

## MISCELLANEOUS: Neuropathologist Training

**Neuropathology Training Worldwide—Evolution and Comparisons**

Marc R. Del Bigio<sup>1</sup>; Johannes A. Hainfellner<sup>2</sup>; Catriona A. McLean<sup>3</sup>; Suzanne Z. Powell<sup>4</sup>; Beata Sikorska<sup>5</sup>; Hitoshi Takahashi<sup>6</sup>; Joachim Weis<sup>7</sup>; John H. Xuereb<sup>8,9</sup>

<sup>1</sup> Department of Pathology, University of Manitoba, Winnipeg, Canada.

<sup>2</sup> Institute of Neurology, Medical University Vienna, Vienna, Austria.

<sup>3</sup> Anatomical Pathology Unit, The Alfred Hospital, Melbourne, Australia.

<sup>4</sup> Department of Pathology, The Methodist Hospital, Houston, TX.

<sup>5</sup> Medical University of Lodz, Lodz, Poland.

<sup>6</sup> Brain Research Institute, Niigata University, Niigata, Japan.

<sup>7</sup> Institut für Neuropathologie, Aachen, Germany.

<sup>8</sup> Department of Pathology, University of Cambridge; <sup>9</sup> Cambridge University Hospitals NHS Foundation Trust, Addenbrooke's Hospital, Cambridge, United Kingdom.

**Keywords**

history, medical education, medical specialization, pathology.

**Corresponding author:**

Marc R. Del Bigio, MD PhD FRCPC,  
Department of Pathology, University of  
Manitoba, 401 Brodie Centre, 715 McDermot  
Avenue, Winnipeg MB R3E 3P5, Canada  
(E-mail: [marc.delbigio@med.umanitoba.ca](mailto:marc.delbigio@med.umanitoba.ca))

Received 2 August 2013

Accepted 8 November 2013

Published Online Article Accepted 20  
November 2013

doi:10.1111/bpa.12104

**Abstract**

Training of neuropathologists varies worldwide. Systems range from highly organized specialist and subspecialist education with national certification, to regulated training with diploma recognition, to informal apprenticeships in neurological hospitals and no formal recognition. This overview compiles and summarizes the history of regulated training systems, the status of neuropathology within various countries' medical systems and the manner in which neuropathologists are trained. Anecdotal evidence suggests that countries with regulated systems of neuropathology training and an active professional organization are more likely to have an adequate supply of diagnostic specialists and a vibrant research community. The different training systems reflect the style of medical services delivery in the respective countries. In general, the existence of formal neuropathology training systems occurs only in countries with relatively high levels of per capita health expenditures, reflecting the development of medical specialization overall. Evolving diagnostic technologies and major international research endeavors, whose goals are to understand structure and function of the human brain, demand that neuropathology training is more than simply diagnostic histopathology.

**INTRODUCTION**

Enormous effort goes into the scientific investigation of neurological diseases and dissemination of the findings so that the information might eventually be used to improve the understanding of disease and the health of humans. Major international research initiatives are being developed to understand the workings of the human brain, one desired outcome of which will be the ability to diagnose brain disease earlier so that treatments can be started before the occurrence of irreversible damage. Within the new European Union (EU) program Horizon 2020, the Human Brain Project was selected in 2012 as one of two flagship research programs (73). In the United States (US), the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative was announced in 2013 (53). Detailed examinations of human brains and accurate disease diagnoses are required to develop and utilize the anticipated information. Currently, the definitive diagnosis of many neurological diseases remains dependent on direct examination of tissues obtained by biopsy or at autopsy. Hence,

there is a worldwide need for well-trained neuropathologists capable of making these diagnoses and communicating the findings in wording that can be widely understood (with inter-language translation if necessary). The purpose of this manuscript is to compare and contrast the modalities used for training neuropathologists in countries with formalized training systems. Specific competencies that should be acquired by neuropathologists-in-training are not considered here.

**HISTORICAL BACKGROUND**

An understanding of the current training of neuropathologists requires some appreciation of relevant history (49, 99). Neuropathology (NP) is the medical discipline concerned with the evaluation of tissues (and cerebrospinal fluid) for diagnosis and understanding pathogenesis of diseases of the central nervous system and its coverings, the peripheral nervous system, and the skeletal muscle. Following Rudolf Virchow's pioneering concepts of cellular pathology (95, 104, 113), the academic pursuit of NP in

the late 19th century arose mainly from the desire of neurologists and psychiatrists to better understand diseases of their patients (41). These pursuits were facilitated by the application of rapidly evolving neuroanatomical staining techniques [eg, Santiago Ramon y Cajal and others (46, 76)]. Special institutions dedicated to the study of the physiology, anatomy and pathology of the nervous system were founded in the late 19th century, first in Vienna (by Heinrich Obersteiner) and subsequently in other European centers, in the US, and in Japan. In the late 19th and early 20th centuries, more focused study of NP evolved rapidly particularly in Germany, Switzerland and Austria, as well as in England and France (3, 50, 99).

During the early 20th century, NP training was an informal apprenticeship structured largely by the (often multidisciplinary) interests of the trainee. Harvey Cushing and Wilder Penfield, both renowned neurosurgeons, were disciples of the renowned pathologist William Osler (33). Following training in a range of disciplines, Cushing along with Percival Bailey (also principally a neurosurgeon) devised the first histopathologic classification of brain tumors in 1926 (10, 81), while Penfield edited the first multiauthor textbook on NP in 1932 (25).

In the mid-20th century, with the advancement of medical knowledge and technologies NP became less and less a hobby of neurological clinicians. As the infrastructure needs (eg, tissue processing, autopsy facilities, microscopy) of neuropathologists converged with those of other pathology disciplines there was a tendency for practitioners to be housed together. In general, medical training was becoming more structured with the creation of oversight organizations. These forces gradually led to formalization of NP training, the structure of which differed considerably worldwide. The purposes of this manuscript are to describe the various systems for training neuropathologists worldwide, to identify common themes and challenges, and to suggest future needs.

## METHODS

In 2011, the lead author began acquiring information and documents from government and medical organizations responsible for the oversight of specialty medical training, and specifically NP training, worldwide; this information was revalidated in 2013. Published historical information concerning the development of NP was sought through structured searches of PubMed and GoogleScholar online databases. Simultaneously, individuals identified as leaders in their respective countries were contacted (the Society News section published in each issue of *Brain Pathology* and the website of the International Society for NP was one source for this information). Important factors in the training of neuropathologists were identified through in-person and e-mail discussions. A good resource for comparing general aspects of postgraduate medical education is the website of the Foundation for Advancement of International Medical Education and Research (FAIMER), Postgraduate Medical Education (PME) Project (<http://www.faimer.org/resources/pme/index.html>).

## NP TRAINING AS A PRIMARY MEDICAL SPECIALTY

Six countries [Austria, Canada, Germany, Ireland, Switzerland and United Kingdom (UK)] recognize NP as a primary specialty, that

is, a discipline of medicine sufficiently distinct that medical school graduates can enter the training programs directly. In these jurisdictions, highly structured paths of training are mandated and monitored by national organizations, most incorporating some form of competency-based training followed by standardized examination and mandatory continuing education after certification. The countries are considered in the temporal sequence that specialty recognition was achieved because some of the historical details and guidelines of training are similar (Table 1).

## Canada

The history of NP in Canada was described in detail in a recent publication (25). The Royal College of Physicians and Surgeons of Canada (RCPSC) was founded in 1929 to oversee postgraduate medical education. In 1946, certification in General Pathology was formally recognized. Beginning in 1960, the Canadian Association of Neuropathologists (CANP) began lobbying the RCPSC for recognition of NP as a primary specialty. The CANP argued that the knowledge base was distinct from that of general or anatomical (surgical) pathology and that comprehensive clinical skills could only be obtained through several years of focused training. In 1965, the RCPSC introduced eligibility for certification in NP with 5 years of training after medical school. Alternate training paths were an additional 2–3 years of training in NP after certification in pathology. Training sites were eligible only if they also had a residency-training program in anatomical pathology (AP) and there were stipulations on minimum number of autopsy and surgical cases; the guiding document was <2 pages length. The first Canadian certifying examination in the specialty of NP was administered in 1968 (25). Training requirements evolved gradually. The mandatory 6-month rotation in clinical neurology became optional in 1975. In 1976, a specialty committee on NP was established within the RCPSC to oversee training details. The oral examination was replaced by a practical examination in 1984. In the mid-1990s, the RCPSC began to consider core training in Laboratory Medicine but the concept was eventually discarded (102). Clinical neuroscience training was reestablished as mandatory in 1997. Practical oversight of residency programs in Canada was modified considerably with the 2000 introduction of CanMEDS, a framework of competencies organized around seven physician roles (38). Although the philosophical principles were accepted as sound, there were concerns about the work required for documentation and the difficulty teaching and assessing some of the competencies. The most serious threat to NP training in Canada was yet to come. In response to political and administrative pressures, combined with the perception that NP was not recognized as specialty elsewhere (124), in 2003 the RCPSC converted NP to a subspecialty of AP, effectively increasing the mandatory training period to 7 years. Until 2008, when the decision was overturned, not a single Canadian medical school graduate began NP training in Canada. During this period, two of the seven approved training centers closed (25). Following restoration of NP's specialty status, vitality returned to the system. In 2012, the RCPSC Committee on Specialties concluded that NP was functioning well as a specialty. Currently, training consists of 1-year clinical service including 6 months of neurosciences, 1 year of AP (autopsy, cytology, surgical pathology) and 3 years of core NP including elective periods. Following completion of training,

**Table 1.** Comparison of training to become neuropathologist in various national jurisdictions (data for 2013). Abbreviations: NP = neuropathology; RCPSC = Royal College of Physicians and Surgeons of Canada; FMH = Fédération des Médecins Helvétiques; SIWF = Schweizerisches Institut für ärztliche Weiter- und Fortbildung; ISFM = Institut Suisse pour la formation médicale postgraduée et continue; Euro-CNS = European Confederation of Neuropathological Societies; AP = anatomical pathology; ACGME = Accreditation Council for Graduate Medical Education; CMKP = Center of Postgraduate Medical Education; GP = general pathology; N/A = not applicable.

Country	Population (millions)*	Annual health expenditure per capita†	Status of neuropathology discipline‡	Total years of training (years of NP training)§	Clinical neurosciences	Number of training sites	Written exam	Practical exam	Language	Oversight organization	Professional society (year established)
Canada	34	5200	Specialty (since 1965)	5 (3)	Yes (6 months in first year)	5	Yes	Yes	English/French	RCPSC	Canadian Association of Neuropathologists (1960)
Germany	82	4700	Specialty (since 1985)	6 (4)	Optional	27	Yes	Oral	German	German Medical Association	German Society of Neuroanatomy and Neuroanatomy (1950)
Austria	8	5000	Specialty (since 1994)	6 (4)	Yes	3	Yes	Oral	German	Austrian Medical Chamber	Austrian Society of Neuroanatomy (1956)
Ireland	5	4200	Specialty (since 2005)	5 (3)	Optional in final year	2	Yes	Yes	English	The Irish Medical Council, through the Royal College of Physicians in Ireland and the National Training Body for Histopathology and Neuropathology	Irish Neuropathological Association (1997)
Switzerland	8	7800	Specialty (since 2007)	5 (3)	Optional	3	Yes	Yes	German/French	FMH/SIWF/ISFM	Swiss Society of Neuropathology
United Kingdom	63	3500	Specialty (since 2011)	6 (4)	Yes	12	Yes	Yes	English	The General Medical Council, through the Royal College of Pathologists and Lead Dean for Histopathology and Neuropathology	British Neuropathological Society (1950)
European Union	504	3400	European Fellow in Neuropathology exam	5 (3)	Yes		Yes	Yes	English	Euro-CNS	Euro-CNS (1993)
United States	312	8400	Subspecialty of AP (certification with exam since 1948)	4–6 (2)	No	35	Yes	Yes	English	ACGME oversees training; the American Board of Pathology oversees the examination and certification	American Association of Neuropathologists (1930)
Finland	5	3900	Subspecialty of Pathology	7 (2)	No	N/A	Yes	Yes	Finnish	Ministry of Education	Scandinavian Neuropathological Society (1965)
France	65	4700	Subspecialty of Anatomical Pathology or Neurology (Diploma with exam)	6 (2)	Yes	16	Yes	Yes	French	Ministry of Health	Société Française de Neuropathologie (1965)
Poland	38	900	Subspecialty of Pathology, Neurology or Neurosurgery	8 (3)	Yes	2	Yes	Yes	Polish	CMKP	Polish Association of Neuropathologists (1964)
Australia / New Zealand	27	4700	Subspecialty of AP GP	6 (1)	No	5	Yes	Yes	English	Royal College of Pathologists of Australasia	Australian and New Zealand Society for Neuropathology (1979)
India	1241	50	Subspecialty of AP (Post Doctoral Certificate Course)	3–4 (1)		1				Indian College of Pathologists	Japanese Society of Neuropathology (1966)
Japan	128	4100	Subspecialty of AP, Neurology, Neurosurgery—no formal recognition	Variable after primary specialty							Neuropathology Groups in the Neurology and Pathology Societies of the Chinese Medical Association
China	1344	200	Subspecialty of AP—no formal recognition	Variable after primary specialty							Sociedade Brasileira de Patologia
Brazil	197	1000	Subspecialty of AP—no formal recognition	4–6 (1–3) informal apprenticeship							
Russia	142	500	Subspecialty of AP—no formal recognition	2 years of “ordinatura” and 3 years of PhD research studies							

\*Population data reported for 2011 by the World Bank (see <http://www.worldbank.org/>).

†Health expenditure data reported in \$US, rounded to nearest \$100 for 2010 by the World Bank (see <http://www.worldbank.org/>).

‡Specialty denotes a free-standing discipline in which training can be started directly following medical school. Subspecialty denotes a discipline that depends on primary certification in another discipline, typically AP or clinical/general pathology, or less often neurology.

§The total years denotes the minimum duration of training including, for example, general medicine, clinical neurosciences, anatomical/surgical pathology or general/clinical pathology, and NP.

candidates are eligible to write the 2-day examination, which consists of short answer and multiple-choice questions and practical material (glass slides and images including digital microscopy). It is likely that a structured oral examination component will be reinstated in 2015. CanMEDS guidelines will be revised in 2015 and training milestones will be introduced in the following few years.

### Germany

It can be argued that the roots of modern pathology arose in German-speaking European countries (26). The rich history of NP in Germany is well documented (6, 94). The Vereinigung Deutscher Neuropathologen (Association of German Neuropathologists) was founded in 1950 (114). This group initially advocated for the integration of NP into pathology institutes, in part to avoid isolation from other pathology specialties (7). In 1975, the association was renamed as Deutsche Gesellschaft für Neuropathologie und Neuroanatomie (DGNN—German Society of Neuropathology and Neuroanatomy). There are currently 21 independent university departments of NP in Germany as well as six divisions of NP associated with departments of pathology. Oversight of medical specialty training is through the Bundesärztekammer (German Medical Chamber) and the specific guidelines for training neuropathologists are created by the Qualification and Training Committee of the DGNN and passed by the DGNN general assembly. Beginning in 1966, representatives of the DGNN began lobbying for a specialist route of training. Initial proposals included the possibility of entering NP by way of neurology or psychiatry (94). In 1976, the Bundesärztekammer introduced a framework of NP training as a subspecialty of pathology, which included 3 years in pathology and 2 years in NP. Subsequently, the NP community sought to define NP as a discipline in its own right (93). After years of opposition from the German Society of Pathology and with the support of the German Societies of Neurosurgery and Neurology, NP achieved primary specialty recognition in 1985 (106). The current training curriculum includes 2 years of training in a “common trunk” that includes pathology and 4 years of training in NP of which up to 1 year can be neurosurgery, neurology, pediatric neurology, neuroradiology and/or psychiatry. In 2012, the Bundesärztekammer officially adopted a modification of the CanMEDS framework as a template for defining postgraduate training competencies (13).

### Austria

The clinical neurosciences as an interaction between psychiatry, neurology, pathology and anatomy/physiology began to develop in Austria during the late 18th century (55, 109). The Institute of Neurology was founded in Vienna in 1882 by the neurologist Heinrich Obersteiner as the world’s first interdisciplinary university institution exclusively dedicated to the investigation of structure, function and diseases of the human nervous system (55, 64). Franz Seitelberger, a neurologist and neuropathologist, oversaw considerable postwar rebuilding as director from 1959 to 1987. In 1961, he was the founding editor of the international journal, *Acta Neuropathologica* (56). The Austrian Association of Neuropathology was organized in 1956 (108). Leaders in the community believed that the best way to ensure quality of the diagnostic

discipline was to train individuals as primary specialists with some degree of independence from pathology. NP thereby was an equal partner with neurology and neurosurgery in the development of interdisciplinary clinical neuroscience centers at the medical universities. The Austrian Medical Chamber enacted specialty training guidelines in 1994. Current minimum training requirements consist of 6 months in histopathology, 18 months in clinical neuroscience and 4 years in diagnostic NP. At the end of the competence-based (knowledge, skills, experience) training curriculum, candidates are assessed by means of structured oral exam and a practical slide exam. A committee of three examiners is nominated from the Austrian Medical Chamber. As elsewhere, competency-based training concepts are evolving. A new modular system that comprises a core module of basic competences and additional optional modules of special competences (eg, clinical neurochemistry) will be implemented within the next years. Currently, there are three training sites (Vienna, Graz, Linz) with the mandated minimum of two board certified specialists. Only the largest center in Vienna has the capacity to teach all aspects of diagnostic NP; it furthermore houses central referral laboratories that focus on neurochemical, molecular and genetic aspects of neurologic disease as well as large brain and tissue bank for teaching and research purposes (eg, MedUni Vienna neurobiobank).

### Ireland

Through the Faculty of Pathology and the Irish Committee on Higher Medical Training (ICHMT; Royal College of Physicians of Ireland), NP training has been offered as a specialty since 2005. Two years of Basic Specialist Training (BST) in histopathology is the first step followed by a 3-year competency-based curriculum in NP at the Higher Specialist Training (HST) level. The community of neuropathologists in Ireland is small with training programs in two cities (Dublin, Cork) (Michael Farrell, pers. comm.).

### Switzerland

Following the lead of Germany and Austria, neuropathologists in Switzerland began to advocate for specialty recognition in the 1990s. The goals were to protect those who entered the training, and to increase the interest in diagnostic NP. In 2007, the Fédération des Médecins Helvetica (FMH) officially launched NP training programs in Zurich, Basel and Geneva. Other locations are being considered (Elisabeth Rushing and Adriano Aguzzi, pers. comm.). The training consists of 3 years of clinical NP, 1 year of clinical pathology and 1 year of another clinical neuroscience or research. The training guidelines have adopted CanMEDS principles.

### UK

The history of NP in the UK is well documented (3, 40, 112). Organization of medical services under the National Health Service Act of 1947 led to the establishment of specialty posts in NP at large centers in the UK, typically focused on a neurosurgical service (78). The regional centers provided a framework for the clinical services, as well as for teaching, training and research (3). In 1950, J. Godwin Greenfield established the Neuropathological Club, which in 1962 came to be known as the British

Neuropathological Society (3, 40). In the same year, the College of Pathologists was founded. Some individuals, including the neuropathologist William McMenemey, argued against the formation of a separate college of pathologists, citing the dangers of a fragmented medical profession and the homogenization of NP training (79) (77). The College, which received Royal Charter in 1970, has responsibility for training curricula and assessments in histopathology and other laboratory specialties (118, 123). One of the consequences was the specific alignment of NP as a subspecialty of histopathology and abandonment of neurology as an entry point.

In a 1967 survey, Marion Smith identified a shortage of neuropathologists in Great Britain. She attributed this in part to the protracted training duration, with 5 years of general pathology mandated prior to an additional 2–3 years of NP training. She also noted that a lack of clinical neurology was “the most frequent regret as to a deficiency in their own training,” particularly in relation to neurological postmortem studies (111). Concern about the training of neuropathologists persisted for decades. In 2001, Jennian Geddes wrote “the demands of modern training curricula now make it difficult for those without a background in general pathology to enter the specialty. This is likely to favour the assimilation of clinical NP into general pathology in the UK, with the neuropathologist inevitably being replaced by a general pathologist ‘with an interest in’ NP at some centres” (40). In June 2004, the Royal College of Pathologists and Department of Health (England) launched a scheme to help ameliorate the consultant workforce crisis in NP; this would allow selected histopathologists to undertake a “Conversion Fellowship” of abbreviated education and training. Consensus was finally reached that the conduct of NP training as a subspecialty of histopathology was no longer tenable. In 2010, the Royal College of Pathologists and the British Neuropathological Society jointly submitted an application to the Department of Health requesting establishment of a specialty in Diagnostic Neuropathology. The arguments for this change were very similar to those used successfully in Canada and Germany (eg, NP has its own defined competences; the lengthy two-step training deters applicants and is wasteful; specialty status would allow entry of trainees from neurology and neurosurgery; NP is an emerging parent to new subspecialties). In 2011, NP was granted specialty status. The minimum training requirements are 1 year in histopathology, 1 year in clinical neuroscience and 3 years in diagnostic NP. This is essentially identical to the curriculum in Canada. Candidates are eligible to write the Euro-CNS (European Confederation of Neuropathological Societies) examination (see below). Staged competences, outlined using standards of the then Postgraduate Medical Education and Training Board (PMETB), now subsumed within the General Medical Council (GMC), are defined in the training documents ([http://www.gmc-uk.org/Curriculum\\_Diagnostic\\_Neuropathology.pdf\\_51121493.pdf](http://www.gmc-uk.org/Curriculum_Diagnostic_Neuropathology.pdf_51121493.pdf)).

## EU

The European Union of Medical Specialists (UEMS) was founded in 1958 to deal with various matters including quality of specialty training. Pathology, which was broadly defined in 1962, was divided in 1988 into separate sections including anatomic pathology. The European Board of Pathology (EBP) was established in 1992, followed by the European Association of Pathology Chairs

and Residency Programme Directors in 2005. Committees have been created to address harmonization of training, to establish general and specialty-specific competencies, to assess the feasibility of European exit examinations, and to examine the conflict between general and subspecialty competencies in pathology (103, 125). The EBP has acknowledged that the regulatory status of NP differs between countries (ie, specialty vs. subspecialty). In 2011, the EBP agreed upon requirements for a 5-year postgraduate pathology-training curriculum, with a 3- to 4-year trunk leading to subspecialization (120). Alarming, the architects wrote, “Training in so-called areas of interests [including neuropathology] can cover the remaining 12–24 months” and “Following this structure, isolated specialization in parts of pathology such as . . . neuropathology (UK) can be avoided” (119). We must emphasize that these statements reflect the view of general pathologists who are concerned about the integrity of their discipline, but not the view of European neuropathologists and clinical neuroscientists.

The Euro-CNS was established in 1993 to facilitate the development and harmonization of NP across the EU. In 2006, Mikol and Weller reviewed the status of NP in European countries (83). They reported that this ranged from an officially recognized specialty or subspecialty, to the absence of official recognition. In their consideration of challenges, they advised renewed efforts to gain official recognition for NP “in as many countries as possible,” following the 2004 rejection of specialty status by the UEMS EBP. Their publication documents some of the political aspects of this struggle and the importance of attracting trainees with backgrounds in clinical neurosciences. The curriculum for the European Fellowship in Neuropathology (EFN), adopted in 2011, is a modification of that used for the recently approved specialty training in NP developed in the UK (see <http://www.euro-cns.org/examefn/examination/>). Eligibility for the examination includes 5 years of supervised training including 1 year in histopathology, 1 year in clinical neuroscience (clinical neurology or neurosurgery, either adult or pediatric), and 3 years in diagnostic NP, as well as documented experience with a specified minimum number of autopsy brains and spinal cords, neurosurgical biopsy specimens, skeletal muscle biopsies, peripheral nerve biopsies and cerebrospinal fluid cytological preparations. Note that this is essentially the same as the national requirements where NP is recognized as a specialty, although need for enumeration of cases is not unanimous. Although Euro-CNS guidelines do not override member country regulations, ultimately this broad agreement overcomes some of the problems seen in neurology training, wherein there is considerable variation across Europe (115). Euro-CNS has also established a set of continuing medical education courses that cover many areas of NP and are designed to enhance training and raise standards in NP.

## NP TRAINING AS A MEDICAL SUBSPECIALTY

Many countries officially recognize NP as a subspecialty, usually of AP (histopathology) and less often of neurology or neurosurgery. In this circumstance, training (and usually certification) in the primary specialty must precede structured training in NP. Several populous countries and many smaller countries generally consider NP to be a subspecialty of AP, but do not formally recognize its status and lack structured training programs (Table 1).

## US

Although not the birthplace of NP, the US has become the most prolific breeding ground for neuropathologists. The Neuropathology Club, a group for sharing interesting cases, started in 1925 and it gave rise to the American Association of Neuropathologists (AANP), which was founded in 1930 (48, 49). In the US, NP training is a mandatory subspecialty of AP. The American Board of Pathology (ABP), a branch of the American Board of Medical Specialties (ABMS), was established in 1936 and is responsible for evaluation and certification of pathologists. ABP certification examinations in NP began in 1948 (30). According to Harry Zimmerman, in the 1950s NP training efforts were often lost on people who subsequently became neurologists or neurosurgeons. He and others decided that the best way to ensure a lasting commitment to NP was to demand prior training in laboratory medicine; they did not view this as a divorce from the clinical neurosciences (136). Abner Wolf wrote in 1954, “neuropathology is a branch of general pathology and should be rooted in it,” although he did not think that complete general pathology training was necessary because of the time needed (131). Lester King suggested that 3–6 months of study in the basic neurosciences during a general pathology residency was sufficient (62). Nevertheless, for decades some leaders of the NP community including Armando Ferraro (34) expressed continued opposition to the separation of NP from neurology and psychiatry. In 1964, Orville Bailey advocated for a background in clinical neurology and general pathology with “at least two years of special training in neuropathology” (9). Martin Netsky wrote in 1965, “It is unfortunate that the American Board of Pathology, although a relatively enlightened group among the certifiers, has taken on itself the accreditation of neuropathologists, because they represent their specialty, and not neurology or the combined field” (85). Because of the practical impossibility of fully staffing all centers with neuropathologists, Kepes and Burger advocated for a balance, “the general pathologist takes part in diagnosing neuropathologic specimens, particularly where no neuropathologist is available . . . neuropathologists will, and should, remain in the forefront of perfecting diagnostic procedures and advancing knowledge in neuropathology” (61).

Training of neuropathologists in the US remained for some time a very local issue. In 1964, there were 16 programs that offered 1–4 years of training, mainly to individuals from pathology backgrounds (132). When Netsky surveyed nine training programs in 1976, he observed “an enormous diversity of methods used to achieve a common goal—the training of a neuropathologist.” He was concerned that the “lack of knowledge of clinical [neurological] problems is a defect in the training of some neuropathologists.” At that time, the programs expected 1–2 years of training in general pathology plus 2 years in neuropathology. Seven directors opined that trainees should be “able to take an examination in neuropathology alone” (86). Unification of agencies responsible for graduate medical education began in 1972 and the Accreditation Council for Graduate Medical Education (ACGME) was created in 1981. This led to standardization of training requirements across the country. Currently, 4-year AP/NP (2 years each) programs are most commonly offered, with eligibility for the NP examination only after certification in AP. Other options include: (i) a 3-year AP residency with a subsequent 2-year

NP fellowship; (ii) a triple fellowship in AP, clinical pathology and NP (2 years each); or (iii) entry from neurology or neurosurgery with 1 year of supplemental training in AP and 2 years in NP (4). Hence, NP training in the US can take 4–6 years. Training requirements are in accordance with the competencies defined by the ACGME, which also provides oversight of training. Certification and examination are governed by the ABP. With respect to organ-related competencies, there is a greater expectation of knowledge about ophthalmic pathology than in most other countries. The current challenge for the providers of NP training in the US is refinement of the assessment tools to include specific milestone indicators within the competencies.

## Poland

Foundations for the development of the discipline of NP in Poland were laid with the establishment of the Department of Neuropathology in the Polish Academy of Sciences in 1954. In 1964, the Polish Association of Neuropathologists (PANP) was founded and the periodical journal, *Neuropatologia Polska* (now *Folia Neuropathologica*), was launched (90). The PANP lobbied the Medical Centre of Postgraduate Education, and in 1973 NP became a separate medical subspecialty, followed in 1976 with a change in status to second-grade specialty. NP remains a subspecialty that a trainee may begin only after 5 years of training in general pathology, neurology or neurosurgery. The Center of Postgraduate Medical Education (CMKP) approved a 3-year NP curriculum in 2004. Accredited training occurs at two of the four academic centers with NP activities. Training culminates in a final written, oral and practical examination. At least two neuropathologists are needed to have an accredited training site. The lengthy training duration has been a major hindrance to recruitment of trainees, consequently Poland is lacking in subspecialty areas like muscle pathology. Plans are underway to convert NP to a specialty with a 5-year training program; however, there are concerns about the earning potential of fully specialized neuropathologists.

## France

Critical developments in the clinical neurosciences occurred in France in the 1800s to mid-1900s under the leadership of luminaries such as Jean-Martin Charcot and Paul Broca (15, 16). Perhaps in part because of the preeminent status of clinical neurology, diagnostic NP has been institutionalized under AP since the 1950s (18). NP is recognized as a subspecialty in France. Following residency training in AP or neurology, the Société Française de Neuropathologie (SFNP) offers educational opportunities leading to the *Diplôme d'études spécialisées complémentaires* (DESC). This course, approved in 2002 by the Ministries of Health and Education, includes 2 years of didactic and practical training followed by written and practical examination. The diploma alone does not allow one to practice NP; this must take place within a pathology department (Charles Duyckaerts, pers. comm.).

## Italy

The history of NP research in Italy mirrors that in other European countries, but NP only became distinguished as diagnostic

discipline in the 1980s (105). The Italian Association of Neuropathology (now known as the Italian Association of Neuropathology and Clinical Neurobiology) was established in 1966 and the need to develop “neuropathology specialty schools” was identified by Macchi in 1981 (72). Within research domains, the discipline of NP is important, and centralized diagnostic laboratories are well established within neurological clinics. However, because NP is not recognized as a distinct clinical specialty, it has negligible profile in the undergraduate medical curriculum and diagnostic neuropathologists have become fewer (Marina Melone, pers. comm.).

## Spain

Despite being the homeland of among the most famous neurohistologists (eg, Santiago Ramon y Cajal, Pio del Rio Hortege), NP is not officially recognized as even a subspecialty in Spain. Specialty training in Pathologic Anatomy includes some teaching in tumor NP during the 4-year program. The full spectrum of NP is practiced in Spain by individuals who train at regional specialty centers (eg, in Madrid and Barcelona) or abroad. New trainees are encouraged to get certification through the Euro-CNS examination process (Isidro Ferrer, pers. comm.).

## Scandinavia

In Finland, pathology residency is 5 years followed by a national certification examination. NP is considered a subspecialty, which requires 2 years of training under guidance of a senior pathologist. At least three Euro-CNS courses must be attended and there is a national exam at the end of the training (Maria Gardberg, pers. comm.). NP is not officially recognized as a subspecialty in Sweden, Norway or Denmark. Trainees undertake informal apprenticeships with senior neuropathologists supplemented by Euro-CNS courses (Eva Løbner Lund, pers. comm.).

## Russia

In Russia, the term “neuropathologist” describes physicians who elsewhere are called neurologists. The term “neuromorphologist” may include pathologists who study the nervous system or anatomical researchers (66). Pathology training consists of a 2-year “ordinatura” regulated by the Ministry of Health. Some have declared that the training is of inconsistent quality and in need of standardization (54, 137). Research-oriented neuroscience training may follow the ordinatura, but NP is not a formally recognized specialty and only a small number of medical institutes in Russia have individuals working primarily in NP (Andrey Korshunov, pers. comm.).

## Australia and New Zealand

Oliver Latham established a NP laboratory in Sydney in 1908, and his work provided the foundations for NP in Australia (37, 51). However, there was little collaboration between neurosurgeons and pathologists for decades (110) and there was no formal training program. In 1973, the shortage of neuropathologists in Australia was lamented; it was suggested that the resistance lay with the general pathologists (27, 28). The Royal College of Pathologists of

Australasia (RCPA) has been responsible for the training oversight and professional development of pathologists since 1956. In 1979, during the Annual Meeting of the RCPA, pathologists interested in NP formed the Australian and New Zealand Society for Neuropathology (ANZSNP). During the 1990s, the RCPA ran a subspecialty option where training in NP was taken in addition to AP, extending the training program from 5 to 6 years. There is an expectation that all AP fellows can diagnose brain tumors, vasculitis, basic neurodegenerative diseases and basic muscle pathology. The RCPA had adopted Core CanMEDS objectives for AP; however, a modified competency structure was created in 2010. In the same year, the RCPA formalized a 1-year post-Fellowship Diploma in Neuropathology (Dip. Neuropath) for fellows who have completed a 5-year fellowship in AP, forensic pathology or general pathology. The additional training concentrates on more advanced and rare brain, nerve, and muscle disorders. Assessment includes a submitted portfolio, a structured oral examination and a practical slide examination. In practice, the portfolio requirements, which are based on the UK requirements, typically take 1–2 years or more to fulfill. Some in the community have expressed interest in establishing specialty level training (31); however, the vast majority favors the current system because it already meets stringent guidelines and because there are very few pure NP positions funded by the Australian state governments.

## Japan

Japan adopted a German-style medical system in the mid-1800s and until the 1950s psychiatrists drove most neuropathological research, after which time NP began to converge with histopathology. The Japanese Society of Neuropathology (JSN) was established in 1966 (74). This vibrant research society has over 1200 members. Postgraduate medical education in Japan was reformed extensively in 2004 {Teo, 2007 #19696}. The Japanese Board of Medical Specialties oversees medical specialty residencies including a 5-year course of training in AP, which leads to board certification by the Japanese Society of Pathology (63, 89). However, there is no specific residency or certification for clinical NP and consequently it is difficult to train young neuropathologists. Although many train in other countries, especially the US, UK, and Germany, a limited number of Japanese doctors are specialized in NP. Without sufficient numbers it is difficult to establish a specialist training system. Japanese neurology programs suffer from significant variability despite the creation of guidelines, in part due to small numbers of faculty in the university hospitals (88). Members of the JSN are currently discussing improvement of the specialist system of NP. Some neuropathologists in Japan believe that formal recognition of NP as a subspecialty of general pathology would improve the situation. Most academic neuropathologists are affiliated with neuroscience institutes, and are not always well associated with the Japanese Society of Pathology. In some cases, trainees return to clinical practice but continue to provide brain tumor pathology diagnoses because there is no law that limits doctors to specific areas of diagnostics in Japan.

## China

In the early to mid-1900s, the few practicing neuropathologists working in China had trained in Germany or England (52). The

academic pursuits of neuropathologists were interrupted by political circumstances from 1967 to 1976. Thereafter, pathologists interested in brain diseases again began to train abroad and within China through local apprenticeships (133). In Hong Kong during the 1970s and 1980s, pathologists with aspirations to NP trained in the UK. The first Hong Kong College of Pathologists examination in NP was offered in 1997; however, the broader community of pathologists did not readily accept NP as a specialty discipline (87). Typically, postgraduate training in pathology had consisted of a 2- to 3-year research-oriented graduate degree followed by a 2- to 3-year residency and transition into a faculty position without examination. This training was often poorly regulated (128). In 2012, a 3-year standardized training curriculum for residents in clinical pathology was initiated (<http://www.moh.gov.cn/zhuzhan/zqyj/201306/0216517e893a44a8bda852990d7128a7.shtml>), but there is no formal NP residency (F. William Orr and Ho-Keung Ng, pers. comm.). Currently in China, neurologists or pathologists with additional specialized NP training practice NP. Clinicopathological conferences are an important platform for education of young neuropathologists and special courses are offered by some hospitals and societies (135). Experience with brain tumors is considerable in China, particularly in the neurosurgical centers. The Neurology Branch of the Chinese Medical Association has numerous working groups, including ones devoted to NP, cerebrospinal fluid (CSF) cytology and neuromuscular disease (128). Unfortunately, the low rate of autopsies in China (134) and the relatively low research productivity in pathology (65) are two factors that could inhibit the training of neuropathologists as it is done in Europe and North America.

## India

Following medical school, 3 years of training in AP and autopsy permits trainees to write the nationwide exam for Anatomic/Histopathology (Diplomate of National Board Examination in Pathology). In addition, many postgraduate medical colleges conduct their own examination after 3 years and award degrees. Unfortunately, there is a wide variation in the quality of pathology training across India (12). There is no formal recognition of NP in India and therefore few people have a true specialty practice. One wrote, “due to faulty policy and lack of job opportunities, the field of [diagnostic] neuropathology had a stunted growth” (22). Individuals working as neuropathologists in some of the large neurological centers typically had fellowship training abroad (especially the UK and Germany). Most have good diagnostic capability with respect to tumors and there are referral centers in New Delhi, Bangalore and Chandigarh. The National Institute of Mental Health and Neuro Sciences in Bangalore has had a Post Doctoral Fellowship in NP for ~10 years. Training is not broad, however, because materials from suspected neurodegenerative and neurometabolic disorders are often sent abroad. For 10–15 years, there have been discussions about the formalization of training; however, given the small number of full-time neuropathologists these efforts have not yet been fruitful (S.K. Shankar, pers. comm.).

## Saudi Arabia

In the past decade, many individuals trained at North American NP centers have returned to Saudi Arabia. The RCPSC has worked

extensively with the Saudi Commission on Health Specialties to facilitate the development of standards in postgraduate medical education including CanMEDS competencies for residency training in some large disciplines (91). The potential value of establishing NP training in Saudi Arabia was discussed recently (31). However, because of the paucity of autopsies, either training restricted to surgical NP or collaboration with other countries (where most of the neuropathologists in Saudi Arabia trained) would be necessary. There is no formal move toward this development (Hindi Al-Hindi and Ali Assiri, pers. comm.).

## South and Central America

In Brazil, NP is considered to be subspecialty of AP. The oversight body for the 3-year AP residency is the Comissão Nacional de Residência Médica. Most neuropathologists in Brazil (~15) are general or anatomic pathologists who became interested in NP and either went abroad for further training (typically 1–3 years), worked with experienced neuropathologists in Brazil, or got their own experience by examining or studying neuropathological cases. There is no formal examination or recognition of completed NP training (Leila Chimelli and Myriam Dumas Hahn, pers. comm.).

In Mexico, an official NP training program was approved by the National University of Mexico (UNAM) in 1990. Following 3 years of pathology training and certification by the Consejo Mexicano de Médicos Anatomopatólogos, residents may apply for the 2-year NP residency program, offered only at the Hospital General de México. Three months of the training is spent in a different hospital, in Mexico or abroad. The theoretical and practical examination is validated through the UNAM. Currently, ~13 neuropathologists in Mexico have the diploma issued by UNAM (Laura Chávez Macías, pers. comm.).

## DISCUSSION

Several important points and recurring themes can be appreciated from the above survey:

(i) History and economics are important in the recognition of the NP discipline. Formalized training in NP occurs in countries with long histories of neuropathological research, especially those where an appreciation of autopsies spread from Europe in the late 1800s. The countries with codified training and defined oversight organizations are ones with greater wealth and greater per capita expenditures on health services, and not necessarily ones with large populations. With the exception of Poland, all countries that formally recognize NP as a medical specialty or subspecialty had annual per capita spending of >\$US3500 (in 2010; see Table 1). The ratio of public to private expenditure on health did not correlate with the existence of formal training systems (eg, UK 84% public to US 53% public). Countries with high expenditures that do not have formal training systems are typically less populous European countries that participate in the Euro-CNS. Some anomalies are apparent. Italy and Spain are populous and have per capita expenditures only slightly lower than that of the UK, but lack organized training. Japan is perhaps most surprising with considerable wealth, population and NP research, but no national training system. It seems that dedicated individuals willing to



pressure the national organizations are the key to getting recognition. Following that, maintaining a credible quality oversight body is absolutely necessary.

(ii) The recognition of NP as a specialty or subspecialty is important in some countries but not others. In jurisdictions where NP is recognized as a specialty, the underlying necessary body of knowledge is considered to overlap but be distinct from that used by anatomical pathologists. History shows that academic interests in autopsy NP arose from neurology and psychiatry in the late 1800s while brain tumor diagnostics were driven by neurosurgical needs in the early 1900s. Shared infrastructure provided the later impetus for convergence of NP and other facets of pathology. While it makes sense that most jurisdictions insist NP training take place only in centers with approved AP training programs, this does not inherently define NP as a subspecialty of AP. Contributors from many countries have noted the difficulty training and sustaining sufficient numbers of neuropathologists when lengthy training in AP is mandated prior to NP training. In these situations, national recognition as a specialty seems critical to solving the problem. The experiences in Canada are instructive; NP and AP were simultaneously identified as distinct specialties by the RCPSC in 1965, but when political expediency forced NP into a subspecialty status from 2003 to 2008 trainee enrollment plummeted.

This leads to the matter of predicting workloads and job opportunities. The training networks should be cognizant of the national needs for neuropathologists. Generation of too few, or inadequately trained, neuropathologists fail to meet societal needs. Generation of too many neuropathologists fail to meet needs of the “surplus” individuals. In 2012–2013, only 58% (42/72) of ACGME-approved NP fellowship positions were filled (98). It is not clear if there are too few trainees or too many positions in the US. Detailed analyses in the US have been designed to predict pathology (98), neurology (21, 39) and neurosurgery (100) workforce needs; their validity remains uncertain. Survey data in Canada suggested that replacement neuropathologists would be needed to make up for two to three retirements per year (24). A NP workforce survey conducted by the CANP in 2011 suggested that one full-time neuropathologist is needed for every ~660 000 population in the current conditions of practice in Canada (Del Bigio *et al*, unpub. obs.).

Global economics and culture are undoubtedly important. In the countries described above, there is considerable variation in the job market. In Australia and the US, most of the positions advertised demand both AP and NP expertise; therefore, a pure NP specialty training stream is not necessary. Furthermore, in the US the mandated training for AP/NP is a reasonable 4–5 years. Developing countries that lack neurosurgeons to remove brain tumors (8) have little need for neuropathologists. Similarly, places where autopsies are rare for fiscal or cultural reasons have no need for neuropathologists to examine whole brains. Hence, spreading formal NP training worldwide is a rather unrealistic goal. The Outreach Program of the International Society of Neuropathology already recognizes that focused education rather than comprehensive training can benefit many regions (42). The minimum need of anatomical/surgical pathologists who provide service in neurosurgical centers is the ability to diagnose brain tumors according to the current WHO (World Health Organization) classification. This ability, however, does not make them neuropathologists. Although we are not far from inclusion of molecular and genetic details as a

diagnostic adjunct (68), it will remain important to retain grounding in morphology to allow pathologists in disadvantaged regions to provide basic neuropathological diagnoses.

(iii) Training content, duration, and organization demand national oversight. The mandated duration of training in core NP ranges from 2 to 4 years in the countries with formalized training. This ensures exposure to sufficient material and time to develop a knowledge, skill and experience base. An apparent exception is in Australasia where officially a 1-year course leads to a diploma in NP; however, as described above the real training period typically approaches 2 years. Not surprisingly, where training curricula are defined, the content is almost identical with only minor variations across jurisdictions. Some demand categorical enumeration of cases studied while others only demand that competency can be achieved through active participation in evaluation of current specimens. It should be noted that excessive reliance on archival material is suboptimal. Some countries set the minimum number of teaching neuropathologists at each site. Although two may be allowable, most centers have more and it can be argued that three or more mentors are desirable in order to provide a varied learning experience (rather than an apprenticeship) and to ensure that the sometimes onerous training regulations can be met. An opportunity for exposure to rare entities through courses or external rotations at larger or specialized facilities is necessary to ensure comprehensive training. At local, national and supranational levels, a cadre of dedicated individuals are needed to avoid stagnancy in the system. Sharing of resources by training centers helps standardize training and make up for local deficiencies, for example, through development of practice examinations such as the Neuropathology fellow In-Service Examination (NPISSE) (97) or web-based lecture series (eg, developed by Julia Keith in Canada). Online education is becoming more and more popular in many fields of study (59, 107); there is no reason why the international NP community could not develop useful educational tools.

(iv) Competency-based training is evolving. In the mid-1990s, the principle of competency-based medical training was envisaged and has since gained wide acceptance (70). National organizations have defined their core competencies slightly differently, but they are conceptual equals. CanMEDS, adopted by the RCPSC in 1996, defines the core competency as medical expert, with contributing competencies of scholar, professional, communicator, collaborator, manager and health advocate (1, 38). The ACGME in 1999 defined six general competency domains as patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice (116). The GMC (UK) describes seven competences including good clinical care, maintaining good medical practice, relationships with patients, working with colleagues, teaching and training, probity, and health. General and NP-specific competencies across jurisdictions have remarkable similarities whether systems were created in parallel or adapted. One of the key features is ongoing and specific evaluation of each of the competencies during training. Most agree that the concept is sound, but implementation has not been entirely easy for a variety of reasons, among them the time required to meet the administrative demands and the difficulty evaluating some of the competencies (2, 36). Many have criticized that the psychometric tools used to assess competencies are inadequate (44, 71) and that

the guidance is vague (35). Medical education developers and administrators must develop systems that are practical, and avoid jargon that serves to confuse the users (both teachers/evaluators and trainees/learners). A survey of anesthesia program directors in the US indicated that the greatest source of stress arose from ACGME documentation and compliance matters (23).

The most important benefit of the educational formalities has been the standardization of NP training objectives (19). A (hopefully) positive step will be the development of “milestones,” which have been defined in the context of education as discreet observable behaviors that characterize each proficiency. In effect, steps needed to acquire the competencies are identified clearly (14). With conscientious design, milestones may be a means for predicting competence for independent practice (80). The Pathology Milestone Project is currently being developed in the US by the ACGME and the ABP and will soon be mapped onto NP training with implementation targeted for 2014 (84).

Trainee selection is a facet of medical education that must also be considered. Is it possible to identify attributes that will enhance competencies in NP? There are no objective studies specifically on the subject. In Canada, neuropathologists who are academically productive are more likely to have had prior formal research training in a neuroscience field (24). It is likely that this contributed to career selection. A few studies relate to selection of candidates for histopathology (AP) training. The author of a comprehensive review concluded, “there are insufficient data to justify the compulsory use of aptitude tests to select suitable candidates for histopathology training, although the employment of standard test of visuospatial reasoning and memory would probably act as satisfactory surrogate measures” (20). Structured interviews at a central location were used for histopathology candidates in the UK in 2009. The details of the interview process, and the advantages and disadvantages of the centralized matching of candidates and training centers have been published (57, 117). In the US, many NP fellowships are outside of the central match (11). In a 2006 survey, US pathology program directors perceived most important criteria for trainee selection to be: recommendation letters, “grades” in related electives and United States Medical Licensing Examination (USMLE) scores (43). However, there is no objective evidence that USMLE step 1 and 2 scores predict performance in clinical medicine residencies and their use for “selection decisions is discouraged” (75). A recent meta-analysis was conducted to determine selection strategies associated with future resident and doctor performance (in any discipline). The authors concluded that examination-based selection strategies are more predictive than subjective selection strategies (eg, reference letters). The subjective strategy with the strongest predictive value was the consensus committee ranking, which is a synthesis of many factors (60).

(v) The teachers must learn and change. As discussed above, training guidelines are typically developed in larger disciplines under test situations and then imposed broadly upon postgraduate medical educators including neuropathologists. NP, being a very small medical discipline, has little influence on the oversight agencies, so it is best to work with them constructively. In 1965, Martin Netsky, then president of the AANP, wrote, “we should be interested in experimenting scientifically with new methods of teaching. . . . The cardinal question should be, how does each student learn best?” He also wrote, “when second-rate

research is rewarded more than first-rate teaching, . . . , when publications and often only their proliferation become the measure of value, then something is wrong” (85). We should embrace his advice. Changes in the training of future medical specialists are demanded by changes in the practice of academic medicine, changing expectations of trainees, changes in information technologies, and the need to balance the art and science of the profession (32). Leaders of some large disciplines hold the opinion that formal education training is an asset for residency program directors (121), although this may not be practical in a small discipline like NP.

(vi) Future expectations. The main tool of the diagnostic neuropathologist is the light microscope. However, this is gradually changing with the inclusion of molecular criteria into brain tumor diagnostics (68) and genetic sequencing especially for neurodegenerative and neuromuscular disease (127). The time may come when excisional biopsies and autopsies play a role in the context of imaging, spectroscopy, genetic, proteomic and lipidomic analyses. Beyond histopathology training, we must ensure that prospective neuropathologists are capable of integrating new and complementary diagnostic information, for example, as a guide for personalized medical therapy.

There is a critical need for imparting a never-ending desire to learn and innovate (69, 122). Perhaps a greater focus on the value of research could do this. In 1960, Alfred Meyer reminded readers of the importance of fundamental advancements, suggesting that neuropathologists should acquire training in the basic translational and clinical sciences or be amenable to participation in a team (82). Many neuropathologists have formal research training prior to or concurrent with their clinical training. Surveys showed that 66% of Canadian neuropathologists have a graduate (MSc or PhD) degree (24); in 2010, 55% of AANP members had protected time for research (17). Gonatas suggested in 1982 that trainees seriously interested in combined diagnostic NP and research careers should take a minimum of 3 years in the basic translational or clinical sciences (129). More recent evidence indicates that formal clinician investigator training, with 2–3 years of mentored research during the residency or fellowship, generates academically successful personnel (29, 58). However, it remains unclear what research should be expected of the “regular” neuropathologist trainee. In 1954, Lester King opined, “The period of special training must avoid like the plague any thought of ‘writing a paper’. This besetting sin, that a young man who tries to learn something must also see his name in print, is the curse of modern education” (62). This was not a widely held opinion then, nor is it today. There are several good reasons to involve trainees in research: to improve the quality of medical care, to improve trainees’ understanding of the medical and scientific literature by contributing to it, and to attract future academicians (47, 92). A longitudinal study of internal medicine trainees showed those who published during residency were more likely to continue publishing after residency (96). In the right setting, diagnostic NP duties and tissue-based research may be of substantial mutual benefit (45). To facilitate research projects, several factors must be possible: trainee interest, available time for trainee, good mentors with adequate time to devote to the project, a curriculum for development of research skills, a formal resident project proposal review process, funding for the work and support for presentation at national or international conferences (130) (101).

At the very least, NP trainees should realize that enormous opportunities remain for research into brain function and disease. The NP discipline has benefitted from research endeavors that arose from the Human Genome Project and Decade of the Brain initiatives in the 1990s. Now we look forward to the Human Brain Project, the Human Connectome Project (126) and the BRAIN Initiative (53). Although primarily driven by imaging technologies, detailed morphologic studies are necessary to understand the non-invasive imaging. When in the next decade the technologies move to the level of human brain investigation, neuropathologists should be in a position to contribute. Perhaps there will even be a convergence of NP and psychiatry and healing of a schism that occurred a century ago for lack of the tools to detect abnormalities in the brains of persons with psychiatric illnesses (67). As noted in an essay in *The Economist*, “Doctors have found it convenient to distinguish between disorders of the mind . . . which leave no obvious anatomical trace, and disorders of the brain . . . which do. But this is surely a false distinction; it is merely that the anatomical traces of psychiatric disorders have not yet been found” (5). The next generation of neuropathologists should be on the forefront of these discoveries.

## ACKNOWLEDGMENTS

Marc Del Bigio chairs the Specialty Committee on Neuropathology for the Royal College of Physicians and Surgeons of Canada, and holds the Canada Research Chair in Developmental Neuropathology. Johannes Hainfellner serves at the Medical University of Vienna as Interim Director of the Institute of Neurology, as coordinator of the PhD Program Clinical Neurosciences (CLINS) and as coordinator of the MedUni Vienna Neurobiobank. JAH serves also as Chair of the Specialty Committee on Neuropathology for the Austrian Medical Chamber, serves as Editor-in-Chief of Clinical Neuropathology (the official publication of Euro-CNS) and as Euro-CNS vice president. Catriona McLean is Chair of the Pathology Board of Education at Monash University and director of the Australian Brain Bank Network. Suzanne Powell is Chair of the neuropathology fellowship program directors group at the AANP, Chair of the Residency Review Committee for Pathology of the ACGME, and Chair of the Residency Program Directors Section (PRODS) of the Association of Pathology Chairs. Hitoshi Takahashi is President of the Japanese Society of Neuropathology. John Xuereb chairs the Euro-CNS Examination Board. Joachim Weis is director of the Institute of Neuropathology, Aachen University, Germany, President of Euro-CNS, and Past-President of the DGNN.

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