Anesthesia for Parturient with Human Immunodeficiency Virus

14

Hasan Kutluk Pampal and Gökçen Emmez

14.1 Introduction

Acquired immunodeficiency syndrome (AIDS) is a global health problem especially seen in low and middle income countries. The disease was first described in 1981 in adults, and the causative agent, human immunodeficiency virus (HIV), was first isolated in 1983 [1, 2]. Infection with this virus is accepted to cause "a disease knowing no borders and respecting no moral codes" [3]. The most recent United Nations update declares 34.5 million adults living with HIV with the fact that 51% of these adults are females. The majority of these women are of childbearing age [4]. Also UNAIDS data reveal that everyday nearly 2000 women are newly diagnosed with HIV infection, and half of these women are aged between 15 and 24 years.

With the dramatic success of highly active antiretroviral treatment (ART), disease "with no borders" has evolved from a fatal condition to a chronic condition. Despite the relative decline in HIV infections for the last few years, as the HIV survivors increase by time, it is inevitable for anesthesiologists to come across such patients. When dealing with HIV-infected patients, the anesthesiologists must pay attention to the stage of the disease, comorbidities, antiviral therapy, and its possible interactions with anesthetic drugs. Moreover, it is also important to protect health-care workers and other patients from contamination.

The aim of this chapter is to review the HIV infection and the challenges of anesthetic management particularly for parturient infected with HIV. The preoperative evaluation, the choice of anesthetic technique, and the problems related to ART as well as the prevention of transmission will be discussed briefly in this chapter.

H. K. Pampal (✉) · G. Emmez
Gazi University Faculty of Medicine, Department of Anesthesia, Ankara, Turkey
e-mail: kutlukpampal@gazi.edu.tr

14.2   Pathophysiology

Human immunodeficiency virus, the causative agent of the disease, is a member of the lentivirus, a subtype of human retroviruses. There are two types of HIV: HIV-1 and HIV-2. Although both of them cause similar clinical problems, HIV-1 is known to be more virulent and infective than HIV-2 and is the major cause of worldwide HIV infections. Human immunodeficiency virus is a single-stranded RNA virus. Upon binding of viral envelope protein GP160 to the specific CD4$^+$ receptors found on T4 lymphocytes with a co-receptor named chemokine co-receptor (CCR5), the virion fuses with host membrane and enters the cell. Viral reverse transcriptase transcribes RNA genome to double-stranded DNA, and the viral DNA imports into nucleus to integrate to host genomic DNA by viral integrase. This integration results in latency of virus and avoids detection of the virus from immune system. The virus can remain silent in the host cells for an indefinite time. Alternatively, the transcription of integrated viral DNA to viral RNA and messenger RNA later forms various viral progeny [5, 6].

14.3   Transmission

Transmission of HIV occurs generally with human secretions and blood. Heterosexual transmission is the most common way of transmission. One important way of transmission is the vertical one, from mother to child, during pregnancy, labor, delivery, and breastfeeding [5, 6].

14.4   Clinical Findings

After transmission, an initial period with acute flu-like symptoms commonly occurs within 2–6 weeks. Following this period, viral levels decrease to and equilibrate at a viral set point. This viral set point helps to predict the speed of progression of the disease. A higher set point is generally related to a rapid progression. In this latent period, the virus can stay dormant in host cells, corresponding to an asymptomatic clinical course for patients lasting for 6–12 years. Thereafter the advanced period of the disease takes place with rising viral loads and declining CD4$^+$ T-lymphocytes counts. This period comes along with quantitative and qualitative T4$^+$ lymphocytes deficiency resulting in opportunistic infections and neoplasms [5, 6].

14.4.1 Seroconversion and Diagnosis

Seroconversion generally occurs within 2–8 weeks but can be prolonged to 12 weeks. A few individuals do not seroconvert until 6 months [5]. There are three types of HIV diagnostic tests: antigen/antibody tests, antibody tests, and nucleic acid tests. Traditional HIV testing is done using enzyme-linked immunosorbent assay (ELISA) to detect antibodies against HIV-1. More specific tests are

polymerase chain reaction (PCR), Western blotting, nucleic acid testing, and immunofluorescence assays (IFA). The latest recommendation by CDC is to start with an immunoassay combination test for HIV-1 and HIV-2 antibodies and p24 antigen [7]. The CDC recommends testing for HIV at least once as a part of routine healthcare for individuals between 13 and 64 and annually for those with higher risk. In case of a possible HIV exposure, follow-up testing for HIV is recommended by CDC at 45th and 90th days of exposure if the earlier tests are negative [7].

14.5 Anesthetic Management

14.5.1 Preoperative Evaluation

Preoperative evaluation should involve past medical history, systemic examination, laboratory tests, assessment of the organs involved, and ART including the complications related to drugs. Most of the anesthesiologists do not question about drug abuse which is an important coexisting problem in patients with HIV, and it is also mentioned that the number of anesthesiologist assessing the patients whether they are HIV-positive or not is even fewer [8]. However, possibility of HIV infection, intravenous drug use, and alcohol abuse should always be questioned for safe anesthesia management and for protecting healthcare workers who will deal with the patient.

Detailed history of the patients in terms of multiple organ involvement, drug therapy, and adverse events should also be determined and recorded during preoperative evaluation. Other sexually transmitted diseases such as syphilis and hepatitis B should also be questioned. Detailed neurological examination and documentation are important in patients with syphilis as the disease effects neurological system in later stages [9].

Human immunodeficiency virus infection is a multisystem disease, and nearly all vital organ systems are involved as indicated below:

Cardiovascular system involvement may present as pericardial, myocardial, or vascular lesions. Intravenous drug users may present with infective endocarditis. Pericarditis is the most frequent cardiovascular pathology observed in HIV-positive patients. The pathophysiology of the cardiovascular disease is not clear, but it is thought to be multifactorial. Opportunistic infections, HIV itself, and ART are some of the accused etiological factors [10]. Antiretroviral therapy, especially protease inhibitors, may cause premature atherosclerosis which leads to coronary disease [11].

The respiratory system findings of HIV-positive patients may be related to both the upper and lower respiratory tract. The most important underlying factor for pulmonary disease in these patients is the opportunistic infections. Neoplasms such as Kaposi sarcoma or lymphoma also play a role in the etiology of the HIV-related pulmonary abnormalities. Kaposi sarcoma is the commonest neoplasm found in AIDS patients. It is usually located at the head and neck, and it may present as supraglottic mass without causing stridor which requires vigilance. The most well-known organism in HIV-positive patients responsible for the pulmonary infections is the *Pneumocystis jiroveci* (known as *Pneumocystis carinii* before 1999). It usually occurs when CD4$^+$ count is less than 200 cell/mm^3 [11]. Tuberculosis is a common cause of respiratory failure in HIV-positive patients. Patients with HIV are

more prone to acquire infection when they are exposed to infectious environment, and reactivation of latent tuberculosis is more common because of the defective cellular immunity. Pulmonary secretions should be evaluated for *Myocobacterium tuberculosis* in suspected patients. Arterial blood gas analysis and pulmonary function test may also be performed for preoperative assessment of the respiratory functions in HIV-positive pregnant patients. If general anesthesia is planned, maximum attention should be paid to sterility, and the availability of postoperative intensive care and ventilatory support should be considered [12].

Gastrointestinal system abnormalities are common, and almost all the patients with HIV encounter HIV-related gastrointestinal pathology. Pathologies located at the oral cavity or esophagus lead to increased risk of aspiration and difficulties during intubation or mask ventilation. Viral esophagitis, aphthous ulcers, and leukoplakia cause severe pain and difficulty in swallowing. Hepatobiliary disease is common and may lead to elevated liver function tests. Primer infection of the intestinal epithelium with HIV or with the opportunistic agents leads to severe and chronic diarrhea. These patients may have fluid and electrolyte imbalance which should be corrected before the surgery [8, 9].

Renal system involvement may present as acute renal failure. Sepsis, dehydration, and adverse effects of drugs play an important role in HIV-associated renal failure. Besides, deposition of immune complexes also leads to proliferative glomerulonephritis. There is a specific entity known as HIV-associated nephropathy characterized by a focal segmental glomerulosclerosis and leads to renal failure especially in African-American patients [9].

Nervous system manifestations can occur at any time during the course of HIV infection, and clinical findings are specific to the stage of the disease. These findings are important especially if neuraxial anesthesia is planned. Headache, photophobia, cognitive changes, cranial neuropathy, and meningoencephalitis are nonspecific and self-limited signs observed in the initial period of HIV infection [8, 9]. Even isolation of the virions and antibodies in cerebrospinal fluid is possible during this early phase [13]. Demyelinating neuropathy and cerebrospinal fluid abnormalities, even in asymptomatic patients, occur during latent phase of the infection [14]. Late stages of the HIV infection are associated with meningitis, diffuse encephalopathy, focal central nerve system lesions, myelopathy, and peripheral neuropathy seen in almost all patients. AIDS dementia complex is a severe, late-stage neurological manifestation of the disease in which cognitive and motor functions are impaired, but level of alertness is preserved [9]. Postural hypotension, syncope, or diarrhea can be observed in HIV-positive patients as a result of neurological involvement leading to autonomic dysfunction [14]. Both neoplasms such as Kaposi sarcoma, primary central nervous system lymphoma, and neurological adverse effects of ART should be considered during preoperative neurological evaluation of the patients.

The primary target of the anesthetic techniques is either the peripheric or central nervous system. Therefore, full preoperative neurological evaluation and appropriate documentation are of crucial importance.

Hematologic abnormalities associated with HIV infection include anemia, leukopenia, thrombocytopenia, and coagulation disturbances. Anemia is the most common

cause of hematologic abnormality in HIV-infected patients, and if untreated it indicates poor prognosis [15]. The major cause of hematologic disturbances in HIV-infected patents is bone marrow suppression as a result of direct HIV infection, secondary opportunistic infections, malignancies, and adverse drug reactions [16]. Coagulation abnormalities are common in HIV-infected patients and occur as a consequence of HIV-related immune activation and vascular disease. Prolonged activated partial thromboplastin time may present because of lupus anticoagulants, and it is related with higher incidence of major thromboembolic events [9]. Hence, assessing the whole blood count and coagulation parameters is essential for preoperative evaluation.

Endocrine and metabolic disturbances observed in HIV-infected patients are lipodystrophy and metabolic syndrome (elevated plasma levels of triglycerides, glucose, and cholesterol) which are associated with ART. Most serious endocrine complication of HIV infection is primary or secondary adrenal insufficiency [17]. Although they are asymptomatic, thyroid function tests of the patients with HIV infection are usually abnormal. Possible causes of endocrine and metabolic disturbances in these patients may be direct effects of HIV on the related gland, opportunistic infections, neoplasms, and ART [18].

A list of various organ-related abnormalities is summarized in Table 14.1.

Table 14.1   Clinical findings of organ involvement of HIV infection

Organ systems	Problems associated with HIV infection	
Cardiovascular system	Pericardial effusion	Acute coronary syndrome
	Dilated cardiomyopathy	Vasculitis
	Endocarditis	Pulmonary hypertension
	Valvular lesions	Kaposi sarcoma
Respiratory system	Obstruction (tumor/infection)	Pneumonia
	Bronchitis	Pneumothorax
	Sinusitis	Atypical infections (Tuberculosis)
Gastrointestinal system	Esophagitis/dysphagia	Biliary disease
	Regurgitation	Malnutrition
	Hepatitis	Diarrhea
Renal system	Drug induced nephrotoxicity	HIV-associated nephropathy
Neurological system	Headache	Meningitis
	Photophobia	Diffuse encephalopathy
	Meningoencephalitis	Focal CNS lesions
	Cognitive changes	Myelopathy
	Demyelinating neuropathy	Peripheral neuropathy
	Abnormal CSF findings	Myopathy
Hematological system	Anemia	Thrombocytopenia
	Leukopenia	Coagulation disturbances
Endocrine and metabolic system	Lipodystrophy	SIADH
	Metabolic syndrome	Hypo/hyperthyroidism
	Adrenal insufficiency	Lactic acidosis

In addition to routine laboratory tests such as full blood count, clotting functions, biochemical tests (glucose, hepatic and renal functions, electrolytes), electrocardiography, and organ-specific advanced investigations may be performed in order to elicit the functions of the various systems that are involved. Determining the viral load and CD4+ count is strongly advised in HIV-positive parturient.

14.5.2 Choice of the Anesthetic Technique: General vs Regional

Regional anesthesia (epidural, spinal, and combined spinal epidural (CSE)) is the preferred way of anesthesia management for cesarean delivery. Recent knowledge reveals a progressive increase in the use of regional techniques, especially spinal anesthesia, both in developed and developing countries [19]. Although regional anesthesia techniques have several advantages in otherwise healthy parturient over general anesthesia, one can ask whether it is safe to use them in HIV-positive patients.

The major concern in HIV-infected patients who will undergo regional anesthesia is spreading the infection into the previously uninfected central nervous system or worsening the preexisting neurological symptoms. However, there is no data in the literature that regional anesthesia accelerates the progression of the disease or increases perioperative complications. In fact it is a well-known fact that HIV is a neurotropic virus and virions and antibodies of HIV can be isolated even at the early phase of the disease [20].

Hughes et al. evaluated the effects of regional anesthesia on 30 HIV-infected parturient of whom 18 received neuraxial anesthesia for labor. They followed up 30 patients who received regional anesthesia for labor analgesia and cesarean delivery [21]. They followed up the patients for 4–6 months postpartum and did not observe any neurologic complication or alterations in immune functions. A review by Avidan et al. comparing the effects of spinal anesthesia in 44 HIV-infected parturient with 45 healthy patients undergoing cesarean section confirmed the findings of the above study as they found no difference between the two groups in terms of intraoperative hemodynamic stability or postoperative complications [22].

Another question is whether it is a malpractice to perform regional anesthesia in a patient who has neurologic involvement with or without clinical signs. Considering the benefits of regional anesthesia and other possible organ system involvements such as pulmonary or cardiac and the aforementioned clinical evidence about the early neurologic involvement of the disease, it seems logical to use neuraxial techniques in HIV-infected parturient.

Finally epidural and CSE anesthesia have the advantage of a catheter for effective postoperative pain control. However, placing and holding a catheter in the epidural space for some time after surgery may increase the risk of infection. Therefore, spinal anesthesia with local anesthetic and opioids for postoperative analgesia seems to be safer than the techniques that a catheter is placed.

When administrating general anesthesia for HIV-infected parturient, the most important factors that should be considered are possible immunomodulatory effects

of anesthetic drugs, organ system involvement and drug interactions, and adverse effects of ART. Possible immunodepressant effects of any drug or condition in immunosuppressed HIV-infected patients should be a great concern. Therefore, the immunomodulatory effect of general anesthetics is an important issue in parturient who will have general anesthesia.

The effects of various anesthetic agents on immune system have been widely investigated, but the debate on the topic still goes on. The data is derived mostly from in vitro studies rather than clinical studies. It is hard to investigate the sole role of anesthetics on human studies because various variables such as type and duration of the surgery and patient-dependent variables contribute to the total effect on patient's immune system.

Recent knowledge on this issue reveals that general anesthesia may lead to transient immune depression, but no study was able to show that this depression is of clinical significance in healthy patients [23]. Pregnancy also suppresses patient's cell-mediated immune system [24]. However, no increase in complication rate and worsening of the HIV infection related to general anesthesia were shown in a retrospective study by Gershon and Manning-Williams [25].

It is not possible to recommend general or regional anesthesia in terms of the effects on the immune system in HIV-infected parturient. Further studies assessing the effects of anesthetic drugs and techniques on immune system in HIV-infected parturient are needed. In the light of recent literature, anesthesiologist should also consider the fact that the immune suppression related to general anesthesia could be clinically significant in HIV-infected parturient. The argument for choosing the better anesthetic technique should focus on the stage of the disease, affected organ systems, and drug interactions rather than immunomodulatory effects or neurological spread.

If general anesthesia is preferred, endotracheal intubation should be performed with a strict sterile technique. Prolonged postoperative mechanical ventilation should be avoided in order to prevent ventilator-associated pneumonia [9].

Although both general anesthesia and regional anesthesia seem safe for HIV-infected parturient, potential immunomodulatory effects of general anesthesia, additional risk factors due to organ involvement, drug interactions between general anesthetics and ART, and evidence for the safety of regional anesthesia lead us to recommend regional techniques unless there is a contraindication.

Another concern about the parturient receiving regional anesthesia is the possibility of postdural puncture headache (PDPH). Despite all precautions and using a careful technique, pregnancy remains as a risk factor for PDPH. If PDPH is diagnosed, the initial treatment should be conservative usually pharmacological and noninvasive. Recumbent bed rest and aggressive hydration are common methods. Bed rest can relieve headache but it is not therapeutic. Although hydration is the most common therapeutic regimen for PDPH, there is no evidence in the literature that has showed its effectiveness. Pharmacological treatment of the PDPH includes methylxanthines (caffeine, theophylline, and aminophylline), sumatriptan, adrenocorticotropic hormone and corticosteroids, gabapentin, and pregabalin [26]. If the symptoms of PDPH do not resolve despite the conservative and pharmacological

therapies, then epidural blood patch should be performed. It should be mentioned that the concern about spreading the virus to the central nervous system is unnecessary because no serious complications have been reported to date [5]. Although they are not effective as autologous epidural blood patch, epidural infusion of normal saline or colloidal solutions are alternative invasive methods [26]. Other proposed alternatives are epidural patch with fresh allogeneic whole blood and platelet-rich plasma or epidural injection of fibrin glue. However, these methods need further investigation [9, 26, 27].

14.5.3 Drugs Used for HIV-Infected Parturient and Anesthesia

Drugs used by HIV-infected parturient can be classified into two groups: antiretroviral drugs which are used to treat the primary disease and the drugs used for prophylaxis or treatment of opportunistic infections. The use of ART during pregnancy has the goal of reducing or eliminating mother to child transmission besides the treatment of the maternal HIV infection. All parturients with HIV infection should be treated with combination ART regardless of the CD4+ cell count. Extensive use of ART during pregnancy has led the incidence of mother to child transmission to decrease to levels less than 2% [28, 29]. Although adverse event rates are elevated, mother to child transmission is prevented better with combination therapy than single-drug therapy [30]. When ART is initiated earlier in an HIV-infected parturient, effective reduction in mother to child transmission is achieved [31]. The study by Hoffman et al. showed that each additional week of highly active ART in an HIV-infected parturient reduced the incidence of mother to child transmission by 8% [32]. Therefore, strategies should be developed to facilitate earlier initiation of the combination ART in especially low resource settings. Moreover the treatment should not be limited to antepartum or intrapartum period. A strategy including ART during antepartum, intrapartum, and also postpartum periods for infant prophylaxis is more effective in preventing mother to child transmission [28, 33].

Recent developments in the treatment of HIV infection improved the outcome of the HIV-infected patients. Six groups of antiretroviral drugs which are usually used in combination are listed in Table 14.2. The treatment plan includes different groups of antiretroviral drugs in order to minimize the development of resistance pattern [34]. Human immunodeficiency virus treatment with a combination of three or more antiretroviral drugs is called highly active ART. Usually one or two nucleoside reverse transcriptase inhibitors (NRTI) are combined with one nonnucleoside reverse transcriptase inhibitors (NNRTI) and/or protease inhibitors (PI). If a patient exhibits drug resistance than a fourth agent can be added to the treatment regimen.

Anesthesiologists should be aware of the adverse effects of the ART and question the patient during the preoperative assessment. The adverse effects related to ART can be classified into four groups. Lactic acidosis, hepatic toxicity, pancreatitis, and peripheral neuropathy are related to mitochondrial dysfunction. Fat maldistribution and change in body composition, dyslipidemia, hyperglycemia, and insulin resistance are the result of metabolic disturbances. Bone marrow suppression leads to anemia,

Table 14.2 Classification of anti-retroviral drugs with mechanism of action and side effects

Drug class	Mechanism of action	Examples	Side effects
Protease inhibitors	Prevents cleavage of viral precursor proteins into the subunits required for the formation of new virions	Saquinavir	Nephrolithiasis, diarrhea, enzyme inhibition, elevated triglycerides
		Ritonavir	
		Indinavir	
		Nelfinavir	
Nucleoside reverse transcriptase inhibitors	Inhibiting viral DNA synthesis by preventing reverse transcription Also inhibits human mitochondrial DNA polymerase	Zidovudine	Bone marrow suppression, myopathy, neuropathy, diarrhea, headache, lactic acidosis, pancreatitis
		Lamivudine	
		Emtricitabine	
		Abacavir	
		Didanosine	
Nonnucleoside reverse transcriptase inhibitors	Inhibiting viral DNA synthesis by preventing reverse transcription Do not require phosphorylation/do not inhibit human DNA polymerases	Nevirapine	Rash, dizziness, teratogenicity, enzyme induction
		Delavirdine	
		Efavirenz	
Integrase inhibitors	Inhibit incorporation into cellular genome	Raltegavir	Hepatotoxicity
Fusion inhibitors	Interfere with HIV binding to cells, preventing entry	Enfuvirtide	Headache, bacterial pneumonia
CCR5 antagonists		Maraviroc	

neutropenia, and thrombocytopenia. Finally skin rashes and hypersensitivity responses are related to allergic reactions. Risk of cardiovascular disease is associated with long-term use of the antiretroviral drugs. Premature atherosclerosis which is a characteristic cardiovascular pathology in HIV-infected patients worsens with the use of PI due to further impairment of endothelial function. Hyperlipidemia and insulin resistance occur after PI exposure and they further increase cardiovascular risks. Lipodystrophy is a syndrome of fat redistribution characterized with central fat accumulation and peripheral fat loss [11]. The appearance of the patient may mimic Cushing's disease, but the hypothalamic-pituitary-adrenal axis is normal. Lipodystrophy causes redistribution of fat to the neck, back of the neck, and abdomen. Thus, airway management which may be a potential problem in pregnant patients may be more difficult, and intraabdominal pressure further increases [11]. Drug interaction is an important concern especially for HIV-infected parturient who will have surgery under general anesthesia as anesthetic drugs may interact with antiretroviral medications.

Protease inhibitors are metabolized by cytochrome P450 system and they are inhibitors of CYP3A [35]. However, ritonavir is also a potent inducer of P450 isoenzymes.

Potential drug interactions with PI and opioids, benzodiazepines, local anesthetics, neuromuscular blockers, and antiarrhythmic drugs should be kept in mind during anesthetic management of the HIV-infected parturient.

Impairment in metabolism of opioids, especially fentanyl and alfentanil, has been observed which leads to respiratory depression because of higher serum levels.

Drug interaction with fentanyl occurs both with enzyme induction and inhibition: enzyme inhibition leads to reduction in clearance of fentanyl, and enzyme induction increases its metabolism to active metabolites. Remifentanil is not dependent on P450 metabolism; therefore it can be the safest choice of opioid in these patients.

Administering benzodiazepines to patients using PI may also lead to prolonged sedation and respiratory depression. Dose reduction of midazolam and diazepam is advised in parturient using PI. Amiodarone, calcium channel blockers, digoxin, and quinidine should be used carefully because of the cardiovascular toxicity caused by the interaction with PI [35].

Opioids may also interact with NNRTI. This group of antiretroviral drugs leads to both cytochrome enzyme induction and inhibition depending on the specific drug being administered. They affect the plasma concentration of methadone and opioids. Nevirapine and efavirenz reduce plasma concentration of methadone by 50%. It is recommended to increase the dose of fentanyl and alfentanil in patients using NNRTI [36].

Nucleoside reverse transcriptase inhibitors are prodrugs, and activation requires intracellular phosphorylation. They are main drugs for combination therapy. Fortunately they do not interact through the P450 enzyme system [37]. Interaction with metronidazole may lead to peripheral neuropathy, and combination of zidovudine and corticosteroids is reported to cause severe myopathy and respiratory muscle dysfunction [11].

14.5.4 Role of Anesthesiologist in Preventing Transmission of HIV

Anesthetists play an important role in preventing or decreasing the risk of transmission of HIV infection to uninfected patients. Transfusion of infected blood is the most common cause of transmission of blood-borne infections. Not only HIV but also coinfections frequently found in HIV-infected patients such as HBV and HCV can also be transmitted. Anesthesiologists can reduce the risk of transmission by minimizing allogenic blood transfusion. This is possible by having an adequate knowledge on blood transfusion practices and following the updated guidelines.

Other route of transmission is contamination of the devices used during anesthesia practice. Most of the devices are reusable, but laryngoscope blades, face masks, and endoscopes can be the source of transmission. Human immunodeficiency virus may survive up to 7 days outside the body; however, it is quite sensitive to disinfectants such as sodium hypochlorite and heat [38]. Therefore, ASA Subcommittee on Infection Control Policy recommends that such equipment with visible blood on it should be washed as soon as possible. Routine hospital sterilization techniques are usually enough to eradicate the HIV, but ASA recommends high level of sterilization or disinfection methods [8, 39]. Apart from blood-borne infections, tuberculosis may also be transmitted as a result of inhalational exposure. A filter that protects the anesthesia machine from contamination should be used in the circuit to avoid exposure of the machine to mycobacterium tuberculosis. Internal components of the anesthesia machine should be cared for according to the manufacturer's recommendations. Unidirectional valves, carbon dioxide absorbent chambers, and bellows should be cleaned and disinfected.

Human Immunodeficiency virus can also be transmitted to healthcare workers as a result of exposure to infected body fluids. Universal safety precautions should be used during anesthesia management of the HIV-infected patients regardless of the HIV status.

Not only anesthesiologists but also all healthcare providers should wear gloves in order to avoid direct contact of infected fluids to open lesions of the hands. Double gloving or using virus-inhibiting gloves are extra safety precautions that can be easily practiced [40]. Sharp objects should be handled carefully for preventing penetrating injuries. Needles should not be recapped and discarded properly in the appropriate containers. If there is a risk of exposure of blood or other body fluids to the eye, eye shields should be used [41].

It is impossible to eliminate the risk of exposure although all precautions have been used. Once the percutaneous exposure to HIV-infected blood has occurred, the transmission of HIV is approximately 0.3% [42]. All healthcare workers with needlestick injury should take ART as soon as possible. This is called postexposure prophylaxis, and drugs should be taken maximum of 72 h, at least for 4 weeks [43]. Postexposure prophylaxis usually includes combination of three or even four antiretroviral drug. Group of drugs preferred for PEP are usually NRTI, integrase inhibitors, PI, and NNRTI [44]. According to the guidelines in pregnant healthcare workers, the PEP procedure is the same with any other person, but certain drugs such as efavirenz, stavudine, didanosine, and indinavir should be avoided because of teratogenicity, lactic acidosis, or hyperbilirubinemia in newborns [45].

Modern ART prolongs the lives of the patients with HIV infection. Most of the HIV-infected patients are at the childbearing age which means that anesthesiologist will face with parturient during the perioperative period. The unique properties of the disease such as immunosuppression and multiple organ involvement, adverse effects, and interactions of the drugs make the anesthetic management of these pregnant patients more complex. Possibility of transmission of the virus to newborn or healthcare providers is another important concern in these patients. Therefore, the anesthesiologist must have adequate knowledge of the disease, clinical manifestations, treatment, and complications in order to provide patient safety during anesthetic management.

Key Learning Points
- HIV infection is accepted as a chronic condition rather than a fatal condition due to the success of ART.
- The anesthesiologist encounters HIV-positive parturients more frequently.
- Either general or regional anesthesia can be the choice of anesthetic technique in a HIV-positive parturient.
- Preventing transmission of the disease to newborn and healthcare workers is an important concern when dealing with an HIV-positive parturient.
- It is essential for the anesthesiologist to have adequate knowledge of the disease, clinical manifestations, treatment, and complications in order to provide patient's and healthcare workers' safety.

References

1. Gottlieb MS, Schroff R, Schanker HM, Weisman JD, Fan PT, Wolf RA, et al. Pneumocystis carinii pneumonia and mucosal candidiasis in previously healthy homosexual men: evidence of a new acquired cellular immunodeficiency. N Engl J Med. 1981;305:1425–31.
2. Barré-Sinoussi F, Chermann JC, Rey F, Nugeyre MT, Chamaret S, Gruest J, et al. Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS). Science. 1983;220:868–71.
3. Hughes SC. AIDS: the focus turns to women. Int J Obstet Anesth. 1993;2:1–2.
4. UNAIDS data 2017. http://www.unaids.org/sites/default/files/media_asset/20170720_Data_book_2017_en.pdf. Accessed 20 Feb 2018.
5. Hignett R, Fernando R. Anesthesia for the pregnant HIV patient. Anesthesiol Clin. 2008;26:127–43.
6. Bajwa SJS, Kulshrestha A. The potential anesthetic threats, challenges and intensive care considerations in patients with HIV infection. J Pharm Bioallied Sci. 2013;5:10–6. https://doi.org/10.4103/0975-7406.106554.
7. HIV testing. https://www.cdc.gov/hiv/testing/index.html. Accessed 20 Feb 2018.
8. Kuczkowski KM. Human immunodeficiency virus in the parturient. J Clin Anesth. 2003;15:224–33.
9. Wlody DJ. Human immunodeficiency virus. In: Chestnut DH, Wong CA, Tsen LC, Kee WDN, Beilin Y, Mhyre JM, Nathan N, editors. Chestnut's obstetric anesthesia: principles and practice E-book. Amsterdam: Elsevier Health Sciences; 2014.
10. Ntusi N, O'Dwyer E, Dorrell L, Wainwright E, Piechnik S, Clutton G, et al. HIV-1-related cardiovascular disease is associated with chronic inflammation, frequent pericardial effusions, and probable myocardial edema. Circ Cardiovasc Imaging. 2016;9:e004430.
11. Conte AH. Infectious disease. In: Hines RL, Marschall KE, editors. Stoelting's anesthesia and co-existing disease. 7th ed. Philadelphia: Elsevier; 2018.
12. Prout J, Agarwal B. Anaesthesia and critical care for patients with HIV infection. Contin Educ Anesth Crit Care Pain. 2005;5:153–6.
13. Denning DW, Anderson J, Rudge P, Smith H. Acute myelopathy associated with primary infection with human immunodeficiency virus. Br Med J (Clin Res Ed). 1987;294:143–4.
14. Evron S, Glezerman M, Harow E, Sadan O, Ezri T. Human immunodeficiency virus: anesthetic and obstetric considerations. Anesth Analg. 2004;98:503–11.
15. Leelanukrom R. Anaesthetic considerations of the HIV-infected patients. Curr Opin Anaesthesiol. 2009;22:412–8.
16. Vishnu P, Aboulafia DM. Haematological manifestations of human immune deficiency virus infection. Br J Haematol. 2015;171:695–709.
17. Eledrisi MS, Verghese AC. Adrenal insufficiency in HIV infection: a review and recommendations. Am J Med Sci. 2001;321:137–44.
18. Lo JC, Schambelan M. Adrenal, gonadal, and thyroid disorders. In: Dolin R, Masur H, Saag MS, editors. AIDS therapy. 3rd ed. St. Louis: Churchill Livingstone; 2008.
19. Caton D. Cesarean delivery. In: Chestnut DH, Wong CA, Tsen LC, Kee WDN, Beilin Y, Mhyre JM, Nathan N, editors. Chestnut's obstetric anesthesia: principles and practice. 5th ed. Philadelphia: Elsevier Saunders; 2014.
20. García F, Niebla G, Romeu J, Vidal C, Plana M, Ortega M, et al. Cerebrospinal fluid HIV-1 RNA levels in asymptomatic patients with early stage chronic HIV-1 infection: support for the hypothesis of local virus replication. AIDS. 1999;13:1491–6.
21. Hughes SC, Dailey PA, Landers D, Dattel BJ, Crombleholme WR, Johnson JL. Parturients infected with human immunodeficiency virus and regional anesthesia. Clinical and immunologic response. Anesthesiology. 1995;82:32–7.
22. Avidan MS, Groves P, Blott M, Welch J, Leung T, Pozniak A. Low complication rate associated with cesarean section under spinal anesthesia for HIV-1-infected women on antiretroviral therapy. Anesthesiology. 2002;97:320–4.

23. Cruz FF, Rocco PR, Pelosi P. Anti-inflammatory properties of anesthetic agents. Crit Care. 2017;21:67.
24. Barnett MA, Learmonth RP, Pihl E, Wood EC. T helper lymphocyte depression in early human pregnancy. J Reprod Immunol. 1983;5:55–7.
25. Gershon RY, Manning-Williams D. Anesthesia and the HIV infected parturient: a retrospective study. Int J Obstet Anesth. 1997;6:76–81.
26. Katz D, Beilin Y. Review of the alternatives to epidural blood patch for treatment of postdural puncture headache in the parturient. Anesth Analg. 2017;124:1219–28.
27. Gunaydin B, Acar M, Emmez G, Akcali D, Tokgoz N. Epidural patch with autologous platelet rich plasma: a novel approach. J Anesth. 2017;31:907–10.
28. Townsend CL, Cortina-Borja M, Peckham CS, de Ruiter A, Lyall H, Tookey PA. Low rates of mother-to-child transmission of HIV following effective pregnancy interventions in the United Kingdom and Ireland, 2000–2006. AIDS. 2008;22:973–81.
29. European Collaborative Study. Mother-to-child transmission of HIV infection in the era of highly active antiretroviral therapy. Clin Infect Dis. 2005;40:458–65.
30. Fowler MG, Qin M, Fiscus SA, Currier JS, Flynn PM, Chipato T, et al. Benefits and risks of antiretroviral therapy for perinatal HIV prevention. N Engl J Med. 2016;375:1726–37.
31. Townsend CL, Byrne L, Cortina-Borja M, Thorne C, de Ruiter A, Lyall H, et al. Earlier initiation of ART and further decline in mother-to-child HIV transmission rates, 2000–2011. AIDS. 2014;28:1049–57.
32. Hoffman RM, Black V, Technau K, van der Merwe KJ, Currier J, Coovadia A, et al. Effects of highly active antiretroviral therapy duration and regimen on risk for mother-to-child transmission of HIV in Johannesburg, South Africa. J Acquir Immune Defic Syndr. 2010;54:35–41.
33. Tubiana R, Le Chenadec J, Rouzioux C, Mandelbrot L, Hamrene K, Dollfus C, et al. Factors associated with mother-to-child transmission of HIV-1 despite a maternal viral load <500 copies/ml at delivery: a case-control study nested in the French perinatal cohort (EPF-ANRS CO1). Clin Infect Dis. 2010;50:585–96.
34. Menéndez-Arias L. Targeting HIV: antiretroviral therapy and development of drug resistance. Trends Pharmacol Sci. 2002;23:381–8.
35. de Maat MM, Ekhart GC, Huitema AD, et al. Drug interactions between antiretroviral drugs and comedicated agents. Clin Pharmacokinet. 2003;42:223–82.
36. Schulenburg F, Le Roux PJ. Antiretroviral therapy and anaesthesia. SAJAA. 2008;14:31–8.
37. Piscitelli SC, Gallicano KD. Interactions among drugs for HIV and opportunistic infections. N Engl J Med. 2001;344:984–96.
38. Coates TJ, Collins J. Preventing HIV infection. Sci Am. 1998;279:96–7.
39. American Society of Anesthesiology subcommittee on infection control policy recommendations for infection control for the practice of anesthesiology. https://asahq.org/~/media/sites/asahq/files/public/resources/asa%20committees/recommendations-for-infection-control-for-the-practice-of-anesthesiology-(1).pdf?la=en. Accessed 20 Feb 2018.
40. Bricout F, Moraillon A, Sonntag P, Hoerner P, Blackwelder W, Plotkin S. Virus-inhibiting surgical glove to reduce the risk of infection by enveloped viruses. J Med Virol. 2003;69:538–45.
41. Baluch A, Maass H, Rivera C, Gautam A, Kaye AD, Frost EA. Current perioperative management of the patient with HIV. Middle East J Anaesthesiol. 2009;20:167–77.
42. Diprose P, Deakin CD, Smedley J. Ignorance of post-exposure prophylaxis guidelines following HIV needlestick injury may increase the risk of seroconversion. Br J Anaesth. 2000;84:767–70.
43. Panlilio AL, Cardo DM, Grohskopf LA, Heneine W, Ross CS, US Public Health Service. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for postexposure prophylaxis. MMWR Recomm Rep. 2005;54:1–17.
44. Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents. https://aidsinfo.nih.gov/contentfiles/lvguidelines/adultandadolescentgl.pdf. Accessed 20 Feb 2018.
45. Parthasarathy S, Ravishankar M. HIV and anaesthesia. Indian J Anaesth. 2007;51:91–9.