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The new integrated nuclear medicine and radiology residency program in the Netherlands: why do residents choose to subspecialize in nuclear medicine and why not?

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ABSTRACT

Purpose

To explore reasons that influence a resident's choice for the nuclear medicine subspecialty in the integrated nuclear medicine and radiology residency program in the Netherlands.

Methods

A web questionnaire was developed and distributed among residents in the Dutch integrated nuclear medicine and radiology training.

Results

A total of 114 residents were included. The survey results revealed four categories of incentives to choose the nuclear medicine subspecialty: 1) Expertise of nuclear medicine physicians and their quality of supervision in the training hospital, 2) Opportunities to do scientific research during and after residency, 3) Diversity of pathology, radiotracers, examinations and therapies in the training hospital, and 4) The expectation that the role of hybrid imaging will increase in the future. They also revealed four groups of disincentives to choose the nuclear medicine subspecialty: 1) Lack of collaboration and integration between nuclear medicine and radiology in some training hospitals, 2) Imbalance between nuclear medicine and radiology during the first 2.5 years of basic training during residency at the expense of nuclear medicine, 3) Uncertainty regarding the international recognition of the nuclear medicine subspecialty training, and 4) Uncertain future of nuclear medicine regarding the chances of employment and the ratio of work activities of nuclear medicine to radiology.

Conclusion

This study provided insight into residents' motives to pursue or refrain from nuclear medicine subspecialization in an integrated nuclear medicine and radiology residency program. Medical imaging specialists in training hospitals and developers of curricula for nuclear medicine and radiology training should take these motives into account to ensure a sufficient outflow of newly graduated nuclear medicine specialists.

KEYWORDS

Internship and Residency; Nuclear Medicine; Radiology; Training programs.

CONFLICTS OF INTEREST

No potential conflicts of interest relevant to this article exist.

INTRODUCTION

Nuclear medicine keeps on evolving thanks to the ever-expanding armament of diagnostic and therapeutic radiotracers, and continuing advances in photon detection technology. Due to hybrid imaging techniques that combine single photon or positron emission imaging with computed tomography (CT) or magnetic resonance imaging (MRI), the synergy between diagnostic nuclear medicine and radiology is apparent (1). This synergy is also reflected in the structure of most nuclear medicine and radiology residency programs in the United States and Europe in which cross-over training between the two specialties is common (2-5).

A completely separate residency program for nuclear medicine (with a cross-over internship in radiology) existed in the Netherlands up until 2015, which secured a constant outflow of newly graduated nuclear medicine physicians. In 2015, an integrated residency for nuclear medicine and radiology was implemented in the Netherlands (6). A complete integration of radiology and nuclear medicine was thought to provide the best opportunities for optimal and comprehensive medical imaging, collaboration with clinical colleagues, and quality of patient care, as communicated by representatives from the Dutch Societies of Radiology and Nuclear medicine (6). At the same time, the completely separate residency program for nuclear medicine ceased to exist. The newly integrated nuclear medicine and radiology residency program offers residents a completely free choice between one or two of eight subspecialties to pursue after the first 2.5 years of general integrated nuclear medicine and radiology residency (6). Nuclear medicine, in the Dutch curriculum named “nuclear medicine and molecular radiology”, is among these subspecialties, and includes training in both diagnostic and therapeutic nuclear medicine (6). The other seven radiology-based subspecialties are cardiothoracic radiology, abdominal radiology, interventional radiology, musculoskeletal radiology, neuroradiology and head and neck radiology, breast radiology, and pediatric radiology (6). It should be noted that residents who choose the nuclear medicine subspecialty cannot subspecialize in any other field during their residency in the current program, because this would be at the expense of the time that is considered necessary to master the required nuclear medicine skills (6). Residents who successfully complete the nuclear medicine subspecialty training may bear the title “nuclear radiologist”.

The number of residents that choose the nuclear medicine specialty has been declining in many countries in the past few years (7-9). Importantly, a few years after the implementation of the integrated nuclear medicine and radiology residency program in the Netherlands, it appeared that only 14 residents had chosen the nuclear medicine specialty (7). This number was considerably lower than anticipated and can be considered a threat for the future nuclear medicine workforce. Eventually, this may negatively affect patient care and the future development of the specialty. The reason for this lagging interest is currently unclear and requires

investigation. Such information may potentially be useful to increase recruitment of residents for the nuclear medicine subspecialty and to maintain the future nuclear medicine workforce. It may also reveal targets for improvement in integrated residency programs for nuclear medicine and radiology that are similar to that in the Netherlands.

Therefore, the purpose of this study was to explore reasons that influence a resident's choice for the nuclear medicine subspecialty in the integrated nuclear medicine and radiology residency program in the Netherlands.

MATERIALS AND METHODS

Study Design

The local medical ethics review board approved this prospective study (IRB number: 202000290) which was based on a questionnaire. Upon voluntary participation in this study, informed consent was given.

Participants

The Netherlands has eight teaching and training regions for nuclear medicine and radiology. One regional teaching and training region consists of one academic and several non-academic hospitals, between which the residents rotate during residency. The total number of training hospitals in the Netherlands is 28. All residents spend at least one year of their residency in an academic hospital and at least one year in a non-academic hospital. Each of the eight regional teaching and training regions offers the same integrated nuclear medicine and radiology residency program according to the guidelines set by the Radiological Society of the Netherlands (10). A web questionnaire was developed (described in the next paragraph) and a request was sent via e-mail to the residency program directors in each of the 28 training hospitals to distribute it among their residents. No reminder for participation was sent after the initial e-mail. Both residency program directors and participating residents were informed about the purpose of the questionnaire, i.e. to investigate reasons why residents choose or do not choose the nuclear medicine subspecialty in the integrated nuclear medicine and radiology residency program. The questionnaire was accessible to the residents via an anonymous web link. Anonymous registration via IP addresses ensured unique respondents. Any personal data, including IP-addresses, were not available to the investigators.

Residents participating in the integrated nuclear medicine and radiology program in the Netherlands, regardless of their year of training, were included. Residents that were participating in the previous curriculum, in which nuclear medicine and radiology had not yet been integrated, were excluded. Partially completed questionnaires were also excluded.

Inclusion took place between the 27th of May and the 12th of July 2020.

Questionnaire

The questionnaire was developed by two radiologists (T.V. and T.C.K.), a nuclear medicine physician (W.N.), and a survey specialist (Y.O.). The questionnaire contained fourteen closed-ended questions and nine open-ended questions that were further analyzed for the purpose of this study.

The closed-ended questions aimed to capture the following variables from each resident: age, gender, teaching and training region, exposure to any nuclear medicine education before residency (yes or no), completed or ongoing work on a PhD thesis (yes or no), interest in scientific research (expressed on a 10-point grading scale), clinical working experience before residency (yes or no), started or chosen subspecialty (nuclear medicine or subspecialty radiology training), having been inspired by someone to choose a certain subspecialty (yes or no), if there are any circumstances that make the nuclear medicine subspecialty program in the resident's teaching and training region attractive or unattractive (yes or no), if these circumstances influenced the subspecialty choice (yes or no), if future employment chances influenced the choice for a subspecialty (yes or no), and preference of future working place (i.e. academic hospital, non-academic hospital, or elsewhere).

The open-ended questions aimed to provide a more in-depth exploration of the answers given to some of the closed-ended questions when applicable, i.e. what kind of nuclear medicine education was followed before residency, which person provided inspiration to start the integrated nuclear medicine and radiology residency program, the specialty in which the resident gained clinical working experience before residency, which person provided inspiration to choose a certain subspecialty, circumstances that make the nuclear medicine subspecialty program in the resident's teaching and training region attractive or unattractive, how these circumstances influenced the subspecialty choice, the resident's opinion on the integration of the nuclear medicine and radiology training programs, and any other topics related to the residency training program that a resident wished to share.

The questionnaire was digitized with Qualtrics Core XM survey software (Qualtrics, LLC, an SAP America Inc. company).

Data Analysis

Participants in this survey were divided into three groups: one group consisting of residents who were still in their first 2.5 years of general integrated nuclear medicine and radiology residency and who had not chosen their subspecialty yet (termed "undecided residents"), a second group consisting of residents who were already

in or who had decided to choose the nuclear medicine subspecialty training (termed “nuclear medicine subspecialty residents”), and a third group consisting of residents who were already in or who had decided to choose a subspecialty radiology training (termed “radiology subspecialty residents”).

Variables captured by the closed-ended questions as described in the previous paragraph were compared between nuclear medicine subspecialty residents and radiology subspecialty residents, using the Mann-Whitney test for ordinal variables and the Chi-square test for dichotomous and nominal variables.

The answers to the open-ended questions were qualitatively analyzed by two radiologists (T.V. and T.C.K.), a nuclear medicine physician (W.N.), and a survey specialist to identify common categories that shape a resident’s choice for the nuclear medicine subspecialty training.

P-values less than 0.05 were considered statistically significant. Statistical analyses were executed using MedCalc version 17.2 Software (MedCalc, Mariakerke, Belgium).

RESULTS

Respondents

At the time the survey was conducted, approximately 350 residents were in the integrated nuclear medicine and radiology residency program in the Netherlands (7). All the 28 residency program directors distributed the questionnaire amongst their residents. A total of 129 questionnaires were digitally returned (estimated response rate of 36.9%), of which 15 were excluded due to being partially completed. Finally, 114 residents, consisting of 52 (46%) men and 60 (53%) women (while 2 residents did not indicate their gender), of whom the majority aged between 26 and 35 years (89%), were included. There were 35 (31%) undecided residents, 9 (8%) nuclear medicine subspecialty residents, and 70 (61%) radiology subspecialty residents. Residents from each of the eight Dutch teaching and training regions were represented in the survey (Amsterdam AMC 6%, Amsterdam VUmc 20%, Leiden 5%, Nijmegen 9%, North-east Netherlands 18%, South-east Netherlands 18%, South-west Netherlands 14%, Utrecht 10%). Characteristics of included residents are displayed in table 1.

Comparison of Characteristics between Nuclear Medicine and Radiology Subspecialty Residents

The proportion of nuclear medicine subspecialty residents that had completed or were working on a PhD thesis (79%) was higher than that of radiology subspecialty residents (57%). High interest in scientific research was also more frequent among nuclear medicine subspecialty residents (67%) compared to radiology subspecialty residents (26%). In choosing their subspecialty, nuclear medicine subspecialty residents were more frequently influenced by circumstances that make the nuclear medicine subspecialty program in their teaching and training

region attractive or unattractive (33%) than radiology residents (9%). nuclear medicine subspecialty residents' choice for their discipline was also more frequently influenced by future employment chances (44%) than that of radiology residents (19%). On the other hand, nuclear medicine subspecialty residents were less frequently exposed to nuclear medicine education before residency (11%) than radiology subspecialty residents (33%). There were no other substantial differences between the nuclear medicine and radiology subspecialty residents (Table 1). Nonetheless, there were no statistically significant differences in any of the variables that were analyzed between the two groups of residents (*P*-values ranging between 0.100 and 0.981) (Table 1).

Qualitative Analysis – Incentives to Choose the Nuclear Medicine Subspecialty

Almost one-third of the residents (9 undecided, 5 nuclear medicine subspecialty, and 28 radiology subspecialty residents) marked several favorable conditions to pursue the nuclear medicine subspecialty in their answers to the open-ended questions. These favorable conditions could be grouped into four categories: 1) Expertise of nuclear medicine physicians and their quality of supervision in the training hospital, 2) Opportunities to do scientific research during and after residency, 3) Diversity of pathology, radiotracers, examinations and therapies in the training hospital, and 4) The expectation that the role of hybrid imaging will increase in the future. Representative examples of quotes given by residents in the survey that favor a choice for the nuclear medicine subspecialty training are listed in supplemental table 1.

Qualitative Analysis – Disincentives to Choose the Nuclear Medicine Subspecialty

One-fifth of the residents (4 undecided, 2 nuclear medicine subspecialty, and 19 radiology subspecialty residents) marked several unfavorable conditions to pursue the nuclear medicine subspecialty in their answers to the open-ended questions. These unfavorable conditions could be grouped into four categories: 1) Lack of collaboration and integration between nuclear medicine and radiology in some training hospitals, 2) Imbalance between nuclear medicine and radiology during the first 2.5 years of basic training during residency at the expense of nuclear medicine, 3) Uncertainty regarding the international recognition of the nuclear medicine subspecialty training, and 4) Uncertain future of nuclear medicine regarding the chances of employment and the ratio of work activities of nuclear medicine to radiology. Representative examples of quotes given by residents in the survey that disfavor a choice for the nuclear medicine subspecialty training are listed in supplemental table 2.

DISCUSSION

A total of 114 of approximately 350 residents who were in the Dutch integrated nuclear medicine and radiology residency program in May-July 2020 were included in this study. The estimated response rate (36.9%) is completely in line with previously reported response rates for survey research in healthcare (11). Furthermore, residents from all eight teaching and training regions in the Netherlands were included, as a result of which the survey can be considered representative of the entire country.

No statistically significant differences in characteristics were found between nuclear medicine and radiology subspecialty residents. This is likely due to the relatively low number of nuclear medicine subspecialty residents that was included (n=9) compared to the substantially higher number of radiology subspecialty residents (n=70). Of note, in March 2020, the total number of residents in the nuclear medicine subspecialty was 14 in the Netherlands (12). Assuming that 175 of the total number of 350 residents were in their subspecialty phase of their training in March 2020, 8% (14/175) of residents had chosen the nuclear medicine subspecialty. In addition, the total number of 14 residents in the nuclear medicine subspecialty is substantially lower than the approximately 50 nuclear medicine residents who were in training in the dedicated nuclear medicine residency program before 2015 (7), when it was still separate from the radiology residency program. These data underline the relevance of the present study.

Despite the statistical non-significance in characteristics between nuclear medicine and radiology subspecialty residents, some interesting observations could be made. First, our data suggest that nuclear medicine subspecialty residents generally have more affinity with scientific research than radiology subspecialty residents. This is reflected by higher proportions of completed or ongoing PhD theses (79% vs. 57%) and high interest in scientific research (67% vs. 26%). This is perhaps related to the reputation of nuclear medicine as being a highly innovative field, particularly in Europe where new imaging biomarkers and nuclear theragnostics have been developed in the past few years (5). In the Netherlands, currently theragnostics comprises only a fraction of the daily nuclear medicine workload. Second, regional nuclear medicine training circumstances (such as a wide and/or unique arsenal of nuclear medicine procedures or nuclear medicine staff expertise) more frequently influenced nuclear medicine subspecialty residents in their subspecialty choice than radiology subspecialty residents (33% vs. 9%). This suggests that attractive regional nuclear medicine training circumstances may persuade some individuals to pursue the nuclear medicine subspecialty, but that unattractive regional nuclear medicine training circumstances do not necessarily deter residents from choosing the nuclear medicine subspecialty. Third, expected post-residency employment opportunities more frequently influenced nuclear medicine subspecialty

residents' choice for their discipline than that of radiology subspecialty residents (44% vs. 13%). This seems plausible, because the nuclear medicine workforce is decreasing while the job market for radiologists is currently saturated in the Netherlands. Fifth, nuclear medicine subspecialty residents were less frequently exposed to nuclear medicine education before residency than radiology subspecialty residents (11% vs. 33%). This observation is somewhat surprising but feeds the hypothesis that the overall quality of undergraduate nuclear medicine education in the Netherlands needs to be improved to inspire future residents to subspecialize in nuclear medicine.

The observations of the differences between nuclear medicine and radiology subspecialty residents resonate with the results of our qualitative analysis of the open-ended survey questions. We identified four categories of favorable conditions that influence a resident's choice for the nuclear medicine subspecialty. Three of these four categories, including expertise of nuclear medicine physicians and their quality of supervision in the training hospital, opportunities to do scientific research during and after residency, and diversity of pathology, radiotracers, examinations and therapies in the training hospital, have a common denominator in that being at the forefront of educational, scientific, and clinical expertise and innovation, attracts residents to the nuclear medicine subspecialty. Although it can be argued that leadership in these fields is primarily an academic task, the results of this study suggests that any hospital that is accredited to offer the nuclear medicine subspecialty should fulfill and

maintain a certain standard in this respect. The fourth category that motivates residents to choose the nuclear medicine subspecialty is the expectation that the role of hybrid imaging will increase in the future, which is also one of the reasons why a national taskforce decided to implement an integrated nuclear medicine and radiology residency program in the Netherlands in 2015 (6). Future studies are necessary to confirm and monitor the expected rise in hybrid imaging examinations.

Likewise, we identified four categories of unfavorable conditions that influence a resident's choice for the nuclear medicine subspecialty. One of the potential obstacles that keeps residents from choosing the nuclear medicine subspecialty is a lack of collaboration and integration between nuclear medicine and radiology in some training hospitals. This lack of collaboration and integration may be due to several reasons. It can be speculated that historical differences in clinical workloads, workflows, and reimbursements between the two departments may play a role. If and how the general collaboration and integration between nuclear medicine and radiology can be improved, and whether nuclear medicine and radiology should operate as a single or two different departments, are complicated issues that require further investigation. Imbalance between nuclear medicine and radiology during the first 2.5 years of basic training during residency at the expense of nuclear

medicine is another category that negatively influences the choice for the nuclear medicine subspecialty. However, dedicating more time to nuclear medicine would be at the expense of radiology training or would require prolonging the total duration of residency. The two remaining categories of unfavorable conditions were related to uncertainties regarding the international recognition of the nuclear medicine subspecialty training, and future chances of employment and the ratio of work activities of nuclear medicine to radiology. These knowledge gaps need to be urgently addressed because they interfere with the recruitment of residents for the nuclear medicine subspecialty.

Previous survey studies among radiology residents in the United States (13), United Kingdom (14), and Saudi Arabia (15), reported strong personal interest, intellectual challenge, a successful/enjoyable rotation during training, availability of advanced or multimodality imaging, direct impact on patient care, favorable working hours and on-call commitments, and job prospects, to be among the most popular factors influencing subspecialty choice. In the present study, the role of multimodality imaging and job opportunities also influenced the nuclear medicine subspecialty choice. However, other motivating factors were largely dissimilar between the present study and previous survey studies (13-15), most likely because the latter did not specifically investigate why residents choose or refrain from subspecialization in nuclear medicine.

The present study had some limitations. First, the results of this study should be considered a snapshot in time. Future developments such as adjustments to the Dutch integrated nuclear medicine and radiology curriculum, scientific developments in either nuclear medicine or radiology that lead to clinical paradigm shifts (e.g. the expansion of theranostics and the clinical implementation of artificial intelligence) and employment opportunities, may lead to new insights. Nevertheless, our results provide a baseline framework that can be useful to all stakeholders who wish to increase the recruitment of nuclear medicine subspecialty residents. This recruitment needs further monitoring before a definitive conclusion can be made regarding the viability of the integrated nuclear medicine and radiology curriculum. Second, the role of post-residency fellowships, which, in combination with the training received during residency, may allow a resident to become an accredited subspecialist in both nuclear medicine and a radiology-based field, was not investigated. Third, due to the anonymous nature of the questionnaire, it was not possible to ask for specific feedback from residency program directors and other medical imaging specialists in the training hospitals.

In conclusion, this study provided insight into residents' motives to pursue or refrain from nuclear medicine subspecialization in an integrated nuclear medicine and radiology residency program. Medical imaging specialists in training hospitals and developers of curricula for nuclear medicine and radiology training should take these motives into account to ensure a sufficient outflow of newly graduated nuclear medicine specialists.

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KEY POINTS

Question: Integrated residency for nuclear medicine and radiology in the Netherlands: why do residents choose to subspecialize in nuclear medicine and why not?

Pertinent Findings: No statistically significant differences in characteristics were found between nuclear medicine and radiology subspecialty residents based on a survey. The results provided insight into residents' motives to pursue or refrain from the nuclear medicine subspecialization in an integrated residency program.

Implications for Patient Care: The motives can be used by developers of curricula for nuclear medicine and radiology training to ensure a sufficient outflow of newly graduated specialists.

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Table 1. Characteristics of undecided residents, nuclear medicine (NM) subspecialty residents, and radiology (RAD) subspecialty residents, and *P*-values for differences between NM and RAD subspecialty residents.

Variable	UD (n=35)	NM (n=9) ^a	RAD (n=70) ^b	<i>P</i> -value
Age(years) 20 -25 / 26-30 / 31-35 / 36-40 / 41+ / not indicated	0 / 21 / 10 / 0 / 4	0 / 2 / 4 / 1 / 1 / 1	0 / 24 / 41 / 3 / 1 / 1	0.259 ^c
Gender Male / female / not indicated	18 / 17 / 0	3 / 5 / 1	31 / 38 / 1	0.981 ^d
Exposure to NM education before residency	13	1	23	0.342 ^d
Completed or ongoing work on a PhD thesis	16	7	40	0.409 ^d
Interest in scientific research: low / mid / high / not indicated	6 / 16 / 10 / 3	2 / 0 / 6 / 1	11 / 27 / 18 / 14	0.135 ^c
Clinical working experience before residency	27	5	38	0.777 ^d
Inspired by someone to choose a subspecialty	NA	3	32	0.728 ^d
Attractive circumstances for the NM subspecialty	9	5	28	0.595 ^d
Unattractive NM subspecialty circumstances	4	2	19	0.931 ^d
Influence of (un)attractive circumstances on subspecialty choice	NA	3	6	0.100 ^d
Influence of future employment chances on subspecialty choice	NA	4	13	0.178 ^d
Preference of future working place Academic / non-academic / elsewhere / no choice	11 / 19 / 5 / 0	3 / 3 / 3 / 0	29 / 30 / 10 / 1	0.361 ^d

Notes and abbreviations:

^a 7 residents started the NM subspecialty training and 2 indicated they had already decided to choose the NM subspecialty training

^b 47 residents started a radiology subspecialty training and 23 indicated they had already decided to choose a RAD subspecialty training

^c According to Mann-Whitney test

^d According to Chi-square test

NA: not applicable

Supplemental table 1. Examples of quotes given by residents in the survey that favor a choice for the nuclear medicine (NM) subspecialty according to four categories.

Category	Open-ended questions and quoted answers given by the residents
1. Expertise of NM physicians and their quality of supervision in the training hospital	<p>Are there any circumstances that make the NM subspecialty program in your teaching and training region attractive?</p> <p><i>“Expertise and a great team. Good integration with radiologists.”</i></p>
2. Opportunities to do scientific research during and after residency	<p>Are there any circumstances that make the NM subspecialty program in your teaching and training region attractive?</p> <p><i>“There are lots of opportunities to do research. Treatments (in research setting) and (a lot of) scientific research is done by NM staff”</i></p>
3. Diversity of pathology, radiotracers, examinations and therapies in the training hospital	<p>Are there any circumstances that make the NM subspecialty program in your teaching and training region attractive?</p> <p><i>“Nuclear medicine in the broad sense of the word, a wide range of examinations and an interesting patient population.”</i></p>
4. The expectation that the role of hybrid imaging will increase in the future	<p>What is your opinion on the integration of the NM and RAD training?</p> <p><i>“This is a good development in my opinion, since they are both imaging specialties and in the upcoming future overlap in both specialties will increase (for instance with PET-MRI).”</i></p>

Supplemental table 2. Examples of quotes given by residents in the survey that disfavor a choice for the nuclear medicine (NM) subspecialty according to four categories.

Category	Open-ended questions and quoted answers given by the residents
1. Lack of collaboration and integration between NM and RAD in some training hospitals	<p>Are there any circumstances that make the NM subspecialty program in your teaching and training region unattractive?</p> <p><i>“Mediocre collaboration between NM and RAD and bad reputation regarding NM; some of the old NM staff is not positive about the new integrated program”</i></p>
2. Imbalance between NM and RAD during the first 2.5 years of basic training during residency at the expense of NM	<p>What is your opinion on the integration of the NM and RAD training?</p> <p><i>“Prior to the start of residency, I did not have a good understanding of NM. During residency, information and exposure regarding NM is lacking”</i></p>
3. Uncertainty regarding the international recognition of the NM subspecialty training	<p>What is your opinion on the integration of the NM and RAD training?</p> <p><i>“I am worried about international recognition. I’m hoping to be able to register as a NM physician”</i></p>
4. Uncertain future of NM regarding the chances of employment and the ratio of work activities of NM to RAD	<p>Do you have any remarks regarding the integrated NM and RAD program?</p> <p><i>“An important reason to not choose the NM subspecialty is the unclear future. It feels like a waste to be deployed solely in NM and not being able to do any acute or other RAD tasks. Choosing a RAD subspecialty with NM expertise in the same field would better prepare me for the future”</i></p>