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ASSESSMENT OF DOCTORS IN TRAINING - AT TWO ACADEMIC HOSPITALS - KNOWLEDGE OF THE BASIC PRINCIPLES AND CLINICAL APPLICATIONS OF NUCLEAR MEDICINE

Dr Shireen Dhoodhat

A dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Medicine in Nuclear Medicine

Johannesburg, 12 October 2016

DECLARATION

I, Shireen Dhoodhat, declare that this dissertation is my own work. It is being submitted for the degree of Master of Medicine in the branch of Nuclear Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signed

This 12th day of October 2016

The work reported in this dissertation was carried out in the Departments of Nuclear Medicine and Molecular Imaging at Charlotte Maxeke Johannesburg Academic Hospital and Chris Hani Baragwanath Academic Hospital.

The project was approved by the Ethics Committee, University of the Witwatersrand. (APPENDIX A).

DEDICATION

To my parents (Adam and Aniesa), husband (Mohamed) and son (Ahmad) for their unwavering love and support. I thank you.

LETTER FROM NUCLEAR MEDICINE HEAD OF DEPARTMENT

12 October 2016

To whom it may concern

Re: Dr Shireen Dhoodhat

Student number: 9501216p

Staff Number: A0005540

Degree: MMed Nuclear Medicine

This letter is to certify that Dr Shireen Dhoodhat has done her research in nuclear medicine. Her topic is “Assessment of doctors in training - at two academic hospitals - knowledge of the basic principles and clinical applications of nuclear medicine”. She collected and confirmed the data herself with the assistance of a statistician and followed the protocol for her study accordingly. The report of this research was entirely written by herself with the assistance of her supervisor.

Kind Regards

Prof. MDTHW Vangu

Head: Radiation Science

Head: Nuclear Medicine

ABSTRACT

Nuclear medicine (NM) is the cornerstone of molecular medicine and is an important diagnostic and therapeutic tool in disease management. Undergraduate training of medical students in the field of NM is varied and sometimes limited. This often results in inappropriate patient referrals or the option of NM in the patient management protocol being entirely overlooked.

OBJECTIVE:

To survey interns and registrars at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) and Chris Hani Baragwanath Academic Hospital (CHBAH) to determine their knowledge of the basic principles and clinical applications of NM.

DESIGN AND METHOD:

This is a descriptive study whereby a questionnaire was distributed to the study population. A total of 141 doctors participated in the study. The questionnaire was adapted from an original questionnaire used by Zakavi et al from “Assessment of general practitioners’ knowledge on the clinical applications of nuclear medicine” published in 2004. Additional questions were adapted from a study by Mubeen et al “Knowledge about ionizing and non-ionizing radiation among medical students”, published in 2008. The minimum score was 0 and the maximum score 13. Correct answering of less than 25% of the questions was considered poor, 25-50% was fair, 50-75% was medium and >75% good.

RESULTS:

The interns form 55% of the respondents, while the remainder was registrars. When looking at the overall score of respondents, the largest proportion of respondents

(62/141 or 44%) scored in the medium range, the second largest proportion of respondents (44/141 or 31%)scored in the fair/poor range; whilst the smallest proportion of respondents (35/141 or 25%) scored in the good range. When looking at the individual questions asked, the respondents scores for largest proportion of questions (9/13) was in the medium range and the respondents scores for the smallest proportion of questions (4/13) was in the fair/poor range. The overall result was considered adequate.

Of the 141 respondents, 58 (41%) indicated that they had had undergraduate exposure to NM education. Of these 58 respondents 52% had 5 hours or less NM training. Only 9.9% of the respondents deemed their undergraduate NM education exposure to have been sufficient. The mean NM knowledge score for those who had had undergraduate exposure to NM training (63%, SD 15.4%) was significantly higher than that of those respondents who had not had such exposure (56.0%; SD 17.4%) (p=0.025).

CONCLUSION

Our study shows that the level of knowledge of interns and registrars in the field of NM is satisfactory but can be improved with adequate undergraduate teaching. The study has shown an association between undergraduate training in NM and better scores achieved by respondents. The majority of respondents confirmed that receiving more information regarding NM would be beneficial. There is a need to improve the undergraduate curriculum with regards to NM.

ACKNOWLEDGMENTS

It is with deep appreciation that the following persons are acknowledged:

1. Prof MDTHW Vangu, my supervisor, for his guidance, expertise and insight.
2. Prof Zakavi for allowing me to use the questionnaire which was formulated for his study " Assessment of general practitioners' knowledge on the clinical applications of Nuclear Medicine" as a basis for this study.
3. Prof CD Libhaber for reviewing the questionnaire utilized in this study.
4. Bronwyn van Wyk for his input on Nuclear Medicine physics.
5. Dr Petra Gaylard for her assistance in the statistical analysis of this study.
6. The various Heads of department and subsidiary staff at both CMJAH and CHBH for facilitating the data collection process.

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NOMENCLATURE

CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
CHBAH	Chris Hani Baragwanath Academic Hospital
NM	Nuclear Medicine
P Val.	P-value
Exp.	Experience
Comb.	Combined
Yr	Year
Undergrad.	Undergraduate
Univ.	University
MBBS	Bachelor of Medicine and Bachelor of Surgery
WITS	University of Witwatersrand
UCT	University of Cape Town Africa
MEDUN.	MEDUNSA
UKZN	University of Kwazulu Natal
Dept.	Department
O & G	Obstetrics and Gynaecology
Anaesth.	Anaesthetics

CHAPTER 1

1.0 INTRODUCTION AND LITERATURE REVIEW

1.1. INTRODUCTION

“NM imaging techniques are performed by means of administering pharmaceuticals that are labeled or tagged with radionuclides so that they are preferentially accumulated in the organs of interest. Images are then obtained with detection systems that are sensitive to gamma radiation emitted from the administered radiotracers. These images do not possess the spatial resolution of other imaging modalities such as computed tomography or magnetic resonance imaging; however the information provided to clinicians is generally of a different type, namely functional information. For successful use of these techniques, knowledge of the basic physical principles of NM is required “(1).

In the beginning, preliminary applications of NM were limited to scanning the thyroid; however, with the advancement of science and technology, there has been the development of an increasing number of applications which assist both in patient diagnosis and therapy (2).

General Xin-Zhang Qian, the former Minister of health in China pointed out in the National science conference that development of NM is “a major criterion for judging the modernization of medicine” (3) and that it constitutes one of the greatest achievements in the “peaceful use of atomic energy”. The early “discovery, diagnosis and treatment” of illness affords the patient the best opportunity to overcome the disease state. Unfortunately, by the time patients present with disease symptoms

many “biochemical changes on the molecular level” have already occurred and the opportune time for treatment may have passed. Structural changes lag behind metabolic changes by a significant period of time (3).

As the cost of healthcare escalates, clinicians are responsible for choosing the most appropriate and cost effective method to achieve the desired goal in patient management. At the same time, clinicians also need to be aware that many of the diagnostic imaging investigations increase the radiation burden to the patient. This must be carefully considered before requests for these investigations are made (4).

The challenge for medical professionals who have specialized in imaging as well as medical educators is to adequately prepare and educate future clinicians regarding the cost-effective application of new diagnostic procedures. The importance of limiting the radiation burden to the patient must also be stressed(4).

Unfortunately, direct tuition of NM for medical undergraduates at the University of Witwatersrand is limited to 20 minutes of teaching during the urology block in fifth year. This is a disadvantage and drawback once undergraduates enter their clinical years as junior doctors. The aim of this study was to assess junior doctors and registrars knowledge of the basic principles and clinical applications of NM.

1.2 LITERATURE REVIEW

Diagnostic imaging, including both radiological and NM techniques rely mainly on ionizing radiation. It has been estimated that approximately half of the average radiation that the public is exposed to can be attributed to medical procedures (5). A study by Fazel et al performed in the United States between 2005 and 2007 showed that “CT and nuclear imaging accounted for 21% of imaging procedures and 75% of the total effective radiation dose” (5,6).

It is imperative that clinicians be aware of the specific indications for various NM examinations and have an equally good understanding of both the value and limitations of these studies in the clinical care of patients (4). It is known that imaging investigations are expensive (4). Clinicians are faced with making critical decisions as to how to best assist in patient diagnosis and treatment by choosing the most appropriate investigations. This dilemma is compounded by the fact that there is currently such a wide range of imaging modalities from which to choose (4).

In the NM department it has been our experience that it is usually the junior doctors who are responsible for entering the patient’s history on the NM request form. Request forms are often inadequately completed (a perennial problem) but also the investigations that are requested are sometimes inappropriate or even unnecessary (7).An adequate clinical history is of utmost importance to the nuclear physician for optimal interpretation of scans, which will assist the clinicians in patient management. It is usually the junior doctor’s contact details on the request form and

because they often have been insufficiently taught about the clinical applications of nuclear medicine at medical school, they are unable to assist in relaying vital information about the patient's clinical history relevant to the study requested.

The largest audit to date to assess "the degree of formal teaching at the undergraduate level for the medical specialties of radiology and NM" was conducted by Peter J Ell in 1997 (8). The information was obtained through a questionnaire and provided data from twenty countries and seventy universities.

As can be expected, the data shows "enormous variation" (8). The only data in this audit obtained from Sub-Saharan Africa was from South Africa's University of Pretoria where teaching of NM was as follows: 8 x 45 minute sessions in the second year, 4 x 45 minute sessions in the 3rd and 4th years and 6 x 45 minute sessions in the 5th year.

However, the study does not distinguish between the amount of formal teaching received in the form of dedicated NM lectures versus the amount of time given to integrated teaching with other clinical disciplines which serves to educate students about the application of NM Imaging in that specific specialty's patient management.

Many clinicians feel that "integrated teaching" is the best way to educate undergraduates about how to choose the most appropriate investigation to assist in clinical decision making (8). Nuclear physicians would disagree as the time dedicated to their field of specialty would only allow for "minimal coverage" of the field

(8). As mentioned previously, this is reflected in the inadequacy of the patient referrals put forward by junior doctors. The author (PJ Ell) does concede that a lot is expected to be covered in the undergraduate curriculum in a limited period of time. However, he questions whether the large amount of time dedicated to students looking for example at histology specimens (which is not usually practiced and hence quickly forgotten in clinical practice) could not be better utilized educating students about diagnostic imaging investigations and diagnostic NM tests which young doctors will be looking at frequently during their years of clinical practice(8).

Undergraduates need to be made aware of the values, limitations and hazards of diagnostic imaging and simultaneously be aware of the financial implications. In 1981 the Royal College of radiologists stated that “the emphasis should be on the role of imaging in clinical management rather than the acquisition of interpretive skills” (7)

Another study by Zakavi et al conducted in 2002 (2) assessed the knowledge of general practitioners (G.P’s) in Mashad (North East Iran) regarding the clinical applications of NM. This was a questionnaire based study. The questionnaire comprised fourteen questions, all multiple choice with only one correct answer. The questions were categorized into two groups: four questions about general information in NM and ten questions regarding some of the more common clinical applications of NM. A group of NM specialists and consensus of four reference textbooks of NM confirmed the validity of the study. Reliability of the test was confirmed by alpha co-efficient of 0.62 (2).

The study showed that 69% of participants had no training in NM during their undergraduate years whilst 31% had between 3-15 hours of training in NM. The study concluded that of the 100 G.P's that participated in the study, 62% have relatively poor knowledge of NM. This is based on the fact that this group correctly answered less than 58% of the questions asked (2).

The teaching of NM in Iran appears to be highly variable. In some universities there is no training at all whilst in others a few hours are dedicated to NM during the radiology course. Of the G.P's interviewed, 90% felt that they needed more information about NM. It was noted that 70% of the study sample had graduated in the last 5 years and 92% in the last ten years which suggests that although NM as a field has evolved greatly in the past 50 years, young doctors still have very limited knowledge about the subject. The study by Zakavi et al is one of few to date that tries to assess qualified doctors (in this case G.P's) knowledge of the clinical applications of NM (2).

Most of the previous studies that have been conducted have looked at the objectives of training undergraduates about radiology and not NM specifically (4,9,10,11). To our knowledge, no study of this type (directed specifically to clinicians who request these studies) has been conducted in Sub Saharan Africa.

A study conducted by Lass and Scheffler that assessed the undergraduate teaching of NM in European countries has shown that in European countries, medical students have an average of 17.4 hours teaching in NM whilst outside Europe it is 16.1 hours (12)

Many studies have also been conducted to determine the level of knowledge of both undergraduates and qualified doctors regarding the radiation exposure of patient's to ionizing radiation in medical practice (5,6,13,14,15,16). One such study performed was conducted by Mubeen et al (13) to assess the knowledge on ionizing and non-ionizing radiation among medical students. A cross-sectional study was conducted in one of the private colleges of Karachi, Pakistan having a class of minimum 100 students in each year of five year MBBS (Bachelor of Medicine and Bachelor of Surgery) degree program. A semi-structured questionnaire based on a previously conducted study was developed regarding different aspects of ionizing and non-ionizing radiation. The questionnaire was self-administered to 57 and 60 students of the fourth and final year medical students respectively. Eight questions were asked about various common aspects of ionizing and non-ionizing radiation. All responses (except for one question) showed less than fifty percent correct answers by the students (13).

It is imperative to educate non-nuclear medicine clinicians about ionizing radiation as pertains to imaging and therapy, given their legal responsibility under the ionizing radiation regulations. Clinicians play a vital role in explaining these procedures to patients and in giving the correct information to patients undergoing these scans or therapies (5).

1.3 PROBLEM STATEMENT:

There are no data from a South African context which describe the levels of knowledge of interns and registrars regarding the basic principles and clinical

applications of NM imaging. The relationship between the level of knowledge and the content of the undergraduate programs regarding nuclear medicine has not been documented and may have bearing on the content of medical curricula in South Africa.

The premise for this study was the poor patient referrals to both the CMJAH and CHBAH NM Departments. The patient's history, filled in on referral forms, is sometimes inadequate with vital information omitted or the scan requested is entirely inappropriate based on the history detailed. As these forms are usually filled in by junior doctors it made us question whether their core knowledge of basic NM principles is substantial enough to ensure correct patient referral and for junior doctors to be able to relay clinically relevant information which ultimately affects the nuclear physicians interpretation of a study.

Conducting a study of this nature also allowed us to better assess whether the NM education received during undergraduate training is adequate. It also proved valuable in indirectly assessing whether there is an improvement in doctors knowledge of NM as they progress from being junior doctors to becoming registrars. This study gives some insight into the reason for inadequate NM referrals and how one may try to improve this shortcoming.

This will ultimately create a better forum for communication and understanding between referring clinicians and nuclear physicians which strengthens the multi-disciplinary approach to patient diagnosis and management.

1.4 STUDY OBJECTIVES:

1. To survey junior doctors and registrars at CMJAH and CHBAH to determine their knowledge of the basic principles and clinical applications of NM.
2. To describe the demographic and educational profile of the study group.
3. To determine the association between the demographic and education variables on the one hand, and the level of knowledge of NM on the other hand.
4. To compare the knowledge of the basic principles and clinical applications of NM of interns to registrars.

CHAPTER 2

2 MATERIALS AND METHODS:

2.1 STUDY DESIGN

This is a descriptive study, documenting the demographics and the level of knowledge of interns and registrars at CMJAH and CHBAH. A questionnaire was distributed to the interns as soon as ethics approval (APPENDIX A) was obtained. As this occurred halfway through their second four month rotation I distributed the questionnaires between 1 July 2014 and 31 August 2014; prior to the interns entering the next 4 month rotation in a different field. The questionnaire was distributed to the registrars between 1 July 2014 and 31 December 2014, prior to them entering their next year of study.

The questionnaire (APPENDIX B) which was distributed is based on an original questionnaire used by Zakavi et al from “Assessment of general practitioners’ knowledge on the clinical applications of NM” (2). The questionnaire was adapted with the written permission of Prof Zakavi (see APPENDIX C for email correspondence). Some questions were omitted and other modified from the original Zakavi et al questionnaire (2) due to errors incurred when the questionnaire was translated from Farsi to English. Additional questions were adapted from a study by Mubeen et al “Knowledge about ionizing and non-ionizing radiation among medical students” (9)

The questionnaire was reviewed by senior staff members (Prof. MDTHW Vangu and Prof. CD Libhaber) from the department of NM to their satisfaction.

The questionnaire comprised 23 questions in total. The first 10 questions determined the demographic profile of respondents. Questions one to eight determined respondents age, level of experience, alma mater, current hospital of employment, current specialty respondent is working in, the previous specialty respondent has rotated through and the amount of exposure to NM the respondent had during undergraduate training. Question nine and ten were based on the respondents subjective opinion about the adequacy of NM education received during undergraduate training and whether receiving more information pertaining to NM would assist with the appropriate referral of patients for NM studies. The next 13 questions were multiple-choice questions based on the principles and applications of NM. Each question was followed by a list of alphabetically annotated answers. Participants were asked to circle the most appropriate answer. These last 13 questions had only one correct answer.

2.1.1 SAMPLE SIZE

There were 354 doctors (interns and registrars) eligible to fill in the questionnaire; of which 141 participated in the study.

Sample size calculation

The entire population was sampled. A sample size estimation was done to consider the secondary objectives, namely the tests of association between demographic and

education history data on the one hand and the knowledge outcomes on the other hand. Considering the percentage scores (continuous variable) and a five-level categorical variable (e.g. age, university, duration of NM training), we require a one-way ANOVA.

Assuming a significance level of 5%, a power of 80% and the detection of a small / medium / large effect size, a sample size of 1200 / 200 / 80 would be required. Unbalanced categories increase the sample size requirements further. A sample size of 141 is thus only enough for the detection of medium-large effect sizes. Sample size calculations were performed in G*Power (17)

There was a cover letter (APPENDIX D) detailing the purpose, scope and possible publication of the study attached to the hardcopy of the questionnaire. Participation was voluntary and anonymous with no identifying data being required to complete the questionnaire.

2.2 DATA COLLECTION

This study was conducted subsequent to submission of a research protocol to the Human research ethics committee (medical), University of Witwatersrand. The proposed study received ethics approval from the committee and a clearance certificate was issued, Reference M140545 (APPENDIX A). Consent to distribute the questionnaire to the study group was obtained from the Chief Executive Officer of CMJAH (APPENDIX E) and from the Chief Executive Officer of CHBAH (APPENDIX F).

Hard copies of the questionnaire were distributed by the chief Investigator during the specified specialty's departmental meetings at both CMJAH and CHBAH. Arrangements were made with the relevant HOD prior to the departmental meeting which allowed the chief investigator a short amount of time after the official departmental meeting to introduce the study and explain the merits of participation to the study group.

The questionnaire was self-completed (pen and paper) by the respondents after the departmental meeting. The completed questionnaires were collected by the chief investigator prior to respondents leaving the meeting venue.

Hard copies of the questionnaire were also kept in the NM departments of CMJAH and CHBAH and were distributed by the radiographer at the booking office to any doctors falling within the parameters of the study group who come to request NM investigation and had not already participated in the study. These participants were requested to complete the questionnaire in the nuclear medicine department and immediately hand it in to the radiographer on duty after completion.

Provision was also made for members of the study group who were not in attendance at the departmental meetings during which the questionnaire was distributed. Hard copies of the questionnaire were given to the departmental secretaries at both CHBAH and CMJAH (with the permission of the related head of department) so that eligible candidates could also be given the opportunity to complete the questionnaire. It was requested that these doctors fill in the questionnaire and hand them in

immediately to the departmental secretary. All eligible doctors were informed of this via email with the assistance of the departmental secretaries or relevant doctor's representative.

All attempts were made to ensure that the questionnaire was completed and submitted immediately at the various collection points so that doctors would answer solely based on individual knowledge without any assistance from outside sources. For this reason questionnaires were not distributed or collected electronically.

2.2.1 Inclusion Criteria

1. Interns at CMJAH and CHBAH (both 1st and 2nd year) registered with the Health Professions Council of South Africa (HPCSA) and rotating through the following disciplines: internal medicine, general surgery, paediatric and obstetrics and gynaecology (O&G).

2. Registrars at CMJAH and CHBAH registered with HPCSA in the following Disciplines: internal medicine, general surgery, paediatrics, O&G and radiation oncology.

2.2.2 Exclusion Criteria

1. Medical Officers
2. Specialists
3. Supernumary fellows not participating in the full registrar program of the specified discipline as defined by the HPCSA.

2.3 DATA CAPTURE

Questionnaires which had been filled in by doctors meeting the inclusion criteria were reviewed and relevant data extracted by the chief investigator and captured on a Microsoft excel spreadsheet. Strict confidentiality was maintained in this study as no identifying data was requested. Each questionnaire was assigned a number for record keeping purposes.

2.4 DATA ANALYSIS

The questionnaire included 13 multiple-choice questions about the principles and applications of NM. From this, a percentage score was calculated, which was also categorized [adapted from the Zakavi model (2)] as poor (<25%), fair (25-50%), medium (51-75%) or good (>75%). The categories were slightly modified for this study. In the original Zakavi et el study the categorization was as follows: poor (<50%), medium (51-75%) and good (>75%). In this study the poor (<50%) category was divided into poor (<25%) and fair (25-50%).

Data analysis was carried out using SAS (Version 9.4 for Windows). Descriptive statistics were applied to the data. Categorical data were presented as frequencies and percentages, while continuous data were presented using mean, standard deviation and histogram.

The chi-square test was used to assess the relationships between the demographic and education history variables on the one hand and the categorized NM knowledge score on the other hand. Fisher's exact test was used for 2 x 2 tables or where the

requirements for the chi-square test could not be met. The strength of the associations was measured by Cramer's V and the phi coefficient respectively.

The following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little if any association

The relationship between the demographic and education history variables on the one hand and the percentage NM knowledge score on the other was assessed by the independent samples t-test. The strength of the associations was measured by the Cohen's d. The following scale of interpretation was used:

0.80 and above	large effect
0.50 to 0.79	moderate effect
0.20 to 0.49	small effect
below 0.20	near zero effect

The 5% significance level was used throughout. In other words, p-values <0.05 indicate significant results.

2.5 ETHICS

All participation was completely voluntary. Each participant was encouraged to read the attached cover letter which outlines the objectives of the study and gives assurance that all data obtained from the study is anonymous. The project was approved by the University of Witwatersrand Human research ethics committee.

The MMED dissertation report “Assessment of doctors’ in training - at two academic hospitals - knowledge of the basic principles and clinical applications of nuclear medicine” was submitted to the University of Witwatersrand Johannesburg eLearning Support and Innovation Unit site for a Turnitin (software program) originality report (APPENDIX G).

CHAPTER 3

3. RESULTS

3.1 Response rate

There were a total of 141 completed questionnaires received, which corresponds to a response rate of 40% (141/354). This is below the acceptable response rate of >50% (i.e. representing more than half of the study group), but we accept it as it is and proceed with the data analysis.

The questionnaire was distributed as a classroom paper by the chief investigator after the different specialties' departmental meeting. Various attempts were made to increase the response rate (as outlined earlier in section 2.2 i.e. data collection). Hard copies of the questionnaire were also kept in the NM departments of CMJAH and CHBAH and were distributed by the radiographer at the booking office to any doctors falling within the parameters of the study group who came to request a NM investigation and had not already participated in the study. These participants were requested to complete the questionnaire in the nuclear medicine department and immediately hand it in to the radiographer on duty after completion.

Provision was also made for members of the study group who were not in attendance at the departmental meetings in which the questionnaire was distributed. Hard copies of the questionnaire were given to the departmental secretaries at both CHBAH and CMJAH (with the permission of the related head of department) so that eligible candidates could also be given the opportunity to complete the questionnaire. It was

requested that these doctors fill in the questionnaire and hand them in immediately to the departmental secretary. All eligible doctors were informed of this via email with the assistance of the departmental secretaries or relevant doctor's representative.

Only 5/141 (4%) of respondents were from internal medicine. A major impact on the response from internal medicine is that there is no mandatory departmental meeting, hence fewer junior doctors attend these meetings and this decreased response from this group. An additional attempt to have the questionnaires distributed by the departmental secretary (who regularly interacts with the junior doctors) was not successful. The relevant intern representative (from CMJAH) and registrar representative (for both CMJAH and CHBAH) were contacted and arrangements were made for them to stress to their colleagues the importance of responding to the survey. The intern representative from CMJAH was also given copies of the questionnaire to distribute to her fellow interns. Even though she distributed the questionnaire, none of the interns returned a completed questionnaire to her. The 5/14 interns from CMJAH who did respond to the questionnaire did so because the chief investigator went personally to the medical ward to locate the interns and personally request that they respond to the survey.

The questionnaire included 13 multiple-choice questions about the principles and applications of NM. From this, a percentage score was calculated, which was also categorized [adapted from the Zakavi model (2)] as:

- poor (<25%),

- fair (25-50%)
- medium (51-75%)
- good (>75%).

The categories were slightly modified for this study. In the original Zakavi et el study the categorization was as follows: poor (<50%), medium (51-75%) and good (>75%). In this study the poor (<50%) category was divided into poor (<25%) and fair (25-50%). The minimum score was 0 and the maximum score 13.

3.2 CATEGORIZED NM KNOWLEDGE SCORE

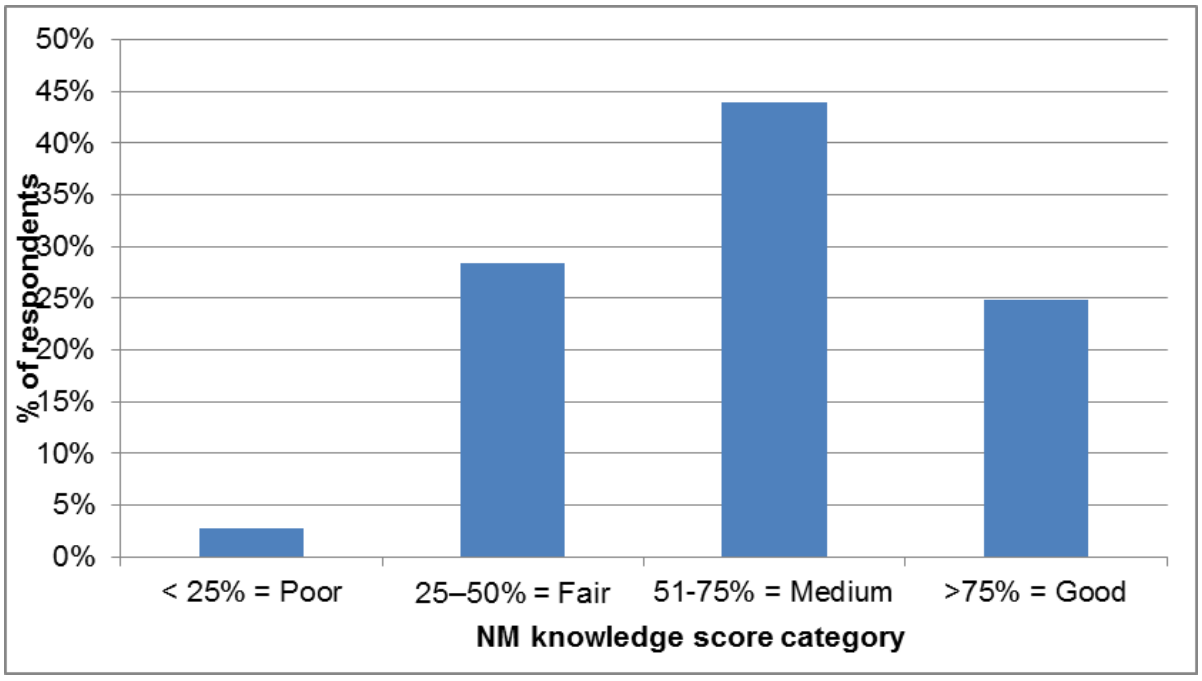


Figure 3.1: A histogram showing the categorized NM knowledge score distribution for the respondents.

The largest number of respondents 62/141 scored in the medium category, followed by 40/141 (28%) who scored in the fair category. Approximately 25% (35/141) of the respondents scored in the good (> than 75%) category, whilst 4/141 (3%) scored in the poor category. For further analysis, the poor and fair groups were combined.

The level of performance of respondents was considered adequate as the majority of respondents (97/141 or 69%) had correctly answered >50% of the questions asked.

3.3 NM KNOWLEDGE SCORE

The mean NM knowledge score was 59% (SD 16.9%; range 15.4-92.3%), which falls in the medium category. The scores are normally distributed.

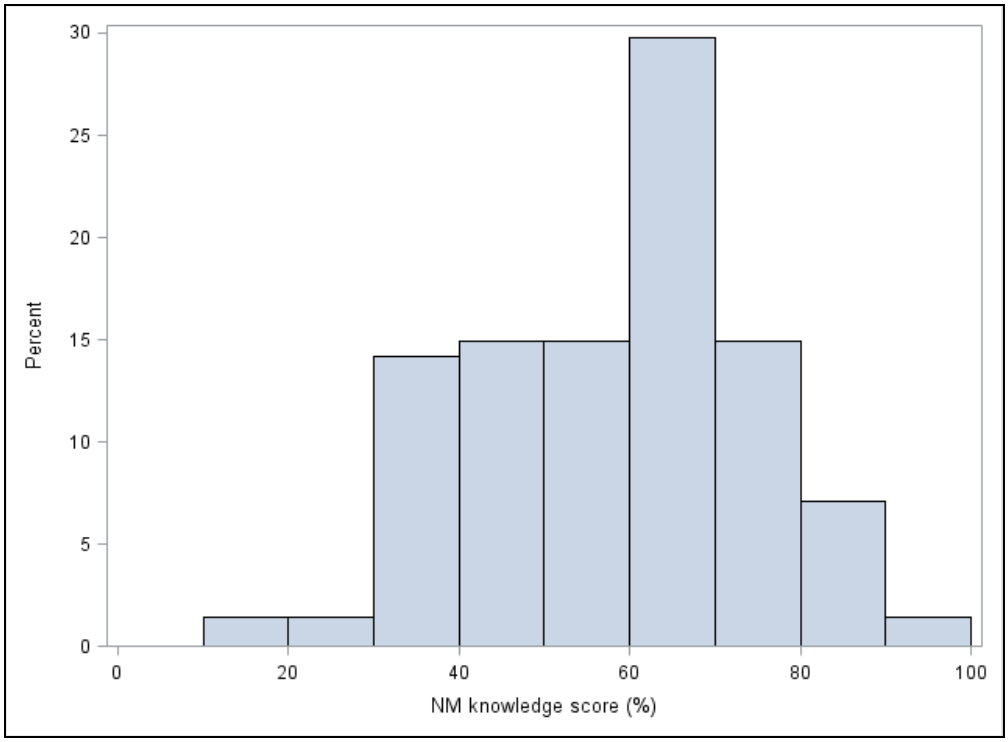


Figure 3.2: A histogram showing the distribution of NM knowledge scores amongst respondents

3.4 NM KNOWLEDGE QUESTIONS

Table 3.1: **Questions 1 to 13 from the Questionnaire (Appendix B) and corresponding number of respondents (A: Overall, B: Intern and C: Registrar) who answered these questions correctly**

Variable	Category	A) Combined (Intern & Reg)		B) Intern		C) Registrar	
n		**141**		**78**		**63**	
		n	**%**	**n**	**%**	**n**	**%**
NM knowledge questions (% answered correctly)	Q1	94	66,7%	47	60%	47	75%
	Q2	90	63,8%	50	64%	40	63%
	Q3	88	62,4%	46	59%	42	67%
	Q4	91	64,5%	51	65%	40	63%
	Q5	63	44,7%	34	44%	29	46%
	Q6	87	61,7%	51	65%	36	57%
	Q7	67	47,5%	33	42%	34	54%
	Q8	54	38,3%	32	41%	22	35%
	Q9	92	65,2%	47	60%	45	71%
	Q10	95	67,4%	51	65%	44	70%
	Q11	104	73,8%	57	73%	47	75%
	Q12	80	56,7%	37	47%	43	68%
	Q13	70	49,6%	39	50%	31	49%

The percentage of respondents who answered each question correctly is shown in table 3.1 above. Questions 5, 7, 8 and 13 appear to have been particularly problematic for respondents (combined intern & registrar).

Questions 5, 7, 8, 12, 13 were problematic for interns whereas questions 5, 8 and 13 were problematic for registrars.

With regards to question 7, 33/78 (42%) of intern respondents answered the question correctly whereas 34/63 (54%) of registrar respondents answered this question correctly.

With regards to question 12, 37/48 (47%) of intern respondents answered the question correctly whereas 34/63 (54%) of registrar respondents answered this question correctly.

3.5 THE ASSOCIATION BETWEEN DEMOGRAPHIC AND EDUCATION HISTORY DATA ON THE ONE HAND AND THE NM KNOWLEDGE OUTCOMES ON THE OTHER HAND

There were no significant differences in either the mean NM score percentage or categorized NM scores and level of experience (registrars vs. interns; interns year 1 vs. year 2; or registrars < 2 years vs. > 2 years).

There were no significant differences in either the percentage or categorized NM scores and age group (reduced categories) or undergraduate university (within WITS, UCT and UP).

There were no significant differences in either the percentage or categorized NM scores with regards to hospital.

There were no significant differences in either the percentage or categorized NM scores with regards to current department (reduced categories) at overall level (registrars and intern respondents combined) or for registrars.

For interns, the mean NM knowledge score for those from O&G (65.6%, SD 11.6%) was significantly higher than that of those from paediatrics (54.1%; SD 16.0%) (p=0.039). The effect size was large (Cohen's d=0.81). There were no other differences between departments. Similarly, there was a significant, moderate, association between categorized NM score and department: those from paediatrics had a higher proportion of respondents in the fair/poor group, compared to the other two departments, and vice versa for the good group (see figure 3.3 below).

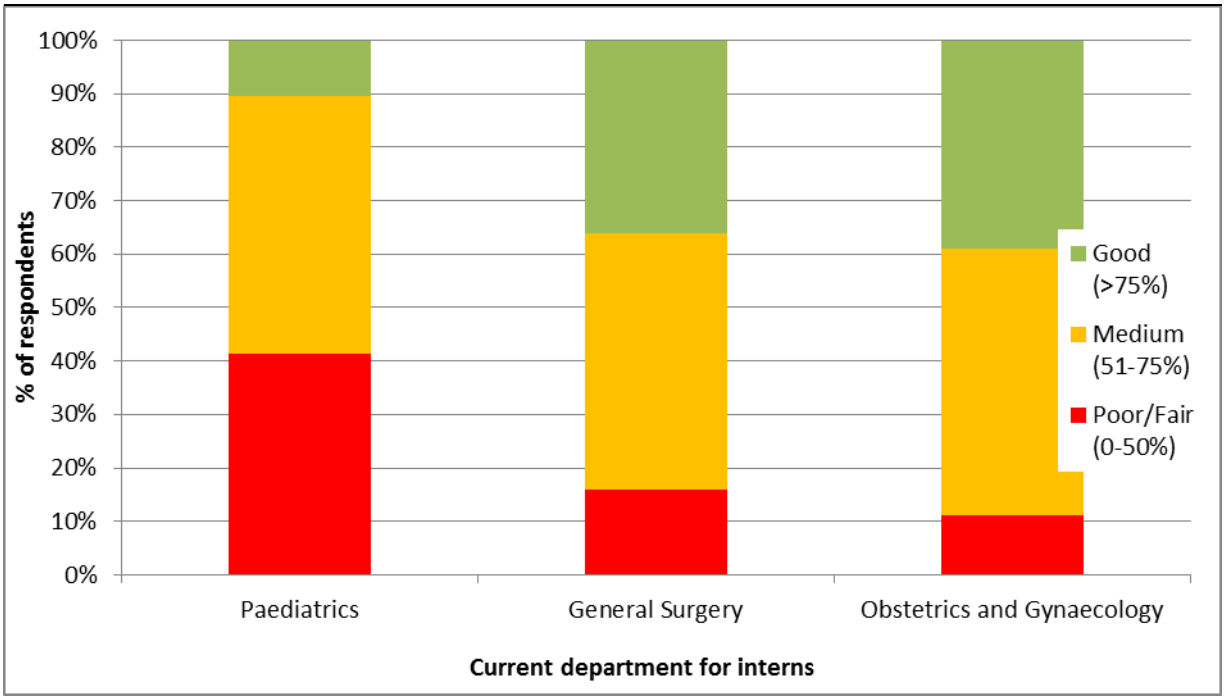


Figure 3.3: The association between the current department for interns and the NM knowledge outcomes

There were no significant differences in either the percentage or categorized NM scores with regards to previous department for Intern 1's (reduced categories).

The mean NM knowledge score for those who had had undergraduate NM education exposure (62.5%, SD 15.4%) was significantly higher than that of those respondents who had not had such exposure (56.0%; SD 17.4%) (p=0.025). The effect size was small (Cohen's d=0.39). Similarly, there was a significant, weak, association between categorized NM score and whether or not respondents had had undergraduate exposure to NM training: those with no previous training had a higher

proportion of respondents in the fair/poor group and lower proportion for the good group (see figure 3.4 below).

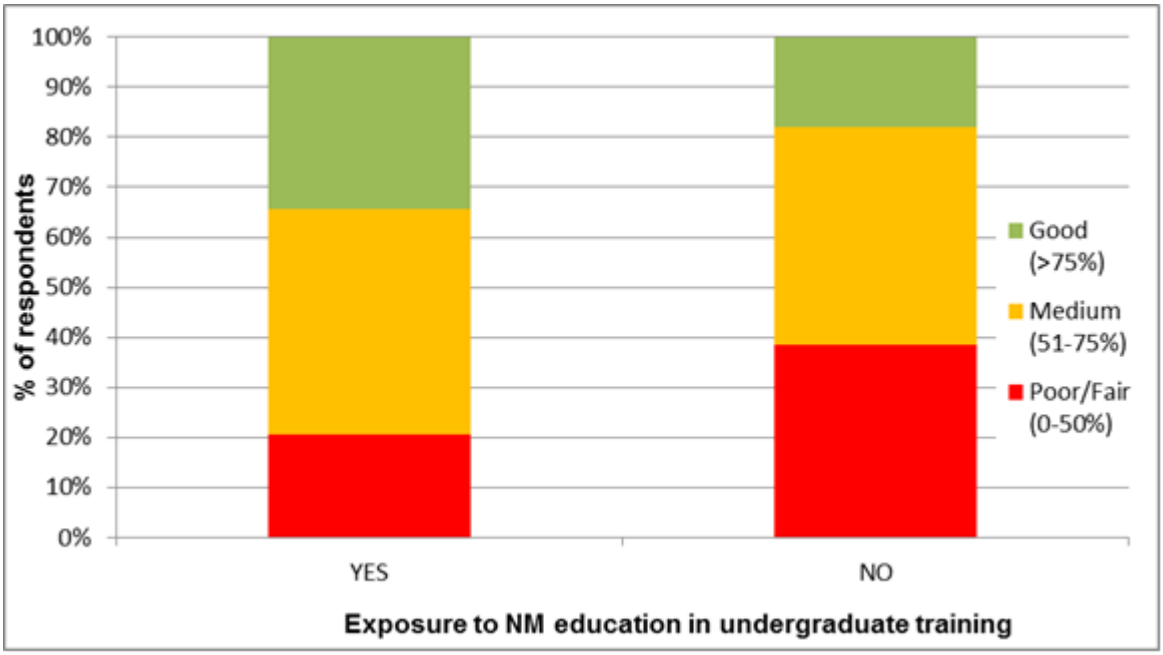


Figure 3.4: The association between whether the respondent's exposure to NM during undergraduate training was deemed adequate (YES) or not (NO) AND the NM knowledge (%) outcomes

Amongst those who had had undergraduate NM training (n=58), there were no significant differences in either the percentage or categorized NM scores and the duration of this training (reduced categories).

There were no significant differences in either the percentage or categorized NM scores and whether or not respondents deemed their undergraduate exposure to NM training to have been sufficient

3.6 LEVEL OF EXPERIENCE

The majority of respondents 78/141 (55%) were interns of whom only 20/141(15%) were in the second year of internship. Registrars 63/141 made up 45% of respondents with senior and junior registrars equally represented in that group (see figures 3.5 and 3.6 below).

With regards to the interns, almost equal number of interns had fair/poor (19/78 i.e. 24%) and good (23/78 i.e. 30%) scores, whilst the remainder (36/78 i.e. 46%) had a medium score. The registrars had an almost equal number with fair (24/141 i.e.40%) and medium (26/63 i.e. 41%) scores; whilst the remainder (12/63 i.e. 19%) had good scores.

The mean NM knowledge score for the interns (78/141) was 61% (std. dev 16.1) whilst he mean NM knowledge score amongst the registrars (63/141) was 56% (std. dev 17.7).

There were no significant differences in either the NM knowledge score versus level of experience [registrars versus interns (p=0.12); interns year 1 vs. year 2 (p=0.75); or registrars <2 years vs. > 2years (p=0.18)]; or the categorized NM scores versus level of experience [registrars versus interns (p=0.11); interns year 1 vs. year 2 (p=0.26); or registrars <2 years vs. > 2years (p=0.15)].

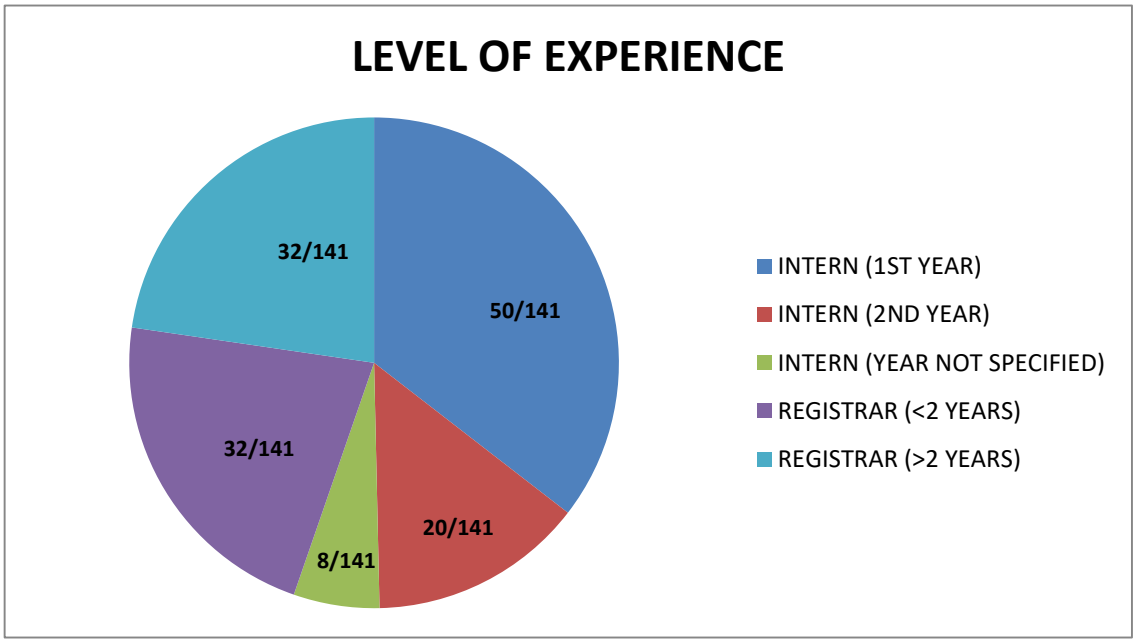


Figure 3.5: **Pie chart showing the level of experience of respondents (as specified above)**

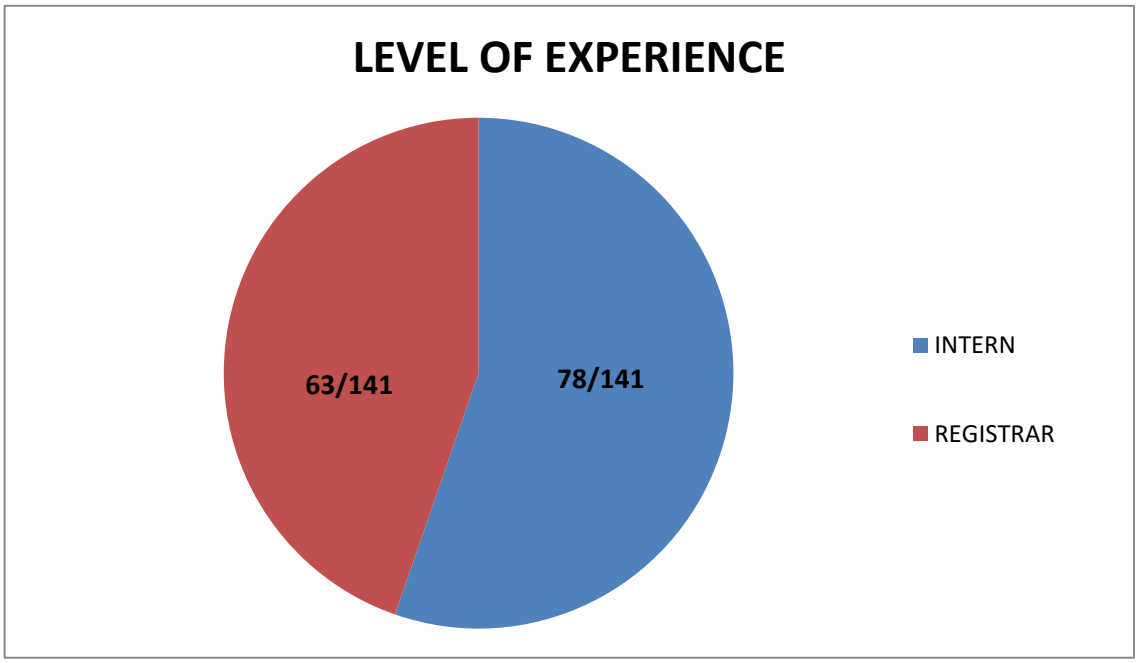


Figure 3.6: Pie chart showing the level of experience of respondents categorized as intern or registrar.

3.7 AGE CATEGORY (2.1% missing data)

The age distribution of the respondents is shown below (figure 3.7). The lowest age in the sample was 24 years old and the highest age in the sample was 42 years old.

The majority (102/141 i.e. 72%) of respondents were aged 30 years or older. This is expected in the group of interns who have recently completed undergraduate training but it appears that doctors going into specialty training are also in this younger (less than 30 years) age category. Slightly more than a quarter of respondents were older than 30 years of age (comprising 23% of respondents aged between 31-40 years and only 5% being older than 40 years).

There were no significant differences in either the NM knowledge score versus age group (reduced categories), (p=0.31); or the categorized NM scores versus age group (reduced categories), (p=0.57).

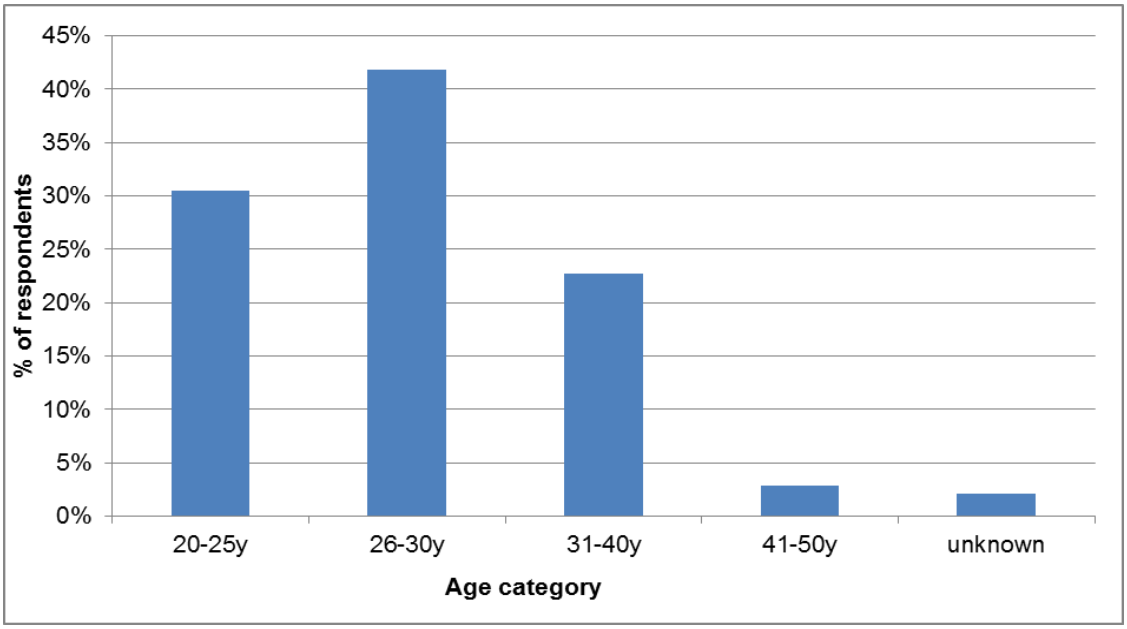


Figure 3.7: The age distribution of respondents (n=141)

3.8 UNDERGRADUATE UNIVERSITY (2.1% missing data)

The largest number of respondents graduated from the University of Witwatersrand [64/141 (45%)], situated in Johannesburg, South Africa (see figure 3.8 below). This was expected as the study was conducted at CMJAH and CHBAH which are both located in Johannesburg, Gauteng Province. The second largest sub-group graduated from UCT 22/141(16%), situated in Cape Town, Western Cape Province; followed by UP 17/141(12%) in Pretoria, Gauteng Province. This may imply that doctors qualifying in a particular institution prefer to be employed in the same region of this institution after graduating.

For further analysis, only WITS, UCT and UP were considered, since the group sizes for the other universities were too small (n<15).

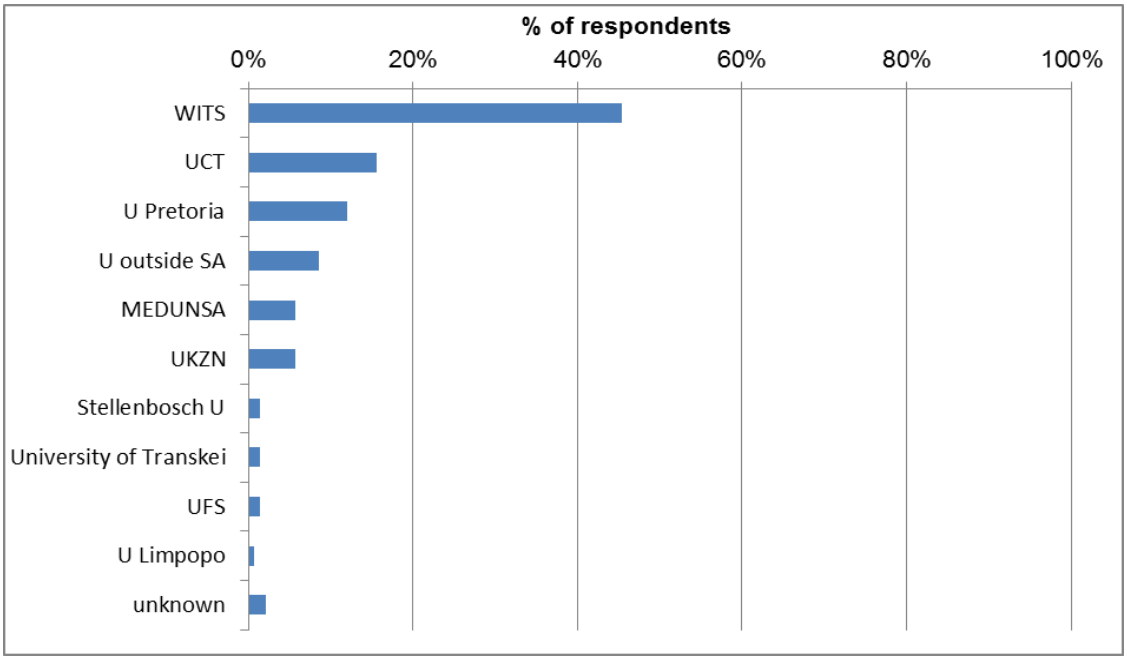


Figure 3.8: The undergraduate universities attended by respondents (n=141)

Amongst the respondents from WITS, the largest number (27/64 i.e. 42%) scored in the medium category, followed by 22/64 (34%) in the good category and 15/64 (23%) in the poor/fair category. The mean NM knowledge score was 61% (std. dev. 17.7).

Amongst the respondents from UCT, almost equal numbers scored in the poor/fair (7/22 i.e. 32%), medium (8/22 i.e. 36%) and good (7/22 i.e. 32%) groups. The mean NM knowledge score was 59% (std. dev. 17.8).

Amongst the respondents from UP a similar number of respondents scored in the poor/fair (6/17 or 35%) and moderate groups (8/17 i.e. 47%), whilst 3/17 (18%) scored in the good group. The mean NM knowledge score was 58% (std. dev. 17.8).

There were no significant differences in either the NM knowledge score versus the undergraduate university (WITS versus UCT versus UP) attended by respondents ($p=0.85$); or the categorized NM scores versus the undergraduate university (WITS versus UCT versus UP) attended by respondents ($p=0.66$).

3.9 CURRENT HOSPITAL

Of the 141 respondents, the largest number of respondents (76/141 i.e. 53.9%) were working at CMJAH, and the remainder (65/141 i.e. 46%) at CHBAH.

Looking at the scores from CMJAH a similar number of respondents scored in the fair/poor (27/76 i.e. 35%) and medium groups (28/76 i.e. 37%), whilst 21/76 (28%) scored in the good group. The mean NM knowledge score percentage was 60% (std. dev. 17.4).

Most of the respondents from CHBAH i.e. 35/45 (52%) scored in the medium group, followed by 17/65 (26%) in the fair/poor group and 14/65 (21%) in the good group. The mean NM knowledge score was 57% (std. dev. 16.4).

There were no significant differences in either the NM knowledge versus the current hospital of employment (CMJAH versus CHBAH), ($p=0.42$); or the categorized NM scores versus the current hospital of employment (CMJAH versus CHBAH), ($p=0.18$).

3.10 CURRENT SPECIALTY

The majority of the respondents (Interns and registrars combined) were working in paediatrics (51/141 i.e. 37%), general surgery (44/141 i.e. 31%), and O&G (31/141 i.e. 22%) at the time the questionnaire was distributed (see figure 3.9 below).

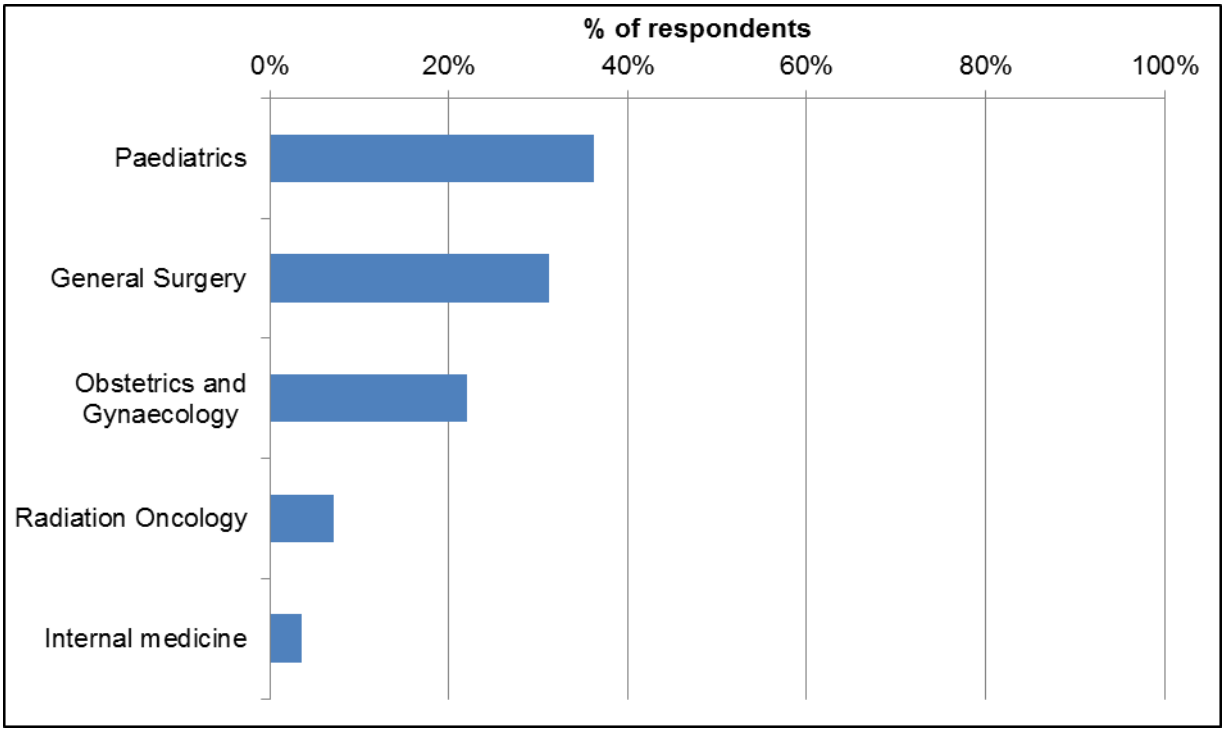


Figure 3.9: The specialties respondents were working in (n=141) at the time the questionnaire was distributed

The reason for the higher response rate from theses specialties could be due to the fact that the chief investigator received more assistance from these specialties in the process of distributing and collecting of questionnaires.

Another reason is that there are more members of our target group employed in these fields as opposed to the other specialties. However, this is only true in the case of radiation oncology in which we had only 10 respondents. This department does not employ interns and there are only 10 available registrars, hence the response rate was 100%. We included this small sub-group as knowledge of ionizing radiation is a part of their course material and their patients form a large part of the referral base to NM.

This statement does not hold true in the case of internal medicine and O&G. At the time of the questionnaire being distributed the department with the most number of the target group in its employ was internal medicine (99/354). This department was followed (in descending order) by O&G (93/354), pediatrics (88/354), general surgery (64/354) and lastly by radiation oncology (10/354).

For further analysis, only the three largest categories were considered, since the group sizes for the other categories were too small .Splitting the three most common specialties by intern/registrar, the distributions are shown (see figure 3.10 below).

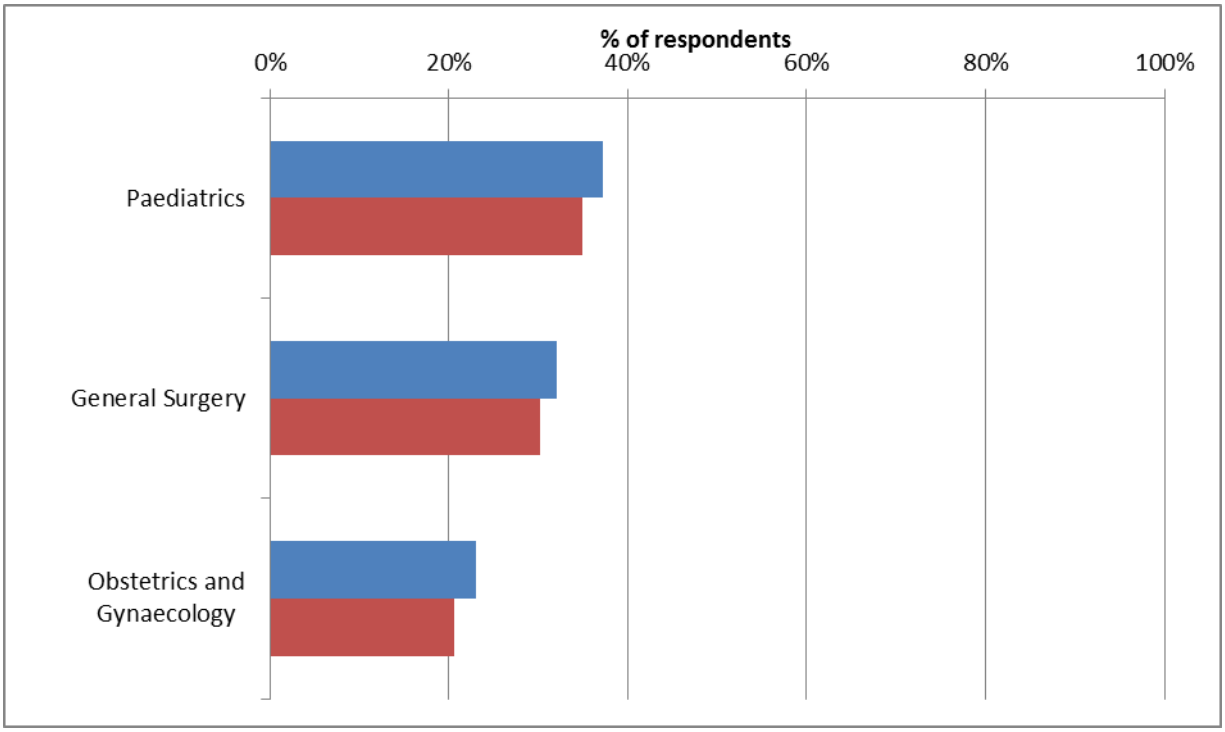


Figure 3.10: The most common specialties respondents [separated into interns (blue) and registrars (red)] were working in at the time the questionnaire was distributed

Of intern 1 respondents (n=50), the largest number were working in general Surgery (24/50 i.e. 48%), followed by O&G (14/50; i.e. 28%), then paediatrics (7/50 i.e. 14%). The smallest number of respondents was from internal medicine (5/50 i.e. 10%).

Of the registrars who answered the questionnaire, 22/54 (35%) were working in paediatrics, 19/54 (30%) in general surgery and 13/54 (21%) in O&G.

Table 3.2: Comparison of NM knowledge performance and the current specialty respondents [A) Intern and Registrar (n=141), B) Intern (n=72), C) Registrar (n=54)] were working in.

Variable	Category	Overall		NM Knowledge score (categorized)						*p-val	NM Knowledge score (%)			**p-val
				Poor/Fair (0-50%)		Medium (51-75%)		Good (>75%)			n	Mean	Std Dev	
A) Current Specialty (Intern and registrar; **n=141)**	Paediatric	51	36%	20	39%	21	41%	10	20%	0,63	51	54	17,7	0,16
	General Surgery	44	31%	11	25%	20	46%	13	30%		44	61	16,6	
	O & G	31	22%	11	36%	13	42%	7	23%		31	58	15,7	
B) Current Specialty (Intern only; **n=72**)	Paediatric	29	37%	12	41%	14	48%	3	10%	0,038 (phi= 0.37)	51	54	16	d=0.81 for O&G vs paed.
	General Surgery	25	32%	4	16%	12	48%	9	36%		44	64	17.4	
	O & G	18	23%	2	11%	9	50%	7	40%		31	66	11.6	
C) Current Specialty (Reg. only **n=54**)	Paediatric	22	35%	9	41%	7	32%	6	27%	0,18	51	55	20.2	0,18
	General Surgery	19	30%	7	37%	9	47%	3	16%		44	58	15	
	O & G	13	21%	9	69%	4	31%	0	0%		31	46	13.7	

***p-value: refers to the comparison of the categorized knowledge score for the indicated variables (i.e. for between group test)**
****p-value: refers to comparison of NM knowledge score for the indicated variables (i.e. for between group test)**

There were no significant differences in the NM knowledge score with regards to current department (reduced categories) at overall level (registrars and intern respondents combined); (p=0.16) or for registrars (p=0.16). There was no significant differences in the categorized NM score with regards to current department (reduced categories) at overall level (registrars and intern respondents combined); (p=0.63) or for registrars (p=0.63); (see table 3.2 above).

From the “Intern only” category the largest number of respondents scored in the medium category: paediatric (14/29 or 48%), general surgery (12/25 or 48%) and O&G (9/18 or 50%). The proportion of respondents from the different specialties who scored in the medium group was almost equal.

For interns, the mean NM knowledge score for those from O&G (65.6%, SD 11.6%) was significantly higher than that of those from paediatrics (54.1%; SD 16.0%) (p=0.039). The effect size was large (Cohen’s d=0.81). There were no other differences between departments.

Similarly (in the intern category), there was a significant, moderate, association between categorized NM score and department: those from Paediatrics had a higher proportion of respondents in the fair/poor group, compared to the other two departments, and vice versa for the good group.

From the registrar only group, the largest proportion of respondents for both paediatrics (9/22 or 41%) and O&G (9/13 or 69%) scored in the poor/fair category. The largest number of respondents from general surgery (9/19 or 47%) scored in the medium category whilst the second largest number of respondents (7/19 or 37%) scored in the fair/poor category. None of the respondents from O& G scored in the good category.

3.11 PREVIOUS SPECIALTY (Intern 1 only; n=50; 4.0% missing data)

The largest number of Intern 1 respondents had previously worked in internal medicine (24/50 i.e. 48%) followed by and general surgery (17/50 i.e. 34%). Only 3/50 (6%) had previously rotated through paediatrics and a further 3/50 (6%) through O&G (see figure 3.11 below).

The explanation for this is that the largest number of intern 1 respondents was from general surgery (24/50); all of whom had previously rotated through internal medicine. The second largest of Intern 1 respondents were from O&G (14/50); all of whom had previously rotated though general surgery**.**

For further analysis, only the two largest categories were considered, since the group sizes for the other categories were too small.

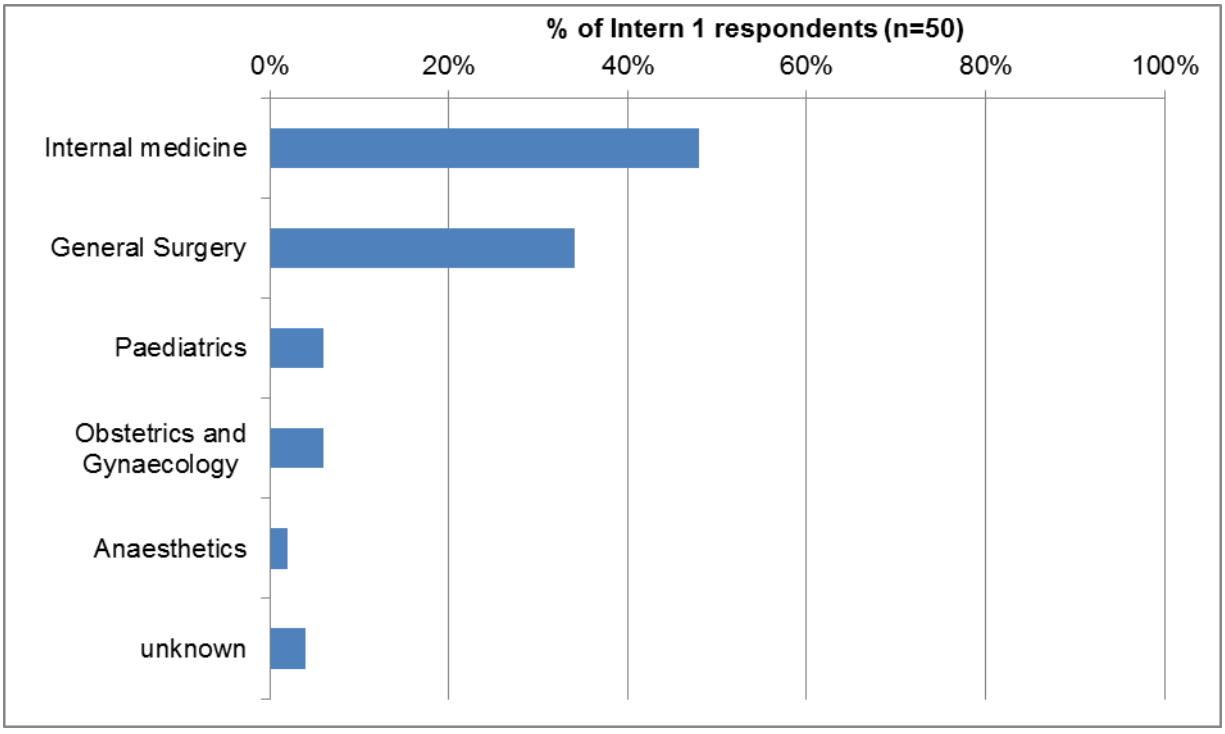


Figure 3.11: The specialties respondents (Intern 1) had most recently rotated through (n=50).

There were no significant differences in either the NM knowledge score with regards to previous department for Intern 1's (reduced categories), (p=0.78); or the categorized NM with regards to previous department for Intern 1's (reduced categories), (p=0.91); (see table 3.3 below).

Table 3.3: Comparison of NM knowledge performance for the first year interns (n=50) and the specialties from which they rotated most recently

Variable	Category	Overall		NM Knowledge score (categorized)						*p-val	NM Knowledge score (%)			**p-val
				Poor/Fair (0-50%)		Medium (51-75%)		Good (>75%)			**n**	**Mean**	**Std Dev**	
Previous dept. (Intern 1 only; n=50)	Internal Medicine	24	48%	4	17%	9	37%	11	46%	0,91	24	63	18,5	0,78
	General Surgery	17	34%	3	18%	8	47%	6	35%		17	64	12,4	

***p-value: refers to the comparison of the categorized knowledge score for the indicated variables (i.e. for between group test)**
****p-value: refers to comparison of NM knowledge score for the indicated variables (i.e. for between group test)**

3.12 EXPOSURE TO NM EDUCATION IN UNDERGRADUATE TRAINING (5% missing data)

Of the 141 respondents, 58 (41%) indicated that they had had undergraduate exposure to NM education (YES group) whilst the majority 83/58 i.e. 59% (NO group) indicated that they had no undergraduate exposure to NM education. Of the 58 respondents from the YES group, 38 (65%) had one day or less allocated to NM education (see figure 3.12 below).

The largest number of respondents from the one day or less group i.e. 30/38 (80%) had less than 5 hours training.

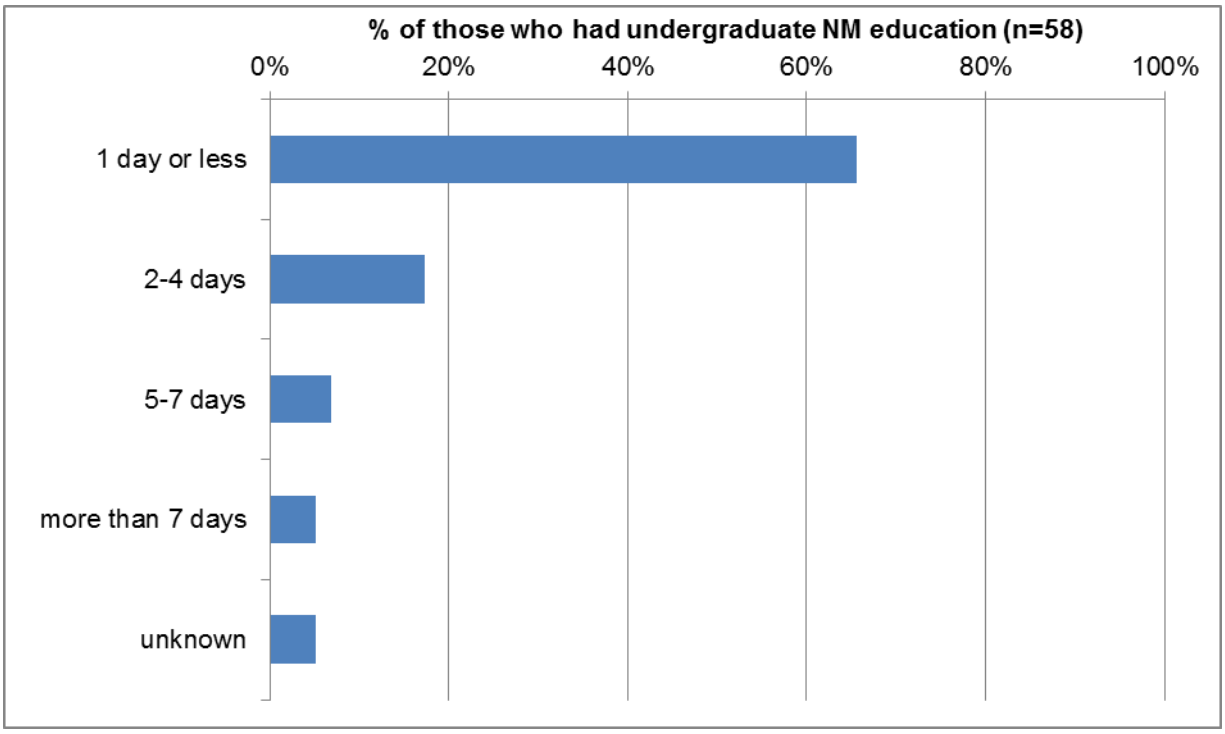


Figure 3.12: The amount of time allocated to undergraduate NM education

When comparing the level of performance between the YES group and the NO group a similar proportion of candidates (YES: 26/48 or 45% versus NO 36/83 or 43%) scored in the medium group (see table 3.4 below).

Table 3.4: Comparison of NM knowledge performance for respondents (n=141) based on (A) whether or not there was exposure to NM education in undergraduate training and (B) the specific amount of time allocated to undergraduate NM education

Variable	Category	N	(%)	NM Knowledge score (categorized)						*p-value	NM Knowledge score (%)			**p-value
				Poor/Fair (0-50%)		Medium (51-75%)		Good (>75%)			n	Mean	Std Dev	
(A) Exposure to NM education in undergrad. training (n=141)	YES	58	41%	12	21%	26	45%	20	34%	0.027 (V= 0.23)	58	63	15,4	0.025 (d= 0.39)
	NO	83	59%	32	39%	36	43%	15	18%		83	56	17,4	
(B) Number of hours of undergrad. NM education (n=58)- *combined*	1 day or less	38	65%	7	18%	15	40%	16	42%	0,21	38	63	15,8	0,71
	more than 1 day	17	29%	4	23%	10	59%	3	18%		17	62	12,1	

***p-value: refers to the comparison of the categorized knowledge score for the indicated variables (i.e. for between group test)**
****p-value: refers to comparison of NM knowledge score for the indicated variables (i.e. for between group test)**

There was a significant, weak, association between categorized NM score and whether or not respondents had had undergraduate exposure to NM training. A larger proportion of respondents: 30/58 (34%) in the YES group scored in the good category

versus a smaller proportion: 15/83 (18%) from the NO group who scored in the good category.

The reverse holds true when looking at the respondents who scored in the fair/poor category. A larger proportion of respondents from the NO group 32/83 (39%) scored in the fair/poor category compared to a smaller proportion: 12/58 (21%) form the YES group who scored in this category.

The mean NM knowledge score for those who had had undergraduate NM education exposure (62.5%, SD 15.4%) was significantly higher than that of those respondents who had not had such exposure (56.0%; SD 17.4%) (p=0.025). The effect size was small (Cohen's d=0.39).

The mean NM knowledge score percentage score for the "greater than one day" group and the "one day or less" group was similar being 63% and 62% respectively. Amongst those who had had undergraduate NM training (n=58), there were no significant differences in either the NM knowledge score with regards to the duration of this training (reduced categories), (p=0.71); or the categorized NM score with regards to the duration of this training (reduced categories), (p=0.21).

3.13 UNDERGRADUATE NM EXPOSURE SUFFICIENCY (3% missing data) AND REQUIREMENT FOR MORE INFORMATION ABOUT NM (1 % missing data)

Table 3.5: Respondents opinion of (A) whether or not their undergraduate exposure to NM was deemed sufficient and (B) respondent's opinion of whether more information about NM would be helpful in referring patients for NM Scans

Variable	Category	Overall (n=141)	
		n	**%**
(A) Undergrad NM exposure deemed to be sufficient	YES	14	10%
	NO	122	87%
	unknown	5	3%
(B) More info about NM would be helpful in referring patients for NM scans	YES	134	95%
	NO	6	4%
	unknown	1	1%

The majority of respondents: 122/141 (87%) deemed their undergraduate NM education insufficient. Of the total 141 respondents the majority: 134/141 (95%) indicated that more information about NM would be helpful in their referral of patients for NM scans (see table 3.5 above).

There were no significant differences in either the NM knowledge score with regards to whether or not respondents deemed their undergraduate exposure to NM training to have been sufficient (p=0.31); or the categorized NM scores with regards to whether or not respondents deemed their undergraduate exposure to NM training to have been sufficient (p=0.45).

CHAPTER 4

4. DISCUSSION AND CONCLUSION

4.1 DISCUSSION

The response rate for this study was 40% (141/354). This is below the acceptable response rate of 50% for a classroom paper type survey and may have resulted in response bias. There is no indication in the Zakavi et el study as to what the response rate was in their study or what they defined as an acceptable response rate. They only state that 106 general practitioners participated in the exam and that the study group was general practitioners in Mashad, North east Iran. Therefore, we cannot determine if any response bias was introduced into the Zakavi et el study due to a low response rate.

In this study, 44% of respondents scored in the “medium” group (score between 51-75%) whilst 31% of respondents scored in the “fair/poor” group (score of 50%) and only 25% of respondents scored in the “good” group (score >75%). The mean NM knowledge Score was 59%. This differs somewhat to the results of the Zakavi Study (2) in which 56% of respondents scored in the “medium” group, 32% in the “poor” group and only 12% in the “good” group.

In the Zakavi et el study the authors stated that “correct answering of less than 50% of the questions was considered poor, 51-75% was medium and >75% good” (2). The authors of the Zakavi study concluded that 62% of G.P’s in Mashad

(North East Iran) had relatively “poor” knowledge in NM; which was defined as correctly answering <58% of the questions asked (2). The level of performance of respondents in this study was considered adequate as the majority of respondents (97/141 or 69%) had correctly answered >50% of the questions. As compared to the Zakavi et el study 42% of the respondents in our study had “relatively poor knowledge” as this proportion of respondents correctly answered <60% of questions asked.

In this study, when looking at the individual questions asked, the respondents scores for largest proportion of questions (9/13) was in the medium range and the respondents scores for the smallest proportion of questions (4/13) was in the fair/poor range. Even though the level of performance of respondents in this study was satisfactory, there is room for improvement with adequate undergraduate teaching.

This result gives one the impression that the doctor’s knowledge regarding NM in Johannesburg, South Africa is better than that of general practitioners in Mashad. Before coming to this conclusion, the following should be considered. Firstly, Zakavi et el study was conducted in 2002 and our study in 2014; a full 12 years later. In this time there has been an increase in the utility of NM Imaging as many NM studies have been integrated in patient management algorithms which form the guidelines of patient management in different specialties. By default, clinicians have had increased exposure to the various types of NM Imaging.

We also have to consider the degree of difficulty of the two questionnaires. As has been stated, 6 of the 14 original questions from the Zakavi study were omitted from our study, as they were deemed too difficult. These questions dealt with specific clinical applications of NM and would most likely only be answered correctly if a doctor had rotated in a very specific department. As we were interested in ascertaining knowledge about basic principles and basic clinical scenarios regarding NM, the experts who reviewed the questionnaire advised replacing these questions for a few more basic questions regarding the utility of ionizing radiation in imaging. These questions were adapted from the Mubeen et el study and formed the basis of the remaining 5 questions in our study.

Bearing the differences between the two questionnaires in mind, we cannot directly compare the results from the Zakavi study with the results from our study. To accurately compare the two studies, the complete, unchanged questionnaire would have been distributed to a study group in South Africa. This may form the basis of a future study.

Questions 5,7,8 and 13 (APPENDIX B) were particularly problematic for respondents (interns and registrars combined).With regards to question 5, approximately 55% of respondents knew that gamma rays were more hazardous than x-rays. This question was based purely on the electromagnetic spectrum where gamma rays are deemed more hazardous that x-rays as they have a higher frequency and shorter wavelength. However respondents who answered this question may have interpreted the question differently due to the fact that many

NM radiographers are not required to use protective lead shielding as compared to radiographers in radiology where usage of lead aprons is mandatory when doing x-rays and CT scans. Clinicians are also aware that the ionizing radiation dose to patients and workers in NM is significantly less as compared to alternative studies of the same organs utilizing x-rays in radiology.

Question 8 scored the lowest by respondents with only 38% knowing that DMSA and DTPA scans are used to evaluate renal pathology. Renal scintigraphy is one of the more commonly requested NM investigations and is specifically covered in the tutorial that is given by a nuclear physician to Wits students in their 5th year of study during the urology rotation. Attendance of this lecture is mandatory; hence a higher score was expected.

Regarding question 7, although it appears that this question was problematic for all respondents, it was in fact the interns who had a lower score in this particular question. Of the intern respondents, 33/78 (42%) answered the question correctly whereas 34/63 (54%) of registrar respondents answered this question correctly. Less than 50% of the respondents (interns and registrars combined) knew that NM perfusion scan is the screening imaging modality of choice to exclude acute pulmonary embolus. However, to be fair, the wording of this question may have been ambiguous as the question does not ask what the screening investigation of choice is, it asks which modality has been used for screening and intern respondents may have chosen pulmonary angiography as a reasonable alternative. This may be true in centers without nuclear medicine facilities. In this

instance the registrars, who have a higher level of experience than interns, scored better in this question.

Lastly, with regards to question 13, the results indicate that 50% of respondents think that intravenous contrast is radioactive. This concept is a fundamental basic which should be covered in undergraduate training of radiology. However, the result is comparatively better than the Mubeen et el (13) study, in which only 20% of respondents answered correctly to a similar question.

Question 12 is another question in which the registrars scored better than interns. The question tries to assess whether respondents knew that MRI does not result in the emission of ionizing radiation. Of the intern respondents, 37/48 (47%) answered the question correctly whereas 34/63 (54%) of registrar respondents answered this question correctly.

Our results show that the level of experience of the respondents, the university where medical degree was obtained and the current specialty of rotation (for interns and registrars combined and registrars only) had no discernible influence on the overall level of performance of the respondents.

For interns, the current specialty of rotation did impact the level of performance. The mean NM knowledge score for those from O&G (65.6%, SD 11.6%) was significantly higher than that of those from paediatrics (54.1%; SD 16.0%) ($p=0.039$). The effect size was large (Cohen's $d=0.81$). There were no other

differences between departments. Similarly, there was a significant, moderate, association between categorized NM score and department: those from paediatrics had a higher proportion of respondents in the fair/poor group, compared to the other two departments, and vice versa for the good group.

To better assess whether the rotation in a certain department impacts the NM knowledge of a respondents, specific questions regarding NM scans more often requested by specific specialties would need to be included. An example to illustrate this would be to include a question regarding the utility of bone scan in the assessment of loosening of a hip prosthesis. This would be a topic more specific to the orthopedics departments. Colleagues at the same level who have never rotated through orthopedics may only know of the utility of bone scan in the assessment of breast and prostate bone metastasis.

Young doctors need to be aware that there are risks to patient's health when utilizing ionizing radiation to image and treat patients. They need to "equip themselves with the current and appropriate knowledge of ionizing and non-ionizing radiation" (13).

The results from question 3 in our study (APPENDIX B) show that 38% of respondents incorrectly thought that NM used in medicine is explosive. This result is worse than that from Mubeen et el (13) study where 30% of respondents answered this question incorrectly.

With regards to question 10 (APPENDIX B), 33 % of respondents incorrectly believe that thyroid ultrasound results in the emission of ionizing radiation whilst 60% of respondents from the Mubeen et el study (13) incorrectly answered that the use of protective measures is required by healthcare staff while performing an ultrasound examination.

In our study, 57 % of the respondents knew that the radiation dose to the patient is higher with a F18 FDG PET-CT scan than an MRI scan (APPENDIX B, question 12). In a similar question from the Mubeen study (13) only 20% of respondents knew that MRI imaging does not result in the emission of ionizing radiation.

Although the results from some questions are better than those from the Mubeen et el study (13) we need to bear in mind the level of experience of the different study populations. Our questionnaire was aimed at qualified doctors i.e. interns and registrars whereas the Mubeen study was aimed at fourth and final year medical students.

The fact that a significant number of the respondents from our study answered these very basic yet conceptually important questions incorrectly further supports the concern that interns and registrars may not have mastered the mandatory principles of ionizing radiation. It calls into question whether interns and registrars can safely refer patients for radiological and NM investigations.

The United States National Council on radiation protection and measurements reported that x-ray and NM accounts for 15% of all exposures to radiation (13). In the United Kingdom an estimated 100-250 deaths occurred from cancers related to medical exposure to radiation. This has sparked international interest and a call for imaging specialists to limit radiation doses to patients as emphasized in the Alliance for Radiation Safety in Pediatric Imaging (the “Image Gently” (17)) and the American College of Radiology (ACR) and the Radiological Society of North America (RSNA) Joint Task Force’s Adult Radiation Protection “Image Wisely” (18) campaigns.

The Atomic Energy Organization of Iran (AEOI) guidelines regarding dose reduction and optimizing the use of radioactive agents have drawn attention to the fact that knowledge of medical students is not adequate (in medium) range of 9.5 +- 2.2 $p<0.05$ (3). This is in line with results of a study by Mubeen et el which is analogous to a Dutch study involving medical students that showed an insufficient knowledge about radiation hazards of in hospital procedures (13)

Although our study comprised 6 questions related to ionizing radiation a more specific questionnaire aimed at gauging young doctor’s subjective perception of radiation risk should be considered for a future, large study. Recent publications have shown that doctor’s appreciation of the relationship between radiation doses and cancer is poor (20).

With the availability of the internet, patients are becoming increasingly sensitive to

the question of radiation risk. Patients range from underestimating risks to rejecting tests even at the risk of deleterious health outcomes (5). When this is paired with junior doctor's lack of knowledge of the benefits of medical imaging and lack of understanding of the effects of ionizing radiation, this may ultimately lead to inappropriate diagnostic and clinical decisions.

Owing to the overwhelming evidence of inadequate knowledge of radiation and its effects amongst physicians; the World Health Organization (WHO) has made a number of suggestions for improvement (20). These include giving a greater emphasis to the "education of medical students on radiation and its effects". They also recommend that "radiation awareness composes part of the induction of junior doctors. For established clinicians, clinical behavior can be modified through audit, educational outreach, and individual guideline-based feedback messages embedded into Imaging reports, which has shown to reduce inappropriate use of diagnostic imaging by 20%" (20).

An important result of the study was that the mean NM knowledge for candidates that had undergraduate teaching dedicated to NM was higher than those who did not (62.5%, SD 15,4) vs (56%, SD 17.4) (p= 0.025). Related to this was a significant, weak association between categorized NM and whether respondents had NM teaching. Those with previous exposure to NM had more candidates in the "good" group as compared to respondents with no previous NM exposure who had more candidates in the "fair/poor" group. This would imply that a sound grounding in the basic principles and application of NM at the

undergraduate level better equips junior doctors and registrars when referring patients for NM studies or therapies.

Of the total 141 respondents only 41.4% had NM teaching incorporated in the undergraduate curriculum. Of this group the majority (i.e. 51.7%) had <5 hours of teaching and 56.9% received a total of < 10 hours of teaching.

This adds credibility to the statement that despite the fact that there has been significant progress in NM, one of the most profound obstacles to future development is the little awareness of the importance of NM in the medical community (21).

Clinicians will argue that integrated teaching is the best way forward. However, imaging specialists would argue that this is insufficient and only gives minimal coverage of the very important subject matter related to radiology and NM imaging. Imaging specialists frequently observe the inadequacy of referrals put forward by “young doctors” and even “not so young doctors” (8). This is cause for concern and indicates that integrated teaching is not delivering what is required.

The fact that the majority of respondents (87%) agreed that their NM education was insufficient during undergraduate training and 95% expressed interest in getting more information about NM to aid in referring patients for NM scans confirms that junior doctors often feel ill-equipped to appropriately refer patients

for NM scans. The problem of inadequate NM education is further compounded by the fact that young doctors are daily spending a considerable amount of time looking at the results of diagnostic imaging investigations and diagnostic NM tests (8). An inadequate understanding of what the study entails and of how the results impact clinical management is detrimental to patient care and can lead to a waste of resources.

In 2003, Lass et el (12) did an overview of the curricula of NM undergraduate training in 34 Central and Eastern European (CEE) medical facilities. The average NM curriculum was 17.5 hours versus our study where 51.7% of respondents had less than 5 hours of NM teaching. The authors identified that new systems i.e. integrated teaching, problem–based learning probably don't serve NM very well but agree that the new system will spread (12). NM is an independent discipline with its own goals and identity (22). This independence should be preserved. It should be recognized by the medical community that NM is not a branch of radiology. Whereas radiology is more anatomy-based, NM focusses on physiological and molecular imaging. Radionuclide targeted therapy is a rapidly growing field which is an integral component of NM. It is currently one of the aspects of NM which is dominating research in the field. If inside the integrated course of training, NM is viewed as a less important "offshoot" of radiology, it serves neither the students' knowledge nor NM as a discipline (22).

In Europe, an elegant compromise has been reached to meet both the needs of the students and requirements of NM through optional elective classes as an addition to the obligatory course offered. In our experience at the University of the Witwatersrand, students are offered only 20 minutes of obligatory NM teaching during the urology rotation. An increase in the curricula to the suggested 18 hours (22) with the option of additional elective courses will dispel the impression of undergraduates that NM is a small and unimportant discipline lost in the peripheries of medical science. This will improve the management of patients for whom useful studies may be done, studies that are until now misunderstood or even not known to exist.

In an article by Dasgupta and Ryan (23) the author states that “nuclear medicine can image or acquire data about virtually every organ in the human body” which is the reason why junior doctors need to know more about this expanding field. It would allow clinicians to consider a NM scan more often as part of the management of their patients.

4.1.1 LIMITATIONS and RECOMMENDATIONS

The following were considered limitations of our study:

1. The response rate of <50% may have resulted in response bias. However as the purpose of this study was to gain insight, the response rate may have been less important.

Possible reasons for the low response rate are as follows:

- People were too busy to spare the time to complete the survey. We attempted to make the survey as as concise as possible limiting the number of questions asked and by making it a multiple choice type questionnaire.
- People may have had no interest in the subject content of the study or potential outcomes. The chief investigator attempted to convey the importance of the questionnaire and how it could lead to improvement in the undergraduate NM curriculum. This was explained both in writing (see appendix D) as well as face to face; in a classroom type setting.
- People may have been reluctant to share their opinions. The chief investigator made every attempt to assure the study of population about the anonymity of the survey. This was done both in writing (see Appendix D) and face to face; in a classroom type setting.

We recommend that further attempts to increase the response rate should be addressed in a future, large study. In such a study, an online survey (with repeated email reminders and a direct link to the survey) should be considered in addition to the face to face, classroom paper type survey. This will provide members of the study group; who were not in attendance at the relevant departmental meeting; with an alternative method to participate in the study

2. Only 5/141 (4%) of respondents were from internal medicine. A major impact on the response from internal medicine is that there is no mandatory departmental meeting, hence fewer junior doctors attend these meetings and this decreased response from this group. An additional attempt to have the questionnaires

distributed by the departmental secretary (who regularly interacts with the junior doctors) was not successful. The relevant intern representative (from CMJAH) and registrar representative (for both CMJAH and CHBAH) were contacted and were asked to to stress to their colleagues the importance of responding to the survey. The intern representative from CMJAH was also given copies of the questionnaire to distribute to her fellow interns. Even though she distributed the questionnaire, none of the interns returned a completed questionnaire to her. The 5/14 interns from CMJAH who did respond to the questionnaire did so because the chief investigator went personally to the medical ward to locate the interns and personally request that they answer the questionnaires. We recommend that this should be addressed in a future, large study. In this study the chief researcher could arrange a specific meeting with the interns and the registrars in order for the survey to be distributed and answered. This would need to be done in collaboration with department of internal medicine and with the full support of the relevant head of department to avoid low attendance of this meeting.

3. A pilot study was not conducted with the adapted questionnaire to establish its validity. The degree of difficulty of the adapted questionnaire was not established which limits the comparison of the results from our study with the Zakavi et el study. We recommend that in a future, large study a pilot study should be done to establish the validity of the questionnaire and the degree of difficulty of the adapted questionnaire should also be assessed. Another recommendation for a future, large study would be to distribute the original, validated questionnaire from the Zakavi et el study to the chosen study population. These results could then be directly compared with the results from the Zakavi et el study.

4. Five out of the thirteen questions were true or false (not multiple choice as in the original Zakavi questionnaire) which may have made it easier for some candidates to correctly “guess” the answers to these questions. We recommend that in a future, large study, true or false type questions should be avoided and the chief investigator should adhere to the multiple choice type question format.
5. The sample size was not big enough to evaluate for other interesting predictors. There is a high likelihood of a Type 2 error as a result of the relatively small sample size and multiple small groups not suitable for statistical analysis. We recommend that in a future, large study; further attempts to increase the response rate should be made; as described previously (limitation number 1). The sample size could be increased by including more hospitals in the Gauteng region or by making it a National survey thereby including more of the hospitals in South Africa.
6. Another source of possible bias and inaccuracy in the study would be in the sub-group of candidates who may have taken the study home for completion prior to handing it at one of the specified collecting points. This would allow respondents to look up the answers to the questions leading to a falsely elevated number of correctly answered questions and impacting the final score. Unfortunately this may have happened in some instances in our study when the questionnaire was obtained from the departmental secretaries and thereafter completed by respondents at home; but we had to compromise on this in order to increase the response rate. This would also be unavoidable in the online type questionnaire which we earlier recommended introducing for a future large study as a means of increasing the response rate.

7. Some of the respondents did not fill in all sections regarding the demographics, resulting in incomplete/missing data which is a limitation in the data analysis. It is recommended that the importance of filling in data should be stressed by the chief investigator repeatedly.

4.2 CONCLUSION

Our study shows that the level of knowledge of interns and registrars in the field of NM is satisfactory but can be improved with adequate undergraduate teaching. Although 43% of respondents scored in the medium (51-75%) group, if we consider that the questions were intended to evaluate very basic principles, it would have been preferable for more respondents to have scored in the “good” (>75%) range.

There is an association between undergraduate training in NM and better scores achieved by respondents. The majority of respondents confirmed that receiving more information regarding NM would be beneficial.

There is a need to improve the undergraduate curriculum regarding NM. For those who have already graduated; educational pamphlets, continuous medical education courses or a junior doctors handbook on NM procedures may assist in addressing this deficiency in NM knowledge.

With regards to developing knowledge amongst students about radiation hazards and prevention, an effective medical education model would be helpful to

disseminate information amongst those with limited NM knowledge.

In short, life sciences and healthcare has entered a new “molecular” era. As the cornerstone of molecular medicine, NM will unlock tomorrows mysteries of medical science. Undergraduate and junior doctors need to be made aware of these medical advances so as to better prepare them to make appropriate imaging and therapy related referrals which will improve patient management.

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APPENDIX A

M140545



HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140545

NAME: (Principal Investigator)	Dr Shireen Dhoodhat
DEPARTMENT:	Department of Radiation Sciences CM Johannesburg Academic Hospital
PROJECT TITLE:	Assessment of doctors in Training at an Academic Hospital; Understanding of the Basic Principles and Clinical Applications of Nuclear Medicine
DATE CONSIDERED:	30/05/2014
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof M Vangu
APPROVED BY:	Professor PE Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 04/07/2014

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature M140545Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX B

QUESTIONNAIRE:

Demographics

Please answer the following questions in writing or circle the correct answer, where applicable

1. What is your age?
2. At which University did you obtain your medical degree?
3. What is your level of experience
   a. Intern (Year 1)
   b. Intern (Year 2)
   c. Registrar (Kindly specify which year in training) :
4. Which hospital are you currently working at?
   a. Charlotte Maxeke Johannesburg Academic Hospital
   b. Chris Hani Baragwanath Academic Hospital
5. Which department are you currently working in?
   a. Internal Medicine
   b. General Surgery
   c. Paediatrics
   d. Obstetrics and Gynaecology
   e. Radiation Oncology
6. Which Department/Departments were you working in prior to this?
   a. Internal Medicine
   b. General Surgery
   c. Paediatrics
   d. Obstetrics and Gynaecology
   e. Other(please specify) :
7. Did you have exposure to Nuclear Medicine Education in your undergraduate training?
   a. Yes
   b. No
8. If you chose “yes”, how much time (in hours/days) was dedicated to Nuclear Medicine Education?
9. Do you feel that your exposure to Nuclear Medicine as an undergraduate was sufficient?
   a. Yes
   b. No
10. Would receiving more information about Nuclear Medicine assist you in your referral of patient’s for Nuclear Medicine Scans?
    a. Yes
    b. No

Questionnaire:

Please circle the correct answer. Each question has only one correct answer.

1- Nuclear medicine is a branch of medicine which uses radioactive materials for:
   a) Human skeletal and organ imaging.
   b) In vitro laboratory tests.
   c) Treatment of diseases.
   d) All of the above

2- Which of the following factors has the most importance in nuclear medicine imaging?
   a) Organ anatomy
   b) Organ function
   c) Changes in organs shapes and sizes
   d) Presence of tumoral lesions

3- Nuclear Material used in medicine is potentially explosive?
   a) True
   b) False

4- What is the difference between “radiotherapy” and “nuclear medicine”?
   a) Both of them use radioactive substances for therapy and there is no difference between them.
   b) Radiotherapy uses both internal and external sources of radioactivity while in nuclear medicine radioactive substances are used internally.
   c) Radiotherapy has only therapy goals while nuclear medicine has only diagnostic roles.
   d) In nuclear medicine Beta radiation is used and in radiotherapy Alpha radiation is used.

5- Gamma Rays which are used in Nuclear Medicine are more hazardous than X-Rays?
   a) True
   b) False

6- Comparing radiation burden to the patient from a VQ (Ventilation Perfusion) Scan to CTPA (CT Pulmonary Angiography), which option is true?
   a) It is lesser for a VQ Scan.
   b) It is higher for a VQ Scan.
   c) They are equal.
   d) It depends on the sensitivity of the patient.

7- Which of the following modalities has been used as the screening test for pulmonary embolism?
   a) Lung ventilation scan

b) Lung perfusion scan
c) Pulmonary angiography

8- DMSA and DTPA scans are diagnostic modalities for evaluation of ……diseases.
a) Hepatic
b) Renal
c) Bladder
d) Bone

9- In a case of prostate cancer which of the following options has more sensitivity for detection of bone metastasis?
a) MRI of Thoracic spine
b) Whole body bone scintigraphy
c) Abdominal & Pelvic CT scan
d) Conventional Radiography (X-Rays)

10- Both thyroid ultrasound and nuclear medicine thyroid scans result in the emission of ionizing radiation?
a) True
b) False

11- Which of the following pathologies is **not** an indication for thyroid scan?
a) Toxic Adenoma
b) Toxic Multi-nodular Goitre
c) Acquired Hypothyroidism
d) Grave's Disease

12- The radiation dose to the patient is higher with an MRI scan than with a F18 FDG PET (without the CT component) Scan
a) True
b) False

13- IV contrast material injected during a F18 FDG PET-CT Scan increases the radiation dose to the patient?
a) True
b) False

Thank you so much for your time!!!

APPENDIX C

Subject: Re: Information re. the article "Assessment of general practitioners knowledge of clinical applications of nuclear medicine"

From: Shireen Dhoodhat (sdhoodhat@yahoo.com)

To: zakavir@mums.ac.ir;

Date: Monday, July 2, 2012 11:10 AM

Dear Dr Zakavi

Thank you so much for all your kind assistance. I truly appreciate it

Kind regards
Shireen

Sent from my iPhone

On 30 Jun 2012, at 10:49 AM, "Seyed Rasoul Zakavi (MD)" <zakavir@mums.ac.ir> wrote:

> Dear Dr.Shireen Dhoodhat;
>
> Thank you for your interest in education of Nuclear medicine. The original questionnaire was in Farsi and I should translate it to English and send it to you. Please just give me few days and I will do that.
>
> Kind regards
>
> Dr.S.Rasoul Zakavi,MD.IBNM
>
> Head, Nuclear Medicine Research Center
>
> Mashhad University of Medical Sciences
>
> Mashhad, Iran
>
> Tel: +98-511-8022729
>
> +98-511-8022202
>
> Fax: +98-511-8599359
>
> e-mail: zakavir@mums.ac.ir

From: Shireen Dhoodhat [mailto:sdhoodhat@yahoo.com]
Sent: Friday, June 29, 2012 5:03 PM
To: Seyed Rasoul Zakavi (MD)
Subject: Information re. the article "Assessment of general practitioners knowledge of clinical applications of nuclear medicine"

Good day Prof. Zakavi

I hope this e-mail finds you in good health. My name is Dr Shireen Dhoodhat. I am a Specialist Nuclear Physiscian employed at C.M Johannesburg Academic Hospital in Johannesburg, South Africa which is affiliated to The University Of Witwatersrand, Johannesburg, S.A.

I was very interested in the study (of which you were the Primary Author) entitled "Assessment of general practitioners' knowledge of clinical applications of nuclear medicine" which was published in the Journal of Medical Education in 2004. Having spoken with numerous undergraduate students and junior doctors at our centre in Johannesburg I feel that the undergraduate teaching syllabus is sorely lacking in educating undegraduates in the clinical application of nuclear medicine and information regarding ionising and non-ionising radiation. I find this worrisome as it is these junior doctors who are required to ask for nuclear medicine investigations of which they have very little knowledge about.

For this reason I would be keen to reproduce a similar study in our institution with the focus being more on undergraduates and junior doctors. I would ask your permission to allow me access to the questionaire which you distributed to the general practitioners in your study. The article makes reference to the questionnaire but the actual questionaire was not published. Any assistance you can afford me in this regard would be greatly appreciated and I will most certainly make reference and give credit to any sources cited in the study I wish to propose. Thank you for your time.

Kind Regards

Dr Shireen Dhoodhat
Specialist Nuclear Physician
Department of Nuclear Medicine and Molecular Imaging
University of the Witwatersrand, Johannesburg, South Africa
Tel + 27 11 488 3559
Fax + 27 11 488 3501
Email: sdhoodhat@yahoo.com

Subject: Re: Thanks for Questionnaire requested by Dr Shireen Dhoodhat

From: Shireen Dhoodhat (sdhoodhat@yahoo.com)

To: zakavir@mums.ac.ir;

Date: Wednesday, August 8, 2012 11:16 AM

Dear Prof Zakavir.

I thank you so much for your prompt response and kind assistance. I truly appreciate it. I will give you feedback once I have initiated the study. Thank you

Kind Regards

Dr Shireen Dhoodhat
Specialist Nuclear Physician
Department of Nuclear Medicine and Molecular Imaging
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Tel + 27 11 488 3559
Fax + 27 11 488 3501
Email: sdhoodhat@yahoo.com

From: Seyed Rasoul Zakavi (MD) <zakavir@mums.ac.ir>
To: Shireen Dhoodhat <sdhoodhat@yahoo.com>
Sent: Tuesday, August 7, 2012 8:54 PM
Subject: RE: Questionnaire requested by Dr Shireen Dhoodhat

Dear Dr.Dhoodhat;

I sincerely apologize for the delay. I was very busy in last month. Please find the questionnaire attached to this e-mail. It is finally translated although it may need minimal English editing.
Hope you get is helpful.

Kind regards
Rasoul

Dr.S.Rasoul Zakavi,MD.IBNM
Head, Nuclear Medicine Research Center
Mashhad University of Medical Sciences
Mashhad, Iran
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APPENDIX D

INFORMATION AND INFORMED CONSENT LEAFLET

PROJECT : Assessment of doctors in training; at an academic hospital; understanding of the Basic principles and Clinical Applications of Nuclear Medicine

Dear Colleague
You are invited to take part in a research study. The following study is being undertaken for a Masters of Medicine Dissertation in Nuclear Medicine by Dr Shireen Dhoodhat at the University of the Witwatersrand.

AIMS OF THE STUDY
This is a questionnaire based study:

1. To survey junior doctors and registrars at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) and Chris Hani Baragwanath Academic Hospital (CHBAH) to determine their understanding of the Basic Principles and clinical applications of Nuclear medicine
2. To determine the profile of the surveyed South African doctors at CMJAH and CHBAH(i.e age, gender, University where medical degree was obtained, level of experience) and to assess whether the level of experience from 1st year Intern to Second year Intern and from Intern (1st and second year) to Registrar impacts the answering of the questionnaire and outcome of the study.
3. To determine the amount of time which was dedicated to Nuclear Medicine education during the surveyed population's undergraduate training.

PARTICIPATION IN THE STUDY

- Participation in this study is voluntary and no identifying data is attached to the questionnaire, therefore your responses are anonymous.
- Refusal to participate will involve no penalty or loss of benefits to which the participant is otherwise entitled.
- The participant may terminate the questionnaire at any point without penalty or loss of benefit.
- In choosing to complete the questionnaire you acknowledge giving consent to participate in the study.

There are 23 questions in total.

- The first 10 questions will determine your demographic profile, level of experience and illicit information about your undergraduate exposure to Nuclear Medicine.
- The next 13 questions are related to the Basic Principles and Clinical Applications of Nuclear Medicine and consist of Multiple Choice Answers.
- Each question has only 1 correct answer, kindly circle the appropriate option.

Please bear in mind:

- ***The results of the study may be published and/or presented at a congress. All information presented will be <u>anonymous</u>.***
- ***For this reason, <u>the benefit</u> of participating in this study will be to assist us in determining the current understanding junior and middle grade doctors have about the basic principles and various applications of Nuclear Medicine when wanting to book a patient for a scan or therapy.***
- ***In this way we can look at methods to improve educating undergraduates and doctors about Nuclear Medicine and thereby assist future clinicians.***
- ***<u>This will ultimately lead to better patient management and care.</u>***

Kindly complete the following questionnaire if:
(PTO)

- You are an intern (either 1st or 2nd year) registered with the Health Professions Council of South Africa), currently rotating through either Internal Medicine, General Surgery, Paediatrics, Obstetrics and Gynaecology or Radiation Oncology.
- You are a Registrar registered with the Health professions Council of South Africa specializing in either Internal Medicine, General Surgery, Paediatrics, Radiation Oncology or Obstetrics and Gynaecology
- You have **<u>not</u>** completed this questionnaire previously

<u>Thank-you for taking the time to read this information leaflet, your honest input will be appreciated!</u>

<u>Chief researcher</u> : Dr Shireen Dhoodhat
Department of Nuclear Medicine and Molecular Imaging
University of Witwatersrand
sdhoodhat@yahoo.com
011 488 3559/3590

Supervisor : Professor MDTHW Vangu
Head of Department of Nuclear Medicine and Molecular Imaging

APPENDIX E

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Ms. O. Noge
Office of the Chief Executive Officer
Tell: 011 488 3792
Fax: 011 488 3753
Email: Lindiwe.Mngomezulu@gauteng.gov.za
Date: 06th May 2014

Dr. S. Dhoodhat
Department of Nuclear Medicine
Charlotte Maxeke Johannesburg Academic Hospital

Dear Dr. Dhoodhat

RE: "Assessment of doctors in training - at an academic hospital – understanding of the Basic Principles and Clinical Applications of Nuclear Medicine"

Please note that permission to conduct the above mentioned study is provisionally approved. Your study can only commence once ethics approval is obtained. Please forward a copy of your ethics clearance certificate as soon as the study is approved by the ethics committee for the CEO's office to give you the final approval to conduct the study.

Approved/not approved

Ms. G. Bogoshi
Chief Executive Officer
Date: 6.5.2014

1

APPENDIX F

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
IN THE OFFICE OF THE CEO
Enquiries: Ms. Thabile Ndlovu
Tel : (011) 933- 9145
Fax: (011) 938-1005
Email: Thabile.Ndlovu2@gauteng.gov.za

To : Dr. Shireen Dhoodhat
(M140545)

From : Dr. Sandile Mfenyana
CEO: CHBA hospital

Date : 16 July 2014

Re : Assessment of Doctors In Training-Understanding the Basic Principles and Clinical Applications of Nuclear Medicine

Your application to request permission to conduct an Assessment of Doctors in Training-Understanding the Basic Principles and Clinical Applications of Nuclear Medicines at Chris Hani Baragwanath Academic Hospital is approved by the CEO: Dr. Sandile Mfenyana

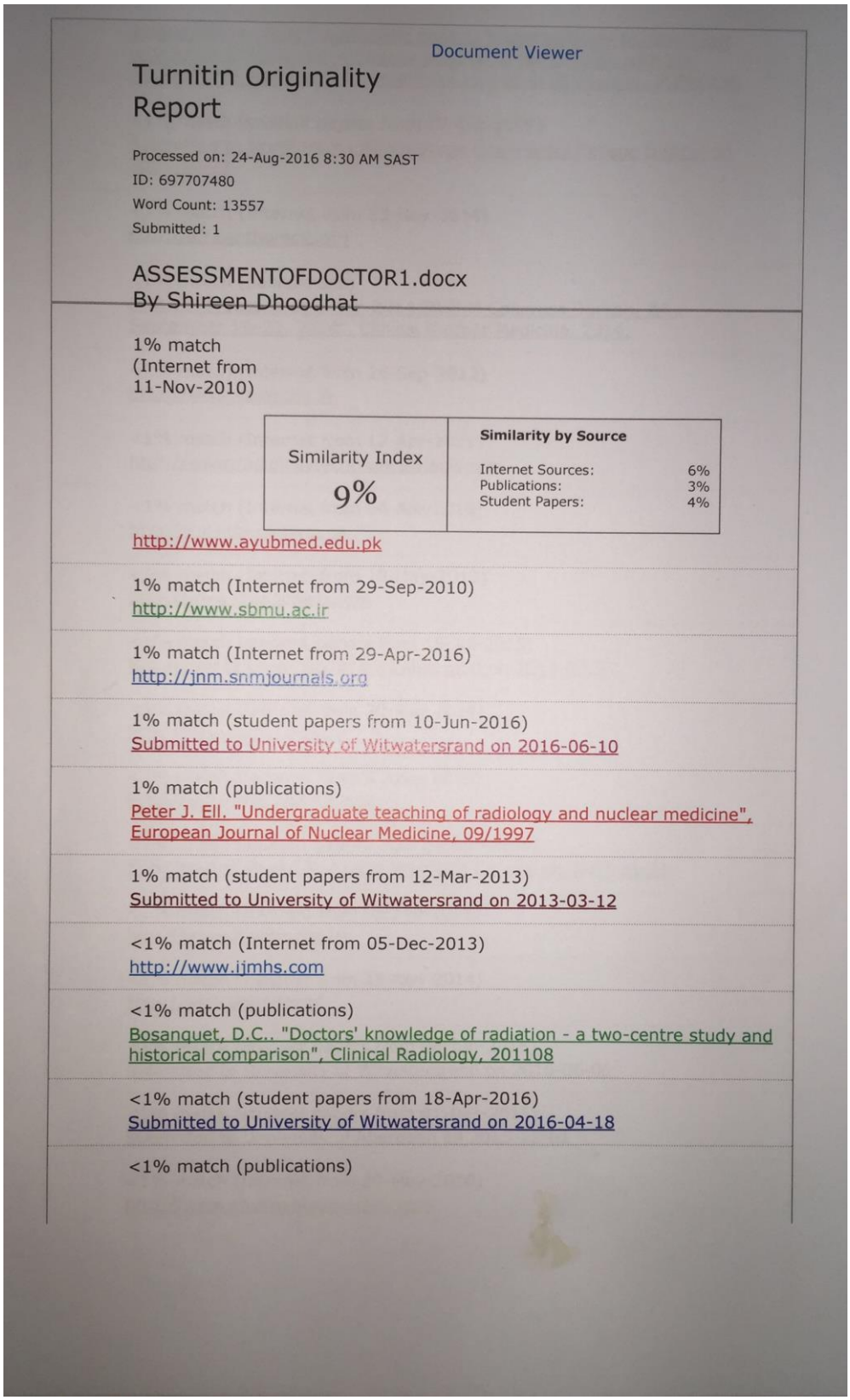
Hoping that the Institution (CHBAH) will meet the requirements of the study concerned.

Wishing you well in your future endeavors

Regards,

DR. SCB Mfenyana
CEO: CHBA Hospital 2014. 07. 16

APPENDIX G



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ASSESSMENT OF DOCTORS' IN TRAINING - AT TWO ACADEMIC HOSPITALS - KNOWLEDGE OF THE BASIC PRINCIPLES AND CLINICAL APPLICATIONS OF NUCLEAR MEDICINE Dr Shireen Dhoodhat A dissertation submitted to the Faculty of Health Sciences,