NUCLEAR MEDICINE EUROPE
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# Why do medical students decide not to get trained in the most appealing speciality, nuclear medicine?

About the author

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## Highlights

- Nuclear medicine emerged with hopes of harnessing nuclear energy for medical benefits but faces challenges due to public perceptions.

- Initially a niche field, nuclear medicine gained prominence with PET imaging and advancements in radiochemistry.

- Challenges in attracting students: Declining interest among medical students due to concerns over nuclear energy, radiation risks, and complexity of the field.

- Competition with radiology: Integration of PET/CT imaging blurs lines between nuclear medicine and radiology, leading to competition for student interest.

- Efforts needed to improve the image of nuclear medicine to attract more students and ensure its continued growth and impact in healthcare.

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# Introduction

In people's mind, the discovery of an incommensurable amount of energy within the nucleus of atoms appeared to be double sided: on the upside, it was the hope of an infinite source of energy ensuring long-lasting well-being to humanity, and, on the downside, it was the fear that humanity may disappear if a huge amount of energy were inappropriately released.

Nuclear medicine has emerged on the shiny side of the coin, raising the hope that ionising radiation released by nuclear energy would bring major benefits to human health: new methods to investigate all types of cellular mechanisms in vivo, and methods for the destruction of life-threatening cancer cells.

The benefit of X-rays for medical imaging has been so immense that the implementation of ionising radiation use in medicine has been accepted without a contest. For a few decades, nuclear medicine represented just a small proportion of the medical activity making use of ionising radiation; it was considered as a special form of medical imaging providing some functional and molecular information that X-rays could not bring. It also had some rare therapeutical indications.

The position of nuclear medicine dramatically changed during the last decade of the 20th century, due to extraordinary developments in instrumentation, leading to the adoption of PET as an unavoidable imaging method, and in radiochemistry, offering infinite perspectives for new radiotracers with diagnostic and therapeutical potential.

The full translation of these developments in the clinics necessitates that nuclear medicine attracts enough professionals to ensure extensive exploitation of its advances. Apart from radiochemists, radiopharmacists, engineers and physicists active in nuclear detection and instrumentation, we need young physicians opting for a specialisation in nuclear medicine. In this article, we will address this specific question: while nuclear medicine is in a phase of successful development in instrumentation, radiotracer production and therapeutical applications, is the number of physicians adopting this speciality sufficient to allow this expansion to really benefit to all patients around the world?

Various sources indicate that a decreasing number of young physicians choose this speciality in various countries, the situation being particularly manifest in the US (ref 1-2).

At first sight, a speciality that is highly dynamic, diversified, and versatile, making use of the most advanced technologies should be attractive. What are therefore the reasons for young physicians not to go for training in nuclear medicine?

The reasons are multiple, and this article will isolate some of those that may not be sufficiently considered by the nuclear medicine community.

# The reasons for not choosing nuclear medicine after medical school

## Nuclear Medicine is on the nuclear planet

A first reason that is identified is the fact that nuclear medicine belongs to the nuclear field. As mentioned in the introduction to this article, nuclear energy has in people's mind a bright side and a dark side that are inseparable: nuclear energy has been domesticated in nuclear plants, but atomic bombing and nuclear disasters unfortunately occurred.

Nuclear medicine is obviously on the bright side of the coin, but it remains indissociable from the risks inherent to civil and military exploitation of nuclear energy. Even the worst, over the last ten-fifteen years, the shiny side of nuclear energy has started to fade. The environmental movements have gained a large audience in the populations, particularly in the youth, and these movements have targeted the use of nuclear energy as a major risk for humanity, exemplified and symbolised by the Fukushima disaster. The political influence of these movements has been steadily increasing until the recent boost given by the current climate crisis. Even if this crisis is independent of the nuclear question, the ultimate risks inherent to nuclear energy remain associated with the global ecological preoccupations. This may certainly influence the choice of medical students who have chosen to dedicate their life to human welfare and are therefore sensitive to all questions related to the living conditions on earth.

It is rarely recognised that this factor participates to the decision of students fascinated by the advances in nuclear medicine but who still opt for another speciality.

This effect is enhanced by various indirect factors that I have identified as a teacher at the medical school. Students are strongly influenced by campaigns calling for a reduction in the use of ionising radiation in medicine because of its deleterious effects on health. These campaigns keep medical students away from nuclear medicine because they instil two questions in their mind. Should I dedicate my career to a harmful way of practising medicine? Should I adopt a speciality that will be subjected to the risk of being banned or being limited in its applications? In the same line, students have compulsory courses on radioprotection during their medical education. They know to what extent regulation of ionising radiation use is getting increasingly stringent, asking for the replacement of methods using ionising radiation by non-irradiating methods. Advances in ultrasound, magnetic resonance and optical imaging are systematically presented as announcing non-

irradiating alternatives to functional and molecular imaging by PET and SPECT. Students therefore wonder: should I go for an activity that is destined to be replaced by others?

Also, I have realised that the opinions of medical students are influenced by events that may occur during their medical education. The periods of shortage in radioisotopes, happening from time to time, are viewed by them as revealing a risk for the future of nuclear medicine. They probably consider that these episodes of shortage are globally linked to a disinvestment in the nuclear industry and this, again, takes them away from the speciality.

## Nuclear Medicine is a multidisciplinary discipline

Compared to all medical specialities, nuclear medicine is characterised by the largest diversity of interactions with medical and scientific domains. There is not a single medical field that we can consider alien to nuclear medicine. Also, specialists in nuclear medicine are playing with concepts that come from a large range of scientific domains such as biology and radiobiology, physics and radiophysics, chemistry and radiochemistry, pharmacology and radiopharmacology, sensor and detection devices, imaging instruments, computer sciences, including artificial intelligence.

Then, the question arises: does this wide range of subjects related to nuclear medicine attract or, on the contrary, repel young students who plan to find a medical speciality that would correspond to their expectation? The answer is probably dual: it attracts students with an academic profile, happy to participate to scientific and medical innovations.

But all students do not have this profile, and some will be afraid by the multiplicity of knowledge and understanding nuclear physicians need to have.

The fact that nuclear medicine belongs to diverse fields has another consequence: during their practice, nuclear medicine physicians must know and comply with a wide range of regulations in the areas of medicine and radioprotection. Students know there is an increasing number of rules related to the use of radioactive materials. Interestingly, this very strict frame imposed to all actors in the nuclear field is indirectly linked to the extreme menace that the atomic energy represents in the popular imagination. Imposing very strong rules in the nuclear field, including nuclear medicine, is a way to exorcise this fear.

Obviously, rules are numerous and evolving in the practice of any branch of medicine, but in the case of nuclear medicine, the rules are imposed from outside of the medical world; they are enforced by agents external to hospitals and outpatient clinics. As a comparison, surgeons have strict rules to follow, but these are intrinsic to their medical activity, controlled internally, and directly related to the gestures they make as surgeons. So, students choosing surgery as a medical career consider that they will just conform to rules that ensure the quality of their practice, rules that are put in place and updated by experts in surgery. They do not see those rules as constraints, but rather as necessary guidelines.

The large diversity of fields of knowledge in nuclear medicine has a major consequence for the training of future nuclear medicine physicians. They need to acquire knowledge, skills and competences in such a large set of domains that, exposed to this exigence (ref 3), students may prefer a speciality for which most, if not all, the knowledge to be acquired during the training is in continuity and directly connected to the medical knowledge gained during their medical school education. The new developments that make nuclear medicine so attractive also impose the acquisition of increasing theoretical knowledge on instrumentation and radiopharmaceuticals. In fact, this raises a question that all specialities face. Should we structure nuclear medicine in subspecialities in order to distribute the specific knowledge necessary for specific practices? This raises a secondary question: Do we have sufficient nuclear medicine physicians to envisage such a structuration. There is no direct answer to these questions; they need to be analysed by the national and international authorities implicated in medical training.

## Nuclear Medicine is on a feminized medical planet

The importance of the theoretical education in technological and engineering sciences imposed to trainees in nuclear medicine has a consequence related to the gender balance among medical students on one side and among trainees and physicians in nuclear medicine on the other side. The proportion of women in medical schools is gradually increasing; in the US, women represented 55,6% of the persons graduating from medical school in 2023, while this proportion was 47,2 % in 2014 (ref 4). At the same time, the proportion of women among the residents in nuclear medicine was only 21,1 %. The reason given for this low representation

of women is related to the weak affinity manifested by female students for the Science, Technology, Engineering and Mathematics (STEM) fields. Nuclear medicine is indeed considered as a STEM-oriented speciality, as reflected by the theoretical education received by trainees in nuclear medicine (ref 3). So, the increasing proportion of women in medical schools, combined with the low proportion of female students attracted by nuclear medicine, is probably contributing to the reduction in the global number of medical students choosing nuclear medicine. The influence of the gender question on the number of nuclear medicine physicians is not limited to women's relative reluctance to enter in a STEM-oriented speciality.

A factor that is not mentioned in a thoughtful analysis of the gender balance in nuclear medicine (ref 4) is the simple fact that training in speciality covers a period in life that corresponds to the childbearing age. Among all specialities, nuclear medicine imposes the most stringent constraints for women with a project of pregnancy and during the childbearing period, and this may also represent a disincentive for female medical students who will have a prolonged training time in case of a project of pregnancy. Obviously, a clear and positive organisation of the time spent by women who are excluded from activities in nuclear medicine would reduce the impact of this issue on the decision to go for a career in nuclear medicine. But the relation between pregnancy and exposition to ionising radiation is not limited to the question of the exclusion period. The general insistence on the effect of ionising radiation on the embryonic and fetal development, associated to the necessary protection of the gonads of women in the childbearing age, probably participate to a frequently observed feeling that working in a department of nuclear medicine represents an ill-defined risk for women's offspring. From my experience, I may attest that the contradiction between the scientific data accessible to medical students and the stringent measures based on the precautionary principle intensifies the mixed feeling of female medical students about the risks related to activities in nuclear medicine.

## Nuclear Medicine is the turbulent little twin of radiology

Apart from these general considerations about the reasons why we face difficulties in orienting medical students towards a career in nuclear medicine, there is a practical reason due to the links between radiology and nuclear medicine.

Historically, radiology and nuclear medicine emerged from a single evidence: ionising radiation interacts in the depths of living organisms allowing producing internal images and to deposit energy to treat various diseases. The revolution brought by the first images obtained by Wilhelm Roentgen led to the birth of radiology, also called roentgenology, a new branch of medicine initially dedicated to the production of diagnostic images thanks to X-rays. As already mentioned, nuclear medicine was initially viewed as an adjunct to radiology, providing diagnostic information that X-rays could not bring. For what concerns the therapeutical applications of radioactive compounds, it was initially not clear, for instance, if radioactive iodine for thyroid diseases would not just be a tool in the hands of clinicians active in endocrinology. This second aspect has now been resolved. The manipulation of radioactive compounds requires safety conditions that are better managed in a department that is devoted to the use of radioactive compounds, i.e. the department of nuclear medicine. A question that has not been completely and definitively answered relates to the links between nuclear medicine and radiology. In several countries around the world, nuclear medicine is organised as a subspeciality of radiology. Since radiologists have discovered that PET combined with CT is a hybrid imaging technique that is far superior to CT alone for a large variety of medical conditions, they have obtained in various countries that a complement of training would be sufficient to allow radiologists to practise PET/CT.

Concurrence between fully trained nuclear medicine specialists and radiologists with just a complement of training in nuclear medicine has therefore emerged. The number of radiologists being ten times the number of specialists in nuclear medicine, this concurrence became the spectre of nuclear medicine disappearance. The nuclear medicine community has made repeated efforts to defend the specificity of nuclear medicine, a task facilitated those last years thanks to the successful development of therapeutical applications of radiopharmaceuticals, an activity that only nuclear medicine specialists have the capacity to carry out properly (ref 5). Still, in a medical student's mind, nuclear medicine often remains an easy prey that will be devoured by the radiology giant. Some of them will therefore choose to embrace radiology instead of nuclear medicine. This trend is reinforced by advances in ultrasound, magnetic resonance and optical imaging that are in the hands of radiologists and that threatens the domination of nuclear medicine in molecular and functional imaging. A study conducted in the Netherlands, where nuclear medicine is a subspeciality of radiology, confirms this feeling among trainees in radiology. The study analysed the incentives and the disincentives to choose, or not to choose, the subspeciality of nuclear medicine. Among the disincentives mentioned appear the uncertainty about the future of nuclear medicine, the chances of employment and the ratio of nuclear medicine to radiology work activities (ref 6). This is obviously a matter of reflection and action for those who are involved in the promotion of nuclear medicine.

## Conclusion

Nuclear medicine is a speciality that has made extraordinary advances during the last two decades, gaining a very strong position thanks to the exceptional value of its instrumentation, the versatility of its radiopharmaceutical tools and the unique possibilities offered by its activities in the therapeutical field. While this is not contested, there is some reluctance among medical students to choose nuclear medicine for their future career. The reasons are multiple and there is a necessity to tackle the problem with the eyes wide open because some of the reasons are not explicitly expressed and recognised. The extraordinary benefits that nuclear medicine may bring to the patients require a strong effort to improve the image of this speciality in the eyes of medical students, because we need a sufficient proportion of them to join the dynamic community of nuclear medicine physicians.

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