IAEA/ESNM Webinar Series on basic NM
Introduction to Infection & Inflammation Imaging

Self-assessment questions

Q1: Infection and Inflammation are:
1. Synonymous terms
2. terms that can be substituted for each other clinically
3. different – infection can cause inflammation
4. different – inflammation results in infection

Answer: 3
Description: Inflammation and Infection have different definitions. Inflammation is the response of the body to a noxious stimulus, this may be injury, an autoimmune attack or an infectious agent. Infection is the invasion of a microbiologic pathogen – this can lead to an inflammatory response. Inflammation cannot cause an infection.

Q2: The final outcome of an acute inflammation can be:
1. Resolution
2. Scarring (Fibrosis)
3. Development into Chronic inflammation
4. Abscess formation from a superadded infection
5. all of the above

Answer: 5
Description: Acute inflammation can either resolve completely with the tissue regaining its initial function or there can be a deterioration of function through fibrosis, development of a chronic inflammatory process or superadded infection. Hence, inflammation, though a protective response, may cause harm in certain situations.

Q3: The following white blood cells are involved in an acute inflammatory response:
1. Neutrophils
2. Monocytes
3. Macrophages
4. Basophils

Answer: 1
Description: Neutrophils are the mainstay of an acute inflammatory response. These comprise a majority of circulating white blood cells and respond to inflammatory stimuli. Imaging of labelled white blood cells demonstrates the accumulation of neutrophils in areas of acute infection and inflammation. Similarly monoclonal antibodies to granulocytes also depict the accumulation of these cells in acute inflammation.

Q4: The following white blood cells take part in a chronic inflammatory response:
1. Neutrophils
2. Monocytes
3. Eosinophils
4. Basophils

Answer: 2
Description: Monocytes and macrophages are a key component of a prolonged chronic inflammatory response. Lymphocytes are the type of other white blood cells, involved in a chronic response.

Q5: Biofilms are:
1. easily removable
2. part of the physiological skin barrier
3. a protective mechanism
4. often multidrug (antibiotic) resistant

Answer: 4
Description: Biofilms are collections of bacteria at solid-liquid interfaces and form readily over multiple devices and catheters used in clinical medicine. Biofilms are an important source of hospital acquired infections as up regulation of certain genes in the bacteria in biofilms causes them often to be multidrug resistant.

Q6: ^{67}\textit{Gallium Citrate} is an:
1. Aluminium Analogue
2. Iron Analogue
3. Enzyme inducer
4. Antibiotic

Answer: 2
Description: ^{67}\textit{Gallium Citrate} is an iron analogue and binds to lactoferrin and transferrin transport proteins which also function as acute phase reactants. The presence of lactoferrin and transferrin at sites of infection/inflammation cause gallium to be accumulate in these areas which when imaged with a gamma camera, are seen as areas of increased uptake.
Q7: Antibiotics should be stopped for at least ___ days prior to white blood cell imaging for infection:

1. One
2. Three
3. Seven
4. Fourteen

Answer: 2
Description: Antibiotics dampen the inflammatory response produced by infectious agents and therefore decrease the sensitivity of labelled white blood cell imaging. Antibiotics should therefore be stopped prior to white blood cell and monoclonal antibody imaging for infection for at least three days, though ideally for seven days – which is almost never possibly clinically.

Q8: White blood cells can be labelled to:

1. $^{111}$Indium Oxine
2. $^{99m}$Tc HMPAO
3. $^{18}$FDG
4. $^{64}$Cu
5. All of the above

Answer: 5
Description: White blood cells can be attached to all the above radiolabels. Indium and HMPAO labelled cells are imaged with SPECT gamma camera while FDG and Cu labelled cells are imaged with PET cameras.

Q9: A monoclonal antibody for infection imaging is:

1. $^{99m}$Tc labelled besilesomab
2. $^{111}$In labelled ritoximab
3. $^{90}$Y labelled infliximab
4. $^{131}$I labelled tositumomab

Answer: 1
Description: Antigranulocyte antibodies ($^{99m}$Tc labelled besilesomab or Scintimun) are produced in mice against the CD66 glycoprotein expressed on the human granulocyte surface. Since the entire antibody is used, there is a chance of a human anti mouse antibody (HAMA) immune response. Some countries mandate that a blood test for HAMA antibodies is carried out prior to injecting monoclonal antibodies.
Q10: Leukoscan ($^{99m}$Tc labelled monoclonal antibody Fab fragments) is licensed for the following clinical use:

1. Fever of unknown origin
2. Renal infections
3. Spinal infections
4. Infections of peripheral bones and joints

Answer: 4
Description: Leukoscan has a high background activity with high physiological uptake in the blood, urinary system and gut, hence it is licensed by EMEA for peripheral infections only.

Q11: $^{18}$Fluorodeoxyglucose is taken up by inflammatory cells through:

1. Passive diffusion
2. Increased expression of GLUT transporters
3. Active diffusion along the sodium glucose transporter
4. Phagocytosis

Answer: 2
Description: Inflammatory cells show an increased expression of GLUT transport proteins, particularly types 1 and 3. This is the pathophysiological basis for FDG accumulation within inflammatory cells – using a fluorinated radiolabel allows inflammatory processes in the body to be highlighted as areas of increased uptake.

Q12: Over time, areas of infection show:

1. an increase in the activity of radiolabelled white blood cells
2. a decrease in the activity of radiolabelled white blood cells
3. increase in the activity but decrease in the extent of radiolabelled white blood cell accumulation
4. no change

Answer: 1
Description: Radiolabelled white blood cells show an increase in the activity and/or extent in areas of septic infection over time. This differentiates infection from sterile inflammation which does not show this temporal increase in white blood cell activity.

Q13: $^{18}$Fluorodeoxyglucose can be used to image the following conditions:

1. Tuberculosis
2. Sarcoidosis
3. Lung Cancer
4. Large vessel Vasculitis
5. All of the above

Answer: 5
Description: FDG is a non-specific PET agent that can be used to image infectious (e.g. tuberculosis), inflammatory (e.g. sarcoidosis), autoimmune (vasculitis) and malignant conditions.
Q14: Patients undergoing FDG PET/CT scans for fever of unknown origin require:

1. Strict glucose control (BM <150mg/dl)
2. Glucose-insulin drips to optimise blood glucose
3. Prolonged fasting (>12 hours)
4. Adequate glucose control (BM < 200mg/dl)

Answer: 4

Description: Inflammatory processes are less influenced by high background glucose activity as compared to malignant cells. Hence strict glucose regulation is not a mandatory preparation for FDG PET/CT scans for infectious/inflammatory conditions. Fasting is a requirement though, usually 4-6 hours suffice. Water does not need to be restricted. Prolonged fasting protocols with dietary modifications are required for cardiac sarcoidosis imaging with FDG.

Q15: The clinical features (pillars) of inflammation were first described by:

1. Hippocrates
2. Galen
3. Celsius
4. Aristotle

Answer: 3

Description: Celsius first described rubor (redness), callor (increased temperature), dolor (pain) and edema (swelling) as the pillars of inflammation. A fifth feature – loss of function – was added by later added by Virchow.