

# Undergraduate teaching of nuclear medicine: a comparison between Central & Eastern Europe and European Union countries

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## Abstract

This paper overviews the curricula of nuclear medicine (NM) undergraduate training in 34 Central & Eastern European (CEE) and 37 European Union (EU) medical faculties. The data show enormous variation in the number of hours devoted to nuclear medicine, varying between 1–2 to 40 hours and highly differentiated concepts/ideas of nuclear medicine training in particular countries. In most EU countries this teaching is integrated with that of radiology or clinical modules, also with training in clinical physiology. In many CEE countries teaching and testing of NM are independent, although integration with other teaching modules is frequent. The paper discusses the differences in particular approaches to nuclear medicine teaching.

**Key words:** medical education, nuclear medicine

## Introduction

Undergraduate teaching of nuclear medicine (NM) is an important factor for the future of the nuclear medicine community. Tomorrow our students will be our clinical partners and in business terms — our business partners. There is a question if we

— NM lecturers — see and appreciate this fact. Surprisingly few data are available. To the authors' knowledge an interesting overview has been published by Riccabona in 1996 [1], followed by a similar survey by Ell in 1997 [2].

The topic was hot at that time and today it remains hot for three reasons:

- the future of nuclear medicine in general;
- the forthcoming European integration — many Central & Eastern Europe countries in the foreseeable future will join the EU — therefore on the eve of this integration some comparisons might be fruitful;
- then and now it is not only the matter of the NM curriculum, expressed as the number of teaching hours, but what is also important is the relation of NM teaching to the other pre-clinical and clinical courses; also the issue of an integrated curriculum and problem-based-learning (PBL) [3–5].

## Material and methods

We circulated an enquiry addressed to the members of the Board of Editors of *Nuclear Medicine Review* and some colleagues from different medical universities. We were interested in the curriculum of nuclear medicine, its integration with radiology or other courses and in the curriculum of radiology.

## Results

The results are showed in Tables 1 and 2.

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**Table 1. Undergraduate teaching for radiology and nuclear medicine in CEE countries**

Country/City/University	Nuclear medicine	Remarks*	Radiology*
<b>Bosnia</b>			
Banja Luka	30 hours	Independent	60 hours
<b>Bulgaria</b>			
Sofia	20 hours	Integrated with radiology and radiotherapy	
Varna	10 hours	Integrated with radiology and radiotherapy	59 hours
<b>Croatia</b>			
Zagreb	30 hours	Independent	75 hours
<b>Czech Republic</b>			
Hradec Kralové	16 hours	Integrated with radiology	45 hours
Olomouc	30 hours	Integrated with radiology	40 hours
Plzen	9 hours	Integrated with radiology	46 hours
Prague Charles University			
1 <sup>st</sup> Medical Faculty	25 hours	Independent	
2 <sup>nd</sup> Medical Faculty	24 hours	Integrated with radiology	72 hours
3 <sup>rd</sup> Medical Faculty	37 hours	Integrated with clinical modules	
<b>Estonia</b>			
Tartu	5 hours	Integrated with radiology	48 hours
<b>Hungary</b>			
Budapest	6 hours	Integrated with radiology	
Debrecen	15 hours	Integrated with radiology	42 hours
Pécs	4 hours	Integrated with radiology	
Szeged	14 hours	Independent	
<b>Lithuania</b>			
Kaunas	24 hours	Integrated with radiology	
Vilnius	12 hours	Integrated with radiology	
<b>Poland</b>			
Białystok	32 hours	Independent	90 hours
Bydgoszcz	15 hours	Independent	90 hours
Gdańsk	20 hours	+ 10 hours of elective lectures; independent	100 hours
Kraków	30 hours	Independent	95 hours
Lublin	30 hours	+ elective seminars; independent	95 hours
Łódź	25 hours	Independent	50 hours
Poznań	20 hours	Independent	72 hours
Szczecin	20 hours	Independent	85 hours
Warsaw	30 hours	Independent	90 hours
Wrocław	15 hours	Independent	105 hours
<b>Serbia</b>			
Belgrade	30 hours	Independent	60 hours
Kragujevac	30 hours	Independent	60 hours
Niš	30 hours	Independent	60 hours
<b>Slovak Republic</b>			
Bratislava	12 hours	Integrated with radiology	18 hours
Košice	20 hours	Integrated with radiology	32 hours
Martin	28 hours	Integrated with radiology	32 hours
<b>Slovenia</b>			
Ljubljana	5 hours	Integrated with internal medicine	51 hours

\*Blank space means no data were available

These data are not complete, especially the section concerning the radiology curriculum. This material cannot by any means undergo the classic statistical analysis, but even simple calculations allow us to start thinking about some tendencies. The average curriculum of nuclear medicine in our sample was 17.5 hours (range 0–40 hours): in CEE medical universities/faculties it was 21 hours (range 4–37 hours), in EU medical universities/faculties 14.2 hours (range 1–40 hours). In CEE countries, if nuclear medicine was taught as an independent course, the average curriculum was 25.1 hours, whereas

when integrated with radiology and/or radiotherapy it was 15.7 hours. In the case of EU countries this comparison was not possible, as out of 37 curricula under analysis, only 3 had an independent NM course.

## Discussion

As can be seen, the data show enormous variation from 1 to 40 hours in nuclear medicine courses. Also there is a considerable variation in the approach to NM teaching. The following questions arise:

**Table 2. Undergraduate teaching for nuclear medicine and radiology in chosen EU universities**

Country/City/University	Nuclear medicine	Remarks*	Radiology*
<b>Austria</b>			
Innsbruck	18 hours**	Integrated with radiology, radiotherapy and radiation safety; optional course of NM (14 hours)	22 hours
<b>Belgium</b>			
Leuven	4.5 hours	Independent	32 hours
Louvain/Brussels	18 hours	Integrated with clinical modules	40 hours
<b>Denmark</b>			
Aarhus	8 hours	Independent	
Copenhagen	15 hours	Integrated with clinical physiology	
<b>Finland</b>			
Kuopio	20 hours	Integrated with clinical physiology	
Tampere	15 hours	Integrated with clinical physiology	
Turku	10 hours	Integrated with clinical physiology	
<b>France</b>			
Clermont-Ferrand	—	Integrated with radiology (total 20 hours); two optional modules 10 hours of NM each	—
Montpellier	30 hours	Independent; (including 10 hours of radiobiology & dosimetry); optional course of additional 70 hours of NM	40 hours
Nice	28 hours	Integrated with radiology	55 hours
<b>Germany</b>			
Bonn	8 hours	Integrated with radiology, radiotherapy and radiobiology (total 36 hours)	
Essen	10 hours	Optional lectures; integrated with radiology, radiotherapy and radiobiology (total 35 hours)	14 hours
Greifswald	17 hours	Integrated with radiology; some single hours in the lectures of anatomy and physiology; dentistry — 4 hours of nuclear medicine	101 hours
Hannover	15 hours	Additional elective courses e.g. PET imaging	
Heidelberg	4 hours		
Homburg/Saar	5 hours		
Ulm	18 hours	Integrated with radiology; radiobiology; radiation safety and radiotherapy (total: 70 hours)	
<b>Greece</b>			
Thessaloniki	26 hours	Optional course; out of radiology optional course of next 26 hours	130 hours
<b>Italy</b>			
Cagliari	—	Integrated course of diagnostic imaging — 34 hours	
Ferrara	20 hours	Integrated with radiology	60 hours
Florence	25 hours	Integrated with radiology	
Milan	8 hours	Integrated course of diagnostic imaging — 52 hours	30 hours
Modena	27 hours	Integrated with radiology	63 hours
Naples	—	Integrated course of diagnostic imaging — 90 hours	
Pisa	24 hours	Integrated course of diagnostic imaging	96 hours
<b>The Netherlands</b>			
Nijmegen	20 hours	Optional; integrated with radiology	25–50 hours
Utrecht	2 hours	Integrated with endocrinology; optional 6 weeks internship in nuclear medicine	24 hours
<b>Portugal</b>			
Coimbra	12 hours	Integrated with radiology	78 hours
<b>Spain</b>			
Barcelona	40 hours		
Santander	18 hours	Integrated with radiology	75 hours
Sevilla	35 hours	Integrated with radiology	
Valencia	17 hours	Integrated with radiology, radiotherapy, and rehabilitation.	34 hours
<b>Sweden</b>			
Stockholm/Huddinge	2 hours	Integrated with radiology	32 hours
Stockholm/Karolinska	3 hours	Integrated with radiology	80 hours
<b>United Kingdom</b>			
University College of London	1–2 hours	Integrated with clinical modules	Less than 10 hours
Royal Free Hospital London	1–2 hours	3–4 hours in clinical modules; 20 + 40 hours elective	20 hours
St Bartholomew's London	—	Some hours in clinical modules	

\*Blank spaces mean no data were available; \*\*New curriculum integrated with clinical modules starting 2003

- about the curriculum of nuclear medicine (in hours)?
- should nuclear medicine be an independent course or should it be integrated with radiology or any other course?
- should nuclear medicine classes be obligatory, elective or both?

### **The curriculum of nuclear medicine**

For how many hours should students be taught nuclear medicine? This is a good question. An average of about 18 hours met in most of the universities is probably enough, but in some it amounts to 1, 2 or 4 hours. Frankly, that is a disaster for our discipline. A graduate leaving the university will have in mind an impression of nuclear medicine as a small and unimportant discipline lost on the peripheries of medical science.

Reduction of the NM curriculum seems to be a constant tendency. In 1986 Riccabona stated an honest average of 33 hours of NM courses (range 0–100 hours) when surveying 23 medical faculties in the EU [1]. In the survey by Ell in 1997 the average curriculum in 56 European universities was 11 hours, ranging from 0 to 32 hours [2]. In our study it looks better — 17.5 hours, but the fact of decreases in this curriculum is beyond doubt.

CEE countries, probably due to some paradoxical conservatism of their university system and their traditional approach to NM teaching, have bigger NM curricula. New systems — integrated teaching, Problem-Based-Learning — probably do not serve NM teaching well. But this new system will spread. Therefore we should think about compromising with those new tendencies and trying to avoid harm to NM teaching.

### **Nuclear medicine teaching — independent or integrated?**

An independent course is applied in relatively few places. It dominates in Poland and Serbia, in this material we met it also in some universities in Belgium, Bosnia, the Czech Republic, Denmark, France and Hungary. In the rest of our material, NM is integrated most often with the training of radiology, sometimes it is included in clinical modules. In Scandinavian countries it is frequently integrated with clinical physiology. Integration is becoming a golden standard in the majority of universities. Problem Based Learning is becoming increasingly fashionable.

There are two questions:

- is integrated teaching delivering to the students a sufficient amount of knowledge of nuclear medicine?
- which model serves nuclear medicine better?

A direct answer to the first question is difficult. This could be done only on the basis of additional studies into the state of the medical knowledge of graduates. Indirectly, as shown by our results, integrated teaching may at least decrease the number of hours of nuclear medicine training.

An interesting comparison would be between two different models of teaching: British, with the domination of integrated teaching and Polish, where an independent model is applied in all medical universities.

In the UK all medical schools follow slightly different courses but, at present, not all medical schools have nuclear medicine courses (only about 50% do). They have 1–2 hours of formal teaching compared to 20–30 hours of radiology in their entire course. The students will also be exposed to a further 3–4 hours of nucle-

ar medicine during their clinical attachments e.g. renography in renal medicine etc. Some schools offer special study modules with an increased number of hours of nuclear medicine, inside so-called “physiological imaging”.

In Poland, nuclear medicine is taught as an independent course in all 10 medical universities, with an average of 25 hours of teaching and with its own separate examination.

The state of nuclear medicine in the UK is much better than in Poland but of course many other factors influence the state in a particular country. The author, however, would insist that a somewhat traditional model of NM teaching may have some advantages.

Nuclear medicine is an independent discipline with its own goals and identity. This independence should be preserved. Nuclear medicine is not a branch of radiology because of its focusing on pathophysiology and, recently, on molecular imaging. This independence should also be kept in the minds of students, our partners of tomorrow. If, inside the integrated course of training, NM performs as a “younger and smaller brother” of radiology | it serves neither the students' knowledge nor nuclear medicine as a discipline.

Last but not least — is it possible to teach students nuclear medicine in 1–5 hours?

### **Nuclear medicine classes: obligatory, elective or both?**

An elegant compromise between the needs of the students and the requirements of nuclear medicine could be optional/elective classes. Elective teaching can be met in France, Germany, Greece, Poland and the UK (see Table 1), probably also in the other countries. Our research is not complete. Below some examples are shown.

In Montpellier, France, following an obligatory course of 20 hours in NM (+ 10 hours of radiobiology — 1<sup>st</sup> and 2<sup>nd</sup> year of studies), an optional course in NM with 70 hours (!) is given during the 3<sup>rd</sup> and 4<sup>th</sup> year, with e.g. labelling. This was probably the most interesting model met in this query, although one might dispute the necessity of teaching labelling. But in Montpellier medicine has been taught for more than 800 years. *Chapeaux bas!*

In Poland medical universities have the obligation to offer at least 14% of the curriculum in the form of elective lectures, classes or seminars. For example, in the Medical University of Gdańsk, there is an obligatory course of 15 hours of lectures and 5 hours of classes, giving a hard core of knowledge in NM, whereas during 10 hours of elective lectures refinements in hot and current issues are given.

In UK some medical schools offer special study modules with an intensive 20 hours of teaching and the students have to produce essays on nuclear medicine (year 4). In year 5 some students (in groups of 4) have an additional 4 weeks (about 40 hours of teaching and research project) These special study modules are called „physiological imaging”. They are popular and receive high scores from the students.

In the University of Pennsylvania, Philadelphia, PA, USA, some students (usually two to three students in each class) decide to spend some hours for 3 to 12 weeks in the NM department during their enrolment in the school — in some cases the entire year.

Perhaps elective teaching can be the best compromise for NM teaching in the forthcoming years. At least the authors believe so.

## Conclusions

As discussed above, undergraduate teaching of nuclear medicine is not a simple thing, it varies greatly from country to country and is in many aspects an object of controversy.

The authors — subjectively — advocate the traditional model of NM training, but some findings are objective: the number of hours of nuclear medicine teaching is low, the training is dependent on integrated courses, mostly with radiology, and elective training is rare. These issues should be objects of discussion inside the international nuclear medicine community.

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