# New Zealand's neurologist workforce: a pragmatic analysis of demand, supply and future projections

Annemarei Ranta, Priyesh Tiwari, John Mottershead, David Abernethy, Mark Simpson, Kiri Brickell, Christopher Lynch, Elizabeth Walker, Richard Frith


## ABSTRACT

**AIMS:** To estimate current and future specialist neurologist demand and supply to assist with health sector planning.

**METHODS:** Current demand for the neurology workforce in New Zealand was assessed using neuro-epidemiological data. To assess current supply, all New Zealand neurology departments were surveyed to determine current workforce and estimate average neurologist productivity. Projections were made based on current neurologists anticipated retirement rates and addition of new neurologists based on current training positions. We explored several models to address the supply-demand gap.

**RESULTS:** The current supply of neurologists in New Zealand is 36 full-time equivalents (FTE), insufficient to meet current demand of 74 FTE. Demand will grow over time and if status quo is maintained the gap will widen.

**CONCLUSIONS:** Pressures on healthcare dollars are ever increasing and we cannot expect to address the identified service gap by immediately doubling the number of neurologists. Instead we propose a 12-year strategic approach with investments to enhance service productivity, strengthen collaborative efforts between specialists and general service providers, moderately increase the number of neurologists and neurology training positions, and develop highly skilled non-specialists including trained neurology nurses, physician assistants, and/or general practitioners with a special interest in neurology.


The worldwide burden of neurological disease is significant and rising.[1,2] A 2006 World Health Organization report indicated that neurological conditions rank highest when it comes to loss of disability-adjusted life years (DALYs) compared with other important conditions affecting health status worldwide.[3] Analysis of the most common neurological conditions and predicted trends over the next 15 years suggests the greatest impact will be on high-income countries, including New Zealand.

Worldwide there has been a longstanding under-provision of neurological services for a variety of reasons.[3] This gap of service provision is forecast to widen and the pressures on the health system are going to increase over the next decades.[3] It will be challenging to address this increasing neurological service need solely through increases in the number of specialists. Other potential options to help address service requirements may include better primary and secondary prevention,[4] improved neurological management in primary care,[5,6] enhanced collaboration between health providers and other societal stakeholders,[3] developing new workforce roles in innovative models of care[7] and utilisation of technological resources to improve efficiencies.[8-10]

This paper explores the current workforce, estimates current and future service demands and how we might provide sustainable neurological services into the future. We hope that our proposed models can serve as


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**Figure 1:** Proposed model of neurologic service demand and supply

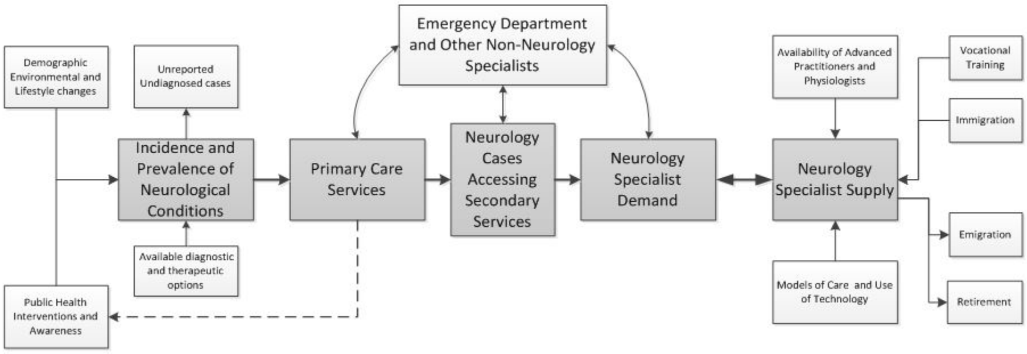



**Table 1:** Comparing known New Zealand epidemiologic neurological data with international figures

| | Overseas estimate | New Zealand Estimate |
|---|---|---|
| Stroke incidence per 100,000 population per year | 200[2] | 204[11,12] |
| Multiple Sclerosis- Point prevalence per 100,000 population | 60[1] | 71.9[13] |

a reference for service planning and initiate discussion as to how New Zealand and other countries around the world can work toward addressing the challenges in global neurological service provision.

# Methods

This paper focuses on specialist adult neurological workforce. The contribution of non-medical service providers such as neurophysiology technicians, neurology nurses, and neurology clinical nurse specialists is to some extent captured in the neurologist productivity figure.

## Building a model

The New Zealand demand for specialist neurological services depends on the incidence and prevalence of neurological disease in New Zealand. Other contributing factors include public awareness of neurological disease, public health interventions, availability of diagnostic and therapeutic options, quality of primary care services, referral and service protocols and the ability of non-neurology specialists (eg, geriatricians and internal medicine specialists) to manage common conditions (Figure 1). The incidence and prevalence of neurological disease is subject to demographic change as well as changes in the epidemiology of neurological disease.

## Estimating demand

New Zealand epidemiological data for neurological disease is limited and we primarily estimated incidence and prevalence rates using international evidence.[1,2] Comparing international to New Zealand figures, where such were available, suggests that neuro-epidemiologic data may be similar between the populations. (Table 1)

MacDonald et al estimated an incidence of 0.6% of new neurological conditions and a lifetime prevalence of 6% in the UK.[2] A US study by Kurtzke et al arrived at different figures, with an incidence of 1.0% and point prevalence of 3.6% (people deemed to require care by a neurologist).[1] However, relying completely on these estimates may be erroneous given that not all patients with neurological conditions seek health provider input, not all health providers diagnose neurological conditions accurately, prevalence and incidence can vary significantly among populations and access to care and methods used to collect data across studies are not always consistent.[3,12] Taking into account these difficulties we took a pragmatic and conservative approach.

We made estimates following Kurtzke's assumption that much neurological care is provided by non-neurologists, and that only a proportion of patients with neurological conditions require neurologist review. He assumes that even if all headache, all trauma, all spinal disorders, all alcohol-related illness, and all retardation, blindness, deafness, and psychosis were managed by other specialists, one percent of the population per year will require the attention of a physician skilled in clinical neurology.[1] If we exclude a proportion of stroke, Parkinson's disease and dementia, diseases which in New Zealand are often managed by other physicians—it is estimated that a minimum of 0.6 percent of the population will require first specialist assessment (FSA) by a neurologist per year. This is consistent with the incidence rates estimated by MacDonald, et al.[2]

After excluding all the aforementioned disease categories, prevalence rate estimates suggest that 3.6 percent of the population at any one time should be under the follow-up (FU) care of a neurologist.[1,2]

We multiplied these estimated incidence and prevalence rates by projected total New Zealand population over the next 12 years[14] to arrive at projected volume of patients requiring neurology services in New Zealand. The figures were not adjusted for population changes relating to age and ethnic distribution. Such adjustments would likely further increase estimated demand and thus our projections are conservative.

## Estimating supply and productivity

To assess current supply of specialist neurological services, we conducted a survey seeking information on head count and full-time equivalent (FTE) figures for neurologists working in public hospitals from each neurology department in New Zealand. In addition, case volumes and time allocation for each scheduled activity were also collected. This allowed estimation of workload and productivity of neurologists in New Zealand. To validate these data, we also contacted the Ministry of Health to provide publicly funded neurologist FTEs and annual case volumes. The relatively small contribution of the private sector was not considered in this analysis.

Specialists perform a range of clinical activities of varying duration and complexity. To account for these variations we converted case volumes to new neurology assessment equivalents that we call Patient Contact Equivalents (PCEs). For example, on average 45 minutes are allocated for a new clinic patient or FSA (base figure for PCEs), but if 15 minutes are allocated to assess and manage a new patient for botulinum toxin injection then one botulinum injection appointment equals 0.33 PCE. PCE does not reflect the total workload of a specialist but is a notional figure which allocates weights to all countable patient encounters such as FSA, FU, inpatient consultations, inpatient case weights, patients undergoing botulinum toxin injections, electromyography procedures, and virtual clinic patients. Clinical activity provided by non-neurologists eg, tests such as electroencephalography (EEG) performed by neurophysiology technicians and only *interpreted* by specialists were excluded. Average times spent for each activity were calculated based on average appointment duration at each unit. Such formulae were developed for all clinical cases assessed in order to arrive at an annual PCE figure that one full time neurologist can provide. Dividing the total number of PCEs per year by currently available neurologist FTE provides a figure of cases/FTE to estimate current productivity level.

*Total number of PCEs/Total number of FTEs = Productivity*

Productivity is expressed in PCEs per year per neurologist FTE. This figure represents an average across neurology departments in the country. Neurologists spend significant amounts of time with activities such as reviewing and reporting diagnostic tests, writing reports and other administrative tasks, training and teaching, service development and audits, continuing medical education, to name but a few. These activities were considered when arriving at the productivity estimates, but are not numerically reflected in the PCE figure. The productivity will be higher in some departments and lower in others depending on other service requirements and resources. This figure also averages varying degrees of sub-specialisation, models of service, and referral pathways/protocols across New Zealand as well as contributions made by existing residents, nurse specialists and clinical physiologists to the productivity of specialists.

We considered inflows and outflows to the current workforce pool to estimate neurology specialist workforce supply over the next 12 years. We estimated inflows using the number of advanced training positions and actual historical retention rate in the New Zealand workforce. The analysis does not consider recruitments from overseas, as it is seen as desirable to be self-sufficient over the long run. We estimated outflows on the basis of age/estimated retirement time of specialists currently employed within the public sector. We assumed that the currently employed pool is relatively stable and the emigration rate would be zero over the next 12 years.

### Mapping demand-supply projections and developing scenarios

Quantifying supply of neurology services against the estimated demand is difficult given a large number of confounding factors and variable practice patterns. Kurtzke estimated a ratio of 800 new and 1,200 follow-up neurological specialist consultations per year per 100,000 population, or approximately 1 neurologist per 50,000 people.[1] The latest neurology workforce data available from the US indicates a geographic range between one neurologist per 56,000 people in rural areas to one per 9,000 people in metropolitan areas.[15] However, in New Zealand many neurological patients are seen once or twice and are then referred back to their general practitioner or a different service, such as geriatrics for ongoing care. This reduces the need for FU appointments, but also means that during the course of the illness, which can last many years, some patients are re-referred for a 'new' assessment a second time. Some of the focus on FSAs is politically driven in an effort to reduce waiting and a general push to devolve specialist care to generalist services. Whether it is appropriate to devolve neurological care to generalists in many instances is debatable, but this paper makes the assumption that such a model is acceptable to New Zealanders. These practice patterns shift the ratio of FSA to FU in New Zealand in favour of more FSAs compared to Kurtzke's US estimates.

In light of the above, the analysis presented in this paper assumes each new case would generate demand for an average of 1.2 PCEs per year and existing cases on an average would demand one PCE every 5 years (ie, 0.2 PCEs/case/yr). The total estimated demand for PCEs per year was calculated by adding total demand for FSAs (estimated incidence multiplied by 1.2 PCEs) and demand for FU consults (estimated prevalence multiplied by 0.2 PCEs). The assumptions are made qualitatively based on in-depth analysis of overseas evidence, currently funded Ministry of Health volumes, expert opinion and the experience of specialists practicing in New Zealand.

We mapped the estimated demand for neurology specialist services over the next 12 years (ie, from 2014 to 2026) against the projected number of specialists considering retirement. We then developed models that considered the effects of increasing training sites, increasing contributions by new workforce roles, and greater application of new technologies/service models in hopes to improve efficiency.

## Results

### Estimated demand

We estimated that the current average productivity rate of neurologists practising in New Zealand is 875 PCEs/specialist/year. Dividing the total yearly demand for PCEs by current productivity rate allowed a prediction of demand for FTE neurology specialists over the next 12 years (Table 2, column A).

This analysis was compared with four additional scenarios. Column B in Table 2 shows demand for neurology FTEs assuming the productivity increases by almost 15% (from current 875 PCEs/specialist/year to 1000 PCEs/specialist/year). Such increased efficiency could potentially be achieved through the application of new technologies or the adoption of alternative models of care. While such an increase in productivity is conceivable, there is currently no evidence that it is, in fact, achievable.

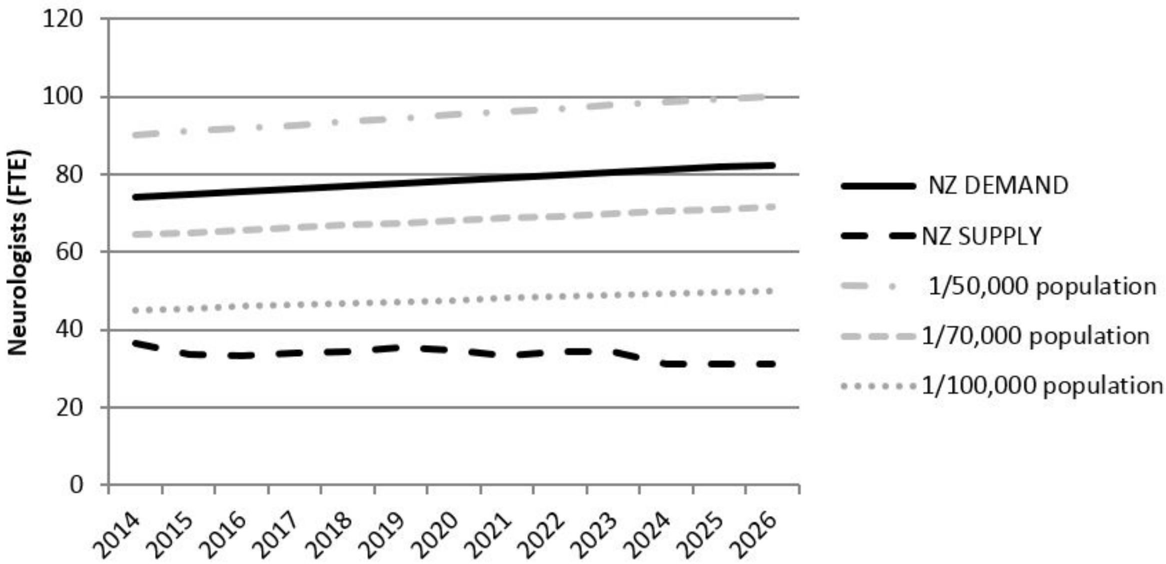
The other three scenarios (columns C, D and E) show predicted demand on the basis of specialist to population ratios suggested in international publications (columns C & D).[1,16] Kurtzke suggested that the health system required one neurologist for every 50,000 people.[1] The UK Royal College of Physicians indicated a more conservative figure of 1:70,000.[16] A 1989 New Zealand workforce report recommended a more conservative estimate of 1:100,000 (column E).[17] To our knowledge, there is currently no other country in the OECD that recommends a 1/100,000 staffing level and most current ratios range between 1/10,000 and 1/70,000.[3,16,17]

**Table 2:** Neurology specialist service demand in New Zealand over the next 12 years:

| Year | Projected total NZ population | Estimated volume of new cases (0.6%) | Estimated volume of existing cases (3.6%) | Estimated total number of PCEs / year* | Estimated demand for neurology specialists in NZ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Based on incidence and prevalence | | Based on specialist population ratio | | |
| | | | | | A (current productivity) | B (higher productivity) | C 1/50,000 | D 1/70,000 | E 1/100,000 |
| 2014 | 4,511,400 | 27,068 | 162,410 | 64,964 | 74 | 65 | 90 | 64 | 45 |
| 2015 | 4,553,280 | 27,320 | 163,918 | 65,567 | 75 | 66 | 91 | 65 | 46 |
| 2016 | 4,595,450 | 27,573 | 165,436 | 66,174 | 76 | 66 | 92 | 66 | 46 |
| 2017 | 4,637,390 | 27,824 | 166,946 | 66,778 | 76 | 67 | 93 | 66 | 46 |
| 2018 | 4,679,585 | 28,078 | 168,465 | 67,386 | 77 | 67 | 94 | 67 | 47 |
| 2019 | 4,721,465 | 28,329 | 169,973 | 67,989 | 78 | 68 | 94 | 67 | 47 |
| 2020 | 4,762,765 | 28,577 | 171,460 | 68,584 | 78 | 69 | 95 | 68 | 48 |
| 2021 | 4,804,050 | 28,824 | 172,946 | 69,178 | 79 | 69 | 96 | 69 | 48 |
| 2022 | 4,845,520 | 29,073 | 174,439 | 69,775 | 80 | 70 | 97 | 69 | 48 |
| 2023 | 4,887,325 | 29,324 | 175,944 | 70,377 | 80 | 70 | 98 | 70 | 49 |
| 2024 | 4,928,175 | 29,569 | 177,414 | 70,966 | 81 | 71 | 99 | 70 | 49 |
| 2025 | 4,968,660 | 29,812 | 178,872 | 71,549 | 82 | 72 | 99 | 71 | 50 |
| 2026 | 5,008,605 | 30,052 | 180,310 | 72,124 | 82 | 72 | 100 | 72 | 50 |

* Estimated total number of PCEs /year = (Estimated Incidence x 1.2 PCEs/case/year) + (Estimated Prevalence x 0.2 PCEs/ case/year)
A - Estimated number of specialists required in NZ = Total PCEs required in a year/PCEs provided per specialist (i.e. current productivity of 875 PCEs/ specialist/year)
B - Estimated number of specialists required in NZ at higher productivity = Total PCEs required in a year/PCEs provided per specialist (i.e. productivity of 1000 PCEs/specialist/year)
C - Estimated number of specialists required in NZ at the specialist population ratio of 1/50,000 as suggested by Kurtzke in the US.
D - Estimated number of specialists required in NZ at the specialist population ratio of 1/70,000 as suggested by British
E - Estimated number of specialists required in NZ at the specialist population ratio of 1/100,000

**Figure 2:** Projected supply and demand for the neurology specialist workforce in New Zealand




Estimated need for neurologists per population is displayed for illustrative purposes to allow comparison to estimates from the international literature:
1/100K = 1989 NZ Health Department estimated need for neurologists per population
1/70K = Recent UK estimate for neurologist need per population
1/50K = US Kurtzke estimate for neurologist need per population

## Estimated supply

As of 2014, there were 36 FTE specialist neurologists in New Zealand with an average age of 52.7 (± 9.2) years. This figure translates into an average of 1 neurologist per 126,000 people.

Nearly half the current workforce is expected to retire within the next 12 years, assuming the age of retirement to be 65 years. New Zealand has nine one-year neurology advanced training posts, six to seven of which are usually filled at any given time. The advanced training duration is three years and on average two to three new neurologists could join the consultant pool each year.[18] However, due to additional sub-specialty training and emigration, the annual retention rate of New Zealand-trained neurologists has been one per year over the past five years. Neurologist workforce supply projections, shown in Figure 5, consider both upcoming retirements and recruitments at the rate of one per year over the next 12 years. The data from column D, which closely match column B in Table 2, are used to draw the demand curve. These projections assume that current service configurations will not change over time. Demand estimates based on proposed ratios of neurologists per population are added to provide further context.

Regional variation is not the focus of this paper. However, it is noteworthy that neurologist access in rural areas is currently especially limited with the equivalent of one neurologist per 700,000 in some rural/provincial districts.

## Modeling of potential future scenarios

An undersupply of specialists is evident, both currently and into the future, creating an increasing risk for unmet need and pressure on health resources. This paper does not present a particular solution but explores several options that could be considered or may develop.

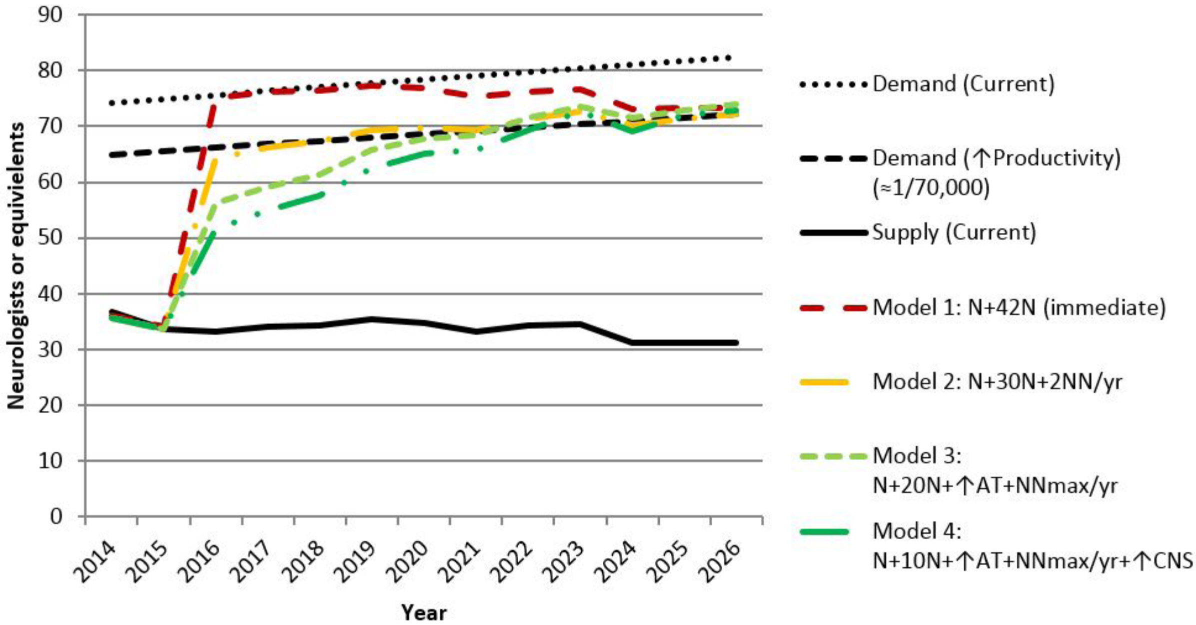
One solution is to increase supply by increasing the number of consultant neurologists. The earliest this could be achieved would be 2016, at which point the gap will have widened, requiring the recruitment of 42 additional neurologists. This solution requires large upfront resource investments, depends on the ability to recruit sufficient specialists (presumably from overseas), and does not address the issue of long-term sustainability (Figure 3, Model 1).

The gap could also be narrowed by reducing demand through neurologist productivity gains using modern technologies such as telemedicine, which can help to save on travel time and costs to remote locations.[9,19] This may also help to mitigate the regional disparities. Other technological advances that could improve efficiency include the use of better referral pathways and electronic decision support that could improve sector integration and can help to reduce duplication and administrative work.[8,10,20] Administrative work could also be alleviated through recruitment of additional administrative staff support. We estimate that a maximum of a 15% increase in productivity is achievable. If every neurologist can increase productivity by 15% to an annual caseload of 1,000 PCEs, lesser FTEs will need to be recruited (shown as a black dotted line in Figure 3 and used as demand target for Models 2–4 below).

Another option to reduce the demand and supply gap is to increase efforts to retain more neurology trainees in New Zealand. If all New Zealand trained neurologists stayed in New Zealand, or trained neurologist attrition was replaced with oversees trained neurologists, the annual recruitment rate could rise from one to two neurologists each year. This would see an increase in neurologists over time. Assuming the above presumed productivity gains are achieved this would require additional funding of eight specialist neurology posts across New Zealand over the next 12 years and reduce the need for immediate increase of neurologists from 42 to 30 (Figure 3, Model 2).

A further option is to expand the number of currently available neurology advanced trainee posts. Adding neurology training posts has the benefit of increasing the immediate workforce by adding extra neurology trainees while also producing more senior specialists over time providing improved long-term sustainability. There is capacity to train more neurologists in New Zealand and we estimate a maximum rate of one advanced trainee (AT) per two neurologists can be feasibly achieved by gradually increasing the number of training posts—initially 4 extra posts in 2016, then

**Figure 3:** Projected neurology workforce demand and supply under different modeling conditions.




**Demand (Current):** based on productivity of 875 PCE/neurologist/year,
**Demand (↑ Productivity):** based on a 15% increase in neurologist productivity to 1000 PCE/neurologist/year, which is near identical to 1 neurologist per 70,000 population
**Model 1:** current neurologists (N) plus the immediate recruitment of 42 additional consultant neurologists (N42)
**Model 2:** current neurologists (N) plus immediate recruitment of 30 additional neurologists (30N) plus maximal annual retention of current NZ trained New Neurologists (2NN) or equivalent (i.e. 100% retention of NZ trainees or new recruitment of oversees trained neurologist to replace trainee attrition)
**Model 3:** model 2 plus increasing neurology advanced trainee posts in a staggered fashion to reach to feasible capacity over seven years (AT↑) plus maximal trainee retention (NNmax/yr) plus immediate recruitment of 20 additional neurologists (20N)
**Model 4:** model 3 plus feasible number of nurse specialists or equivalents recruited immediately plus 10 immediate extra neurologists (10N)

1–2/year, until a total of 14 new training posts is reached in about seven years. We estimate that advanced trainees, averaged over their training duration, add about 50% of the productivity of a fully-trained neurologist to the service. Coupled with increased productivity and maximal trainee retention (Model 2) would reduce the number of neurologists immediately required from 30 to 20 (Figure 3, Model 3).

Yet another option, Model 4, is the addition of supporting clinicians such as clinical nurse specialists (CNS), nurse practitioners (NPs), or possibly physician associates (PAs) or general practitioners upskilled in a particular condition, such as headache management, to the neurology teams.[7,21,22] We believe that these professionals primarily help to enhance the team's ability to provide patient-focused, well-coordinated, and more comprehensive neurological services to patients, which are becoming increasingly important as neurological therapies are growing ever more complex. Thus, while we believe that the contribution of these clinicians is invaluable, we believe that their contribution to overall specialist level productivity will be more modest at around 30% of a specialist neurologist. We estimate that a reasonable ratio of neurologist to specialist nurse (or similar) is 2:1 allowing the addition of 18 new nurse specialists as soon as feasible. One advantage of clinical nurse specialists is that they can be recruited and add productivity while still completing their post-graduate qualification. Combining this initiative with the aforementioned options would further reduce upfront investment into an immediate increase in consultant level neurologist from 20 to 10 across New Zealand.

# Discussion

The analysis shows a significant shortfall in specialist workforce that will worsen over time if status quo prevails. As of 2014, the New Zealand neurologist workforce does not match international recommendations from other OECD countries, the recommendations from a New Zealand neurology workforce report in 1989, or estimated current demand based on epidemiological data. The gap will increase as the population grows over time.

Increasing the current specialist neurology workforce to achieve the US recommended 1 in 50,000 would require the creation and recruitment of an additional 64 full-time consultant neurologist positions—nearly tripling the current number of neurologist FTE in New Zealand. Such an increase in the specialist workforce, while perhaps desirable, is unlikely to be affordable or practically achievable given current and ever increasing health resource constraints. Our own demand estimates are somewhat more conservative and more closely align with recent recommendations from the UK, a health system similar to the New Zealand health system,[16] but would still require an immediate addition of 42 neurologists—more than doubling the current workforce.

As an alternative, we propose a combination of strategies that may achieve adequate neurological service provision into the future without relying exclusively on an immediate dramatic increase in neurologists. Firstly, we suggest that investment is made into services to enhance efficiency. This includes technology to assist with remote support of more rural populations to reduce travel time. In addition, we propose that investments are made into an enhanced primary/secondary/tertiary interface through the use of electronic pathways and electronic decision support tools with more active support from specialists to generalists both intra- and inter-DHB. These service provisions require proper funding and a culture shift from the current model, where funding across DHB lines is based on inter-district flow case volumes rather than on provision of comprehensive sub-regional or regional services. The ongoing assumption by some that non-neurologists can manage neurological patients as well as neurologists is not backed by evidence.[23-25] In fact, local audits have confirmed that insufficient access to neurologists results in poorer outcomes.[26] Lack of specialist access has been the main driver behind generalists managing neurological patients, especially in more rural areas, and if new technologies, funding streams, and models of care can achieve better equity of access than these should be explored.

Adjusting current models of care and supplementing with new technologies will help, but are insufficient to close the service gap. In addition, we need to increase the number of neurologists immediately. We propose several options requiring varying degrees of upfront immediate investment. A modest number of new neurologist posts may be sufficient and provide long-term sustainability if this is combined with a gradual but substantial increase in advanced training posts, a commitment to retain and employ all newly trained New Zealand neurologists, and investment in training and recruitment of clinical nurse specialists or other non-neurologist equivalents.

Our data have several limitations. Firstly, the neuro-epidemiological and neurologic case mix data in New Zealand are insufficient, and relying on overseas data could be misleading. For example, the contribution of non-neurologists to neurological service provision could be greater than estimated despite best efforts. This may mean that more patients receive specialist input than estimated, but of course they would still not be cared for by a neurologist a situation that, by international standards, would be deemed sub-optimal.

Second, neurologists also perform diagnostic test interpretation. The degree to which neurologists participate in this varies between hospitals. To ensure maximum consistency we excluded test interpretation from the analysis. We hope that the contribution to diagnostic test interpretation will have been captured in the overall neurologist productivity figure, but this is not certain. The consistency between New Zealand neurologist productivity and expected neurologist per capita demand based on other sources[1,2,16] gives some reassurance in this regard.

Furthermore, our data do not include the relatively modest contribution from private sector neurology in New Zealand, which may have led to an underestimate of supply in our data. However, conversely, while population growth has been incorporated into our analysis we have not adjusted for aging and ethnic changes within popula-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tions, which will likely increase prevalence of some neurological conditions. Along with these demographic changes, new neurological therapies become available every year, increasing the complexity of care provided by neurologists, and this will further affect future demand, making our these estimates on balance highly conservative and likely significant under-estimates of the growing crisis that lies ahead. To improve precision of projections future work could include estimates of the private sector contribution and the impact of demographic and medical advance related changes on demand and supply.

In addition to the implications for neurological workforce, we have suggested a novel method of estimating service contribution of specialists (ie, the concept of PCEs as a unit of supply), present the concept of quantifying increase in productivity using PCEs as a unit of measurement, and present a team-based service model approach that considers the needs of multiple stakeholders. Future research could include validation, refinement, and testing of the PCE unit method.

In summary, we have identified a significant gap between neurological service demand and current supply in New Zealand. We have further demonstrated that unless changes to current service provisions are implemented, this gap will worsen over the next 12 years and we have proposed some potential solutions. Our approach could be adopted to assist with other medical workforce planning.

**Competing interests:** Nil

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**Author Information:**

Annemarei (Anna) Ranta, Consultant Neurologist, Department of Neurology, Executive Clinical Director, Medicine, Cancer, and Community Directorate, Capital & Coast DHB and Senior Lecturer, Department of Medicine, University of Otago, Wellington; Priyesh Tiwari, Senior Project Manager, Workforce Innovations Programme, Ministry of Health, Wellington; John Mottershead, Consultant Neurologist, Department of Neurology, Southern DHB, Dunedin; David Abernethy, Consultant Neurologist and Clinical Leader, Department of Neurology, Capital & Coast DHB, Wellington; Mark Simpson, Kiri Briknell, Elizabeth Walker, and Richard Frith, Consultant Neurologists, Department of Neurology, Auckland DHB, Auckland; Christopher Lynch, Consultant Neurologist and Clinical Director, Waikato DHB, Hamilton.

**Correspondence:**

Anna Ranta, MD, PhD, FRACP, Medicine, Cancer, and Community Directorate, Wellington Regional Hospital, Level 6, Grace Neil Block, Private Bag 7902, Wellington South.
anna.ranta@otago.ac.nz

**URL:**

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