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A survey of the role of the UK physicist in nuclear medicine: a report of a joint working group of the British Institute of Radiology, British Nuclear Medicine Society, and the Institute of Physics and Engineering in Medicine

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Summary

Guidelines for the provision of physics support to nuclear medicine were published in 1999 by a joint working group of the British Institute of Radiology, the British Nuclear Medicine Society, and the Institute of Physics and Engineering in Medicine. Following publication of the guidelines, a survey was conducted by the working group to gather data on the actual level of physicist support in UK hospitals of different types and on the activities undertaken by physicists. The data were collected in the 12 months following the publication of guidelines and cover different hospital models and seven UK regions. The results provide evidence that many of the smaller units – small teaching hospitals and, particularly, small district general hospitals – have insufficient physics support. Although, on average, there is good agreement between the guidelines and the survey data for medium and large district general hospitals, there is wide variation in the level of physics provision between hospitals delivering apparently similar services. This emphasizes the need for national guidelines, against which institutions may be bench-marked and which may be used as a recommendation for the staffing levels necessary to ensure services are delivered safely and standards are not compromised. The complexity and variety of workload is an important factor in determining the level of physics support. As services develop, it is vital that this aspect is recognized to ensure that appropriate resources are available for the required physics input, even if any new service represents only a modest clinical throughput in terms of patient numbers. (© 2003 Lippincott Williams & Wilkins)

Keywords: nuclear medicine, medical physics, recruitment and retention, staff, standards, guidelines, clinical scientist, survey.

Background

Guidelines for the provision of physics support to nuclear medicine [1] were published in 1999 by a joint working group of the British Institute of Radiology (BIR), the British Nuclear Medicine Society (BNMS) and the Institute of Physics and Engineering in Medicine (IPEM). These guidelines represent a revision of previously published policy statements from the IPEM [2,3] and were endorsed by three of the major professional societies supporting nuclear medicine in the UK. They provide professional guidance on the level of physicist support required for the provision of a safe, effective and responsive nuclear medicine service.

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To define the role of the physicist in nuclear medicine, the working group adopted the approach of defining 'core' and 'non-core' duties (see Appendices 1 and 2). Core duties are those in which the expertise of a physicist is essential. Other duties (non-core) may be performed by the physicist in nuclear medicine or by staff from another discipline, depending on local circumstances. It was recognized that in many centres the physicists have a significant involvement in service management, including budgetary control. This is an acceptable physics role provided that the physicist as service manager has the organizational and administrative authority to deliver a safe service [4,5]. Additionally, it was recognized that a physicist acting as an independent practitioner may have radiopharmacy duties and may also act as a radiopharmacy production manager. The separation of duties into core and non-core tasks takes into account these differing situations. Sixteen core activities were defined [1]. The background to this work is given in the original publication [1].

Following publication of the guidelines, a survey was conducted by the same working group in order to gather data on the actual level of physicist support in UK hospitals of different types and on the activities carried out in those hospitals by physicists. In this paper the results of the survey are presented and compared with the guidelines. This report is endorsed by the three societies represented on the working group.

Methods

Selection of sites to survey

It was important to obtain as high a response rate as possible for this survey in order to avoid biasing the study in favour of those departments with more active physics support. Since it was considered impractical to successfully survey all departments in the UK, a subset of regions was selected for study, with the aim of achieving a 100% response rate from this subset.

Seven regions were selected for study. The choice of these regions was based on two criteria to achieve

- as wide a geographic spread as possible;
- as broad a range of physics cover as possible.

Regions were chosen on the basis of information supplied by the IPEM on the number of nuclear medicine physicists in various regions.

Within the seven regions, there was a total of 82 departments. This comprises approximately 32% of the total number of departments carrying out nuclear medicine in the UK. At the outset of the study, from the data available, it was estimated that there was between 0.4 and 2.2 physicists per department averaged over each region.

Data collection

Data were collected over the period 1999–2000. Each department was sent a questionnaire requesting information on

- the type of hospital (small/medium/large district general hospital (DGH), small/large teaching hospital (TH), defined according to the model used by the Royal College of Physicians (RCP) [4]);.
- the equipment available;
- the type and number of procedures carried out annually;
- staffing levels (not only for physicists, but also for other staff);
- the time which physicists spent on core and non-core activities (listed individually);
- the time spent by other staff members (non-physicists) on physics core activities.

A study co-ordinator was assigned to each region. Where possible this was someone who worked outside of the region concerned. Where responses were slow, the questionnaire was followed up by a telephone call, in order to answer any queries and to encourage completion of the questionnaire.

Following data collection, preliminary analysis showed that there were returns for only two large teaching hospitals. In order to obtain a more representative picture of physicist activities in this type of institution, a further three large teaching hospitals were subsequently specifically targeted for inclusion in the survey.

Results

For the initial survey (excluding the three additional teaching hospitals), 74 out of the 82 hospitals responded, giving a 90% response rate. However, only 76% of the hospitals targeted provided a complete response to the questionnaire. The main areas of non-response to the questionnaire related to the detail of the activities of the physicists. A breakdown of the region response rates is given in Table 1.

The distribution of hospital types responding to the initial survey was: small DGH (31%, n=23), medium DGH (31%, n=24), large DGH (8%, n=6), small TH (23%, n=17), large TH (3%, n=2), other specialist hospital (4%, n=3). Specialist hospitals were not included in the RCP model and the guidelines for physics support do not specifically address this hospital type. Excluding the specialist hospitals and including the three additional teaching hospitals gives the distribution of hospital types as 31%, 32%, 8%, 23% and 7% (small DGH, medium DGH, large DGH, small TH and large TH, respectively).

Data analysis

Specialist hospitals were excluded from the analysis. The average number of hours per week spent by physicists on core activities is shown in Fig. 1. The line represents the data from the guidelines [1] and the vertical bars represent the results from the survey. There is reasonably good agreement between the guideline figures for core activities and the survey data for the medium and large DGHs. The small THs and particularly the small DGHs have less physics support than that recommended by the guidelines (58 ± 32 h vs 80 h for small THs, and 8 ± 9 h vs 22 h for small DGHs) (mean ± 1SD). On average, the five large THs reported more core physics hours than that recommended by the guidelines (157 ± 36 h vs 109 h). For completeness, Fig. 2 shows the average number of physicist hours per week spent on core plus non-core activities. The line again represents data from the guidelines for core activities – guideline figures for non-core activities were not specified by the working group as this was considered inappropriate [1]

Figures 3 to 7 show the variation in the number of physicist hours across each of the hospital types. The white vertical bars represent core activities, the dark vertical bars non-core activities and the solid line the guideline data. There were 22 small DGHs, with a wide variation in levels of physics support within this grouping (Fig. 3). Only three hospitals exceeded the guideline figure for core activity, and only one exceeded the figure by more than 10%. The remainder had less physics support than that recommended, with seven hospitals claiming less than 1 h per week of physics time, and one with no physics support whatsoever. Just less than one

Table 1. Region response rates for the survey.

Region	*Number of departments surveyed*	*Number of returns*
S.E. Scotland	7	6
Oxford	5	5
S. Thames	18	17
Wessex	11	10
Trent	15	14
Northern	13	9
Manchester	13	13

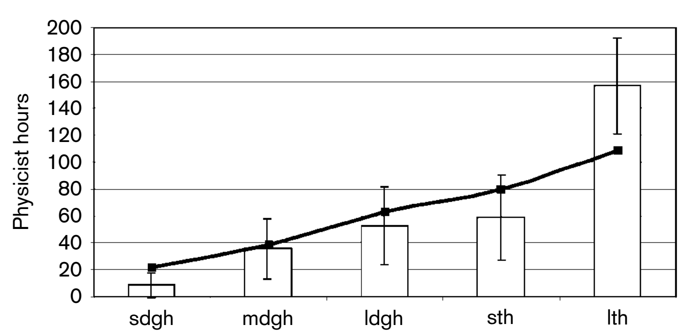

Fig. 1. Average number of physicist hours per week spent on core activities (sdgh, small district general hospital; mdgh, medium district general hospital; ldgh, large district general hospital; sth, small teaching hospital; lth, large teaching hospital). Vertical bars represent the survey results, with error bars representing ± 1SD around the mean. The solid line represents the guideline data.

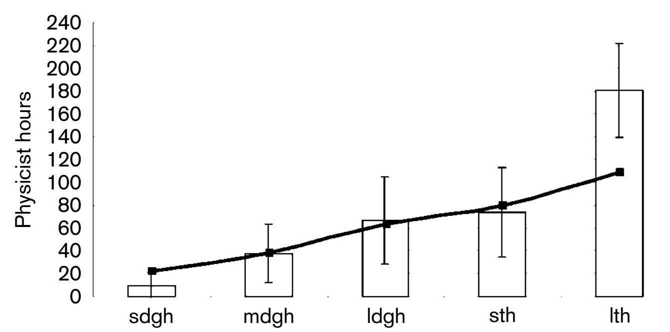

Fig. 2. Average number of physicist hours per week spent on core and non-core activities. Vertical bars represent the survey results, with error bars representing ± 1SD around the mean. The solid line represents the guideline data. Abbreviations as in the legend to Fig. 1.

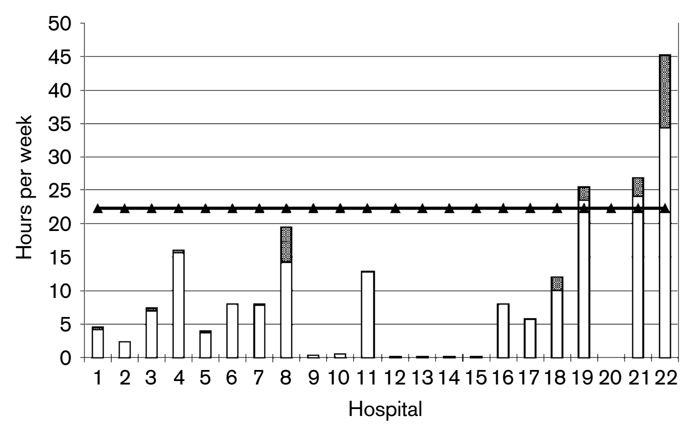

Fig. 3. Variation in physicist hours per week spent on core and non-core activities for hospitals in the category small district general hospital. (■), non-core activities; (□), core activities; (▲), guidelines for core activities.

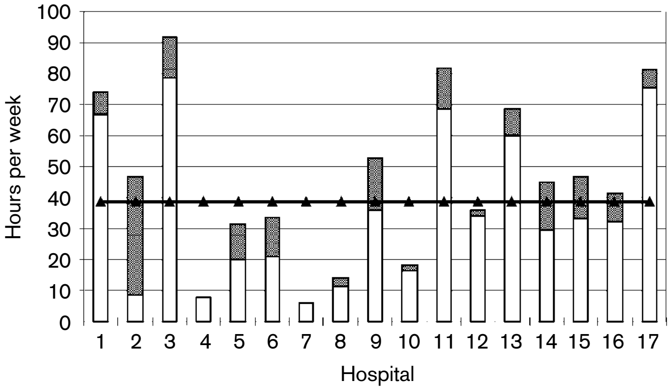

Fig. 4. Variation in physicist hours per week spent on core and non-core activities for hospitals in the category medium district general hospital. Key as in the legend to Fig. 3.

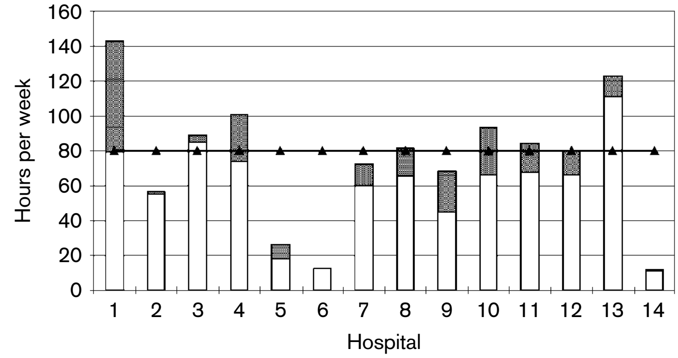

Fig. 6. Variation in physicist hours per week spent on core and non-core activities for hospitals in the category small teaching hospital. Key as in the legend to Fig. 3.

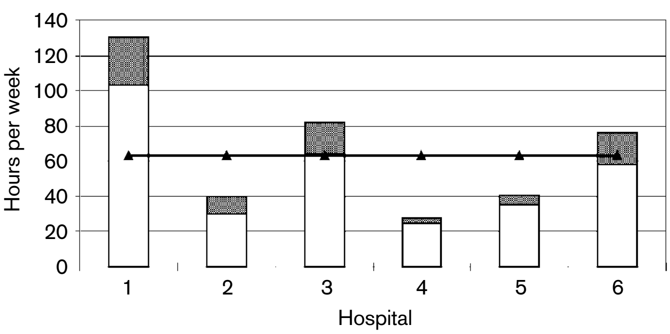

Fig. 5. Variation in physicist hours per week spent on core and non-core activities for hospitals in the category large district general hospital. Key as in the legend to Fig. 3.

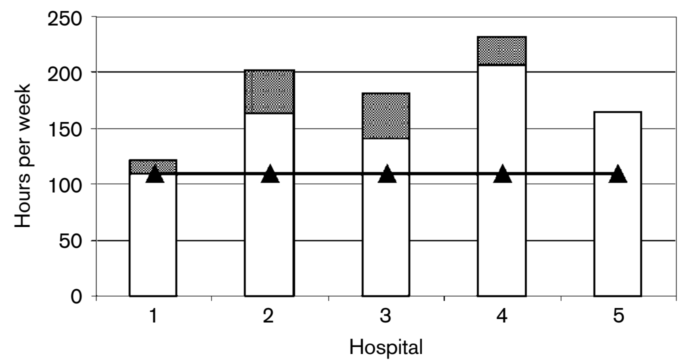

Fig. 7. Variation in physicist hours per week spent on core and non-core activities for hospitals in the category large teaching hospital. Key as in the legend to Fig. 3.

half of the hospitals in the small DGH category had some physics hours being spent on non-core activities. In the medium DGH category (Fig. 4) there were 17 hospitals, with the physics hours being spread above and below the guideline figure. Again, there was considerable disparity between hospitals, with a 10-fold difference in the number of physics hours between hospitals offering apparently similar services. All but two of the hospitals claimed some physics hours which were non-core, and in one hospital the non-core activity accounted for 80% of the total physics hours (this was due to the physicist acting as the radiopharmacy production manager in this instance). For the large DGHs (n=6) (Fig. 5) there were three hospitals which fell significantly below the guideline figure, two which showed good agreement and one which exceeded the guideline in terms of core activity by 64%. All had some element of physics activity which was non-core. In the small THs (Fig. 6) only one out of 14 hospitals exceeded the guideline figure to any significant degree (38%); the remainder were within 10% (n=3) or well below the recommended level (n=10). All but one hospital claimed an element of non-core physics activity. Results for the large teaching hospitals showed levels of core physics activity equal to the guideline in one case, and exceeding the guideline in the remaining four cases (by 28%, 50% (two cases) and almost 100% respectively) (Fig. 7). All but one of the large teaching hospitals were undertaking some non-core activity, which accounted for some 10–20% of the total physics hours.

The data showing how the core activities are distributed are given in Figs 8 to 12. The vertical bars indicate the results from the survey (as a per cent of total physics core hours) and the solid line the recommended distribution from the guidelines. Note that because the results are expressed as a per cent of the total, any disparity between total recommended hours and total actual hours is not evident on the graphs. For the small DGH (Fig. 8) the majority of time is being spent on

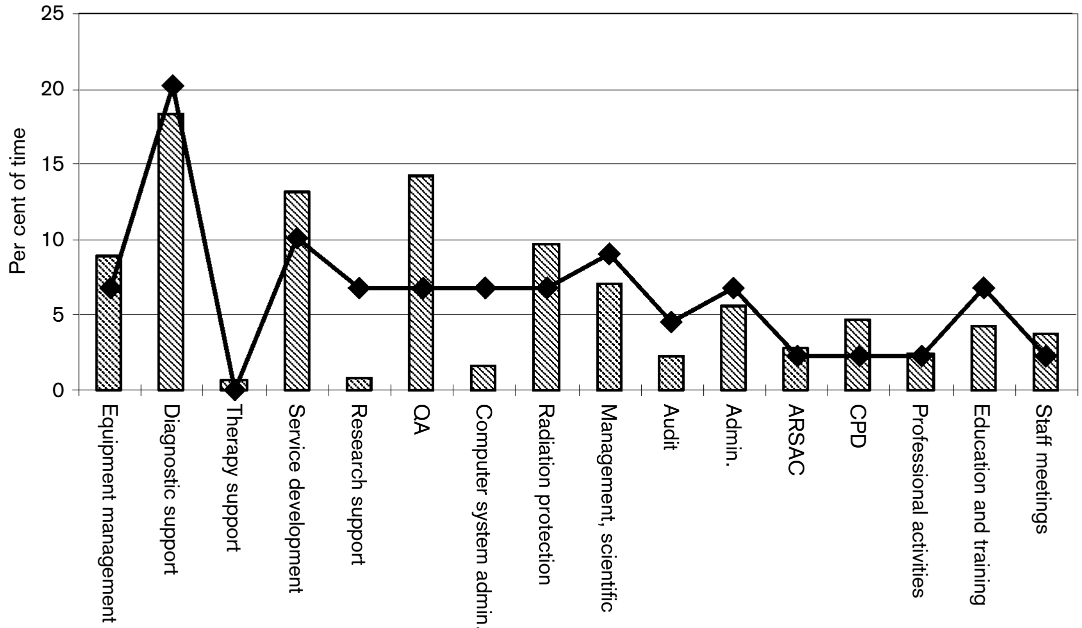

Fig. 8. Distribution of physicist time according to type of core activity for hospitals in the category small district general hospital. CPD, continuing professional development; ARSAC, Administration of Radioactive Substances Advisory Committee; QA, quality assurance. (■), per cent of the total; (◆), per cent of the guidelines.

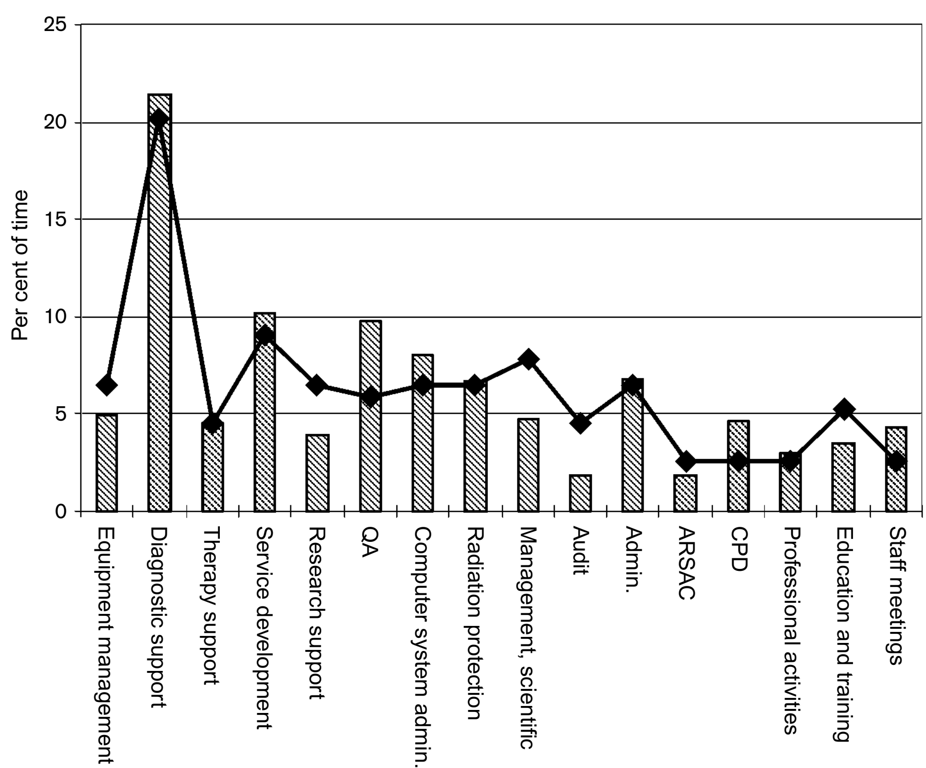

Fig. 9. Distribution of physicist time according to type of core activity for hospitals in the category medium district general hospital. Abbreviations and key as in the legend to Fig. 8.

diagnostic support, service development and quality assurance (QA). The main deviations from the guideline data are in research support and computer system administration. In the medium DGHs (Fig. 9) by far the most time is being spent on diagnostic support. This is again followed by service development and QA, although there is now proportionately more research support and computer system administration (when

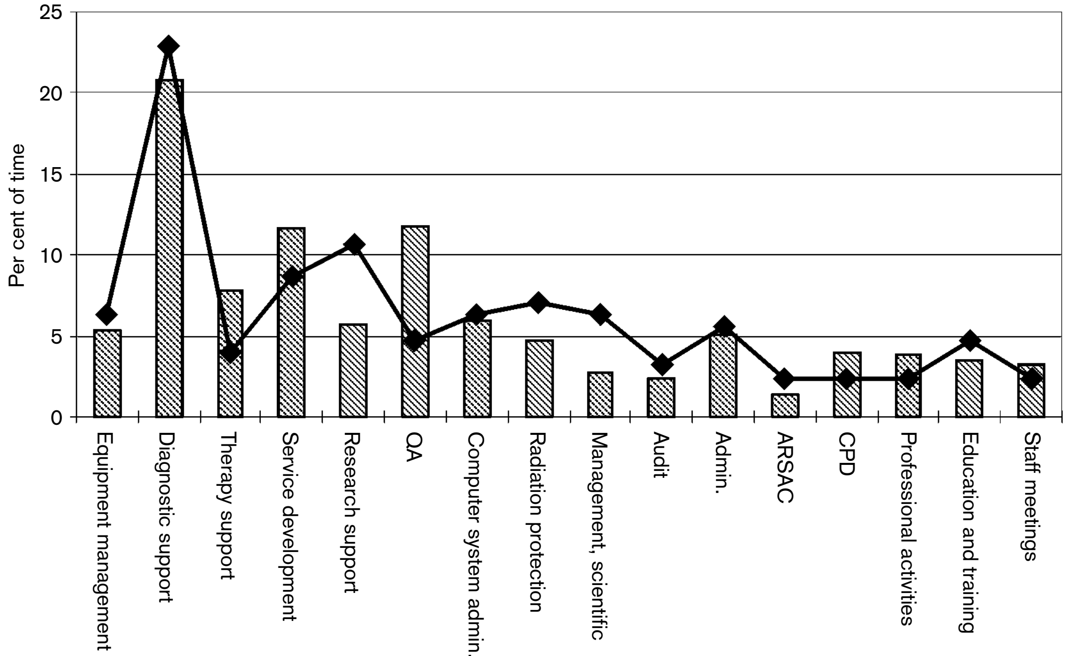

Fig. 10. Distribution of physicist time according to type of core activity for hospitals in the category large district general hospital. Abbreviations and key as in the legend to Fig. 8.

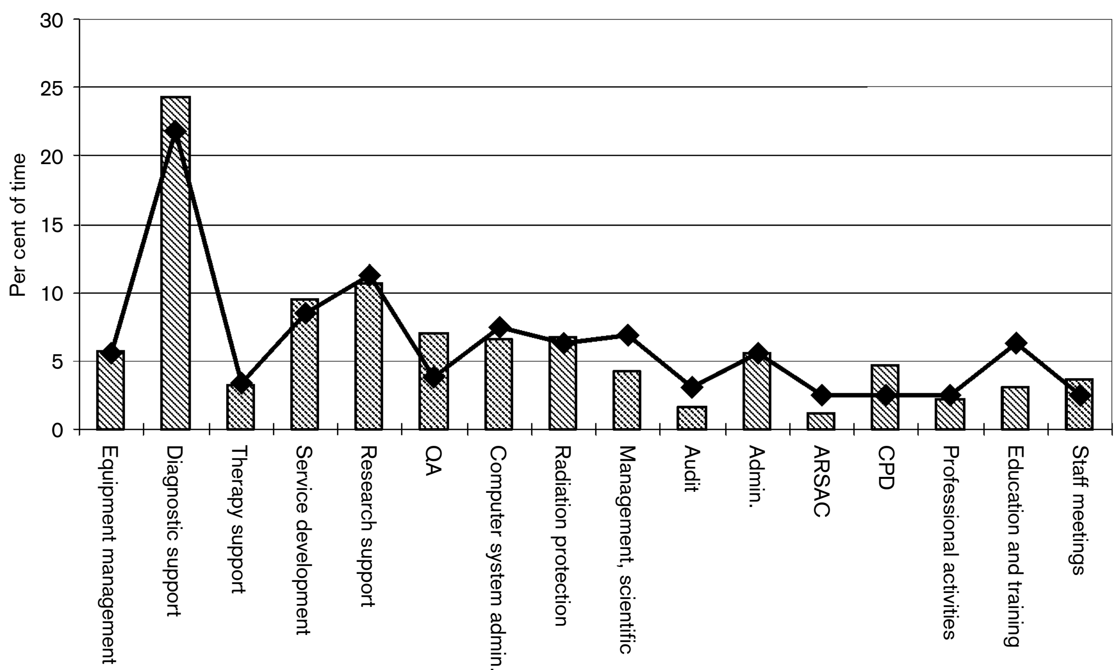

Fig. 11. Distribution of physicist time according to type of core activity for hospitals in the category small teaching hospital. Abbreviations and key as in the legend to Fig. 8.

compared to small DGH levels). The results are similar in the large DGHs (Fig. 10) and for all DGHs, whatever size, there is more time, proportionately, being spent on QA than would be expected based on the data from the guidelines, and less on research support. In the small THs, diagnostic support again dominates and there is a significant proportion of time being spent on research support. The distribution in this category of hospital closely follows the guideline distribution (Fig. 11). In contrast, in the large THs, the biggest proportion of time is being spent on research support, closely followed by service development and diagnostic support (Fig. 12).

The workload for each hospital was grouped into categories of static and dynamic imaging, gated and single photon emission tomography imaging, positron emission tomography, therapy, non-imaging, other (maximum number of categories=6). Figure 13 shows the relationship between number of physicist hours per week and the number of different categories of work being undertaken. The number of hospitals claiming the different categories of workload was as follows: one category (9), two categories (20), three categories (13), four categories (22), five categories (11) and six categories (2). There is a rising number of physicist hours per week with increasing categories of work, with a clear linear relationship between the two over the range one to five categories. Note that there were only two hospitals claiming six different categories of work.

Interestingly, although there is a larger number of total studies being undertaken annually in the hospitals with higher categories of work compared with those doing less varied work (as might be expected), the relationship between physics hours and number of categories of work does not appear to be simply due to volume (i.e. numbers of studies) since normalizing for total number of studies still shows an increase in physics hours with increasing complexity of work. For example, the number of physicist hours per week per 1000 studies (excluding dual-energy X-ray absorptiometry) is 2 for the one category departments and approximately 17 for the four and five category departments.

Three areas of core activity were examined in terms of the staff group carrying out this activity, if it was not done by a physicist. The areas were research support,

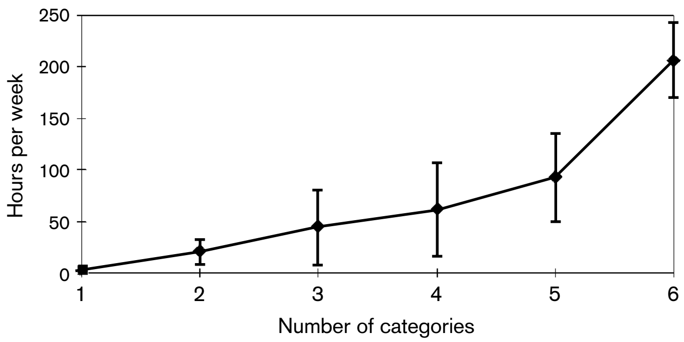

Fig. 13. Relationship between the average number of physicist hours per week and number of different categories of work undertaken (mean ± 1SD).

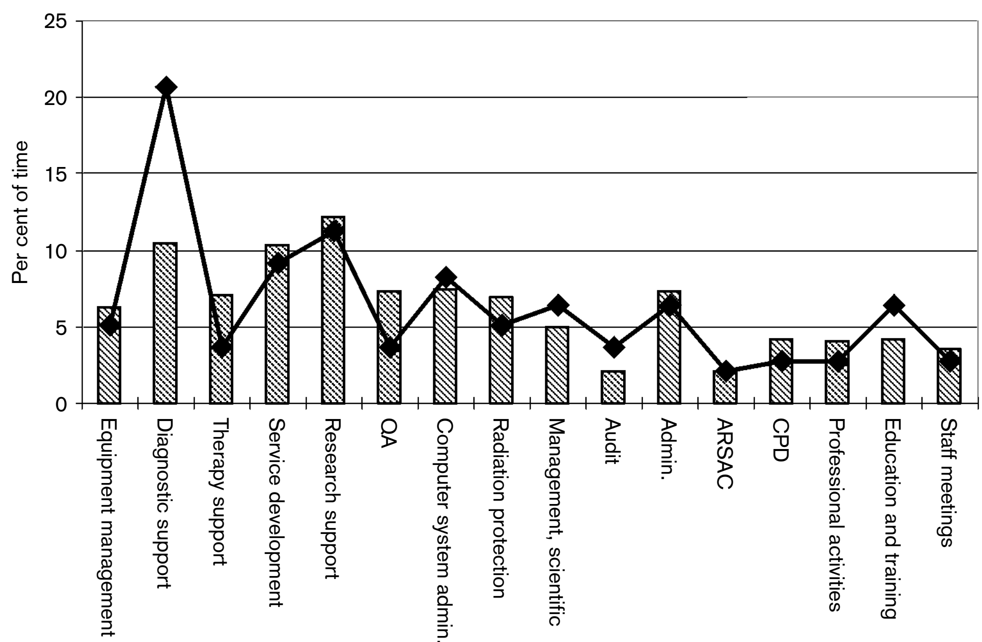

Fig. 12. Distribution of physicist time according to type of core activity for hospitals in the category large teaching hospital. Abbreviations and key as in the legend to Fig. 8.

service development and therapy support. Results were collated for those hospitals in the survey claiming less than 0.1 physicist (eight hospitals). No other staff group was identified as providing nuclear medicine research support in these hospitals. In terms of service development, this was being done in five cases by radiographers or medical technical officers (MTOs). In the remainder of the hospitals, service development was not evidently being undertaken. Therapy was being undertaken in three of the eight hospitals, with support in two cases from radiographers/MTOs and in one case from another unspecified staff group.

Conclusions

The results of this survey provide an insight into the UK provision of physics support to nuclear medicine. The data cover a range of different hospital models and seven UK regions. They were collected in the 12 month period following the publication of guidelines for the provision of physics support to nuclear medicine, which were endorsed by three major professional societies supporting the specialty in the UK. They do not reflect the response of NHS Trusts to the guidelines, as the time period between publication and survey data collection was too short for responses to have been observed. Indeed, this was not the intention of the survey; rather, it was intended to provide a representative 'snapshot' of the prevailing physics support and to provide information on the activities with which physicists were engaged in the various models of hospital.

The results provide evidence that many of the smaller units – the small teaching hospitals and particularly the small district general hospitals – have insufficient physics support. Most of the 22 small DGHs included in the survey had a level of physics support far below the guideline recommendation for core physics activity for an institute of that type. Approximately one third of the small DGHs had less than 1 h of physics support per week (this included any input from radiation protection advisers to nuclear medicine). It is difficult to see how compliance with legislation and the maintenance of quality standards can be achieved with such a minimal level of support. Indeed, one hospital which claimed to have no physics support whatsoever would have been unable to satisfy the legal requirements for the provision of a clinical nuclear medicine service. Just under half of the small teaching hospitals had physics support which was at least 25% under the recommended level and in 20% of cases the support was less than a quarter of the guideline figure.

It is of interest that although, on average, there is reasonably good agreement between the guideline figures for core activity and the survey data for the medium and large DGHs, there is a wide variation in the level of physics provision between hospitals delivering apparently similar services. This emphasizes the need for nationally agreed guidelines, against which institutions may be benchmarked and which may be used as a recommendation for the physics staffing levels necessary to ensure that services are delivered safely and that standards are not compromised. The identification of core physics activities for the different hospital models and the comparison of the physicist workload distribution with this may also help to highlight any work activities in a particular institution which are inappropriately resourced. Whilst any particular local circumstances must be taken into account, the sub-division of core physics activity in the guidelines provides a useful comparator tool.

The large teaching hospitals surveyed in this study were well-resourced in terms of physics support, with the physicists being particularly active in research. This was the only hospital model where research support dominated the physicist workload.

It is clear that the distribution of workload is different in the various hospital models and that the provision of physics support is not simply related to the clinical nuclear medicine workload in terms of patient numbers. The complexity and variety of workload is an important factor in determining the level of physics support. As services develop, it is vital that this aspect is recognized in order to ensure that appropriate resources are available for the required physics input, even if any new service represents only a modest clinical throughput in terms of patient numbers.

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Appendix 1. Core duties of the nuclear medicine physicist.

Duties	*Examples*
Equipment management and equipment quality control (QC)	Equipment procurement (specification, evaluation of tenders, acceptance testing) and responsibility for all aspects of equipment QC, including fault diagnosis.
Support for diagnostic procedures	Applies to both imaging and non-imaging work and includes provision of advice on the range and suitability of investigations, responsibility for the technical aspects of acquisition, data analysis and presentation of investigations, non-clinical reporting, scientific support for technical and/or radiography staff and liaison with other staff groups as appropriate.
Support for radionuclide therapy	The responsibility for the provision of advice, dosimetry, activity calculations and administration of therapeutic doses and liaison with other staff groups as appropriate.
Service development and monitoring	The establishment, introduction and validation of new procedures and protocols and the review of existing procedures and protocols.
Research support	The provision of scientific and technical support for the research infrastructure within the hospital. For the assessment of physics staffing requirements those aspects of research in which the physics support is independently funded are not included.
Quality assurance (QA)	The continuous monitoring of service organization, imaging and non-imaging procedures, equipment and software performance, non-clinical reporting, data presentation and staff training.
Computer system administration, software development, maintenance and QA	This is specific to the activities of the nuclear medicine department and includes advice on the legal liabilities associated with in-house software. It excludes information technology (IT) support to other hospital departments.
Radiation protection	Radiation protection adviser duties and other radiation protection duties related to the work of nuclear medicine and radiopharmacy, in line with legislative requirements. This includes the management and responsibility for radioactive waste and its disposal and the stock control and transport of radioactive materials.
Management of scientific service	The management of the scientific service and the delivery of scientific support. This may include the management of other nuclear medicine physicists.
Audit	Multidisciplinary clinical audit and external audit (e.g. Health and Safety Executive, Environment Agency).
Administration	Correspondence and record keeping.
Support for ARSAC certification procedure	Applications, review and advice.
Continuing professional development	To comply with the IPEM programme, a minimum of 50 hours per person of recorded study per year is required.
Professional	Involvement in hospital committees (including radiation safety) and activities associated with revelant professional societies.
Education and training	Education and training of other NHS staff groups (for example, medical, nursing, pharmacy staff, etc.) particularly in relation to statutory legislation. For the assessment of physics staffing requirements, formal teaching and the structured training of Grade A physicists in accredited training centres are not included.
Staff meetings	Clinical meetings, hospital management briefings and departmental meetings.

ARSAC, Administration of Radioactive Substances Advisory Committee.

Appendix 2. Non-core activities of the nuclear medicine physicist.
Non-core activities include other essential activities which may or may not be carried out by the nuclear medicine physicist.

Duties	*Examples*
Nuclear medicine service managment and budgetary control	Man-management responsibilities (covering secretarial and possibly nursing staff as well as physicists and technicians/radiographers), budget management, and Trust audit.
Radiopharmacy duties	Duties of radiopharmacy production manager, implementation of quality systems within the radiopharmacy, Medicines Control Agency audit.
Equipment maintenance	All maintenance other than first line.
Information technology support	General IT support to other hospital departments and to administrative and clerical staff.
Scientific support for DEXA scanning	Equipment procurement, calibration and data analysis.

DEXA, dual-energy X-ray absorptiometry.