



# Infection and inflammation imaging standardization: the EANM guidelines

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Inflammatory and infectious diseases may have serious consequences for the patient, if not diagnosed in time. In the past decades, nuclear medicine modalities have allowed us to study in depth the pathophysiology of these processes, and today it plays a leading role in the diagnosis, characterization and follow-up of infectious conditions.

Different nuclear medicine techniques and radiopharmaceuticals are currently available for imaging inflammation and infection (including gallium-citrate, radiolabelled white blood cells, anti-granulocyte antibodies and FDG) and it is, therefore, essential for nuclear medicine physicians to have a complete vision of pros and cons of each method and to know how to correctly position nuclear medicine examinations in the diagnostic workup of patients [1–4].

Despite the relevance of nuclear medicine in the field of diagnosis of infectious processes, we observe important differences in diagnostic accuracy of nuclear medicine techniques, between different centres and between different nations. Differences concern the choice of diagnostic procedures to be performed, how these are performed and how results are interpreted. Because of different methodology and different interpretation criteria, conflicting data with

wide variability of diagnostic accuracy have been published in the past decades. This variability has not favoured, over the years, the diffusion among the clinicians of the most common methods of nuclear medicine for the diagnosis of infections, such as, for example, the use of radiolabelled autologous leukocytes, or the use of monoclonal anti-granulocyte antibodies or the use of fluorodeoxyglucose. This is even more evident, if we look at the results published in recent meta-analyses [5–8]. As a consequence, clinicians have turned mainly to radiological diagnostic investigations (CT, NMR and ultrasound) although not always optimal in the assessment of the extent and activity of the infectious disease, nor useful in the follow-up of therapies unlike nuclear medical methods.

Therefore, since its creation, in 2012, the EANM Committee on Inflammation and Infection has worked on three main goals: (1) the standardization of nuclear medicine techniques for the diagnosis of infection and/or inflammation and their interpretation criteria, (2) the divulgation of these techniques amongst nuclear medicine physicians and (3) the preparation and divulgation of joint diagnostic guidelines with clinicians.

To reach the first goal, several procedural guidelines have been published about how to label autologous white blood cells (WBC) with <sup>99m</sup>Tc-HMPAO [9] or with <sup>111</sup>In-oxine [10] and about the quality controls that should be performed for the initial validation of the procedure by each centre and on a routine base. Similarly, a guideline on the use of [<sup>18</sup>F]FDG in inflammation/infection has been published in 2013 in collaboration with SNMMI [11]. Finally, in the beginning of 2018 the members of the EANM Committee on Inflammation and Infection, in some cases together with other committees and societies, published other important procedural guidelines on multimodality imaging for infective endocarditis [12], for large vessel vasculitis and polymyalgia rheumatica [13],

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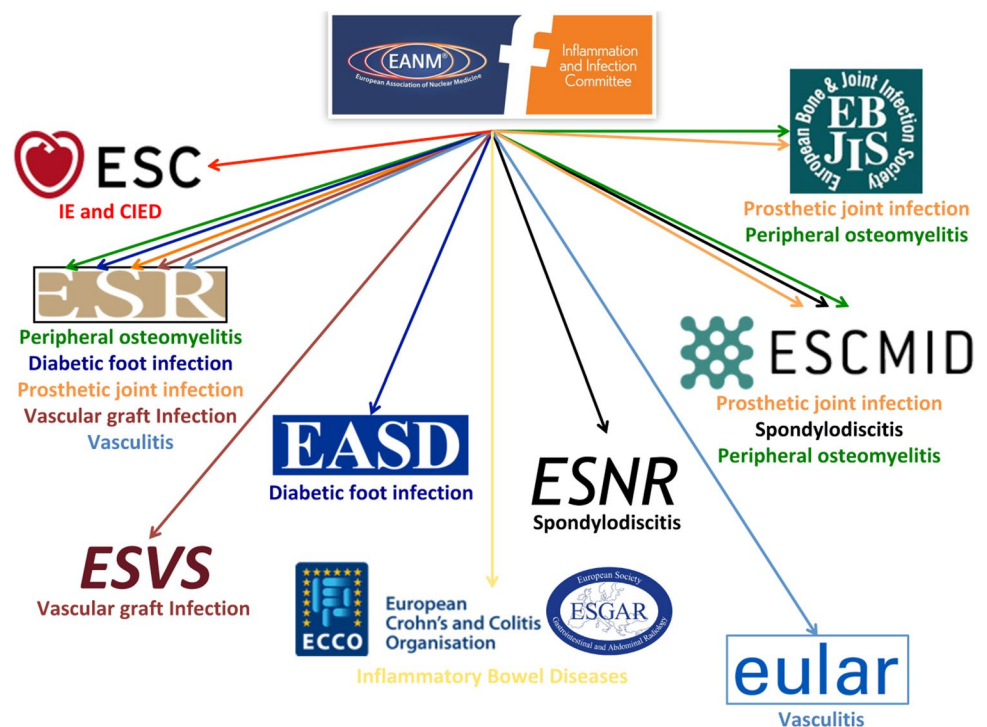
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**Fig. 1** The network of collaborations established over the last 6 years by the EANM Committee on inflammation/infection and other European societies



for cardiac sarcoidosis [14, 15] and on acquisition and interpretation criteria for WBC and anti-granulocyte imaging in infections [16].

The aim of all these guidelines is to reach a worldwide standardization of imaging modalities and patient preparation, but also a standardization on image acquisition and display parameters and on interpretation criteria.

This is extremely important for our discipline since the use of correct acquisition protocols will lead to good and accurate scans. Furthermore, using standardized interpretation criteria will lead to reliable and reproducible reports to clinicians that will increase our visibility, role and reliability.

Particularly in the field of infection, almost every centre had a slightly different procedure for WBC labelling and for protocols of image acquisition and interpretation. We, therefore, absolutely needed to standardize these techniques, to provide top quality examinations.

The second goal of divulgation was reached by organising courses and congresses dedicated to imaging of infection and inflammation. The EANM website also hosts several webinars that can be downloaded. Indeed, the new organization of the European School of Molecular Imaging and Therapy (ESMIT) includes a level 1 teaching program based on webinars, a level 2 teaching program based on courses in which infection/inflammation imaging is included particularly in the musculoskeletal and cardio-vascular system, and a level 3 teaching program of advanced courses in selected topics, amongst which, the WBC labelling.

After accomplishing these two goals, we were ready to approach several other European societies to prepare, jointly, diagnostic guidelines. We approached several societies, the European Crohn's and Colitis Organization (ECCO), the European Society of Gastrointestinal Radiology (ESGAR), the European Society of Cardiology (ESC), the European Society of Radiology (ESR), the European Society of Vascular Surgery (ESVS), the European Association for the Study of Diabetes (EASD), the European Society of Clinical Microbiology and Infective Diseases (ESCMID), the European League Against Rheumatism (EULAR), the European Bone and Joint Infection Society (EBJIS) and the European Society of NeuroRadiology (ESNR), as shown in Fig. 1.

With these societies, we organized several symposia and congresses all over Europe and we published in 2015 a monographic issue with a proposal of diagnostic flow charts for the most relevant inflammatory/infective diseases [17–21].

In the last 3 years, the Committee also started several evidence-based guidelines (as shown in Fig. 1) of which two (on infective endocarditis and inflammatory bowel diseases) have been already published [22, 23] and others (prosthetic joint infection, peripheral bone infection, spondylodiscitis, vascular graft infection, and infected diabetic foot) will soon be submitted to clinical journals.

With a huge multidisciplinary effort, we reached unanimous consensus to standardize the diagnostic approach in patients with infectious/inflammatory diseases. This consensus has an impact for correct patient management and to harmonize and increase the efficacy of national health care.

## Compliance with ethical standards

**Conflict of interest** Alberto Signore, Elena Lazzeri and Andor Glaudemans have no conflict of interest to declare.

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