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OCCASIONAL SURVEY

Myocardial perfusion scintigraphy in Europe 2005

A survey of the European Council on Nuclear Cardiology

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Abstract
Purpose We have conducted a survey of myocardial perfusion scintigraphy (MPS) in 2005 in Europe with the intention of initiating a regular series of surveys to track usage of the technique.
Methods Information was obtained from 234 centres in 18 counties. The returning centres served 27% of the population of their countries, and estimates of the numbers of MPS per million of population (pmp) were made assuming that the population not reported either performed no studies (lower estimate) or the same number pmp as the reporting centres (upper estimate).
Results Estimates of MPS for the countries surveyed ranged from a lower limit of 373 pmp to an upper limit of 1,388 pmp. There were marked variations between countries with higher numbers (lower limit of estimate above the mid range of all countries combined) in Austria, Greece, Hungary, the Netherlands, Sweden and Slovenia, and lower numbers (upper limit of estimate below the mid range of all countries) in Finland, Germany and Poland. The ratio of MPS to coronary angiography to revascularisation procedures was 0.6 to 1.5 to 1. The median number of studies per centre was 496, with 32% of centres performing fewer than 250 studies in the year. The median waiting time for routine studies was 21 days and for urgent studies 3.4 days. Fifty-three percent of studies used pharmacological stress, with roughly equal numbers of adenosine and dipyridamole. Eighty-two percent of studies used ^{99m}Tc-based tracers. Tomographic acquisition was almost universal with 65% of studies being ECG-gated and 20% attenuation-corrected. Eighteen percent of studies were reported from hard copy alone, and 60% of studies were reported without viewing the rotating planar data.
Conclusion We conclude that relatively low numbers of MPS studies are being performed in the surveyed centres, particularly when compared with coronary angiography and revascularisation. The use of ^{99m}Tc-based tracers is high, but ECG-gated studies are less common. Some reporting practices are not ideal. These data will serve as a valuable baseline for future surveys, which are likely to be more complete.

Keywords Myocardial perfusion scinitgraphy · Survey

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Introduction

Myocardial perfusion scintigraphy (MPS) provides effective and cost-effective diagnostic and prognostic information in patients with known or suspected coronary disease [1, 2]. Despite the development of other non-invasive imaging techniques such as stress echocardiography, X-ray computed tomography and magnetic resonance imaging, the use of MPS is increasing in most European countries. There is however a disparity of service provision within Europe and significant differences in use of the technique between Europe and the United States of America [3, 4]. The planning of service delivery requires accurate information on clinical use and practice, and we have therefore initiated what is intended to be a regular survey of the scale and nature of myocardial perfusion scintigraphy within Europe.

Materials and methods

We conducted an internet-based survey of European centres known to perform MPS with the aim of capturing information on the majority of MPS studies performed in the calendar year 2005. The survey was coordinated by the European Council on Nuclear Cardiology (ECNC) with the assistance of national leads in each country. The national leads provided lists of centres performing MPS and assisted with promoting, collecting and verifying the data collected. It was not envisaged that data collection could be complete in the first year of such a survey, and the process was expected to inform future surveys that may become more complete.

The survey contained only two obligatory questions concerning the number of MPS studies performed in 2005 and the population served for MPS (see Appendix). In addition, there were a number of optional questions concerning the numbers of other cardiac investigations performed and procedures used for MPS. It was envisaged that many centres would not be able to provide accurate numbers for population served, and so, guidance was given in how to estimate this from the number of coronary revascularisations performed and the national rate of revascularisation, assuming an average centre.

In order to correct for incomplete data collection, numbers of MPS and other studies were corrected for the percentage of each national population returned, assuming either that centres without returns performed no studies (lower limit of estimate) or that they performed the same number of studies per million population as the centres that did return (upper limit of estimate). The range between the lower and upper estimates provided a measure of the precision of the data.

Results

Returns were obtained from 234 centres in 18 countries (Table 1). No national coordinator was available in Belgium and France, and no responses were obtained from these countries. No responses were available from Italy because of a contemporaneous national survey.

Table 1 Countries and numbers of centres responding to the survey

Country	Centres
Austria	13
Belgium[a]	0
Czech Republic	11
Denmark	14
Finland	17
France[a]	0
Germany	21
Greece	8
Hungary	7
Israel	4
Italy[b]	0
The Netherlands	24
Norway	10
Poland	3
Portugal	6
Slovenia	3
Spain	11
Sweden	16
Switzerland	15
Turkey	7
United Kingdom	44
Total	234

[a] No national coordinator available
[b] Contemporaneous national survey

Nature of departments

Of the centres with returns, 55% were under- or postgraduate teaching hospitals, 31% were non-teaching hospitals, 5% were privately funded hospitals and 9% had a different setting (mainly private outpatient centres). Austria, Germany, Greece and Portugal had a particularly high proportion of studies performed in private centres.

Gamma cameras

Twenty-six percent of centres had a single gamma camera (of which 65% were multi-headed tomographic cameras), 28% had two cameras (of which 84% had tomography on at least one camera), 21% had three cameras, 15% had four cameras and 9% had five or more cameras, and all centres with more than two cameras had tomographic capability on at least one camera.

The median (inter-quartile range) age of the single headed tomographic cameras was 10 (5–14) years, of the multi-headed general purpose tomographic cameras was 5 (2–8) years, of the dedicated cardiac tomographic cameras was 3.5 (1–6) years and of the planar cameras was 12 (9–15) years.

Scan activity

The number of non-cardiac nuclear medicine studies reported was 903,519 in a population of 89,727,527, which is between 2,209 and 10,070 studies per million population (pmp), depending on the assumption made for studies performed in the non-reported population.

The number of MPS studies reported was 152,547 in a population of 109,880,969, which is between 373 and 1,388 pmp. Figure 1 shows the numbers of MPS studies pmp in each country. In centres reporting numbers of revascularisation procedures (percutaneous or surgical), the ratios of MPS to coronary angiography to revascularisations were 0.6 to 1.5 to 1.

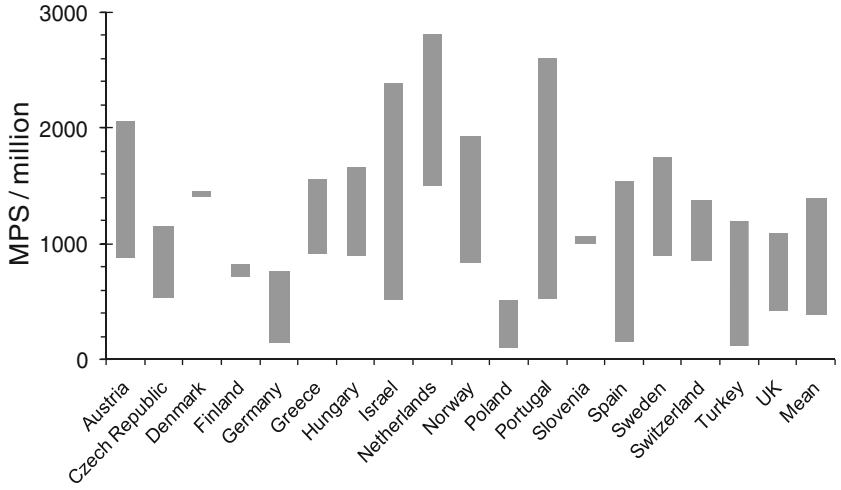

Fig. 1 Numbers of MPS studies per million population according to country, together with the weighted mean for all countries surveyed. The lower limit of each *bar* is the number reported assuming centres not reporting performed no studies. The upper limit is the extrapolated figure assuming that the unreported population has the same rate of MPS studies as the reported population. The *length of the bars* is inversely proportional to the percentage of the population reported

The median number of MPS studies per centre was 496 (inter-quartile range 200 to 900). Thirty-two percent of centres performed fewer than 250 studies, 52% performed fewer than 500 studies and 7% of centres performed more than 2,000 studies (Fig. 2).

MPS referrals

The median waiting time for routine MPS was 21 days (inter-quartile range 7 to 56 days) and for urgent studies it was 3.5 days (inter-quartile range 1 to 7 days). Eighty-two percent of MPS studies were performed on outpatients and 18% on inpatients. Thirty-four percent of referrals were from centres other than the site performing MPS. Seventy-two percent of referrals were from cardiologists, 13% from non-cardiac physicians, 10% from primary care physicians and 5% from surgeons (cardiac and non-cardiac). Fifty-seven percent of referrals were for diagnosis of coronary disease, 36% for the assessment of known coronary disease and 7% for the assessment of myocardial viability or hibernation.

Stress techniques

Dynamic exercise stress was used in 46% of studies, adenosine 25%, dipyridamole 23% and dobutamine 5% (Fig. 3). Dynamic exercise was used as an adjunct to dipyridamole or adenosine in 49% of vasodilator studies. In the Czech Republic, Germany, Finland, Greece, Israel, Norway, Slovenia, Sweden, Switzerland and Turkey, dynamic exercise was the commonest form of stress, whereas in Austria, Denmark, Hungary, Netherlands, Poland, Portugal and the UK, pharmacological stress was most common.

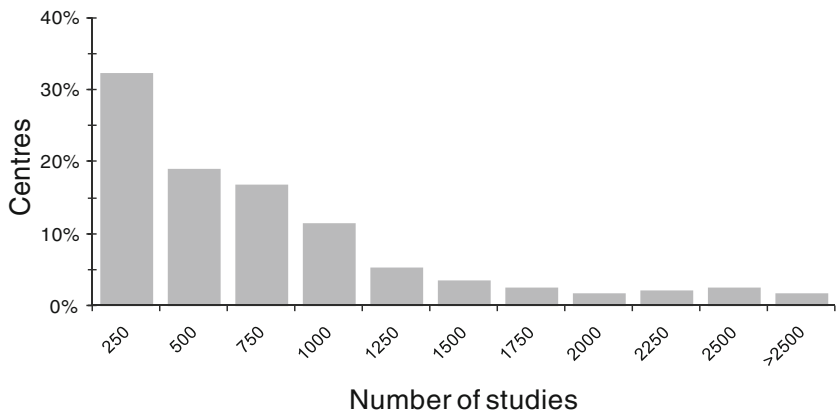

Fig. 2 Frequency histogram showing percentage of centres according to number of MPS studies reported

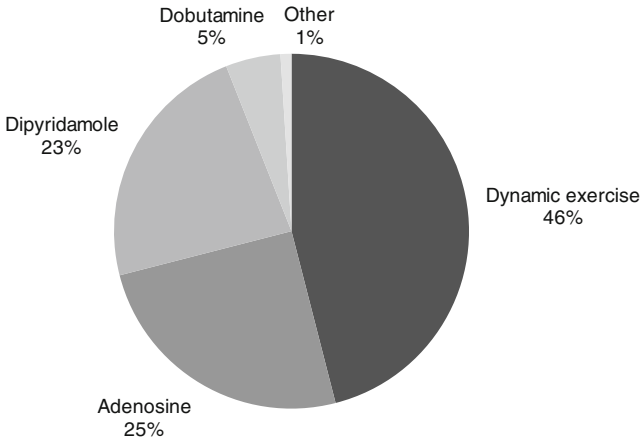

Fig. 3 Percentages of studies performed according to type of stress

The mean number of staff performing stress was 2.6. Stress was supervised by at least one doctor in 99% of centres (nuclear physician 88%, cardiologist 77%, other physician 44% and radiologist 27%), with additional involvement of a nurse, a radiographer or a cardiac technician.

MPS radiopharmaceuticals

The radiopharmaceutical used was ^{99m}Tc-tetrofosmin in 41% of studies, ^{99m}Tc-MIBI in 39%, ^{201}Tl in 18% and both ^{99m}Tc and ^{201}Tl were used in 2%. For ^{201}Tl studies, reinjection imaging was performed in 18% of studies. For ^{99m}Tc studies, a 2-day protocol was used in 66% of studies, a 1-day stress-rest protocol in 28% and a 1-day rest-stress protocol in 6%.

MPS imaging techniques

Single-photon emission computed tomography (SPECT) was the acquisition technique in 98% of centres. Sixty-five percent of studies were ECG-gated. Twenty percent of studies were attenuation-corrected. Twelve percent of centres used motion correction when appropriate. Nine percent of centres performed prone imaging either as well as supine or instead of supine imaging.

MPS reporting

A nuclear physician was involved in reporting in 82% of centres, either alone (11%) or together with a cardiologist (77%), a radiologist (22%), another physician (22%), a radiographer (16%), a physicist (11%), a nurse (5%) or a cardiac technician (5%). A cardiologist was involved in reporting in 25% of centres (together with a nuclear physician in 100% and/or a radiologist in 5%).

Sixty-eight percent of studies were reported from computer screen alone, 18% from hard copy alone and 14% from both computer and hard copy. In 40% of studies, the raw data were inspected alongside the tomograms at the time of reporting.

Eighty percent of centres used a continuous colour scale for assessing tracer uptake (cool 50%, rainbow 18%, other 12%), 14% used grey scale, 10% used a discrete colour scale with banding, 7% used a monochrome colour scale such as hot body and 14% used other scales. More than one colour scale was used in some centres.

Sixty-eight percent of centres used a continuous colour scale for the assessment of left ventricular function (46% cool, rainbow 13%, other 9%), 15% used grey scale, 7% used a monochrome colour scale such as hot body, 4% used a discrete colour scale with banding and 10% used other scales.

Discussion

We have surveyed the scale and nature of nuclear cardiology practice in a number of European countries. The response rate differed between countries, and the population covered by the reporting centres was 27% of the summed populations of their countries. The returns covered a particularly high proportion of the populations of Denmark, Finland and Slovenia, but, in general, the survey was incomplete, and extrapolation to the whole of Europe would be invalid. This was however the first of what is planned to be a regular series of surveys, and it is anticipated that future surveys will be more complete.

Overall MPS activity

The lower and upper estimates of MPS activity in 2005 were 373 and 1,388 pmp, respectively. These figures are relatively low, and there is a large range of the estimate, but it is likely that the true value is nearer the upper than the lower estimate, since it is unlikely that the centres not included in the survey did no studies. They may not have had the same rate as the surveyed centres, because there will have been a bias towards the larger academic centres in the responders, but the non-responders are unlikely to have been far below the responders in their use of MPS. It is unfortunate that we were unable to obtain data from France and Italy, since they are large countries, and also from Belgium, because it is thought to have a particularly high level of nuclear cardiology activity for its population.

Despite the different sampling rates in each country, our data suggest that MPS activity in Finland, Germany

and Poland is relatively low and that in Austria, Greece, Hungary, the Netherlands, Sweden and Slovenia is relatively high. The "correct" level of activity is unclear, but it is relevant to compare MPS with coronary angiography and rates of revascularisation. Revascularisation cannot be performed without prior angiography, and in that sense, angiography is the "gatekeeper" to revascularisation. The ratio of 1.5 angiograms to revascularisations is likely to be an underestimate because of primary angioplasty for acute myocardial infarction and diagnostic angiography that proceeds to intervention in the same session. Ratios between 1.5 and 2 are common in national databases that more completely capture the numbers of angiograms and interventions. The ratio of 0.6 MPS to each revascularisation is however very low, suggesting either that the MPS numbers have been underestimated or that many revascularisations are performed without the knowledge of coronary function. The numbers of stress echocardiograms or other stress functional imaging is even lower, and they are unlikely to explain the low MPS ratio.

It is relevant to compare the figures in this survey with other published figures. The British Nuclear Cardiology Society has conducted regular surveys since 1988 [3–9] and has reported 1,200 MPS pmp in 2000 and 1,900 in 2004, with an annual growth rate of 12.5%. The upper estimate for the UK in this survey was 1,082. A recent survey of the German Society of Nuclear Medicine reported 1,370 MPS pmp [10], which is higher than the upper estimate from this survey of 761 MPS pmp. In the Czech Republic, recent MPS activity was reported to be 1,733 MPS pmp [11], which is within the range of estimates from this survey. In Denmark in 2001, 930 MPS pmp were reported [12], and in 2005, 1,732 MPS pmp were reported to the Danish National Health Authority [13] compared with 1,402 MPS pmp from this survey. In Spain in 1999, 1,100 MPS pmp were reported, which is within the range of estimates from this survey [14]. In Sweden in 2005, the Swedish Radiation Protection Authority reported 1,438 pmp, which is similar to the estimate from this survey [15]. The contemporaneous national survey performed in Italy for 2005 reported a lower limit of MPS of 426 and an upper limit of 1,968 pmp (Marcassa, personal communication, 19 December 2007).

The figures from this survey are therefore generally similar to those published elsewhere, although with some variations, presumably because of changes with time and under-sampling. More importantly, all of these figures are lower than the activity of 4,000 MPS pmp recommended in the NICE appraisal, which was based upon the ratio of MPS to recommended numbers of revascularisation [1, 2]. The figures are also in stark contrast to the 30,833 MPS pmp that were performed in the USA in 2005 [4].

Local MPS activity

The histogram of annual activity (Fig. 2) shows that one third of centres performed fewer than 250 studies, half performed fewer than 500 and only 7% performed more than 2000. There is not necessarily a relationship between quality and quantity, but it is likely that higher volume centres produce more reliable results whether by cause or by effect. Relevant procedure guidelines [16–18] do not state a minimum number of studies to maintain competence, but professional opinion suggests that fewer than 250 studies per year is not ideal and that at least 500 per year is preferable [19]. A typical workload for a single gamma camera dedicated to cardiac studies is between 2,000 and 3,000 studies per year (although higher volumes can be achieved with extended hours), and it is notable that there is a small secondary peak in the histogram above 2,000 studies. These are the higher volume centres with sufficient throughput to dedicate a camera to MPS and to take advantage of more recent technical advances such as attenuation and scatter correction.

Waiting times are a marker of quality of service, at least from the patient's perspective. A median waiting time of 21 days for a routine study and 3.5 days for an urgent study is probably acceptable clinically, although the medians hide the very long waiting times in some centres, with 22 (9%) centres having routine waiting times longer than 90 days and 19 (8%) centres having urgent waiting times longer than 14 days. Waiting times of this length will inevitably lead to MPS not being used even when it might be appropriate and especially if the waiting time for coronary angiography is shorter. There may therefore be a disincentive for patients to undergo more cost-effective strategies of investigation in some centres [20].

Technical issues

Dynamic exercise remains the commonest single form of stress (46%), although combining the different forms of pharmacological stress accounts for the remaining 54%, with adenosine being the most widely used pharmacological stress agent (25%). This may reflect the fact that many patients have already undergone a treadmill exercise test and that an increasing proportion of an aging population is unable to exercise maximally. It is not known from this survey how many centres take advantage of injecting a perfusion tracer during the initial treadmill exercise ECG and hence combine information from both techniques in a single investigation, but it is likely to be only a minority.

Tomographic imaging is now almost universal for MPS, but only 65% of studies were ECG-gated despite the fact that 80% of studies used ^{99m}Tc and so presumably could have been gated. Twenty percent of studies used attenuation

correction, and so, more recent technical developments that extend and improve the information available from MPS have not yet penetrated fully despite recommendations of the procedure guidelines [16–18, 21].

Although a survey of this nature cannot comment on the quality of studies or of reporting, it was notable that 18% of studies were reported from hard copy without viewing on a computer screen, and 60% of studies were reported without viewing the raw data. Neither of these is ideal practice.

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Appendix

European Council of Nuclear Cardiology

Myocardial Perfusion Scintigraphy Survey 2005

This is the first of a regular series of surveys performed by the European Council on Nuclear Cardiology (ECNC). It concerns activity in myocardial perfusion scintigraphy throughout Europe. Previous national surveys have had important roles in service planning and in lobbying for resources, and so, your assistance in this effort may well have indirect benefit for your own practice. The results will be published and will be available to all participants.

Where several options are presented, you may need to select more than one. Where a number is requested, please give an estimate if the exact figure is not available. Please provide data in terms of the number of patients studied rather than the number of image acquisitions. For example, a stress+rest perfusion study=1 patient.

Please provide your contact details in case we need to clarify matters:

1. Contact name:
2. E-mail address:
3. Telephone number:
4. Institution address:

Essential Questions

If you do nothing else, please answer these questions to the best of your ability

5. What size of population does your department serve for nuclear cardiology studies? *See question 8 for hints in how to estimate this.*
6. How many myocardial perfusion studies did your department perform in 2005?

Desirable Questions

Some of these questions are more detailed or complex. The more that you can answer or estimate, the more valuable all of our efforts will be. If you have no estimation of 2005, you can use data from 2004.

About your institution

7. Type of institution:

   □ Undergraduate or postgraduate teaching hospital
   □ Mainly non-teaching hospital (may be allied to a teaching hospital)
   □ Mainly privately funded hospital or clinic
   □ Other (please specify)

8. What size of population do you serve for general cardiology?

This number is difficult to know but important. Please estimate as best you can. If you are an "average" site, one way of doing this may be from your national coronary angiography or revascularisation rate and the number of angiograms or revascularisations performed at your institution. For instance, if your national rate of revascularisation (CABG+PCI) is 2,500 per million population per year and you perform 750 revascularisations per year, then the population that you serve is likely to be 300,000.

If you cannot answer this, then suitable answers in the next question may allow us to do it for you.

9. Number (in year 2005) of:

   Stress ECGs
   Stress echocardiograms
   Cardiac magnetic resonance scans
   Coronary angiograms
   Percutaneous coronary interventions
   Coronary bypass graft operations

About your department

10. Type of department:

    □ Cardiology
    □ Nuclear Medicine
    □ Radiology
    □ Other (please specify)

11. Total number of general nuclear medicine studies in year 2005:

About your equipment

12. How many gamma cameras are there in your department?

    Single head general purpose SPECT:
    Multihead general purpose SPECT:
    Dedicated cardiac SPECT:
    Planar:

13. What are the ages (in years) of each gamma camera?

    Single head general purpose SPECT:
    Multihead general purpose SPECT:
    Dedicated cardiac SPECT:
    Planar:

About routine myocardial perfusion imaging

Patients studied

14. Percentages of inpatients/outpatients studied (should add up to 100):

    Outpatients:
    Inpatients:

15. Percentage referred from your own or from other hospitals (should add up to 100):

    Your hospital:
    Other hospitals:

16. Percentage of referrals from (please estimate if necessary):

    Cardiologist:
    Cardiac surgeon:
    Noncardiac physician:
    Noncardiac surgeon:
    Primary care physician:

17. Percentage indications for myocardial perfusion imaging:

    Diagnosis of coronary disease
    Assessment of known coronary disease (excluding hibernation):
    Assessment of hibernation or viability

18. Average waiting time for routine myocardial perfusion imaging:
19. Average waiting time for clinically urgent myocardial perfusion imaging

Stress

20. How many staff members supervise a typical stress test:

21. What is their background (give numbers of individuals at a typical stress test):

    Cardiologist:
    Nuclear physician:
    Radiologist:
    Other physician:
    Nurse:
    Radiographer or imaging technician:
    Physicist:
    Cardiac technician:
    Other (specify):

22. What type of stress is used? (% of patients studied, should add up to 100%)

    Exercise (bicycle or treadmill):
    Adenosine:
    Dipyridamole:
    Dobutamine:
    Other:

23. When you use vasodilator stress, is it routinely combined with exercise?

    □ Yes
    □ No

Radiopharmaceutical protocols

24. What radiopharmaceutical protocols are used?

    □ Thallium stress/redistribution
    □ Thallium stress/reinjection
    □ MIBI 1-day stress/rest
    □ MIBI 1-day rest/stress
    □ MIBI 2-day
    □ Tetrofosmin 1-day stress/rest
    □ Tetrofosmin 1-day rest/stress
    □ Tetrofosmin 2-day
    □ Dual isotope
    □ Other

Imaging protocols

25. Percentage of acquisition types (should add up to 100%):

    Ungated planar:
    ECG-gated planar:
    Ungated SPECT:
    ECG-gated SPECT:

26. What percentage of SPECT studies is attenuation corrected?

27. In what percentage of SPECT studies do you perform prone imaging, either as well as supine or instead of supine?
28. In what percentage of SPECT studies do you perform motion correction?

Reporting

29. Who reports nuclear cardiology studies (% of patients studied, may add up to more than 100% if several people report together)?

    Cardiologist
    Nuclear physician
    Radiologist
    Other physician
    Nurse
    Radiographer
    Physicist
    Cardiac technician
    Other

30. Do you report from hard copy or from computer screen?

    □ Hard copy
    □ Computer screen

31. In what percentage of SPECT studies is planar projection data examined by the reporter?
32. What percentage of ungated studies do you view for the assessment of perfusion using the following colour tables (may add up to more than 100% if you use a combination):
    Grey scale
    Monochrome colour scale (e.g. hot body)
    Continuous colour scale

    e.g. "Cool" or "GE"
    e.g. "Rainbow"
    e.g. Other

    Discrete colour scale (i.e. with discontinuities or contours)

33. What percentage of ECG-gated studies do you view for the assessment of LV function using the following colour tables (may add up to more than 100% if you use a combination):
    Grey scale
    Monochrome colour scale (e.g. hot body)
    Continuous colour scale

    e.g. "Cool" or "GE"
    e.g. "Rainbow"
    e.g. Other

    Discrete colour scale (i.e. with discontinuities or contours)

About radionuclide ventriculography

34. How many radionuclide ventriculograms were performed in your institution in 2005?

    Equilibrium studies:
    First pass studies:

About other nuclear cardiology techniques

35. Number of patients studied in 2005 with:

    Cardiac (FDG ± perfusion) PET

    – Dedicated PET
    – Gamma camera PET

    FDG SPECT
    Fatty acid imaging (SPECT or PET)
    MIBG
    Other (please specify)

Other comments

36. Please use this space to make any other comments that you think we may find useful:

References

1. Underwood SR, Anagnostopoulos C, Cerqueira M, Ell PJ, Flint J, Harbinson M, et al. Myocardial perfusion scintigraphy: the evidence. Eur J Nucl Med 2004;31:261–91.
2. National Institute of Health and Clinical Excellence. Myocardial perfusion scintigraphy for the diagnosis and management of angina and myocardial infarction. Technology appraisal 73, November 2003. http://www.nice.nhs.uk/ta073 accessed 19/02/2008.
3. Pennell DJ, Prvulovich EM, Tweddel A, Caplin J. Nuclear cardiology in the UK 1994: activity relative to Europe, USA, and British Cardiac Society targets. Heart 1998;80:296–8.
4. IMV Medical Information Division. 2005 Nuclear Medicine Census Market Summary Report (released July 2006).
5. Underwood SR, Gibson C, Tweddel A, et al. A survey of nuclear cardiological practice in Great Britain. Br Heart J 1992;67:273–7.
6. Pennell DJ, Prvulovich E, Tweddel A, et al. Nuclear cardiology in the UK: British nuclear cardiology society survey 1994. Nucl Med Comm 1998;19:305–13.
7. Prvulovich E, Metcalfe MJ. Nuclear cardiology in the UK: activity and practice 1997. Eur J Nucl Med 2002;29:553–8.
8. Kelion AD, Anagnostopoulos A, Harbinson M, Underwood SR, Metcalfe M. Myocardial perfusion scintigraphy in the UK: insights from the British Nuclear Cardiology Society Survey 2000. Heart 2005;91(suppl 4):iv2–5.
9. Hart D, Wall BF. UK nuclear medicine survey 2003–2004. Nucl Med Commun 2005;26:937–46.
10. Lindner O, Burchert W, Bengel FM, Zimmermann R, vom Dahl J, Schaefer W, et al. Myocardial perfusion scintigraphy in Germany. Results of the 2005 query and current status. Nuklearmedizin 2007;46:49–55.

11. Kaminek M, Lang O, Henzlova M. Activity of nuclear cardiology in the Czech Republic between 2000 and 2005. Eur J Nucl Med Mol Imag 2007;34:959–60.
12. Petersen CL, Kjaer A. Myocardial perfusion imaging in Denmark: activity from 1997 to 2001 and current practice. Eur J Nucl Med 2003;30:137–40.
13. Statens Institut for Strålebeskyttelse. http://www.sis.dk accessed 19/02/2008.
14. Martin-Comin J, Alarco R, Banzo J, Campos L, Freire J, Garcia-Solis D, et al. Practice of nuclear medicine in Spain. Eur J Nucl Med 2001;28:105–12.
15. Swedish Radiation Protection Authority. http://www.ssi.se/isotop/index.asp accessed 19/02/2008.
16. Anagnostopoulos C, Harbinson M, Kelion A, Kundley K, Loong CY, Notghi A, et al. Procedure guidelines for radionuclide myocardial perfusion imaging. Heart 2004;90:i1–10.
17. Hesse B, Tägil K, Cuocolo A, Anagnostopoulos C, Bardiés M, Bax JJ, et al. EANM/ESC procedural guidelines for myocardial perfusion imaging in nuclear cardiology. Eur J Nucl Med Mol Imaging 2005;32:855–97.
18. DePuey EG, Corbett JR, Friedman JD, Goldstein RA, Henzlova MJ, Hansen CL, et al. Imaging guidelines for nuclear cardiology procedures. J Nucl Cardiol 2006;13:e21–171.
19. Prvulovich EM, Jarritt PH, Vivian GC, Clarke SE, Pennell DJ, Underwood SR. Quality assurance in myocardial perfusion tomography: a collaborative BNCS/BNMS audit programme. Nucl Med Commun 1998;19:831–8.
20. Underwood SR, Godman B, Salyani S, Ogle J, Ell PJ. Economics of myocardial perfusion imaging in Europe: the EMPIRE study. Eur J Nucl Med 1999;20:157–66.
21. Heller GV, Links J, Bateman TM, Ziffer JA, Ficaro E, Cohen MC, et al. American society of nuclear cardiology and society of nuclear medicine joint position statement: attenuation correction of myocardial perfusion SPECT scintigraphy. J Nucl Cardiol 2004;11:229–30.