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Neurology of Aging: Adapting Neurology Provision for an Aging Population

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Keywords

Neurology · Aging · Multidisciplinary team · Geriatrics · Brain

Abstract

Background: Over the past few decades, advances in the neurology of aging have been considerable and have led to a better understanding of the science of age-related neurological disorders. Likewise, it changed the perception of classical neurology practice, research, and the way of looking at age-related conditions. Neurological disorders are the most frequent cause of major disability in the elderly and account for almost half of the incapacitation occurring beyond age 65 and more than 90% of serious dependency. However, a number of neurological changes occur also in the absence of a specific disease, making the assessment and management of neurological complaints and findings a specific expertise. **Summary:** Maximizing success in clinical care of the elderly requires expertise in geriatric neurology, which includes an understanding of current research regarding aging and age-related neurological dysfunctions, and the ability to work with other geriatric healthcare pro-

viders. Although current therapies for neurodegenerative diseases mainly offer symptomatic relief without slowing progression, the landscape is evolving. Biomarkers of pathology and neuroimaging have continued to develop, with a significant impact on diagnosis and treatment. These advances have not only helped to improve our knowledge of disease pathophysiology but also disease stages, guiding symptomatic monitoring, and possible therapeutic options at a pre-symptomatic stage. **Key Messages:** Neurological disorders are a leading cause of major disability and dependency in the elderly, underscoring the need for expertise in geriatric neurology for effective clinical care of this population. Although current therapies for neurodegenerative diseases primarily provide symptomatic relief without slowing disease progression, advancements in biomarkers and neuroimaging are significantly evolving. These advancements enhance our understanding of disease pathophysiology and stages, guiding symptomatic monitoring and potential therapeutic options at a pre-symptomatic stage. As knowledge about age-associated conditions is steadily rising and geriatric medicine gains further recognition, this article argues for a new focus on the role of neurologists in geriatric medicine,

emphasizing the importance of integrating current research and collaborative care approaches in the management of elderly patients.

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Introduction

Although geriatric medicine emerged as a modern specialty in the second half of the 20th century, human interest in old age has been present since antiquity. Geriatric neurology has emerged as an important subspecialty, that, as defined by the American Academy of Neurology, “focuses on neurological disorders that afflict elderly (...) and the methods of assessment, diagnosis, treatment and management that are often modified to adjust to this special population.” Advances from the late 19th century and early 20th century laid the foundation for geriatric neurology with a better understanding of the effects of aging on the nervous system and the mechanisms of age-related diseases, which led to a focus on preventing, alleviating, or curing disease [1, 2]. In other words, by attenuating the aging process, it may be possible to delay most of the age-related diseases that affect the elderly [3]. Whereas optimizing function in patients suffering from geriatric syndromes became the new standard of care in geriatric medicine, the effects of age-related neurological disorders on the brain came out as a threat to a fulfilling life in older age [4]. Of all the age-related changes, those concerning the nervous system have become of high interest. According to a recent study published in *The Lancet* in 2024, establishing the global burden of neurological disorders from 204 countries from 1990 to 2021, neurological disorders are now considered as the leading cause of ill health worldwide, surpassing cardiovascular diseases [5]. Additionally, Alzheimer’s disease (AD) and other dementias are now recognized as significant causes of mortality, highlighting the severe impact of these conditions [6].

In a recent survey, Jacobs et al. [7] showed that more than 26% of adults aged over 75 years referred to the emergency department for diverse geriatric symptoms had associated acute or chronic neurological issues. Whereas neurological disorders in the elderly are extremely common, they are still often underestimated and therefore underdiagnosed and standard neurology clinical practices are not always well adapted to address the unique needs of older adults with neurological issues [8]. By examining the increasing prevalence of neurological disorders among the elderly and the interdisciplinary nature of geriatrics, we highlight why integrating neurological expertise is crucial for enhancing elderly care.

Increasing Prevalence of Neurological Disorders in the Elderly: A Global Phenomenon

Elderly people account for the largest increase in hospital admissions, with neurological disorders affecting 5–55% of this population [9, 10]. The Rotterdam study, which included 7,893 people aged 55 and older, identified AD and other dementias (26%), stroke (8%), epilepsy (5.7%), and Parkinson’s disease (PD) (4%) as the most prevalent and burdensome neurological disorders [11]. Other neurological disorders such as peripheral neuropathy, traumatic brain injury, and infectious diseases were not considered in this cohort, likely underestimating the overall neurological burden [8].

As life expectancy increases, the prevalence of these disorders is expected to rise globally, including in sub-Saharan Africa, China, and India [12, 13]. Despite predictions of a threefold increase in age-related neurological disorders by 2050 due to the aging population, recent studies suggest a decrease in the incidence of new cases. The Framingham Heart Study reported a 2.8% decline in dementia and a 1.1% decline in ischemic strokes among older adults over the past 25 years [14, 15]. This trend is attributed to higher education levels, better cardiovascular risk management, improved treatments, and overall health benefits from increased socio-professional opportunities [14]. Furthermore, advancement in modern techniques to image and measure brain processes, analyzing big data, artificial intelligence, and the place of drug development has also impacted the classification of disorders, its diagnostic criteria, and so its prevalence [16]. This also leads to some major progresses in fundamental and preclinical research on neurodegenerative diseases and brought about a deeper understanding of both the healthy and pathological brain [17]. Over the last 10-year period, cerebral MRIs nearly tripled and the increase in brain imaging was faster among the elderly compared with younger patients [18]. This allowed the observation that not all pathological brain abnormalities had direct observable (or negative) consequences. Most brain infarcts are silent, like most myocardial infarctions in elderly people; most white-matter lesions, isolated cerebral microbleeds, and brain atrophy did not seem to have visible clinical consequences. These findings, however, do not mean that all pathological signs are harmless. There is evidence that in the long term, silent brain infarcts and white-matter lesions predict consecutive clinical stroke, dementia, and depression [19, 20]. Integration of neurogeriatric expertise will become essential to the appropriate clinical management of the aging population.

Neurologists in Geriatric Units

Differentiating the Physiological Aging Process from the Disease

Aging is associated with a structural and functional decline of the nervous system. There is more neuronal loss, more vascular burden, and more changes at the cellular level compared to younger adults, and consequently more alterations in the neurological findings [4]. In the physiologically aging brain, processing speeds slow down, and multitasking becomes more challenging [4, 21]. However, routine memory, skills, and knowledge remain stable and may even improve with age. This stability is supported by age-related neuronal plasticity, which indicates that the aging brain still possesses the ability to adapt and reorganize itself. Despite these declines, the brain can develop new neural pathways and increase neural activity in response to sustained cognitive training and experience, helping to regulate and maintain cognitive function [21]. Critchley [22], in 1931, first described a number of neurological abnormalities that he had observed in octogenarians and for which no cause could be discerned other than the effects of aging itself. Some of the most consistent are impairment of vibratory sense in the toes and ankles; decrease in visual acuity and progressive hearing loss; depression of tendon reflexes and cortical release signs; hypo- and hyperkinetic movements and light multi-domain cognitive changes. Furthermore, there is evidence that a degree of parkinsonism is common in the elderly, with an estimated presence of mild features in 30–40% of cases. Bennett et al. [23] reported in a study that in a community of people aged 65 years or older, more than a third had mild degree of parkinsonian signs, where axial bradykinesia and postural instability were the most prevalent signs, respectively, of 20% and 30%, followed by rest tremor at 2%. This knowledge is important in interpreting neurological examination findings in the elderly because “normal” aging may also contain individuals with subclinical neurological disease. A prospective study of 506 subjects free of neurological disease and cognitive impairment showed that in people over 65, having more than three abnormal neurological signs was associated with an increased risk of mortality and of cardiovascular events over the next 10 years [24]. In addition, increasing numbers of neurological signs are also associated with functional impairment and a higher probability of falls [25]. For decades, neurological diseases have been based on constellations of symptoms and the pathology of the disease was only defined at postmortem examinations. The emergence of fluid and neuroimaging biomarkers

has, however, permitted the detection of specific pathologies in vivo and led to changes in diagnostic criteria. These latter breakthroughs have resulted in a paradigm shift in how we follow and diagnose many brain disorders, at all ages. For example, research in AD biomarkers showed that AD is a continuum, that different biomarkers reflect various aspects of AD pathology, and that some biomarkers become abnormal before the onset of clinical symptoms [26]. However, among patients with clinically diagnosed AD, previous studies have shown that 12% were negative on amyloid PET and 10–25% did not meet the neuropathological criteria of AD at autopsy [27, 28]. Moreover, while there are advances in some neurodegenerative diseases, in many other instances, such as with PD, progressive supranuclear palsy, corticobasal degeneration, and amyotrophic lateral sclerosis, there are no available biomarkers that are reliable predictors of the disease [29]. Therefore, the clinician’s judgment remains the most important initial element of neurological diagnosis at all ages. Over the past decades, great progress in basic and preclinical research for neurodegenerative disease has at times appeared to predominate the focus and clues to diagnosis over traditional history and physical examination. In short, no laboratory studies can provide an accurate diagnosis without a thorough clinical assessment.

Follow-Up and Management of Neurologic Diseases in Geriatric Inpatients

There is a high prevalence and incidence of neurologic disease in elderly hospitalized patients. Our data show that patients hospitalized in a geriatric division are referred to the neurology team for a diverse spectrum of reasons, the most common of which being movement disorders, epilepsy, cerebrovascular diseases, and cognitive neurology (shown in Fig. 1). Although geriatric patients benefit from interdisciplinary care, a common misperception persists that neurologists are solely concerned with diagnosis, neglecting their important role in long-term patient management [30]. Combining the expertise of neurologists with other healthcare professionals, such as geriatricians, psychiatrists, and palliative care specialists, is essential for managing complex and multimorbid patients. However, interdisciplinarity should not be limited to the medical field alone. The inclusion of neuropsychologists, occupational therapists, and physiotherapists, for example, can help enhance care. Their standardized assessments can support medical diagnoses, follow-up, and management of patients with dementia [31]. Furthermore, neurologists’ involvement in geriatric assessments is crucial because neurological

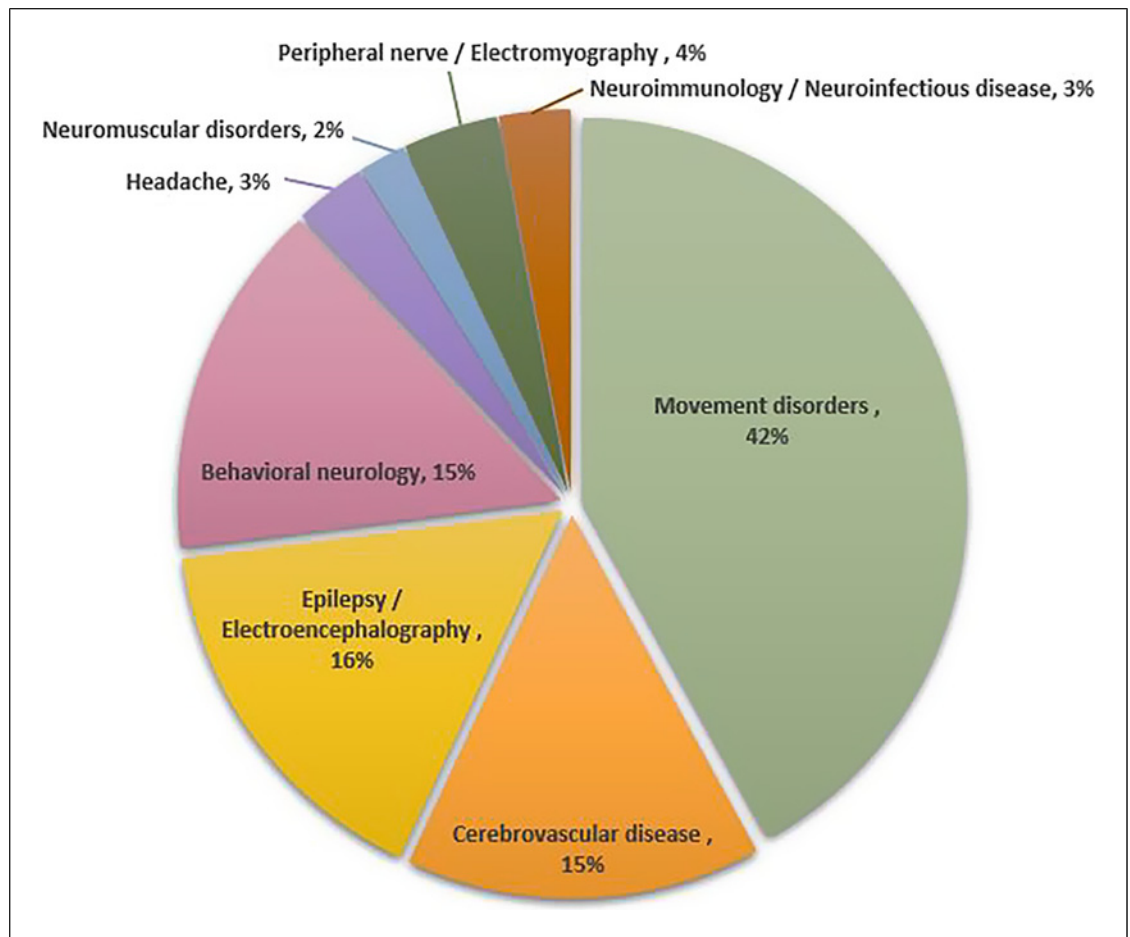


Fig. 1. Reasons for neurological consultation in a sample of 300 inpatients hospitalized in the geriatric division of the Geneva University Hospitals.

deficits often go unrecognized or misinterpreted by non-neurologists, leading to challenges in identifying precise causes and developing effective management strategies [32]. Cruz-Velarde and his colleagues [33] analyzed retrospectively 432 inpatient referrals to the neurology unit. Concordance between the referring team's (coming from the entire spectrum of medical specialties) initial diagnosis and the final diagnosis by a neurologist existed in 68% of cases. Hence, in one-third of patients, the neurologist revised the diagnoses. In a more recent study of 254 hospital inpatients, diagnosis at admission was changed following neurological referral in 55% and management in nearly 70% of cases [34]. More importantly, neurological expertise led to earlier discharge for 65% of patients. In another study, Camicioli et al. [30] highlighted the added value of a comprehensive assessment conducted by a neurologist, both in terms of formulating a diagnosis and providing insights into the

management of diseases in the elderly population. In this study, the mean rate of neurologic diagnosis per patient on admission was 2.3 when assessments were made by the medical house staff, but rose to 3.2 with a neurological consultation. Therefore, a neurologist's participation is important in the setting of geriatric assessment, primarily because misdiagnosis and over-treatment are quite frequent in the elderly. In addition to geriatric assessments, neurologist evaluations include more detailed neurological exams and the use of specific diagnostic tools and tests, such as neuroimaging and electrophysiological studies. Furthermore, even though neurodegenerative disorders are distinct nosological entities, they may overlap due to a lack of phenotype specificity or the co-occurrence of common diseases [35]. For example, AD and PD are two separate diseases, yet parkinsonism features can be observed in proportions of AD patients and a significant number of PD patients may develop

dementia [36]. In conclusion, the role of neurologist in the interdisciplinary geriatric team is important and multifaceted for distinguishing normal aging from neurological diseases, ensuring accurate diagnoses, appropriate follow-up, and avoiding over-treatment.

Neurogeriatrics: An Interdisciplinary Challenge with Future Perspectives

Specialized multidisciplinary geriatric care has been shown in multiple studies to extend survival, improve patients' quality of life and autonomy, and decrease acute-care hospital readmissions [9]. In the early development of neurogeriatrics, some age-related cognitive disorders like dementia were the prerogative of psychiatrists or geriatricians and not neurologists, unless the cognitive impairment was caused by a structural lesion like a tumor or a stroke [1]. However, the progress on the topic with the evolution of neuroimaging (MRI, SPECT, and PET scanning) and the characterization of dementia phenotypes has led to a "cognitive paradigm" change with an opening to neurology [37]. A more bidirectional relationship between neurologists, geriatricians, and psychiatrists emerged, as illustrated by the experience from memory clinics worldwide [38]. Moreover, there is increasing evidence that neuropsychiatric symptoms and non-amnesic focal cortical syndromes may be part of the dementia continuum [26]. For example, the association of late-life depression with AD has been an important area of interest and it is hypothesized to represent an early noncognitive manifestation of AD and PD with shared neurodegenerative etiology [39]. Therefore, while psychiatrists underdiagnose dementia, neurologists underdiagnose depression, which drives the argument for the necessity of more interdisciplinary diagnosis in cognitively disturbed patients [40]. There is also increasing literature suggesting the co-existence of AD and epilepsy. Recent retrospective and prospective studies have shown that there is a higher incidence of epileptic seizures in AD patients in comparison with the healthy population, with a prevalence of seizures ranging from 3.5% to 64% [41].

For now, the development of new treatment strategies for neurodegenerative diseases such as AD, PD, Huntington's disease, and multiple sclerosis remains at the pre-clinical and clinical stages, while available approved drugs predominantly alleviate symptoms temporarily without significantly altering disease progression [29]. The importance of today's debates and innovative care models for elderly patients with neurodegenerative diseases should be put in dedicated units adopting multi-disciplinary team approaches that not only include specialists with specific

skills but also a broader perspective, such as palliative care teams, to ensure that the patient and his goals of care stay at the center of the discussion.

Presently, treatment options for AD are more limited, and while cholinesterase inhibitors or memantine can delay some worsening of symptoms, these medications do not slow the underlying progression of pathology in the brain [42]. The year 2021 marks, however, a new era in neurodegenerative disease research, with a focus on therapies that move biomarkers in AD and related diseases and slow the march of the underlying pathology [43]. This innovative approach is part of a broader shift, toward preventive strategies, emphasizing brain health through the promotion of vascular health, healthy aging, and mental health [44].

Conclusion

The rapidly increasing age of the population challenges our healthcare systems. Many age-related diseases are neurological disorders, accounting for about half of patients older than 65 who are incapacitated and for more than 90% of those whose incapacities are severe. Neurology of aging emerged only in the second half of the 20th century as an important subspecialty. Indeed, further advances in clinical manifestations of aging, more detailed examination of disease states in the elderly, and translational research of geriatric neurology expanded and advanced during this period and into the 21st century. In order to make better use of these recent advances, accurate diagnosis is the basis for expert management and therapy. Similarly, to pediatricians who say that children are not just small adults, a parallel metaphor could be used for seniors, assuming that the elderly requiring medical care are not just older adults and calls for the expertise of a geriatrician. As Critchley [22] elegantly wrote some 85 years ago, aging is associated with physiologically visible changes within the nervous system, and some aspects of the nervous system are more vulnerable than others. This knowledge is crucial in interpreting neurological examination findings. Combined with neuroimaging modalities and neurophysiological studies, neurological expertise is an important tool for the management of elderly patients. Likewise, the recent use of biomarkers has enhanced neurological practice, especially in neurodegenerative diseases, where their role is not only used in diagnosis but also for prognostic potential and in the near future for new treatment opportunities. The dynamic increase of knowledge across medical specialties requires that geriatric medicine

provides the highest level of state-of-the-art care, making the implementation of neurological expertise within the interprofessional geriatric team essential.

Conflict of Interest Statement

Patrick Stancu, Lisa Hentsch, Dina Zekry, Christophe Graf, Vanessa Fleury, and Frédéric Assal report no disclosure. Margitta Seeck is a shareholder of Epilog NV (Ghent, Belgium). She received speaker's fees from Philips and Desitin. She received grants from the Swiss National Science Foundation (163398, CRS115-180365).

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Author Contributions

P.S. drafted and edited the manuscript and created the figures. L.H. made a substantial contribution to the concept of the article. M.S., D.Z., C.G., and V.F. edited the manuscript. F.A. performed critical revision of the manuscript.

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