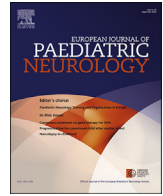




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## European Journal of Paediatric Neurology



## The training and organization of Paediatric Neurology in Europe: Special report of the European Paediatric Neurology Society & Committee of National Advisors



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## ABSTRACT

**Background:** Paediatric Neurology (PN) is a discipline focused on diagnosis, comprehensive management and research into diseases of the central and peripheral nervous system from fetal life to transition into adulthood. The European Paediatric Neurology Society first designed and published the European PN training programme in the European Paediatric Neurology Syllabus in 2002. This was important in gaining recognition for the sub-specialty from the European Academy of Paediatrics and the European Academy of Neurology and in 2003 PN was recognized as a sub-specialty of paediatrics and neurology by the Board of the European Union of Medical Specialties.

In 2004, the EPNS founded the Committee of National Advisors (CNA) that comprised representatives from national Paediatric Neurology societies, in order to further enhance Europe wide standards in training and practice. The EPNS Training Advisory Board (TAB) offers nation specific advice/support to PN societies on developing training and care systems. In 2019, the 2nd revision of the Paediatric Neurology Syllabus was approved by the EPNS Board and CNA. We aim to give an overview of the training of Paediatric Neurology (PN) specialists (i.e. Paediatric Neurologists), the relevant professional bodies and the current practice of Paediatric Neurology in Europe, as defined geographically by the World Health Organization.

**Methods:** A structured online data collection form was completed by CNA representatives from European countries. The data included training routes and structure of training, epidemiological data, nature of professional societies, organization of Paediatric Neurology care, research, academic life and recognition of the specialty.

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**Results:** Data was collected from 43 European countries of which 38 have a national PN Society. In 10 (6 European Union (EU) and 4 non-EU countries) PN is recognized as a core specialty. In 26 countries PN is recognized as a sub-specialty of Paediatrics, Neurology or both (15 EU-11 non-EU). PN is not recognized as a core or sub-specialty in 7 countries (4 EU and 3 non-EU). In 35 countries paediatric neurologists begin their training from Paediatrics, but in 19 countries PN training from Neurology is also possible or the preferred route. Training in PN differs, but in over 50% of countries the three main training modules named in the 2019 2nd revision of the European PN Syllabus (PN, Paediatrics and adult Neurology) are included. Many countries have already adapted their curriculum to the suggestions in the European PN syllabus.

**Conclusions:** There is diversity among European countries in terms of professional organization and PN training. The European PN syllabus has had impact on the development of PN training throughout Europe, independent of duration of training or route from paediatrics or neurology. The syllabus provides a basis for the future development of PN training, the recognition of PN as a (sub) specialty in individual countries and for improving the care of children with neurological disorders in Europe.

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## 1. Introduction

We aim to give an overview of the training of Paediatric Neurology (PN) specialists (i.e. Paediatric Neurologists), the relevant professional bodies and the current practice of PN in Europe, as defined geographically by the World Health Organization (WHO). The Board of the European Paediatric Neurology Society (EPNS) and the Committee of National Advisors to the EPNS board (CNA) created a working group in order to analyze the current status of training and care in PN in Europe. This article is intended to serve as a reference guide for countries who create, organize or develop training in PN. We recommend it as a guide for further improvement of the European PN Syllabus (the European PN training programme established by the EPNS) and for the future shape of PN training at the European regulatory level.

### 1.1. Definition of Paediatric Neurology

PN is the medical discipline devoted to normal and abnormal

development of the central and peripheral nervous system from foetal life up to and including adolescence. Primarily, it involves the diagnosis, prevention, and treatment of diseases of these systems and the comprehensive management of the consequent disabilities. Furthermore, PN specialists are dedicated to research in this field, as well as the transfer of knowledge by means of education and training programs. Finally, ethical and societal issues related to neurologic disorders in the paediatric population, have their attention' [1].

### 1.2. Historical notes

PN has been practiced as an independent specialty in Europe from the 1950's. Prior to this, children with neurological problems were cared for both by Paediatricians and Neurologists and in some countries Psychiatrists. Physicians from each of these disciplines have greatly contributed to the development of the specialty. The list of important early founders of PN in Europe is long and many of them have been appointed as honorary members of the EPNS [2].

There is little published information about the development of PN in Europe when compared to the history of PN in the USA [3]. The need for a discipline of PN developed from the requirement for specialized skills to care for healthy and sick children over the period of nervous system maturation from birth to young adult life [4]. In addition, there are increasing numbers of children surviving with severe neurological illness as a consequence of improvements in foetal, neonatal and paediatric (intensive care) medicine. There is a significant difference between the physiology and pathology of the nervous system in childhood and adult life, making it inappropriate for solely adult trained neurologists to treat children. In the same way that adult Internal Medicine has evolved into different core specialties decades ago, validating narrow and therefore cost-effective approach, Paediatrics has followed; facilitating ever more specialized and higher quality care of children. Advances in diagnostics notably in neurogenetics, neuroimaging, neurophysiology and metabolic medicine, alongside increasing therapeutic options in all areas of child neurology have meant that clinicians caring for children with neurological disease require specialized training in the discipline of PN.

### 1.3. Professional bodies representing paediatric neurologists in Europe

Thirty-eight European countries have a national PN Society. Some countries, notably those with a history of Neuropsychiatry as a recognized specialty, have two national societies, for example Italy, Georgia and Romania. Countries with small populations and few practicing Paediatric Neurologists may not have a national society (Iceland, Moldova, Ireland, Azerbaijan and Armenia).

There are three international professional Paediatric Neurology societies in Europe; the European Paediatric Neurology Society (EPNS), La Société Européenne de Neurologie Pédiatrique (SENP) and Gesellschaft für Neuropädiatrie (GNP).

SENP was founded in 1971 with members primarily from France, Italy, Portugal, Belgium, Switzerland, Luxembourg and Spain. The official language of the society is French with 47 annual international academic meetings held since the founding of the society.

The GNP was founded in 1977 and has members primarily from Germany, Austria and Switzerland with German as the official language of the society.

In 1970 at an interdisciplinary Oxford meeting of the Spastic Society study group in Child Neurology organized by UK paediatric neurologist Ronnie McKeith and attended by 57 leading PN specialists from 19 European countries, the formation of a European study group on Child Neurology was founded that evolved in 1980 into the European Federation of Child Neurological Societies (EFCNS). Their biannual meetings could only be attended by a limited number of representatives of each national society up to a maximum of 60 participants [5,6].

A fourth supra-national society, the East Mediterranean Child Neurology Society founded in 1986 by paediatric neurologists from Turkey, Israel, and Greece was annexed to the EFCNS [6]. In 1993, at the last EFCNS meeting in Bern was decided to transform into an open society in order to widen the membership of the society to all clinicians practicing in PN and researchers in the field. Thus, EFCNS made the transition into the European Paediatric Neurology Society (EPNS), a society based on individual membership; with English as the official language. The constitution of EPNS was registered in Paris, France. The first biannual congress was organized in Eilat, Israel in March 1995 and EPNS looks forward to its 14th congress in Glasgow in 2021. In May 2020, the EPNS had more than 1500 members from 43 European countries, but also from Asia, the Eastern Mediterranean region, Africa, the Western Pacific region and the Americas. The EPNS is led by a Board, elected every four

years by the membership.

In order to maintain close links with national societies the EPNS board established an independent Committee of National Advisors (CNA) made up of single official representatives of each European national PN Society. When a country has more than one PN Society, representatives from these societies take turns in representing their societies on the CNA. The CNA is a forum for information exchange, discussion and debate on matters relevant to PN and serves as an independent advisory group to the board of the EPNS [7].

### 1.4. European training programme in Paediatric Neurology; the European PN syllabus

The EPNS initiated the development of the European PN Syllabus, which details the European training programme in PN (the theoretical knowledge and practical skills that a trainee willing to become a PN Specialist needs to learn/acquire). The EPNS syllabus emphasizes that training should include three trunks which are PN, General Paediatrics and adult Neurology. The first version of the Syllabus was approved in November 2002 by the EPNS That year the Sections of Paediatrics (EAP) and of Neurology (EAN) of the Union of European Medical Specialists (UEMS) approved the syllabus prior to approval and recognition by the full UEMS Board in March 2003 [8].

The purpose of the European PN syllabus is: 1. To improve the care of children with neurological disorders and the support that medical services are able to give to parents/caregivers, associated medical professionals and other disciplines involved in child health and welfare; 2. To set defined standards of knowledge and skills required to practice PN; 3. To ensure that research is developed and encouraged within PN; 4. To harmonize and help develop training programmes in different European countries; 5. To support a high standard of practice of PN in Europe. In short, the European PN syllabus should be the basis for the development of PN training in countries who want to further develop PN in the future.

The European PN Syllabus was revised in 2009 and once again approved by the UEMS Board [9]. In 2019 the 2nd revision of the syllabus was approved by the EPNS Board [10].

### 1.5. Training Advisory Board

In order to facilitate evaluation of national training programmes, in 2004 the EPNS Board and CNA agreed to create a Training Advisory Board (TAB). The TAB included members from the CNA, EPNS board, European Academy of Childhood Disability and the EAN board.

The TAB offered national PN societies a training evaluation programme to assess their national training against the programme recommended in the European PN syllabus. The assessment could be voluntarily initiated by a national PN society. The TAB team assessed the National PN Syllabus over a 2–3 day period, visiting 2–3 representative training centres where they would meet staff and trainees and discuss relevant issues. Meetings were organized with policy makers such as the Dean of the University, Hospital Directors and representatives of the Ministry of Health. The TAB team together with the hosting national PN society produced an assessment report giving recommendations for training and the future development of PN as a specialty.

At the invitation of national PN societies, 13 visits have been performed in 12 countries. The visit-reports can be found on the EPNS website. They illustrate the differences in organization of PN services and training requirements between European countries. They provide insights into the specific challenges faced by national PN societies, individual PN specialist and trainees. Interactive web-

based evaluations or assessments during National PN Society Conferences have also been performed. Support letters to the national societies have been produced with the intention of supporting the position of PN specialty/training for a specific country.

## 2. Methods

Data was collected from 3 sources: 1. An online structured database and form was used to collect data on Paediatric Neurology practice, organisations and training in individual European countries. 2. TAB reports and results of evaluation visits; 3. A literature search to assess published data on PN training and care.

### 2.1. Database on Paediatric Neurology in Europe

CNA representatives and EPNS board members were invited to enter information into the online database.

Section 1 Includes: names of the national society (ies), contact data (name, e-mail addresses of the Presidents, Secretaries and CNA representative), websites details of any affiliated PN journal, society membership and EPNS members from the countries. Section 2 Includes: specialty status of PN, type of specialty (core or subspecialty), year PN was nationally recognized.

Section 3 Includes; information on training including route of entry, curriculum/component modules and their duration, tutorship, examination and certification at the end of training, academic positions, research and access to research funding.

Section 4 Includes: the burden of care including data on population demographics, the age definition for child, number of PN specialists, the spectrum of diseases referred to the PN specialist, levels of care available and the nature of the paediatric neurologists practice.

### 2.2. TAB visit reports

Data was collected on training and organization of care in different countries from the TAB visit reports. CNA representatives verified that the information of the TAB reports was still valid and made relevant changes within the database. The analysis of the database was finalized in November 2019.

### 2.3. Literature search on the training to become a PN specialist

A literature search was performed in PubMed concerning PN training and organization of care. Search terms were: pediatric/child neurology OR paediatric/child neurology AND training AND curriculum. Articles concerning different issues of the training in PN in Europe and United States of America (USA) were selected, to allow comparison.

## 3. Results

Responses were received from CNA representatives of 43 countries. There are differences in PN training and organization of care between European countries (Table 1). In most European countries PN specialists see children from fetal life up to the age of 18 years. In other countries including Finland, Belgium and Switzerland, children are seen to age 16 years and in Spain only up to 14 years. The estimated number of PN specialists for the population served varied enormously between European countries from 1/3000 children in Georgia to 1/173.000 children in the United Kingdom (UK) (Table 2). This reflects differences in the role of a PN specialist between countries.

### 3.1. Organization of PN specialists in the European countries

38 European countries have at least one PN Society; Armenia reported an informal discussion club with 15 members, while Iceland and the Republic of Moldova have no PN society due to the low number of PN specialists. Ireland has an informal PN group which is officially part of the British Paediatric Neurology Association. In Azerbaijan, PN specialists are members of the National Association of Neurologists. In Italy and Romania, who both have a history of Neuropsychiatry for Children as a specialty (this specialty still exists in Italy), there are two societies – one of Paediatric Neurologists and one of Paediatric Neurologists and Psychiatrists. In Georgia there are two societies: 1) the Georgian Association of Child Neurology and Behavioral disorders, whose membership principally includes neuropsychologists and neuropsychiatrists., 2) the Georgian Association of Child Neurology and Neurosurgery whose membership includes paediatric neurologists and neurosurgeons. In Austria, a similar situation existed until recently, but both societies have now merged into a single Austrian Paediatric Neurology society.

### 3.2. Recognition of PN specialty in individual countries in Europe (Table 3)

Although PN was officially accepted at EU level as a subspecialty of Paediatrics and of Neurology in 2002, there are seven (4 EU) countries in Europe in which their Ministry of Health does not officially recognize PN in their lists of (sub) specialties: Azerbaijan, Denmark, Greece, Iceland, the Netherlands, Norway and Spain. However, the majority of these countries already have well organized departments of PN, with a tradition as PN training centres and academic positions for PN. In 10 (6 EU) European countries PN is recognized by their Ministry of Health as a core specialty, with the same standing as Pediatrics and Neurology: Bulgaria, Czech Republic, Finland, Georgia, Latvia, Republic of Moldova, Poland, Romania, Serbia and Ukraine. The other European countries recognize PN as a sub-specialty of Paediatrics, Neurology or both. There is a unique situation in the Republic of Moldova where PN training starts immediately after paediatric medical school, therefore it is considered a core specialty. This was also the case in Azerbaijan until 2011, after which PN training was included in the Neurology residency training programme.

### 3.3. Current training in Paediatric Neurology in Europe (Table 1, Table 3)

The survey revealed that there are different routes of entry into PN training. Some European countries have adopted the concept of PN as a *core specialty*, some as a subspecialty. There are six routes a medical doctor with a medical degree can take to become a PN specialist:

- In Norway, Cyprus and Iceland, no formal PN training as yet exists and PN specialists may be trained abroad.
- In the 10 countries in which PN is recognized as a core specialty, direct entry in a PN training programme is the rule. Duration of training varies between 2.5 years (Ukraine), 3 years (Georgia, Republic of Moldova) 4 years (Bulgaria, Serbia, Latvia), 4.5 years (Czech Republic), 5 years (Poland, Romania) and 6 years (Finland). Training includes rotations in PN, Paediatrics and adult Neurology of variable duration (Table 1). In Bulgaria, Georgia, Poland, Latvia, Ukraine and Romania they also welcome fully board trained Paediatricians and/or Neurology specialists with PN as a second specialty after fulfilling appropriate specific

**Table 1**  
Paediatric Neurology training in 43 (WHO defined) European countries.

	Basic Speciality (N/Y)	Recognized as subspecialty by Ministry of Health	Training as PN specialist from different specialisms or as own basic specialism						
	year of recognition by Ministry of Health	N/Y and year of recognition	Direct entry in PN training programme	Years of Paediatrics + years of PN + exposure AN	Years of Neurology + years of PN + exposure to P	Other training routes	Final Exam	Adult Neurology	Re-registration
Albania	N	Y 1972	N	Y (4P + 2PN)	N		U	U	U
Armenia	N	Y 1963	Y	Y (3P + 2PN)	Y (3AN + 2PN)		Yes: O	6–12 m (obl)	Yes: 5y
Austria	N	Y 1996	N	Y (6P + 3 PN)	N		No	No	No
Azerbaijan	N	1991–2011 \planning restart 2020	N	N	Y (4Y)	individual post residency courses after N training	No	Y (+W)	Y: 5y
Belgium	N	Y 1995	N	Y (5P + 2 PN)	Y (5AN + 2PN)		No	Yes (obl)	No
Bosnia Herzegovina	N	Y 2008	N	Y (5P + 1,5 PN)			U	U	U
Bulgaria	N	Y (year unknown)	Y (4 PN)	Y (4P + 2PN)	Y (4AN + 2PN)		Yes	No	Yes
Croatia	N	Y 2000	N	Y (5P + 3PN) + 0,5 AN			Yes: O	6 M	Yes
Cyprus	N	Y 2007	N	Y (5P + 3PN)	Y		NA	NA	NA
Czech Republic	Y 2017	N	Y (4,5 PN)	N	N		Yes: O	6 M (obl)	No
Denmark	N	N	N	Y (5P + 2,5 PN) + 0,5 AN			No	6 M (ob)	No
Estonia	N	Y 2012	Y (5PN)	Y	N		U	U	U
Finland	Y 1978	N	Y (4 PN+1P+0,25 AN)	N	N		Yes (W)	3 M (obl)	No
France	N	Y	N	Y (4P+1 PN)	N		Yes (O + W)	No	No
Georgia	Y 2011	N	Y (3 PN)	Y (5P + 3 PN)	rare		Yes: W	2 M (optional)	Yes
Germany	N	Y 2012	N	Y (5P + 2 PN) or (5P+1,5 PN + 0,5AN)	N		Yes	6 M (optional)	No
Greece	N	N	No formal training	N	N		No	6 M (optional)	No
Hungary	N	Y 1984	N	Y (5P + 2 PN, incl. 0,5 AN)	Y (5AN + 2PN, including 0,5 Neonatology and P)		Yes	6 M (obl)	No
Iceland	N	N	N	N	N	training abroad	NA	NA	NA
Ireland	N	Y (year unknown)	N	Y (5P + 4PN)	Y (5AN + 4PN)		U	U	U
Israël	N	Y 1995	N	Y (5P + 3 PN)	N		U	U	U
Italy	N	Y (2015)	N	Y (3P + 2 PN)	N	Child Neurology and Psychiatry 4Y (2Ps+2 PN)	Yes: (O + W)	4–6 M (optional)	No (optional: University masters in PN or basic and advanced on line credits managed by PN National Society)
Kazakhstan	N	Y 1991	N	Y (0,5AN+1,5 PN)	Y (0,5P + 1,5 PN)		No	4–6 M (obligatory)	No
Kyrgyzstan	N	Y 1992 (AN)	N	Y (1P+1,5 PN+0,5AN)	Y (1,5 PN+0,5AN)		Yes (O + W)	3–6 M	No
Latvia	Y 2016	N	Y (2PN + 1P + 1 AN)	Y (4P + 2 PN + 1AN)	Y (4AN + 2 PN + 1P)		Yes (O + W)	12 M (obligatory)	Yes: /5 y
Lithuania	N	Y (year unknown)	N	Y (4P + 2PN)	N		Yes	1 M	No
Republic of Moldova	Y 2001	N	Y (1AN+2 PN)	Y	N	After Paediatric Medical school	Yes (O + W)	12 M (obligatory)	No
Netherlands	N	N	N	Y (4P + 1 PN+1AN)	Y (4AN + 1 PN + 1P)		No	12 M	Yes: /5y
Norway	N	N	N	Y (3P+2 PN)	N		No	Yes (optional)	No
Poland	Y 2012	N	Y (5PN)	Y (5P + 3 PN)	Y (5AN + 3,5 PN)	5 Child Psychiatry + 4,5 PN)	Yes	Yes	Yes

Table 1 (continued)

	Basic Speciality (N/Y)	Recognized as subspecialty by Ministry of Health	Training as PN specialist from different specialisms or as own basic specialism						
	year of recognition by Ministry of Health	N/Y and year of recognition	Direct entry in PN training programme	Years of Paediatrics + years of PN + exposure AN	Years of Neurology + years of PN + exposure to P	Other training routes	Final Exam	Adult Neurology	Re-registration
Portugal	N	Y (year unknown)	N	Y (5P + 2 PN)	Y (5AN + 2PN)		U	U	U
Romania	Y 1995	N	Y (1,5P + 0,5AN + 3 PN)	Y (5P + 3 PN + 0,5 AN)	Y (5AN + 3 PN + 1,5P)	Any previous speciality: differences to full PN syllabus should be completed	Yes (O + W)	6 M (obligatory)	No
Russian Federation	N	Y 1932	N	N	Y (6AN + 2PN)		U	U	U
Serbia	Y 1993	N	Y (4 PN)	N	N		Yes: O	6 M (obligatory)	yes
Slovakia	N	Y 1964	Y	Y (4P + 3 PN)	Y (5AN + 3PN)		U	U	U
Slovenia	N	Y 2010	N	Y (4P + 2PN) + 0,5AN	Y (4AN + 2,5 PN)		Yes (O)	6 M (obligatory)	Yes
Spain	N	N	N	Y (P4 + PN2) + 0,3 -0,5AN	Y (4AN + 2PN)		No	3 M (obligatory)	No
Sweden	N	Y (year unknown)	N	Y (P5 + 3PN)					
Switzerland	N	Y 1970-75	N	Y (3P + 3 PN) + 1,0 AN	N		Yes	12 M (obligatory)	No
Turkey	N	Y 1973	N	Y (4P + 2,5 PN) + 0,5 AN	N		Yes	4–6 M	No
Ukraine	Y 1993	N	N	Y (2P + 0,5 PN)	Y		Y (O + W)	No	Y/5y
United Kingdom	N	Y (>15 years ago)	N	Y (5P + 3,0 PN) + 0,5 AN	N		N	6 M (obligatory)	N
Uzbekistan	N	Y 1992	N	Y (6P+2 PN)	N		Yes (O + W)	3–6 M	Yes:/5y

WHO: world health organization; N= No; Y=Yes; U = unknown; P= General Paediatrics; PN Paediatric Neurology; AN = Adult Neurology; NPs = Neuropsychiatry; M = months; O = oral exam, W = written exam.

PN training modules. These extra training modalities have a duration of 2–4,5 years.

- c. Eighteen European countries will admit physicians to PN training only after full board certification in Paediatrics or after fulfilling the criteria of the common trunk of Paediatrics with additional sub-specialization in PN; Albania, Austria, Bosnia Herzegovina, Croatia, Denmark, Estonia, France, Germany, Greece, Israel, Italy, Lithuania, Norway, Sweden, Switzerland, Turkey, Uzbekistan and the United Kingdom.
- d. Entry in PN after full board certification in Neurology: Russian Federation and Azerbaijan
- e. In seventeen countries, entry into PN training is possible after board certification in either Paediatrics or Neurology; Armenia, Belgium, Bulgaria, Georgia, Hungary, Ireland, Kazakhstan, Kyrgyzstan, Latvia, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Ukraine.
- f. In Italy PN training is possible after fulfilling the common trunk criteria of Paediatrics with additional sub-specialization in PN. PN training is possible from Child Psychiatry.

### 3.4. Examination and re-registration at the end of training and certification as PN specialist

In many countries, the final hurdle to become a PN specialist is an Oral and/or Written exam in PN. This is not a requirement in all countries (Table 1). In some countries re-registration is required

under specific country rules.

## 4. Discussion

### 4.1. History

In Europe, Paediatric Neurology developed from both Neurology and Paediatrics evolving into an interdisciplinary specialty. This historical background is reflected in the entry to PN training through core training in Neurology or Paediatrics in seventeen European countries, followed by specific PN training modules and rotations in the other mother specialty. In the Russian Federation and Azerbaijan, the preferred route is through Neurology, while in 18 countries, Paediatrics is the only mother specialty. In 10 European countries PN is recognized as a core specialty by the respective Ministries of Health. In their curriculum they all include not only rotations in PN, but also mandatory periods of training in Paediatrics and adult Neurology to ensure a sound basic knowledge of these specialties. A similar development occurred in the USA where in the early 'pioneer phase', physicians coming from both Paediatrics and Neurology made great contributions to PN [11]. In the USA, the first PN training programs arose from Neurology departments producing graduates in Neurology with additional certification in PN. Subsequently, paediatricians with expertise and interest in childhood neurological disorders were admitted to PN training. Many paediatricians had worked with children with neurological disorders and had experience of the developmental/

**Table 2**  
Epidemiological data on Paediatric Neurology care in 43 (WHO defined) Europe  
(<http://www.euro.who.int/en/countries>).

	Number of PN specialists	Estimated children population	Limits of child's age for PN competency	Estimated PN per/Capita Children
Albania	15	979.110	0-18 y	1/65.000
Armenia	43	800.000	0-18 y	1/18.500
Austria	50	800.000	0-18 y	1/16.000
Azerbaijan	265	2.800.000	0-18 y	1/10.566
Belgium	60	2.285.000	0-16 y	1/38.000
Bosnia Herzegovina	8	700.000	0-18 y	1/87.500
Bulgaria	33	1.100.000	0-18 y	1/33.000
Croatia	20	900.000	0-18y	1/45.000
Cyprus	4	150.000	0-18y	1/37.500
Czech Republic	200	2.000.000	0-18y	1/10.000
Denmark	80	1.160.384	0-17y	1/14.500
Estonia	15	273.155	0-18y	1/18.000
Finland	97	1.000.000	0-16y	1/10.000
France	250	14.000.000	0-15y	1/56.000
Georgia	241	750.000	0-18y	1/3.000
Germany	780	15.000.000	0-18y	1/20.000
Greece	33	1.000.000	0-18y	1/30.000
Hungary	90	1.800.000	0-18y	1/20.000
Iceland	6	80.000	0-18y	1/13.000
Ireland	7	900.000	0-16y	1/128.500
Israel	180	2.800.000	0-18y	1/15.500
Italy	450	9.000.000	0-18y	1/20.000
Kazakhstan	250	7.000.000	0-18 y	1/28.000
Kyrgyzstan	65	2.165.000	0-18 y	1/33.000
Latvia	48	358.762	0-17 y	1/7.480
Lithuania	80	541.300	0-18 y	1/6.766
Moldova	98	707.600	0-18 y	1/7.220
Netherlands	85	3.500.000	0-18 y	1/41.000
Norway	60	1.100.000	0-18 y	1/18.000
Poland	441	7.400.000	0-17y	1/17.000
Portugal	59	2.000.000	0-19 y	1/34.000
Romania	120	4500.000	0-18 y	1/37.500
Russian Federation	3400	>29.000.000	0-18 y	1/8.500
Serbia	42	1.300.000	0-18 y	1/31.000
Slovakia	39	900.000	0-18 y	1/23.000
Slovenia	9	400.000	0-18 y	1/45.000
Spain	521	6.500.000	0-14 y	1/15.000
Sweden	approx 180	2.200.000	0-18 y	1/12.000
Switzerland	77	1.663.752	0-16y	1/26.000
Turkey	240	24.000.000	0-18 y	1/100.000
Ukraine	near 700	7.833.460	0-18 y	1/8.400
United Kingdom	75	13.000.000	0-18 y	1/173.000
Uzbekistan	515	12.000.000	0-18 y	1/23.000

WHO: World health Organization; PN = Paediatric Neurology; y = years.

metabolic aspects of PN, but less training in neuroanatomy, neuropathology and localization of neurological lesions [1]. This historical route ultimately developed in the USA into a 5 year hybrid PN training including Paediatric and Neurology rotations after completion of which, PN residents are board eligible in both Paediatrics and Neurology with a 'special qualification in PN' [12].

#### 4.2. PN training in Europe

The EPNS Syllabus has been developed as a guide to PN training. Depending on country specific factors and the legal requirements of their Ministries of Health, the duration of PN training as described in the EPNS Syllabus will differ. Whichever route is followed – through Paediatrics, Neurology or a separate PN training program – the EPNS syllabus requires that training should include three trunks which are PN, General Paediatrics and adult Neurology. This will ensure that PN trainees will meet the minimum criteria to become a registered PN specialist. In addition to focused training in PN, during which time expertise in diagnosis and management of infants, children and adolescents with neurological diseases is acquired, other fields of PN should be studied including neurological diseases in intensive and neonatal care units, as well as basic

assessment and management of psychiatric illness. The 2019 update of the European PN Syllabus describes a more competency based approach to training in PN. The syllabus emphasizes that all specialists in PN should have a solid training in General Paediatrics equivalent to the Paediatric Common Trunk, as defined by the EAP. The syllabus also emphasizes that a solid training in adult Neurology is essential including knowledge of the structure and function of the central and peripheral nervous system / training in the neurological examination and localization of lesions. The EPNS syllabus recommends a minimum of 5, but ideally 6 years training to become a PN specialist.

As medical care improves, more children with severe neurological disorders are transitioning to adult care. Therefore knowledge of the long term adult care of these diseases is required. Paediatric neurologists can learn from adult neurologists how manifestations and complications change with age and become familiar with adult neurological diseases, of which discrete symptoms often start in childhood [12,13]. PN specialists have an important role in preparing patients and their families for transition into adult life and care. Mutual understanding and the ability to speak 'the same language' for PN and Neurology specialists are vital [13,14].

**Table 3**

Summary of official recognition and training routes in 43 (WHO defined) European Countries with Paediatric Neurology as basic specialty, subspecialty or second specialty.

	Official status of PN in WHO European countries	Direct entry PN training programme	Entry from Paediatrics only	Entry from Neurology only	Entry from Psychiatry or Paediatrics	Entry from Paediatrics and/or Neurology
Basic Specialty	<b>10 countries (*6)</b> Bulgaria*	<b>10 Countries (*6)</b> Bulgaria*				<b>6 Countries (*4), as second specialty after Paediatrics or Neurology</b> Bulgaria* Latvia* Georgia Poland* Romania* Ukraine
	Czech Rep 2017* Finland 1978* Georgia 2011 Latvia 2016* Moldova 2001 Poland 2012* Romania 1995* Serbia 1993 Ukraine 1993	Czech Rep 2017* Finland 1978* Georgia 2011 Latvia 2016* Moldova 2001 Poland 2012* Romania 1995* Serbia 1993 Ukraine 1993				
Sub-specialty	<b>26 countries (*15)</b> Albania Armenia Austria*  Belgium* Bosnia Herzegovina. Croatia* Cyprus* Estonia* France* Germany* Hungary* Ireland* Israel Italy* Kazakhstan Kyrgyzstan Lithuania* Portugal* Russian Federation Slovakia* Slovenia* Sweden* Switzerland Turkey United Kingdom Uzbekistan		<b>15 countries (*8)</b> Albania Austria* Bosnia-Herzegovina Croatia* Cyprus* Estonia* France* Germany* Israel Lithuania* Sweden* Switzerland Turkey United Kingdom Uzbekistan	<b>1 countries</b> Russian Federation	<b>1 country (*1)</b> Italy*	<b>9 countries (*6)</b> Armenia Belgium* Hungary*  Ireland* Kazakhstan Kyrgyzstan Portugal* Slovakia* Slovenia*
No formal status	<b>7 countries (*4)</b> Azerbaijan Denmark* Greece* Iceland the Netherlands* Norway Spain*		<b>3 countries (*2)</b> Denmark* Greece* Norway	<b>1 country</b> Azerbaijan		<b>2 countries (*2)</b> the Netherlands* Spain*

Legend: MH = Ministry of Health, \* = European Union (EU) country; PN: Paediatric Neurology, WHO: World Health organization.

The EPNS syllabus emphasizes that education and training continues throughout the career of a PN specialist. It is strongly recommended that national societies develop or continue a cyclical process of re-registration as PN specialist, in which elements of theoretical and practical knowledge and experience are assessed. A re-registration procedure in PN has been established in only a few countries (Table 1). A European PN exam under the supervision of the EPNS could, alongside the EPNS syllabus, contribute to setting a standard for becoming a PN specialist as well as for any re-registration procedures. The EPNS is developing such an exam.

#### 4.3. Threats to PN training and PN as a (sub) specialty

In some countries, children with neurological problems have poor access to expert PN care because of limited numbers of specialists with PN registration. In the UK and Ireland, this is addressed by a system in which certified PN specialists principally work as consultants in tertiary or quaternary university hospital settings.

Most children with neurological disorders are managed by secondary level Paediatricians and Neurodisability specialists who will refer to PN specialists for diagnostic or treatment advice. This organization of services poses the risk that physicians seeing children with neurological disease at secondary level may have insufficient training to recognize diseases, particularly rare neurological diseases, resulting in delay in referral to tertiary level specialists. In many countries, particularly those with a relatively high number of PN specialists per child capita, a significant part of the certified paediatric neurologist's role will be in the associated specialty of Developmental Neurology. This will include all issues related to intellectual disability, motor deficits and developmental behavioural disorders, particularly where there are limited numbers of child psychiatrists. The number of PN specialists in a country, thus reflects not only the population of children with neurological disorders but the nature of the paediatric neurologists practice.

Most countries do not have an algorithm for calculating the necessary number of new PN resident positions per year. One



exception is Finland, which considers the retirement rate, paediatric population and how paediatric neurological disease management varies with age and new developments. The organization of healthcare in certain countries places unnecessary strain on Paediatric Neurology services. In Romania, the system allows families to seek advice from as many specialists they may want, leading to unnecessary resource utilization and excessive burden of the PN system by doubling/tripling the number of PN consultations (second and third opinions).

We were unable to find any publications which considered why junior doctors would choose PN as a specialty and how they may be attracted to the field. Entries into the database suggested that there are concerns regarding recruitment of trainees to the specialty in several European countries. There are several possible reasons why PN is not considered as attractive a choice as other specialties. The long period of training and in some countries the low (Georgia, Armenia) or absent salary (Spain), when training to be a PN specialist may reduce the attractiveness of the specialty. In a survey among residents and practicing PN specialists in the USA, attitudes regarding recruitment and training in PN were compared [15]. An important reason for the difficulty in recruiting trainees for PN was the absent or very limited exposure to PN in the core medical curriculum. Additional obstacles identified were the long duration of training in PN. This has led to suggestions to reduce Paediatric training to one year and adult Neurology training to 6 months in order to create more time for focusing on newer and evolving fields such as neurogenetics, neuroimaging, neuroimmunology, epileptology and neuromuscular disorders [13].

A common challenge to the development of PN in low resource countries is the migration of physicians, including PN specialists to high resource countries [16]. This means that training from low resource countries is used for the benefit of wealthier nations. When physicians decide to return to their home country from nations with well-developed clinical and training systems many of them will choose to work in the private sector. This may benefit those who can afford private health care, but creates an inequality in health care between children from more deprived and wealthy backgrounds.

#### 4.4. Future of PN in Europe

PN specialists continue to work in primary and secondary centres in the community and increasingly PN departments in university centres and have developed sub-specialisations within the discipline. Tertiary and quaternary level specialists/centres in specific fields in PN (neuromuscular disorders, epilepsy, epilepsy surgery, sleep medicine, etc.) exist throughout Europe. In these highly specialized centres, a philosophy of multi-disciplinary care ensures delivery of high quality, comprehensive care covering all aspects of a disease. For a rare disease, a single centre, or even a country, may not be able to cover all aspects of the disorder. European Reference Networks for rare diseases supported by the European Union have been established to face such challenges. This is rapidly becoming the era of narrow specialization, multidisciplinary approach and European networking. It will not always be necessary for children to travel to centres in Europe to aid diagnosis and management; networks will function collaboratively allowing physicians to discuss cases in virtual meetings and receive advice from the highly specialized centres.

Supra-specialization has led to the concern that it will be impossible for a single physician to supply holistic care for a child and that PN as practiced in the past will disappear. This may become true for tertiary centres, however at secondary level PN specialists will still need to have a broad knowledge of both PN and Psychiatry – as practiced in the past in some countries. Some

pathologies, e.g. attention deficit disorders with or without hyperactivity or autistic spectrum disorders, are managed by Psychiatry in some countries, while in others PN specialists are the responsible physicians. It is of utmost importance that European PN Societies collaborate not only with other PN specialists, but also with other clinicians to improve multi-disciplinary care including: Paediatricians interested in the care for children with complex neurodisability, Neurophysiologists, Child Psychiatrists, Physiotherapists, Speech therapists, Sleep therapists, Neurologists, and Geneticists.

PN is a rapidly changing specialty. The 21st century has seen dramatic advances in our diagnostic capabilities with modern neuroimaging, metabolomics and neurogenetics. The mechanisms of complex neurological disease are being discovered and many new therapies developed. New technologies for children with neurodisability will open up many more opportunities to improve their quality of life. The dawn of the gene therapy era means the paediatric neurologist is at the centre of decision making for transformative treatments. The clinical practice of neuromuscular disease has changed dramatically within the last 5 years and similar changes are likely to come to other areas of Paediatric Neurology practice. It is our challenge to explain to medical students and young doctors, what we already know, that caring for children with neurological disorders is intellectually challenging, incredibly diverse and emotionally rewarding.

## 5. Conclusions and recommendations

1. Paediatric Neurology evolved both from Paediatrics and Neurology, and due to training requirements remains an inter-disciplinary (sub) specialty between these two mother specialties.
2. In Europe the official status of PN as a (sub) specialty still differs between countries, as does duration of training and routes to entering training.
3. Through Training Advisory Board (TAB) visits, the EPNS has helped and can continue to help national societies develop training programs and assist in their discussions with National Ministries of Health.
4. Many countries have developed their PN training curriculum in line with the EPNS PN syllabus including rotations in Paediatrics and adult Neurology. The duration of rotations should be a matter of further discussion.
5. The European PN syllabus should be the basis for the development of PN training in countries who want to further develop PN recommending a minimum of 5, but ideally 6 years training to become a PN specialist
6. The development of highly specialized care centres e.g. epilepsy surgery, neuromuscular disorders, metabolic medicine, sleep medicine has emphasized the need for a multidisciplinary approach.
7. Novel strategies for influencing the development of the specialty should be developed alongside systems for ensuring that training and assessment of competencies are standardised in Europe.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at

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