Key Points
Viral infections are an important clinical entity with varied clinical symptoms and significant overlap with bacterial symptoms. However, some viral conditions have nonspecific symptoms which can be severe enough to cause septicemia.

Viral infections involve all the age groups with common symptoms like fever, common cold, GI symptoms like vomiting, diarrhea, neurological symptoms like headache, confusion, irritation, loss of consciousness. The specific pathological entity has to be defined and differentiated.

18.1 Introduction

PET-CT in viral infections is having a significant role in evaluating the amount or extent of disease, disease burden, disease involvement, and severity of the disease in the affected organs which is quantified by the SUV max value [1]. However, PET-CT cannot differentiate the exact cause and cannot differentiate in the varied overlap findings in malignant and benign conditions [2]. This has relevance in relation to meningitis/encephalitis which can be viral or bacterial or other causes of meningitis.

18.2 Principle of PET-CT

The basic principle of FDG PET is to demonstrate the increased uptake associated findings of nodal involvement, monitoring disease progression, and monitoring response to treatment [3, 4]. The pathological basis of this is a virus infects the body which activates neutrophils, monocytes, and T cells by releasing local chemokines. Thus, in active inflammation, the activated neutrophils are dependent on anaerobic
glycolysis requiring increased glucose which is directly proportional to high FDG uptake. Other cell granulocytes and macrophages also play an important role in facilitating glucose transport in chronic conditions. Thus, FDG uptake is directly proportional to the amount of active inflammation.

18.3 Neurological Infections

Subacute Sclerosing Panencephalitis (SSPE) is one of the important components of the neurodegenerative disease [5]. This has features of cognitive and behavioral changes, atonic and/or myoclonic seizures, periodic paroxysms on electroencephalogram (EEG), and increased measles antibodies in cerebrospinal fluid. SSPE is one of the dreadful forms of disease which is caused by the reactivation of the measles virus in the brain for several years after the episode of the primary measles infection. Although it has been studied for many years, its pathogenesis and treatment have not been elucidated. FDG PET-CT is now evolving as an important imaging modality for SSPE [6]. One of the studies by Yeong Seon et al. proved that cortical glucose metabolism is significantly reduced in patients with SSPE, but some of them are normal [7]. The immune system is involved in this pathogenesis. The pattern of FDG PET-CT shows variable uptake patterns depending on the various locations during viral exposure. CNS's presentations are of meningitis, encephalitis, dural enhancement, gyral enhancement and combination of any of this with or without cerebral edema (Figs. 18.1 and 18.2).

18.4 Head and Neck Viral Infections

18.4.1 Upper Respiratory Tract Infection

Upper respiratory tract infection is one of the most common infections. This includes the varied conditions like rhinitis, sinusitis, ear infections, acute pharyngitis, tonsillitis, epiglottitis, and various infections. Laryngitis is one of the important components of the upper respiratory tract involvement. The amount of FDG uptake is directly proportional to the amount and acuteness of infectivity [8–11].

18.4.2 Acute Pharyngitis

Acute pharyngitis is one of the important viral infections in young children. Various mild changes due to clinical symptoms are important for the evaluation. Acute pharyngitis is caused by viruses in more than 70% of cases in young children. Mild pharyngeal redness and swelling and tonsil enlargement are typical. Streptococcal infection is rare in children under five and more common in older
children. In countries with crowded living conditions and populations that may have a genetic predisposition, post-streptococcal sequelae such as acute rheumatic fever and carditis are common in school-age children but may also occur in those under five. Acute pharyngitis in conjunction with the development of a membrane on the throat is nearly always caused by *Corynebacterium diphtheriae* in developing countries. However, with the almost universal vaccination of infants with the DTP (diphtheria–tetanus–pertussis) vaccine, diphtheria is rare. FDG PET-CT plays an important role in the evaluation of pharyngitis. The amount of uptake is directly proportional to the amount of inflammation [12, 13].

Fig. 18.1 Limited brain PET showing meningeal enhancement on CT image (a) in the right high parietal region corresponding PET (b) and (d) and fused image (c) show mild FDG uptake. FDG is not overly sensitive to brain pathology.
Viral infection in the chest has a varied presentation with an overlap of bacteremia. However, the commonest presentation is patchy consolidations. This is again related to upper respiratory tract and lower respiratory tract which are commonly associated with bacterial infections in later stages. SARS and other viral infections commonly present as ARDS (acute respiratory distress syndrome). FDG PET-CT is now

**Fig. 18.2** Limited brain PET-CT showing meningeal enhancement in right parietal lobe on CT images (a, b, c) and corresponding PET (d, e, f) and fused images (g, h, i) showing focal area of uptake along the meninges suggestive of meningitis

### 18.5 Viral Infection in Chest

#### 18.5.1 Viral Infection

Viral infection in the chest has a varied presentation with an overlap of bacteremia. However, the commonest presentation is patchy consolidations. This is again related to upper respiratory tract and lower respiratory tract which are commonly associated with bacterial infections in later stages. SARS and other viral infections commonly present as ARDS (acute respiratory distress syndrome). FDG PET-CT is now
an important imaging modality to evaluate various viral infections in the chest [14, 15] (Figs. 18.3, 18.4 and 18.5).

**18.5.2 COVID-19**

The pathogenesis is similar to other causes. However, bilateral consolidations predominantly peripheral with air bronchogram and pulmonary vessel cut off sign are the hallmark presentations on CT. These findings are clinically consistent with ARDS. A couple of studies on COVID-19 FDG uptake showed the multiorgan involvement with damage especially to GI tract, kidneys, bone marrow, heart, and

**Fig. 18.3** Whole-body PET-CT for high-grade fever showing patchy parenchymal infiltrates in left lower lobe on CT image (a). These infiltrates show significant increased uptake with SUV max of 6.5 on PET (b) and (d) and fused image (c) consistent with patchy pneumonitis due to viral infection.
other organs. The PET-CT findings are similar to other viral infections. The only advantage is to detect, evaluate the extent, and monitor the response to treatment [16, 17]. Limited imaging is done in this condition. However, the results are correlating with the amount of lung involvement (Figs. 18.6 and 18.7).

18.6 Viral Infections in Abdomen

In early and acute stages, no specific classical findings are there in the GI tract. Liver is one of the commonest organs involved in viral hepatitis especially commonly by Hepatitis-B, Hepatitis-A and C. The FDG presentation depends on the
stage of liver involvement (Figs. 18.8 and 18.9). Early stage no change, acute or chronic stage diffuse increased uptake in the liver secondary to Hepatitis, chronic and delayed stages where liver progresses to chronic liver disease or cirrhosis of liver or further may be predisposing to hepatocellular carcinoma. Here FDG PET-CT evaluates the extent of the disease and response to the treatment especially in acute stages which are reversible [12, 18–21]. The other presentations are mild peritoneal thickening. The next common organ involved are the genital organs, cervix in female and penis in male. Ca cervix is due to various predisposing factors and one of them is by various viral infections [22, 23].

The carcinoma penis is one of the predisposing factors caused by HPV (human papilloma virus) [24, 25].

Thus, FDG PET-CT plays an important role in the evaluation of viral infections to detect, extent disease involvement, monitoring disease progression, and treatment outcomes. There are lots of research going on especially in COVID-19 PET-CT evaluation. The findings mentioned in our chapter are based on preliminary research.

Fig. 18.5 Whole-body PET-CT with images at the level of both the upper lobe of the lung. Inhomogeneous parenchymal opacity with ground glass opacification seen in left upper lobe with focal pleural thickening image (a) and (c) and minimal FDG uptake in fused images (b) and (d) suggestive of infective inflammatory pathology
Fig. 18.6  Small patchy pneumonitis apex of right lung in image (a, c). Fused PET-CT images (b) and (d) show minimal nonspecific FDG uptake suggestive of infective inflammatory pathology.
Fig. 18.7 Limited PET-CT chest. CT showing ground-glass opacities right upper lobe and both lower lobes in images (a, b, and c) with minimal uptake on fused (g, h, i) and PET images (d, e, f) suggestive of nonspecific infective pathology.
Fig. 18.8 Whole-body PET-CT at the level of abdomen liver showing subtle inhomogenous enhancement in liver more in left lobe image (a, c) diffuse intense uptake involving entire liver parenchyma on PET and PET-CT images (b) with SUV max of 13.5. Minimal ill-defined hypodensities in both lobes of liver suggestive of hepatitis
Fig. 18.9 Whole-body PET-CT at the level of abdomen liver showing diffuse intense uptake involving entire liver parenchyma on PET (b, d) and PET-CT (a, c) images with SUV max of 13.5. Minimal ill-defined hypodensities in both lobes of liver suggestive of hepatitis

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