cytomegalovirus disease with onset of symptoms at > 1 month (at a site other than liver, spleen, or lymph nodes)
- Encephalopathy (at least one of the following progressive findings present for at least 2 months in the absence of a concurrent illness other than HIV infection that could explain the findings): failure to attain or loss of developmental milestones or loss of intellectual ability, verified by standard developmental scale or neuropsychological tests; impaired brain growth or acquired microcephaly demonstrated by head circumference measurements or brain atrophy demonstrated by CT or MR imaging (serial imaging is required for children < 2 years of age); acquired symmetric motor deficit manifested by two or more of the following: paresis, pathologic reflexes, ataxia, or gait disturbance
- Herpes simplex virus infection causing a mucocutaneous ulcer that persists for > 1 month; or bronchitis, pneumonitis, or esophagitis for any duration affecting a child > 1 month of age
- Histoplasmosis, disseminated (at a site other than or in addition to lungs or cervical or hilar lymph nodes)
- Kaposi's sarcoma
- Lymphoma, primary, in brain
- Lymphoma, small, noncleaved cell (Burkitt's), or immunoblastic or large cell lymphoma of B-cell or unknown immunologic phenotype
- *Mycobacterium tuberculosis*, disseminated or extrapulmonary
- Mycobacterium, other species or unidentified species, disseminated (at a site other than or in addition to lungs, skin, or cervical or hilar lymph nodes)
- *Mycobacterium avium* complex or *Mycobacterium kansasii*, disseminated (at site other than or in addition to lungs, skin, or cervical or hilar lymph nodes)
- *Pneumocystis jirovecii* pneumonia (PCP)
- Progressive multifocal leukoencephalopathy
- Salmonella (nontyphoid) septicemia, recurrent
- Toxoplasmosis of the brain with onset at > 1 month of age
- Wasting syndrome in the absence of a concurrent illness other than HIV infection that could explain the following findings: a) persistent weight loss > 10% of baseline OR b) downward crossing of at least two of the following percentile lines on the weight-for-age chart (e.g., 95th, 75th, 50th, 25th, 5th) in a child > 1 year of age OR c) < 5 percentile on weight-for-height charge on two consecutive measurements ≥ 30 days apart PLUS a) chronic diarrhea (i.e., at last two loose stools per day for > 30 days) OR b) documented fever for ≥ 30 days, intermittent or constant)

Adapted from: 1994 Revised Classification System for Human Immunodeficiency Virus Infection in Children Less Than 13 Years of Age MMWR. 1994;43:1-10.
Schneider E, Whitmore S, Glynn KM, et al. Revised surveillance case definitions for HIV infection among adults, adolescents, and children aged < 18 months and for HIV infection and AIDS among children aged 18 months to < 13 years — United States, 2008. *MMWR Recomm Rep* 2008;57(RR-10):1-12.

HIV Infection by Age



Reprinted from: CDC. http://www.cdc.gov/hiv/risk/age/youth/index.html

Incidence of Clinical Symptoms Associated with Acute HIV

Clinical Feature	Proportion of Patients (%)
Fever	75
Fatigue	68
Myalgia	49
Skin rash	48
Headache	45
Pharyngitis	40
Cervical lymphadenopathy	39
Arthralgia	30
Night sweats	28
Diarrhea	27

Adapted from: Vanhems P, Dassa C, Lambert J, et al. Comprehensive classification of symptoms and signs reported among 218 patients with acute HIV-1 infection. *J Acquir Immune Defic Syndr* 1999;21(2):99-106.
Daar ES, Pilcher CD, Hecht FM. Clinical presentation and diagnosis of primary HIV-1 infection. *Curr Opin HIV AIDS* 2008;3(1):10-15.

Immunologic Categories Based on Age-specific CD4+ T-lymphocyte Counts and Percent of Total Lymphocytes

	Age of Child					
	< 12 months		1-5 years		6-12 years	
Immunologic Category	µL	%	µL	%	µL	%
No evidence of suppression (Stage 1)	≥ 1500	≥ 34	≥ 1000	≥ 30	≥ 500	≥ 26
Moderate Suppression (Stage 2)	750-1499	26-33	500-999	22-29	200-499	14-25
Severe Suppression (Stage 3)	< 750	< 26	< 500	< 22	< 200	< 14

Adapted from: Centers for Disease C, Prevention. Revised surveillance case definition for HIV infection — United States, 2014. *MMWR Recomm Rep.* 2014;63(RR-03):1-10.

Incidence of Opportunistic Infections in the Pre- and Post-HAART Eras in Patients with CD4% < 15

Opportunistic Infection	Pre-cART Incidence Rate Per 100 Person-years	Post-cART Incidence Rate Per 100 Person-years
Herpes zoster	4.8	3.5
Disseminated MAC and other non-TB mycobacteria	5.0	0.9
Pneumocystis jirovecii (PCP)	3.1	0.8
Candidiasis	3.0	0.5

Adapted from: Gona P, Van Dyke RB, Williams PL, et al. Incidence of opportunistic and other infections in HIV-infected children in the HAART era. *JAMA* 2006;296(3):292-300.

Antiretroviral Medications Used for the Treatment of HIV and AIDS

Protease Inhibitors (PIs)

- Lopinavir
- Atazanavir
- Darunavir
- Ritonavir
- Indinavir
- Saquinavir
- Fosamprenavir
- Tipranavir
- Nelfinavir

Nucleoside/Nucleotide Reverse Transcriptase Inhibitors

- Zidovudine
- Didanosine
- Stavudine
- Lamivudine
- Emtricitabine
- Abacavir
- Tenofovir

Non-nucleoside Reverse Transcriptase Inhibitors

- Efavirenz
- Nevirapine
- Delavirdine
- Etravirine
- Rilpivirine

Fusion Inhibitors

- Maraviroc
- Enfuvirtide

Integrase Inhibitors

- Raltegravir
- Elvitegravir
- Dolutegravir

Supplement to *Emergency Medicine Reports*, November 2, 2014: "Approach to the Pediatric Patient with HIV in the Emergency Department." Authors: Priya Gopwani, MD, Instructor of Pediatrics — Emergency Medicine, Ann & Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, IL; and Kathy T. Ferrer, MD, FAAP, AAHIVS, Assistant Professor of Pediatrics, Division of Infectious Disease, Special Immunology Section, Division of Hospitalist Medicine, Children's National Medical Center, George Washington University School of Medicine, Washington, DC.

TRAUMA REPORTS

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STATEMENT OF FINANCIAL DISCLOSURE

To reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Dr. Dietrich (editor in chief), Dr. Uzcategui (author), Dr. Menaker (author), Dr. Hanlon (peer reviewer), Ms. Behrens (nurse reviewer), Ms. Mark (executive editor), and Ms. Hamlin (managing editor) report no relationships with companies related to this field of study.

AHC Media

Blunt Pelvic Trauma

Blunt pelvic trauma can be devastating, and should be suspected in patients with a significant mechanism of injury or signs of shock. Controversies continue, despite extensive research, regarding the optimal management, particularly for unstable pelvic fractures. A high degree of suspicion and prompt diagnosis and management are critical to optimize patient outcome.

— Ann M. Dietrich, MD, Editor

Introduction

Trauma to the pelvis is a great example of how an entity in trauma has undergone major evolutionary changes. Despite advances, the treatment of pelvic trauma continues to pose difficult challenges, and, thus, it continues to be a widely studied topic. Controversies remain regarding the correct sequence in the treatment algorithm of the unstable trauma patient when pelvic injury is considered to be the primary source of bleeding. It has been proven that a multidisciplinary approach in the treatment of these patients improves outcomes, and has become the standard of care.[1] A team of specialists in emergency medicine, interventional radiology, trauma, and orthopedic surgery should be coordinated for rapid evaluation and treatment.[2] This article will focus on the recognition and management of the trauma patient with pelvic injury.

Epidemiology

The overall mortality rate for patients with pelvic ring fractures is approximately 6%.[2] This rate increases to 18-40% in patients with uncontrolled pelvic-related hemorrhage. Death that occurs within the first 24 hours of injury is most often a result of acute blood loss, while concomitant head trauma accounts for 31% of deaths.[2-6] The incidence of abdominal injury in the presence of pelvic fracture can range from 16% to 55%.[7-8] Schulman et al found that patients presenting with pelvic ring fractures are at increased risk of death regardless of other associated injuries.[9] Additionally, the researchers were able to demonstrate that patients with pelvic fractures presenting with age greater than 65 years, injury severity index greater than 18, respiratory rate greater than 30 breaths per minute, systolic blood pressure (SBP) less than 90 mmHg, and Glasgow Coma Scale (GCS) score less than 8 had an even further increased risk of mortality. Demetriades et al studied the differences between pelvic fractures among the pediatric population and the adult population.[10] They found that adults were twice as likely to suffer pelvic fractures compared to patients in the pediatric group. However, age group was not a significant risk factor for severe pelvic fractures. This difference was identified with all common mechanisms of injury (motor vehicle collisions, pedestrian struck, and falls greater than 15 feet). In falls from a height greater than 15 feet, the risk of pelvic fractures in adults was approximately seven times higher than that in children. The incidence

EXECUTIVE SUMMARY

- Schulman et al found that patients presenting with pelvic ring fractures are at increased risk of death regardless of other associated injuries. Additionally, they were able to demonstrate that patients with pelvic fractures presenting with age greater than 65 years, injury severity index greater than 18, respiratory rate greater than 30 bpm, SBP less than 90 mmHg, and GCS score less than 8 had an even further increased risk of mortality.
- The structures at greatest risk for injury due to their location adjacent to the pelvic bones and ligaments are: the sciatic, femoral, and obturator nerves, as well as the bladder, urethra, and extraperitoneal rectum.
- Higher-energy forces are required to cause APC3 injuries, and the posterior sacroiliac ligaments are completely disrupted, resulting in a severely unstable pelvic ring in which the highest clinical suspicion for hemorrhage should be considered.
- The correct way to test for pelvic stability is to grab the iliac crests and push inward in a gentle motion. Also, the symphysis pubis can be palpated to assess for widening.
- In the setting of pelvic fracture and hematuria, the CT cystogram with distended bladder and post-emptying views has replaced the retrograde cystourethrogram for the diagnosis of bladder injury.

of gastrointestinal and solid organ injury was high in both age groups. Aortic injuries were found exclusively in the adult group, and the researchers identified age older than 55 years as a significant risk factor for aortic rupture in patients with pelvic fracture. When pelvic fractures occur, the most common mechanism of injury is blunt force impact caused by motor vehicle collisions (MVC).[11] Mortality has been demonstrated to decrease when algorithms for management of these injuries are implemented.[12-13]

Anatomy

The pelvis is a complex structure with a small and rigid cavity that contains important nervous, vascular, gastrointestinal, and genitourinary structures. It is composed of three bones that articulate to each other to form the pelvic ring; these are the two large innominate bones and the sacrum. The pubic bones are the most common pelvic bones at risk for fracture due to their thin structure.[2] Posteriorly, the innominate bones articulate with the sacrum to form the sacroiliac (SI) joints, and anteriorly they attach to each other in the pubic symphysis. The SI joint, which receives its support from the anterior and posterior sacroiliac ligaments, is the strongest joint in the body. The sacrospinous and sacrotuberous ligaments provide the integrity for the pelvic floor; they join the sacrum to the ischial spine and the ischial tuberosity, respectively.[2] The acetabulum articulates with the femoral head to form the hip joint like a ball and a socket. Even though the acetabular joints form an important anatomical part of the pelvis, these fractures will not be emphasized in this article.

The internal iliac arteries provide perfusion to the pelvis. They traverse alongside to a large venous plexus that drains into the internal iliac veins. The largest and most commonly injured vessel is the superior gluteal artery.[2] Pelvic fracture-related bleeding arises because the vascular structures of the internal iliac arterial and venous systems are located just anterior to the ligaments that form the SI joints. Therefore, they are exposed to damage from the trauma that causes ligamentous disruption.[11] The structures at greatest risk for injury due to their location adjacent to the pelvic bones and ligaments are: the sciatic, femoral, and obturator nerves, as well as the bladder, urethra, and extraperitoneal rectum.[11] When the ligamentous structures rupture, the pelvic ring loses its integrity and widens, and bleeding potentially ensues. While bony fractures may appear impressive on plain films, what really matters in terms of pelvic stability is the degree of ligamentous disruption.

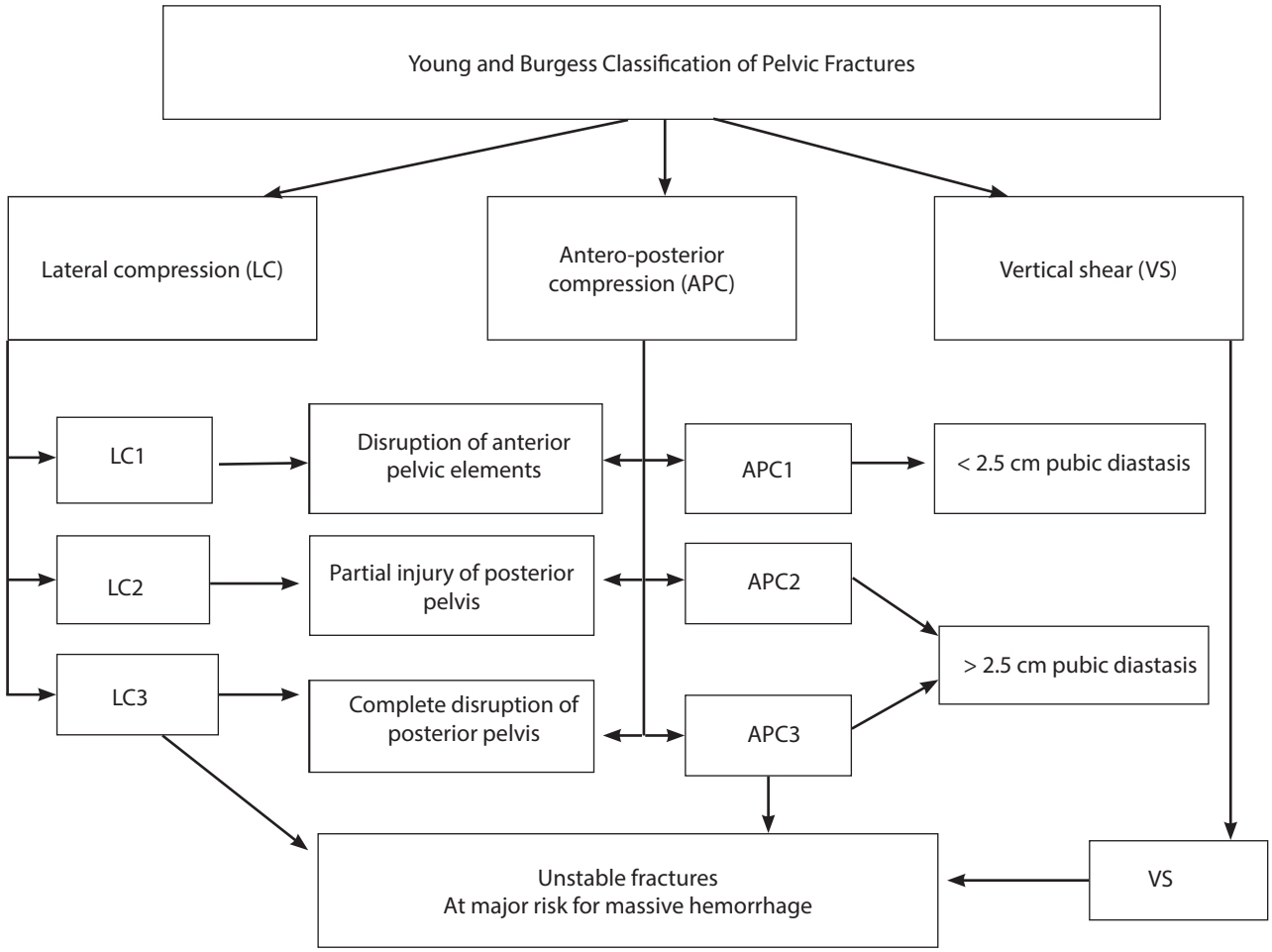
Classification

The most widely used classification for pelvic fractures is the Young and Burgess classification system, which is illustrated in a schematic adaptation in Figure 1. This classification is based on the fracture patterns resulting from vectors of force applied on the pelvic ring.[14] These patterns are divided into lateral compression (LC), antero-posterior compression (APC), and vertical shear (VS). LC fractures are the most common pelvic ring fractures, occurring in approximately 60% of the cases. LC1 fractures are the most common, and are associated with a lower-energy mechanism.[15] There is lateral impact in a horizontal plane. In this mechanism of injury, the force is applied to the side of the pelvis, as occurs in motor vehicle collisions in which the car is "T-boned," or when a pedestrian is struck on his side by the vehicle. As the pelvis "implodes," the structures migrate and rotate medially, causing the structure to collapse inward.

Manson et al conducted a retrospective case control study in which patients with LC1 fractures were analyzed based on outcome. They found that fracture pattern was not a good indicator of risk for death.[15] In this series, mortality was related more to injuries to the chest, abdomen, and head than to the characteristics of the pelvic fracture pattern. They concluded that fracture pattern is a poor marker of mortality for cases of LC1 fractures.

In LC2 injuries, higher-energy forces are required to cause disruption of the posterior sacroiliac ligament and displacement of the sacroiliac joint. The stability of the joint will be dependent upon the degree of the force applied. LC3 injuries are unstable fractures. The

Figure 1. Schematic Representation of the Young and Burgess Classification of Pelvic Fractures



Adapted from: Burgess AR, Eastridge BJ, Young JW. Pelvic ring disruptions: Effective classification system and treatment protocols. *J Trauma* 1990;30 (7):848-856.

force applied causes the hemipelvis to rotate inward to a point at which there is a complete disruption of the integrity of the SI joint. There is a close association between LC fractures and lethal torso injuries, such as aortic dissection.[10,15]

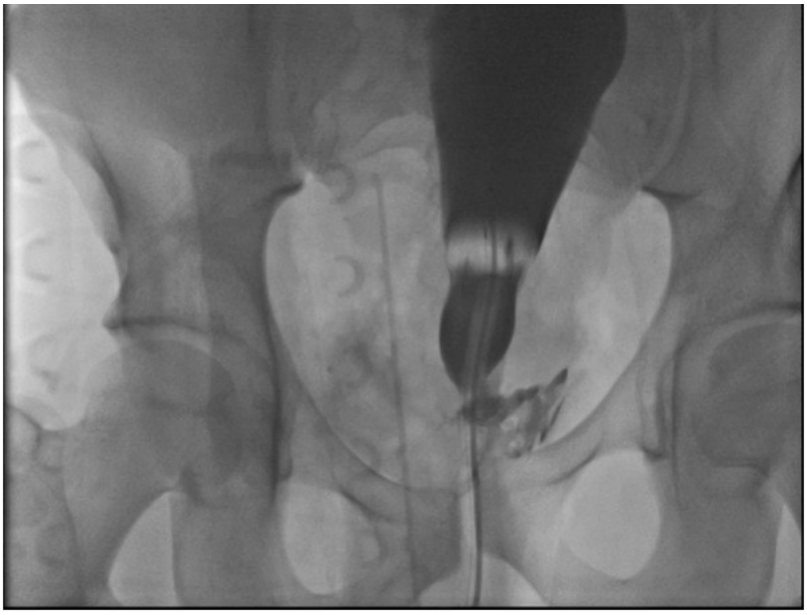
The APC injuries, also known as the "open book" fractures, are caused when the force is applied directly to the pubis, which may occur when a car strikes a pedestrian frontally. In APC1 fractures, the pubic symphysis widens no more than 2.5 cm and there is no injury to the SI joint or to the posterior pelvic elements. In APC2 injuries, the pubic symphysis widens more than 2.5 cm. In this subclassification, there is potential disruption of the anterior sacroiliac, sacrospinous, or sacrotuberous ligaments. The posterior sacroiliac ligaments remain uninjured. Because there is progressive widening of the pelvic ring, bleeding is more likely. Higher-energy forces are required to cause APC3 injuries. The posterior sacroiliac ligaments are completely disrupted, resulting in a severely unstable pelvic ring in which the highest clinical suspicion for hemorrhage should be considered. APC3 injuries are associated with the largest amount of blood loss.[2,15]

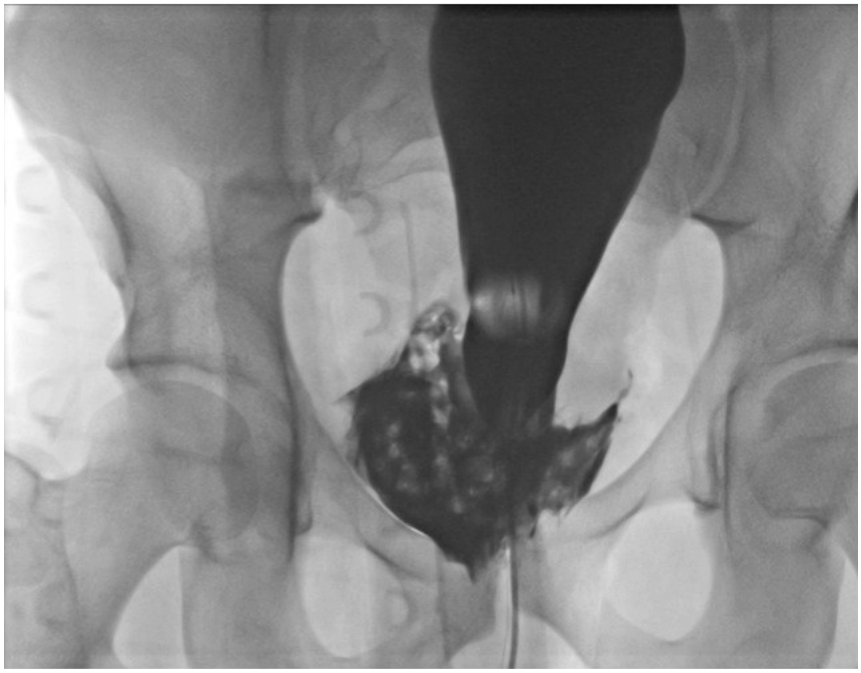
In the VS injury pattern, also known as the Malgaigne fractures, the vector of force is applied cephalad. These injuries are typically caused by falls from a height or motor vehicle or motorcycle collisions. The integrity of the ring is compromised because the hemipelvis is injured anteriorly to the pubic rami and/or pubic symphysis and posteriorly with disruption of the SI joint. As a result, the physical exam may reveal shortening of the leg ipsilateral to the injury, which occurs because there is unopposed force applied by the psoas muscle, pulling the hemipelvis upward. Combination injury patterns can also occur, most commonly with the LC and VS.[2] Of note, there can be a significant amount of patients who have high-grade pelvic fractures without pelvic hemorrhage. Conversely, a great number of patients who have arterial sources of hemorrhage have only minimally displaced fractures in the pelvic plain film.[1]

Initial Assessment

The evaluation of the trauma patient

Figures 2 and 3. Intra-operative Retrograde Cystogram with Bladder Neck Tear





Intra-operative retrograde cystogram in which a bladder neck tear was noted secondary to an APC2 injury for which a circumferential pelvic binder was placed for external stabilization.

has been standardized and should be guided by the Advanced Trauma Life Support (ATLS) guidelines in which a systematic approach is followed for a thorough assessment. There are several compartments into which a patient can bleed: the thoracic, abdominal, muscular, and pelvic/retroperitoneal. In the primary survey, airway, breathing, control of life-threatening hemorrhage, and the establishment of intravenous access are essential. As an adjunct of the primary survey, a Focused Assessment with Sonography in Trauma (FAST) should be performed. Also, focused abdominal and pelvic exams should be conducted to evaluate for tenderness, tympany, distention, or bruising.

The awake patient with a pelvic injury may complain of pain around the hip, lower abdomen, or lower back. When evaluating the stability of the pelvic ring, it is essential to avoid "rocking" of the pelvis. A disadvantage of performing this maneuver is eliciting intense pain. Every time the pelvis undergoes rotational forces applied by the physical examiner, there is potential for further widening of the ring, disruption of a potential clot, aggravation of hemorrhage, and further injury to adjacent organs. The correct way to test for pelvic stability is to grab the iliac crests and push inward in a gentle motion. The symphysis pubis also can be palpated to assess for widening.

Shlamovitz et al conducted a retrospective study in which 115 patients with blunt pelvic fractures, including 34 with mechanically unstable pelvic fractures, were analyzed.[16] The study demonstrated that the presence of either a pelvic deformity or an unstable pelvic ring on physical examination has poor sensitivity for detection of mechanically unstable pelvic fractures in blunt trauma patients. The study suggested that blunt trauma patients with GCS greater than 13 and without pelvic pain or tenderness are unlikely to suffer an unstable pelvic fracture.

The management algorithm for a patient with a pelvic injury depends on the hemodynamic status at the time of arrival. The Western Trauma Association has defined hemodynamic instability in an adult blunt trauma victim with a pelvic fracture as SBP less than 90 mmHg, significant transfusion requirement (4-6 units of packed red blood cells), or a base deficit of -6.[1] It is essential to recognize the institutional limitations and the necessity for a higher level of care early in the evaluation and resuscitation phase for critically injured patients. Transfer arrangements should be made as soon as possible to minimize delays in definitive treatment.

Genitourinary Injuries

Pubic bone fractures can be closely associated with genitourinary injuries (GUI). Attention should be focused on identifying findings that can suggest GUI, such as blood in the urethral meatus, perineal or scrotal hematoma, suprapubic tenderness, lacerations surrounding the perineum, vagina, or rectum, or blood or a periprostatic hematoma with rectal examination. Bjurlin et al analyzed 1,400 patients with pelvic fractures using the national trauma data bank and found that males have twice the incidence of GUI as females.[18] Urethral injuries are fairly uncommon, occurring in approximately 1% of blunt pelvic injury patients. More than 80% of patients who present with bladder injury will have an associated pelvic fracture.[18] Importantly, a negative physical examination for GUI does not exclude it.

Despite being uncommon, injury to the urethra is not confined to males. In a female patient with pubic bone fractures, a vaginal examination is also necessary. The injury patterns that have been most associated with urethral and bladder injuries are straddle fractures (bilateral superior and inferior pubic rami fractures) and forces that cause abrupt thigh abduction.[11] If there are no physical exam findings that suggest GUI, the initial approach should be to attempt to insert a urinary catheter, which should be done by an experienced provider. If any resistance is felt, the procedure should be aborted and the patient should have a retrograde urethrogram for evaluation of the urethra. Insertion of a urinary urethral catheter can potentially exacerbate or worsen a pre-existing injury.

If there is any concern for urethral injury, imaging should be obtained. As mentioned previously, gross hematuria noted after spontaneous voiding or after the insertion of a urinary catheter is the most common sign of bladder injury. In the setting of pelvic fracture and hematuria, the CT cystogram with distended bladder and post-emptying views has replaced the retrograde cystourethrogram for the diagnosis of bladder injury.[11] Figures 2 and 3 are examples of an intra-operative retrograde cystogram with a bladder neck tear. Bladder rupture can occur intra- or extraperitoneally. Management depends upon the location of the tear. Intraperitoneal bladder rupture is an indication for operative repair. Extraperitoneal rupture can usually be managed with an indwelling bladder catheter.[11]

Laboratory Workup

Blood analysis should be sent for all patients with a suspected pelvic injury. The single most important blood sample to send is the blood type and cross. A chemistry and complete blood count should be sent, but waiting for these results should not dictate the need to start early transfusion of blood products in the setting of shock or hemodynamic instability. A coagulation profile can give information regarding possible coagulopathy, which can be quite common in the trauma patient. Serum lactate will define the severity of acidosis, which is translated into the degree of end-organ hypoperfusion, and can be drawn serially to determine the response to resuscitation and resolution of shock. Urinalysis should be ordered to evaluate for hematuria since pelvic fracture patients with ureteral injury do not exhibit gross hematuria 15-45% of the time. In the setting of bladder injury, the hallmark is gross hematuria, which can be seen in up to 95% of patients. Hence, approximately only 5% of patients with bladder injury present with microscopic hematuria.[11,17]

Plain Films

Routinely, the pelvic antero-posterior (AP) plain film has been utilized during the initial trauma evaluation to identify fracture patterns that can potentially predispose the patient to hemorrhage. The plain pelvic AP film is a very useful tool in the poly-trauma patient who presents with hemodynamic instability or a depressed level of consciousness in which pelvic injury needs to be assessed. In patients who are awake, alert, do not complain of pelvic pain, and have no physical exam findings suggestive of pelvic injury, the pelvic plain film has little utility. In the patient who presents with pelvic pain and has stable vital signs, the plain film is an appropriate initial imaging study. However, if the plain film is unremarkable or equivocal and the patient continues to complain of pelvic pain, a computed tomography (CT) scan of the pelvis should be obtained.

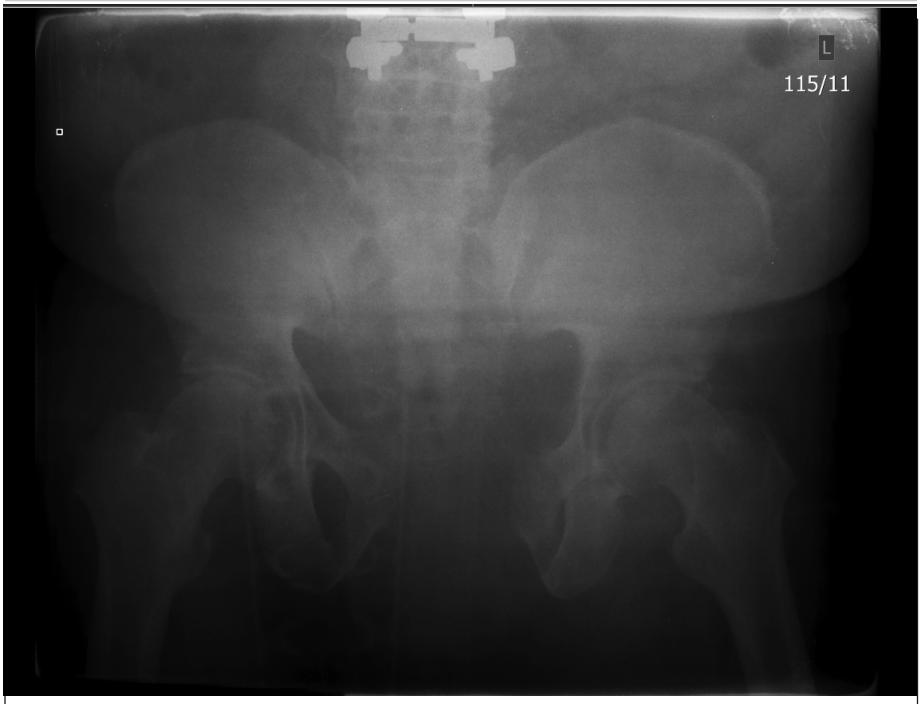
When evaluating plain films, acetabular and posterior pelvic fractures are commonly underestimated and overlooked. Barlebem et al conducted a retrospective study in 174 blunt trauma patients with pelvic fractures.[19] They reported that 51% of blunt trauma patients with pelvic fractures were underdiagnosed by pelvic plain film in the ED, and 22% were completely misdiagnosed as having no pelvic fracture on pelvic plain films. A thorough physical exam and pelvic CT scan are more sensitive and accurate than the pelvic X-ray for the diagnosis of pelvic fracture in blunt trauma patients. The study also concluded that the pelvic X-ray in the ED is obsolete in the absence of hemodynamic instability and significant physical examination findings.

The pelvic plain film should be evaluated with a standardized approach to minimize missing subtle injuries. One systematic way to assess the film is to look away from the bones and focus on the soft tissues to evaluate for edema or foreign bodies. Then look at the three circles and evaluate the bony cortex, as it should be contiguous. Next, focus on the large iliac bones, the sacrum, and the SI joints. Even if bony displacement is not seen but there is loss of the continuance of the lines, that patient most likely has a pelvic fracture. Finally, look at the patient's acetabula. Acetabula and anterior fractures can be hard to diagnose, as they can be quite subtle. It is important to remember that the pelvis is a circular structure and it is almost impossible to break a circle at only one point. If you see one fracture, look carefully, because it is highly likely that there is a second fracture. Inlet and outlet views of the pelvis better evaluate the SI joints, sacrum, and migration of a hemipelvis. Judet views for evaluation of the acetabulum have been replaced by CT scan.

Ultrasound

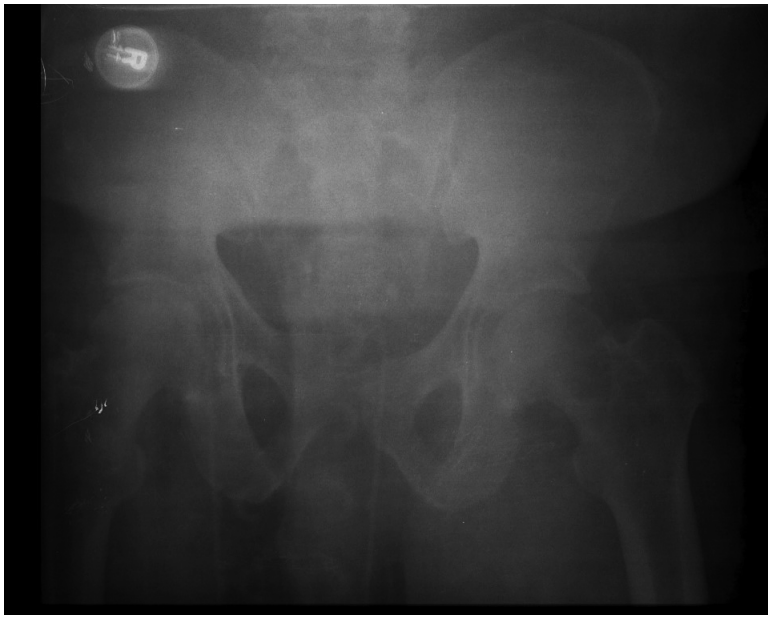
The FAST exam has become an indispensable tool during the evaluation of the blunt trauma patient in the

Figure 4. Patient with an APC2 Fracture



There is pubic diastasis of more than 2.5 cm and there is anterior widening of the SI joint.

Figure 5. Patient with APC2 Fracture After Placement of a Pelvic Binder



Placement of the pelvic binder with approximation and stabilization of the anterior and posterior elements, resulting in decreased pelvic volume.

acute setting. It is utilized to detect free intra-peritoneal fluid, which is presumed to be blood until proven otherwise. It can guide therapeutic interventions based on its findings and the patient's hemodynamics. The FAST is most useful when the patient presents with hemodynamic instability. A positive FAST in an unstable patient mandates the need for an emergent operative intervention. A positive FAST in a stable patient allows for better characterizing the extent of the injuries, most likely with a CT scan.

Chiu et al studied 772 blunt trauma patients, some of whom had concomitant pelvic fractures that were initially evaluated with FAST upon admission.[20] They found that there was a 29% incidence of intra-abdominal injury without hemoperitoneum; the FAST exam as a sole diagnostic tool is not reliable.

In another study, Tayal et al analyzed 87 patients with major blunt pelvic injuries.[21] The authors found that the sensitivity and specificity of the FAST exam decreased when there was a concomitant major pelvic fracture. They theorized that this could be due to several factors, including an intra-peritoneal bladder rupture causing uroperitoneum or seepage of retroperitoneal hematoma, which can cause intra-peritoneal fluid collections secondary to a displaced fracture. The study argues that although intra-peritoneal bladder rupture mandates a therapeutic operative intervention, this should not supersede the need for emergent pelvic angiographic embolization therapy for life-threatening bleeding. They propose the use of an ultrasound-guided supra-umbilical diagnostic peritoneal aspirate (DPA) to differentiate urine from blood. In the DPA, the catheter is inserted above the umbilicus using the Seldinger technique, and intra-peritoneal fluid is aspirated. A positive DPA is aspiration of greater than 10 mL of gross blood.[1] Thus, DPA should be considered prior to laparotomy in a patient responding to resuscitation with a positive FAST and a concomitant major pelvic fracture.

Computed Tomography Scanning

The computed tomography (CT)

scan has become the gold standard for imaging in the blunt trauma patient with multiple injures. It offers superior information that can be easily missed with plain films, ultrasound, DPL, or DPA. The CT scan also helps to better characterize the severity and displacement of the pelvic fracture. In addition, it can identify and quantify the presence and size of a pelvic hematoma. Three-dimensional reconstructions provide even more refined images for management planning.

Another important advantage of CT imaging is the administration of intravenous (IV) contrast, which can help identify the presence of "blush" or active contrast extravasation (ACE) in the presence of arterial injury. The identification of ACE or blush on CT scan has been reported to have an accuracy of 98% for identifying patients who require embolization.[1,22] Data from an analysis of a European trauma registry propose that inclusion of a whole-body CT scan in the initial evaluation of severely injured patients is associated with improved survival.[23] Due to the high incidence of concomitant intra-abdominal injury associated with pelvic fractures, it is recommended to order at least an abdominal and pelvic CT scan as part of the standard initial evaluation. The disadvantage of the CT scan is that the patient has to be hemodynamically stable to be transported into the radiology suite. It can also take time, and there is the potential risk for IV contrast-induced complications, such as allergic reactions and contrast-induced nephropathy.

External Pelvic Stabilization Techniques

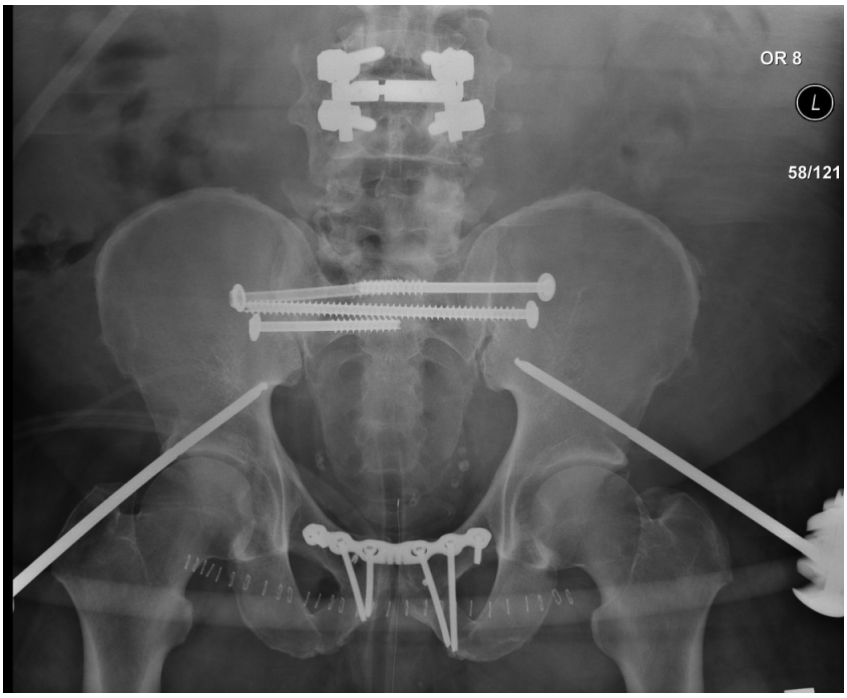
Whenever there is a high suspicion for a pelvic fracture or confirmation of one in a hemodynamically unstable patient, external compression of the pelvis should be performed. The goal is to reduce the pelvic diameter and potentially stabilize the pelvic elements. Limiting the space available for bleeding provides a tamponade effect. There is evidence that external compression reduces the pelvic volume by 10%.[24,25] If there is no widening of the pelvic ring or pubic symphysis diastasis (i.e., LC-type injuries, pubic rami fractures), external pelvic stabilization is not likely to be helpful and may exacerbate the injury.[1]

Noninvasive external compression can be achieved with a bed sheet or with a commercial pelvic circumferential binder. The bed sheets, which should be readily available in any emergency department, are criss-crossed over the patient's pelvis and tied down tightly. The bed sheet should be kept wide, around 20 cm, to distribute the force better. The circumferential pelvic binder can be adjusted with Velcro and pulleys. Figure 4 illustrates a patient with an APC2 fracture, and Figure 5 shows the same patient after placement of a pelvic binder. To confirm the correct placement of these devices, they should be centered over the greater trochanters of the femur and should cover the buttocks underneath in most patients.[26] One common mistake is to place the binder over the lower part of the abdomen, which will not provide adequate pelvic compression. It can also precipitate abdominal compartment syndrome and further worsen hypotension in an already unstable patient due to a decrease in venous return to the heart. These devices are radiolucent and they can be cut if femoral access is needed.

A pelvic AP plain film should be obtained after the placement of an external compression device to confirm the reduction of the pelvic elements. If there is inadequate reduction, it is recommended to readjust and repeat the film. The compression device should not be left in place longer than 24 hours, as it can cause skin necrosis over the injured areas and bony prominences.[27]

Placement of external skeletal fixation is another tool for pelvic stabilization in the unstable patient. In the emergent setting, it has been almost completely replaced by binders and bed sheets because of their rapid application and effectiveness. Many resources are needed for the placement of external fixators in the emergent setting, and the availability will be mostly institutionally dependent. Like the temporary pelvic binder, the external fixator helps

Figure 6. Internal Fixation of Pelvic Fracture



Patient originally stabilized with external skeletal fixation was bridged to definitive stabilization of the anterior and posterior elements with internal fixation.

Table 1. Indications for Emergent Pelvic Angiography

- Pelvic fractures with hemodynamic instability or signs of ongoing bleeding after non-pelvic sources of hemorrhage have been excluded
- Evidence of active contrast extravasation or "blush" in the pelvic CT scan
- Ongoing bleeding after pelvic angiography with or without embolization after non-pelvic sources have been excluded
- Age 60 years or more with major pelvic fracture
- Evidence of pelvic hematoma of > 500 mL in size on pelvic CT scan

control bleeding by reducing and stabilizing the fractured bony fragments and by decreasing the diameter of the pelvis.[26] Additionally, early placement of external fixation has been shown to reduce mortality.[26,28] Because the binder is not a permanent treatment option, external fixation can be used as a bridge to definitive internal fixation or as definitive care itself.[25,26] A patient with hemodynamic instability and an unstable pelvic fracture who will be taken to the operating room for exploratory laparotomy may benefit from skeletal external fixation.[1] Even though skeletal external fixation offers some advantages, a comparison between external fixation and temporary pelvic binder showed that the external fixator was found to have higher blood transfusion needs at 24 and 48 hours when compared to the binder.[29] Figure 6 illustrates placement of definitive internal fixation after the patient was initially stabilized with external skeletal fixation.

Angiography and Embolization

The approach to pelvic bleeding should be selected based on the institutional resources and the instability of the patient. Pelvic angiography is a useful tool and can be diagnostic and therapeutic in the management of arterial pelvic hemorrhage. For this intervention to be an effective option, an interventional radiologist, experienced staff, and an angiography suite need to be available.

The majority of pelvic bleeding is of venous origin. The Eastern Association for the Surgery of Trauma performed a systematic review and published guidelines for the management of hemorrhage in pelvic fracture. Table 1 lists the indications for angiography in these patients.[30] Fracture pattern alone is not a predictor of hemorrhage that will require embolization.[31] Pelvic angiography with embolization seems to be 85% to 97% effective in controlling arterial hemorrhage.[32] Despite angiography with embolization, there is a subset of patients that will require a second angiogram due to ongoing bleeding. It has been reported that 4.6% to 24% of patients with either no bleeding seen on the initial angiogram or initially successful pelvic embolization will require a repeat pelvic angiography with embolization. Independent risk factors for recurring pelvic bleeding include: transfusion requirement of more than two units of packed red blood cells per hour before angiography, more than two injured vessels that required embolization, recurring hypotension after initial angiography, absence of intra-abdominal injury, and a persistent base deficit.[31-33]

Miller et al performed a prospective study in which 1,171 patients admitted with pelvic ring fractures were analyzed based on hemodynamics on presentation.[34] The authors concluded that if patients presented with hypotension from a pelvic fracture and had transient or no response to initial resuscitation, this indicated the presence of arterial bleeding in more than 70% of patients. In this series, in patients who responded to initial resuscitation, arterial bleeding was unlikely, with a negative predictive value of 100%.

Pre-peritoneal Pelvic Packing

Newer operative techniques are being integrated into the treatment of unstable patients with pelvic fractures when there is a delay for angiography or when there are concomitant injuries that warrant operative interventions. Pre-peritoneal pelvic packing is a technique in which laparotomy pads are inserted into the pelvic space to tamponade pelvic bleeding. The procedure consists of performing a horizontal Pfannenstiel incision just above the pubic symphysis, dissecting and identifying the pre-peritoneal fascia, evacuating the pelvic hematoma, and packing the pelvic space with surgical lap pads. The goal of this procedure is to apply direct pressure to the pelvic vasculature without violating the peritoneal space. If the patient warrants an exploratory laparotomy, a separate vertical midline incision can be made. There are conflicting data regarding whether this intervention should be performed before or after angiography/embolization. Eighty-five percent of the bleeding from pelvic fractures is venous and bony in origin, and by "packing" the pelvis first, there is a reduction in the transfusion requirement.[35,36] If the patient is taken to angiography first and has a negative study, time has been lost attempting to control the hemorrhage.

Cothren et al reported data advocating for the integration of external skeletal pelvic fixation in combination with pre-peritoneal pelvic packing as an initial approach before angiography.[36] The authors propose that this technique can be advantageous in rural hospitals. It seems to be a safe procedure, and the packs are usually left in place for 48 hours. This novel approach potentially addresses the primary source of bleeding, which, the majority of the time, is likely to be venous and bony in origin. It can also be done concurrently with other operative procedures such as laparotomy, thoracotomy, fasciotomy, etc. In their study, fewer than 15% of patients required angiography/embolization for ongoing arterial bleeding after being

packed. The study concluded that angiography/embolization should be seen as a complementary procedure for life-threatening hemorrhage control after pre-peritoneal pelvic packing. Dora et al demonstrated that pelvic packing performed as a first-line therapy with subsequent angiography, if needed, may be just as effective, if not better, than angiography alone for controlling bleeding.[37]

Endovascular Technology for Hemorrhage Control

Emerging endovascular technology is being applied in the setting of trauma. The resuscitative endovascular balloon occlusion of the aorta (REBOA) is a catheter device with a balloon in the distal end. It is inserted into the femoral artery through an introducer over a wire and is inflated once at the desired level, creating an internal occlusion of the aorta. The catheter position can be confirmed using a plain film or with ultrasound. When used for hemorrhage control in the setting of pelvic fractures, the balloon is inflated at the level of the infra-renal aorta before the bifurcation. It can serve as a temporizing measure for hemorrhage control. When caring for a patient with hemodynamic instability, it can serve as a temporizing measure and as a bridge for resuscitative efforts, induction of anesthesia, or transfer to the operating room or to the angiography suite in order to achieve definitive hemorrhage control.

Brenner et al published a case series in which the use of REBOA proved to be a feasible and effective method of internal aortic control for patients in end-stage shock from blunt and penetrating trauma mechanisms.[38] Martinelli et al reported the use of intra-aortic balloon occlusion in patients with critically uncontrollable hemorrhagic shock secondary to pelvic fractures.[39] Their study suggests that this procedure may be safe and effective to decrease mortality in this setting. However, further investigation is needed to establish the usefulness of this device.

Conclusion

Blunt pelvic trauma can be a devastating injury that can be accompanied by trauma to other structures, and which places the patient at risk for life-threatening hemorrhage. It is crucial to have a high index of suspicion for this diagnosis when faced with a patient who has unstable vital signs or who has a mechanism of severe trauma. The initial evaluation should always be standardized to all trauma patients. A thorough physical examination is essential. Early transfer arrangements should be made by institutions with limited resources. For patients with an unstable pelvic fracture as the source of hemorrhage, external stabilization of the pelvis should be accomplished as soon as possible. The pelvic plain film is a great tool as an initial imaging study in a patient with hemodynamic instability or depressed level of consciousness. The CT scan of the pelvis is the gold standard imaging study and, when performed with IV contrast, it can provide valuable information regarding ACE in the setting of arterial vascular injury. However, in the setting of hemodynamic instability, a FAST exam should be performed. If positive, the patient should be taken for an operative intervention in which pre-peritoneal packing and skeletal external fixation can be considered as reasonable treatment approaches. In the setting of a negative FAST and an unstable pelvic fracture, the decision of whether the patient goes for an angiogram or to the operating room for pre-peritoneal packing and external fixation depends on the institution. As further clinical research evolves with the REBOA, more patients with pelvic-related bleeding will potentially benefit from its use.

References

1. Davis J, Moore F, McIntyre R, et al. Western trauma association critical decisions in trauma: Management of pelvic fracture with hemodynamic instability. *J Trauma* 2008; 65: 1012-1015.
2. Mattox K, Moore E, Feliciano D. Pelvis. *Trauma*, 7th ed. McGraw Hill; 2013: |655-668.
3. Moreno C, Moore EE, Rosenberg A, et al. Hemorrhage associated with major pelvic fracture: A multispecialty challenge. *J Trauma* 1986;26:987-994.
4. Smith W, Williams A, Agudelo J, et al. Early predictors of mortality in hemodynamically unstable pelvic fractures. *J Orthop Trauma* 2007;21:31-37.
5. Cothren CC, Osborn PM, Moore EE, et al. Preperitoneal pelvic packing for hemodynamically unstable pelvic fractures: A paradigm shift. *J Trauma* 2007;62: 834-839.
6. Gililand MD, Ward RE, Barton RM, et al. Factors affecting mortality in pelvic fractures. *J Trauma* 1982;22:691-693.
7. Ben-Menachem Y, Coldwell DM, Young JW, et al. Hemorrhage associated with pelvic fractures: Causes, diagnosis, and emergent management. *AJR Am J Roentgenol* 1991;157:1005-1014.
8. Cryer HM, Miller FB, Evers BM, et al. Pelvic fracture classification: Correlation with hemorrhage. *J Trauma* 1988;28: 973-980.
9. Shulman J, O'Toole R, Castillo R, et al. Pelvic ring fractures are an independent risk factor for death after blunt trauma. *J Trauma* 2010;68:930-934.
10. Demetriades D, Karaiskakis M, Velmahos G, et al. Pelvic fractures in pediatric and adult trauma patients: Are they different injuries? *J Trauma* 2003;54:1146-1151.
11. Flint L, Cryer H. Pelvic fracture: The last 50 years. *J Trauma* 2010;69:483-488.
12. Balogh Z, Caldwell E, Heetveld M, et al. Institutional practice guidelines on management of pelvic fracture related hemodynamic instability: Do they make a difference? *J Trauma* 2005;58:778-782.
13. Biffl WL, Smith WR, Moore EE, et al. Evolution of a multidisciplinary clinical pathway for the management of unstable patients with pelvic fractures. *Ann Surg* 2001;233:843-850.
14. Burgess AR, Eastridge BJ, Young JW. Pelvic ring disruptions: Effective classification system and treatment protocols. *J Trauma* 1990;30 (7):848-856.
15. Manson T, Nascone J, Sciardini M, et al. Does fracture pattern predict death with lateral compression type 1 pelvic fractures? *J Trauma* 2010;69:876-879.
16. Shlamovitz G, Mower W, Bergman J, et al. How (un)useful is the pelvic ring stability examination in diagnosing mechanically unstable pelvic fractures in blunt trauma patients? *J Trauma* 2009;66:815-820.
17. Mattox K, Moore E, Feliciano D. Genitourinary trauma. *Trauma*, 7th edition. McGraw Hill; 2013: 669-708.
18. Bjurlin M, Fantus R, Mellet M, et al. Genitourinary injuries in pelvic fracture morbidity and mortality using the national trauma data bank. *J Trauma* 2009;67: 1033-1039.
19. Barleben A, Jafari F, Rose J, et al. Implementation of a cost-saving algorithm for pelvic radiographs in blunt trauma patients. *J Trauma* 2011;71:582-584.

20. Chiu WC, Cushing BM, Rodriguez A, et al. Abdominal injuries without hemoperitoneum: A potential limitation of focused abdominal sonography for trauma (FAST). *J Trauma* 1997;42:617-623.
21. Tayal V, Nielsen A, Jones A, et al. Accuracy of trauma ultrasound in major pelvic injury. *J Trauma* 2006;61:1453-1457.
22. Pereira SJ, O'Brien DP, Luchette FA, et al. Dymanic helical computed tomography scan accurately detects hemorrhage in patients with pelvic fracture. *Surgery* 2000;128:678-685.
23. Huber-Wagner S, Lefering R, Qvick LM, et al. Working group on polytrauma of the German trauma society. Effect of whole-body CT during trauma resuscitation on survival: A retrospective, multicenter study. *Lancet* 2009;53:1455-1461.
24. Bottlang M, Simpson T, Sigg J, Krieg JC, et al. Noninvasive reduction of open book pelvic fractures by circumferential compression. *J Orthop Trauma* 2002;16: 367-373.
25. Krieg JC, Mohr M, Ellis TJ, et al. Emergent stabilization of pelvic ring injuries by controlled circumferential compression: A clinical trial. *J Trauma* 2005;9:659-664.
26. Feliciano D, Mattox K, Moore E. Pelvic Fractures. *Trauma,* 6th edition. McGraw Hill; 2008: 669-788.
27. Jowett AJ, Bowyer GW. Pressure characteristics of pelvic binders. *Injury* 2007;38:118-121.
28. Burgess AR. The management of hemorrhage associated witg pelvic fractures. *Int J Orth Trauma* 1992;2:101.
29. Krieg JC, Mohr M, Ellis TJ, et al. Emergent stabilization of pelvic ring injuries by controlled circumferential compression: A clinical trial. *J Trauma* 2005;59:659-664.
30. Culliane DC, Schiller HJ, Ziellinski MD, et al. Eastern association for the surgery of trauma practice management guidelines for hemorrhage in pelvic fracture — update and systematic review. *J Trauma* 2011;71:1850-1868.
31. Starr AJ, Griffin DR, Reinert CM, et al. Pelvic ring disruptions: Prediction of associated injuries, transfusion requirement, pelvic arteriography, complications, and mortality. *J Orthop Trauma* 2002;16: 553-561.
32. Gorlay D, Hoffer E, Routt M, et al. Pelvic angiography for recurrent traumatic pelvic arterial hemorrhage. *J Trauma* 2005;59:1168-1173.
33. Shapiro M, McDonald AA, Knight D, et al. The role of repeat angiography in the management of pelvic fractures. *J Trauma* 2005;58:227-231.
34. Miller P, Moore P, Mansell E, et al. External fixation or arteriogram in bleeding pelvic fracture: Initial therapy guided by markers or arterial hemorrhage. *J Trauma* 2003;54:437-443.
35. Cothren C, Osborn P, Moore E, et al. Preperitoneal pelvic packing for hemodynamically unstable pelvic fractures: A paradigm shift. *J Trauma* 2007;62: 834-842.
36. Cothren C, Moore E, Smith W, et al. Preperitoneal pelvic packing/external fixation with secondary angioembolization: Optimal care for life-threatening hemorrhage from unstable pelvic fractures. *J Am Coll Surg* 2011;212:628-635.
37. Dora K, Tai M, Wing-Hong L, et al. Retroperitoneal pelvic packing in the management of hemodynamically unstable pelvic fractures: A level 1 trauma center experience. *J Trauma* 2011;71:79-86.
38. Brenner M, Moore, L, Dubose J, et al. A clinical series of resuscitative endovascular balloon occlusion of the aorta for hemorrhage control and resuscitation. *J Trauma Acute Care Surg* 2013;75:506-511.
39. Martinelli T, Thony F, Declety P, et al. Intra-aortic balloon occlusion to salvage patients with life-threatening hemorrhagic shocks from pelvic fractures. *J Trauma* 2010;68:942-948.

CNE/CME Questions

1. Which mechanism of injury places the patient at risk for major pelvic injury?
   A. high-speed motor vehicle collision (MVC)
   B. fall from more than 15 feet
   C. pedestrian vs. motor vehicle collision
   D. all of the above
2. When using the Young and Burgess classification for pelvic fractures, a lateral compression fracture is defined as:
   A. migration of the hemipelvis cephalad
   B. pubic symphysis diastasis secondary to force applied directly to the anterior pelvis
   C. lateral impact in a horizontal plane in which the vector of force is applied to the side of the pelvis
   D. none of the above
3. There has been a close association between lateral compression pelvic fractures and lethal torso injuries.
   A. true
   B. false
4. According to the Young and Burgess classification for pelvic fractures, what would be considered as an APC2 fracture?
   A. pubic symphysis diastasis widening of less than 2.5 cm, intact posterior pelvic elements
   B. unilateral superior and inferior pubic rami fractures
   C. unilateral iliac wing fracture
   D. pubic symphysis diastasis of more than 2.5 cm with partial disruption of the SI joint
5. A 60-year-old male is brought in by EMS after suffering a high-speed motorcycle collision. On arrival, vital signs are HR: 120 bpm, BP: 80/40,

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CNE/CME 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.

RR: 30, O2 sat: 95%. On physical exam, the Glasgow Coma Scale is 7, and there are several abrasions over the patient's lower abdomen. The patient is intubated, a bedside FAST exam is performed, and it does not show evidence of pericardial effusion or intra-peritoneal fluid. What imaging study is most appropriate at this time?

A. chest AP X-ray
B. full body CT scan
C. chest and pelvis X-ray
D. pelvic angiography

6. A 20-year-old male is brought in by EMS after being struck by a car traveling at 50 mph. The initial pelvic plain film shows an APC2 fracture. A circumferential pelvic binder is placed. The patient complains of inability to spontaneously void. On physical exam, there is blood at the urethral meatus. What is the best next step?

   A. Place an indwelling urinary catheter; if there is resistance felt, the procedure should be aborted.
   B. A supra-pubic catheter should be placed to decompress the bladder.
   C. Perform an evaluation with a |retrograde urethrogram.
   D. Orient the patient that urinary retention is a common symptom to experience after pelvic fracture and it should resolve spontaneously.

7. A 92-year-old female is brought in for evaluation after she suffered a mechanical fall from standing height while walking to the bathroom. Her vital signs are within normal limits. As part of her initial evaluation, a pelvic AP plain film is ordered, which is unremarkable for an acute fracture. Despite these findings, the patient is unable to bear weight or walk because of pain. What is the best next step?

   A. Consult the physical therapy service for discharge planning.
   B. Prescribe narcotic pain medication and discharge the patient home with follow up with her primary care physician.
   C. Repeat the pelvic plain film.
   D. Obtain a pelvic CT scan.

8. When encountering a hemodynamically unstable patient with a pelvic fracture that is classified as APC, the most appropriate approach is to place a circumferential pelvic binder, as it reduces the pelvic volume up to 10% and potentially offers a tamponade effect.

   A. true
   B. false

9. The identification of active contrast extravasation or "blush" on CT scan has been reported to be a poor predictor for identifying patients requiring embolization.

   A. true
   B. false

10. What is an indication for pelvic angiography for possible therapeutic embolization?

    A. pelvic fractures with hemodynamic instability or signs of ongoing bleeding after non-pelvic sources of hemorrhage have been excluded
    B. evidence of pelvic hematoma of > 500 mL in size on pelvic CT scan
    C. age 60 years or older with major pelvic fracture
    D. all of the above

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