A model to assess staffing needs in Nuclear Medicine

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Foreword

The cost of personnel is one of the most expensive components of running a nuclear medicine service (NMS). To gauge the staffing strength required for a small, medium or large department there are no known standards and no known models to apply. Changes in factors affecting staffing requirements, such as new grades or classification levels, roles and responsibilities, new or changing modalities, may require modifications in staff deployment or policies to ensure the most efficient and effective use of resources.

Over time, distortions in staffing practices may develop. Without regular staffing reviews, these distortions can grow to have profound consequences on the departmental efficiency, safety of operations, and financial performance. For that reason, even the most successful staffing policies and plans require ongoing review and analysis.

Staffing is vital to the ability to provide high-quality care. NMS should make any effort to have highly skilled staff, working in an efficient team and in a well-supported environment and staff management is one of the instruments of clinical governance which should not be used on an occasional basis or confined exclusively to the professional sphere. They must be integrated into all business governance processes, including structural, organizational, financial, professional.

This document supports a tool developed for the calculation of staffing needs and available at the Nuclear Medicine page of the IAEA Human Health Campus.

The technical officers involved in planning and preparing this document were Maurizio Dondi and Diana Paez of the Division of Human Health.
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1. Introduction

This document is a companion publication to an on-line tool base on an Excel worksheet downloadable from the Human Health Campus (1) and addresses the staffing requirements for optimal and safe delivery of nuclear medicine services, considering current standards of practice and relevant documents from IAEA (2-12).

1.1. Background

1.2. Generalities

To help evaluate the staffing needs for Nuclear Medicine Services (NMS) of different level and complexity, nuclear medicine practice was divided into 4 parts:
1. nuclear medicine imaging
2. nuclear medicine therapy
3. radiopharmacy
4. cyclotron operations.

This choice was taken for a stepwise approach to the increasing complexity of practices and their level of organization. Indeed, both imaging and therapy practices could potentially be operational without the need of an in-hospital radiopharmacy, as they could receive radiopharmaceutical preparations from an outside centralized radiopharmacy. Likewise, where there is no PET-CT scanning, a radiopharmacy does not include radiopharmaceutical production from a cyclotron and may not require an FTE radiopharmacist. If all these components exist within the same institution, some staff may be shared, such as general radiopharmacist(s) providing coverage for the PET radiopharmaceutical production.

Staffing levels may need to be assessed in two different scenarios:

1.3. Assumptions

The model discussed in this document assumes that staffing needs are linked to the workload and, to a lesser extent, to the type and number of instruments.

As such, it could be applied to an existing facility with already defined staff, instrumentation and activities. In this case, the user can assess both the actual performance and possible new staffing needs according to a change in the case mix or in relation to the acquisition of new technologies. Indeed, more complex activities, such as implementation of cyclotron-PET/CT activities for a cancer centre, or expansion of SPECT MPI in the framework of cardiac imaging programs, require more complex technologies and perhaps more staff.

However, this model could also be used for newly planned facilities when there is no consolidated level of activities to refer to. In this scenario, after evaluation of clinical needs, staffing of the new department could be assessed according to the projected volume of activity, the case-mix, the modalities being implemented and type and number of instrumentations.

2. Objective and Scope of the document
This project aims to address the previous issues and help departmental leaders plan for their facilities, and tries to answer the following questions:

2.1. Identifying/Projecting Appropriate Staffing Levels, and Needs

The most common objective of a staffing assessment in Nuclear Medicine service departments involve identifying, projecting, and specifying the personnel needs and costs of staffing a nuclear medicine department appropriately. Ensuring a facility is correctly staffed affects the safety of patients and staff, and yearly operating budget. Ensuring the correct number and type of personnel staffed the facility should be a priority for ensuring effective service operation.

2.2. Modifying Staff Deployment to Improve Management and Control

Are staff members deployed in the proper locations and at the optimal time within the department facility? As with many questions concerning nuclear medicine staffing requirements, the answer depends on the size of the department in question (small, medium, large, and university and non-university department). A staffing study evaluates facility posts and based on multiple factors specific to the department, identifies if they are being prioritized appropriately to ensure safe and efficient operations. Nuclear Medicine departments are not “one size fits all”, nor are their staffing needs.

2.3. Documenting and Justifying Resource Needs

One of the biggest obstacles of budgeting and capital planning is being able to defend and justify resource needs. An independent standardised staffing assessment helps further evaluate those needs and arrive at staffing decisions that are purposeful, informed, and defendable. The research and findings gathered during the assessment arms departmental managers with the comprehensive, accurate data needed to properly support resource goals and objectives.

2.4. Assessing System Risks and Identifying Necessary Quality Improvements

Do institutional staff rosters and deployment practices enable facilities to operate in a manner consistent with the departmental and hospital missions, policy, and accepted principles of service delivery? Are additional posts required to improve safe delivery of patient imaging and therapy services? Performing a staffing assessment will identify risks due to staffing shortage and provide clarity.

2.5. Improving Personnel Effectiveness

A professional assessment of nuclear medicine staffing may reveal that important elements are missing or in need of modification, which can profoundly impact the effectiveness of personnel.

A staffing study may identify an inefficiency or area of weakness that can be remedied through additional staff training or resolved completely through the introduction of new technology, thus freeing up staff for more critical responsibilities or post assignments. The study also lays the framework for intelligent post planning. By analysing multiple factors – e.g., current staffing levels,
normal operating practices – the post plan helps define acceptable levels of overtime utilization and identify possible remedies or resources at disposal.

2.6. The QUANUM program: an aid to assess departmental needs

Preliminary identification of areas of deficiency or not responding to require standards, i.e. non-conforming, could also be helpful. To determine the actual level of performance of an NMS, internal and external audits will consider the management, operating and safety procedures, facilities, equipment and human resources and their impacts on clinical practice. Such methodology and tools for comprehensive auditing, including all aspects of NM are applied in the IAEA QUANUM program and described in the corresponding IAEA publication [2]. Adopting these guidelines will allow a NMS to demonstrate the level of efficiency, quality, safety and reliability in delivering clinical services.

3. Methodology

For this model, based on clinical activity, workload data was considered the basic parameter for its development. However, attention was given to the following “infrastructure” parameters.

3.1. Type of institution

A different weight has been given to university-based hospitals, reflecting the need for time dedicated to students. Staffing needs based on the clinical workload for university-based hospitals is then multiplied by 1.05; while for non-university hospitals and private practices, the factor is left equal to 1. The correction factor has been kept at 5% since trainees from one side require staff time, but they are also contributing to clinical activity (under the supervision of experienced staff). This correction factor has been applied to all staff categories.

3.2. Type of equipment

The level and number of pieces of equipment is also considered: in fact, in addition to the clinical work, the operators need to dedicate time to:

- preparation of the equipment;
- QA/QC;
- user-operated maintenance;
- equipment related administrative tasks.

The above is expressed as fraction of Full Time Equivalent (FTE) staff. As an example, the table below (table 1) shows that for a PET-CT scanner 0.2 FTE technologist is involved for QA/QC, calibration, maintenance, and procurement of spare parts or accessories.

<table>
<thead>
<tr>
<th>Instrument type</th>
<th>NM physician</th>
<th>NM tech</th>
<th>Nurse</th>
<th>Radiopharmacist/chemist</th>
<th>Cyclotron operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planar gamma camera</td>
<td>0.1</td>
<td>0.1</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SPECT scanner</td>
<td>0.1</td>
<td>0.2</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SPECT/CT scanner</td>
<td>0.1</td>
<td>0.2</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PET scanner</td>
<td>0.1</td>
<td>0.2</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### 3.3. Work time and Clinical activity

In this model, total working time is rounded up to 1640 hours, down from an average of 2000 hours. This reduction considers annual leave, sick leave, absences for training, etc. for each operator. Adopting this approach, it will not be necessary to make any corrections for staff not on duty. It should be noted that the ratio between the theoretical working time of 2000 hours, and the adopted average of 1640 hours, is 1.22 which is frequently used by the Human Resources Department (HR) as replacement factor.

#### 3.3.1. Weight of clinical activities

The most relevant factor, however, is the amount of time required to carry out clinical procedures, i.e. their “weight”. As an accepted standard, the basic “work unit” for operations has been set at 15 min. Therefore, the weight of each procedure considers the number of “15-minute work units” needed for each type, as suggested by the Centres for Medicare and Medicaid Services (13).

#### 3.3.2. Categorization of procedures and their weight

All procedures, diagnostic and therapeutic, have been categorized into groups according to IAEA NUMDAB nomenclature (14).

In Table 2, “weights” are related to the total number of work units needed for each operator for each specific type of procedure, including all aspects, from patient admission and interview, discussion with referring physicians and attendance to MDMs, to administration of radiopharmaceuticals and other medication, reporting adverse events, assistance during the acquisition, data processing, storing, archiving, reporting of studies, etc.

As an example, consider “Genitourinary” studies, which include both static and dynamic examinations, with different characteristics and radiopharmaceuticals. It is assumed that for an average genitourinary scan, a technologist is busy for three work units, the NM physician for two and a nurse for one.

In the case of treatments that may require hospitalization, such as iodine treatment for thyroid cancer, the weight factor for staff, particularly for nurses, considers an average
hospitalization time of three days. Results from this model could be adjusted to local circumstances, if needed.

Table 2. Weights assigned to staff for the different clinical procedures, based on their complexity. Study nomenclature based on the IAEA NUMDAB data collection form

<table>
<thead>
<tr>
<th>Procedure</th>
<th>NM/attending physician</th>
<th>NM technologist</th>
<th>Nurse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single-photon procedures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Endocrine</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Oncology</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Central nervous system</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Skeletal</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Bone densitometry</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Therapy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroid benign (I-131)</td>
<td>6</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Thyroid cancer (I-131)</td>
<td>14</td>
<td>2</td>
<td>72</td>
</tr>
<tr>
<td>Bone pain palliation (Ra223; Sm153; Sr89; 32P)</td>
<td>6</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Neuroendocrine tumours (131-MIBG; Y-90 peptides; Lu-177 peptides)</td>
<td>14</td>
<td>1</td>
<td>72</td>
</tr>
<tr>
<td>Radio-synovectomy</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Onco-haematology (I-131; Y-90 monoclonal antibodies)</td>
<td>24</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Prostate Cancer (Lu-177-PSMA; 225-Ac-PSMA)</td>
<td>24</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Selective Internal Radiation Therapy</td>
<td>14</td>
<td>4</td>
<td>72</td>
</tr>
<tr>
<td><strong>PET &amp; PET/CT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oncology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18F-FDG; 18F-Na</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Ga68-PSMA</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Ga68-DOPA</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td><strong>Cardiology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In the present model the following comments for different categories of staff should be considered for the proper interpretation of the results:

- Physicians of other specialities involved in some NM procedures, i.e. cardiologists, anaesthesiologists, or other medical specialists, are not included.
- When referring to NM technologists, it is considered to include professionals that may be designated under different names (e.g. radiographers).
- The term “nurses” may include assistant nurses and health care assistants (as applies to local regulations).
- In specific situations, the roles of different categories may overlap.
- Staff related to in-patients (ward therapies) may factor staff (e.g. nurses) who might be provided from wards outside the NM envelop.
- Ancillary staff groups (e.g. porters and cleaners) are not included.
- For administrative staff, a graded approach has then been adopted for calculating the need. The algorithm considers a need of 10% of the total staff, plus a proportional fraction related to the increase in the workload.

3.4. Radiopharmacy levels

The Radiopharmacy Level, as defined by IAEA publications (2,10), is relevant to the facility, e.g. presence or not of a cyclotron (Table 3). The model for staffing a radiopharmacy considers that the workload might be shared with technologists, as they are often involved in radiopharmaceutical preparations at Level 1 and 2. The model is essentially based on the document IAEA: “Operational Guidance on Hospital Radiopharmacy”, STI/PUB 1342, Vienna, 2008 (OGHR).

3.4.1. Operational Level 1

For activities performed at this level, which involve only dispensing and administering of ready-to-use radiopharmaceuticals, the need for a 0.5 FTE Technologist is considered.

3.4.2. Operational Level 2

According to the OGHR, activities at this level require two FTE units of staff. The model considers these units as Technologists or Laboratory or Pharmaceutical Technologists. At the same time, for in-house use only, many radiopharmacies at levels 1 and 2 may not have a trained radiopharmacist. In these cases, oversight is provided by the attending physician and/or hospital pharmacist.
time, a fraction of 0.2 FTE for a Radiopharmacist/Pharmacists is added to cover part-time consultancy on aseptic procedures, microbiological aspects, support in the review of SOPs and quality documentation, as well as for training of the staff.

3.4.3. Operational level 3
At this level, the OGHR indicates the need of three staff, specialist radiopharmacists/radiochemists and a ‘qualified person’ who are required to manage production, quality control and final batch release, and to provide legal oversight. According to this requirement, the model calculates the need of three FTE Radiopharmacists, plus a further 0.5 FTE Technologist.

3.4.4. Operational level 3 advanced
When operations include a cyclotron, a further three FTE radiopharmacist units and one FTE cyclotron operator are added.

In addition to the above requisites, a proportional fraction of FTEs is considered, related to the increase in the workload, expressed as total number of single-photon, PET and therapeutic procedures.

Physicians also might have some level of involvement, according also to the Level of Radiopharmacy, due to managerial responsibility, contacts with suppliers, preparation of documents for GMP compliance and Quality Management System, etc.

3.5. Classification of personnel
The following categories of staff have been considered.

3.5.1. Clinical staff
● Physicians
● Nurses
● NM technologists and/or radiographers according to local regulations
● Radiopharmacists/chemists

3.5.2. Non-clinical
● Administrative staff
● Cyclotron operators

4. Roles and responsibilities
For each category, to account for the weight of clinical and non-clinical activities, the following responsibilities have been considered for the NMS staff.

4.1. Nuclear Medicine/attending Physicians (based on ref. 4)
Responsibilities of the NM/attending physicians include
● Interviewing patients
● Defining the clinical appropriateness and justification for the request or referral; both for diagnostics and for therapy
Based on departmental standard operating procedures (SOPs), giving instructions for the appropriate tests and protocols keeping in mind the safety of both the patient and staff;
When necessary, tailoring the protocols to the needs and condition of the patient;
Interpreting the study based also on the clinical information and provide a diagnosis insofar possible
Providing training (and education) for technical and junior medical staff
When in a managerial position, ensuring proper operations of the department and adhere to Quality Management rules.
Developing and reviewing SOPs on a regular basis
Attending MDMs
Discussing cases with referring clinicians
Running periodic audits of clinical activities
Reporting adverse events when needed
Contributing to the departmental Quality Management System and internal/external audits of the NM Dept

4.2. Radiopharmacists (based on Refs. 8, 10)
Responsibility of radiopharmacists includes

- Overviewing (or contributing) to the acquisition of radiopharmaceuticals, raw materials and medical devices
- The safe and aseptic preparation, and dispensing of radiopharmaceuticals at Level 3
- Realizing and regularly revising SOPs and any other document of the QMS related to Radiopharmacy
- Running QA/QC of radiopharmaceutical preparations and keeping records
- Final release of the batch(es) as Qualified Person.
- Report adverse events when needed
- Training of students and other staff members
- Contributing to the departmental Quality Management System and internal/external audits of the NM Dept

4.3. Nuclear Medicine technologists
Responsibility of technologists includes

- Scanner preparation for the imaging procedures
- Patient preparation prior to study acquisition
- Administration of prepared radiopharmaceuticals (depending on local regulations)
- Image acquisition
- Data/study processing
- Display of imaging or data
- When needed, radiopharmaceutical aseptic preparation, dispensing and quality control.
- Measurement of the activity of prepared radiopharmaceuticals
- Running routine quality control of instrumentation
- Contributing to the departmental Quality Management System and internal/external audits of the NM Dept
Technologists are also likely to have additional responsibilities in management (personnel and data), teaching and research. Although, in several countries, they may have only very specific duties to perform, the trend is for technologists to take an increasing responsibility in the management of studies.

4.4. Nurses
Responsibility of nurses includes

- Booking procedures
- Clerking medical history
- Examining vital signs
- Administering drugs and radiopharmaceuticals, as prescribed
- Taking blood samples as required
- Explaining procedures to patients and providing support to the receptionist;
- Explaining appropriate radiation protection measures for patients and caregivers, especially those comforting children and elderly people
- Providing immediate support in case of emergencies, particularly for night shifts and weekends
- Contributing to the departmental Quality Management System and internal/external audits of the NM Dept

4.5. Administrative staff
Responsibility of administrative staff includes

- Liaising with patients and ensuring they are aware of appointment dates and time
- Registering patients and booking all necessary appointments
- Liaising with doctors/senior/supervisor/planning radiographers or techs to ensure that bookings are scheduled and prioritised according to SOPs
- Demonstrating knowledge of medical terminology to decide on the appropriate patient pathway
- Resolving complaints, enquiries, and requests from patients and to liaise with appropriate members of the multi-discipline team in dealing with these issues
- Organising and maintaining precise record keeping providing details of each individual patient position
- Supervising any change implemented on the processing of the booking forms
- Updating and maintaining knowledge of relevant legislation, policies and procedures and to continuously improve skills through appraisal, supervision and training
- Contributing to the departmental Quality Management System and internal/external audits of the NM Dept

4.6. Medical Physics staffing requirements in Nuclear Medicine

Medical physicists have an essential role in modern nuclear medicine and should be specifically trained and specialized in this area of radiation medicine. They are part of a multidisciplinary team in the nuclear medicine department dedicated to providing safe and effective diagnosis and treatment of disease using radiopharmaceuticals.

Their roles and responsibilities, as well as staffing needs, are described in a specific document which the reader is recommended to refer to [9].
4.7. Contribution to clinical audits

All staff, in addition to their own specific professional duties, should contribute to clinical audits for their competences, as detailed in several documents, including the IAEA QUANUM program [2], whose positive results have been already published [15, 16].

5. Limitations of the model

This model cannot cover local specific differences due to specific conditions, socio-economic factors, local regulations. Particularly this model does not consider:

- complex situations such as a department covering multiple working sites.
- details of available equipment and facilities in radiopharmacy
- needs related to research
- needs related to production of radiopharmaceuticals for commercial purposes or for local non-commercial distribution
- Specific needs related to highly specialized institutions, e.g. paediatric hospitals
- RIA work processes

6. Conclusions

There is a need for a staffing model in nuclear medicine. This model tries to address staffing needs in term of FTE Nuclear Medicine Physicians, radiopharmacists, administrative staff, NM technologists, and nurses. Definitions of the latter two may vary across the world, so that as an example, there are countries in which there are no NM technologists and the role is covered by nurses or other type of medical technologists. Conversely, there are situations where nurses are not employed in NM, since the technologists have among their qualification the capacity to provide patient assistance and administer radiopharmaceuticals. Therefore, results from this algorithm, where data are produced for both technologists’ and nurses’ needs, should then be prudently interpreted: e.g. where technologists also do nurses’ jobs, their staffing needs are the sum of results obtained for both professional profiles.

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