

Learning through in-hospital neurological consultations: a prospective study in neurology residency.

Aprendizaje a través de las interconsultas neurológicas intrahospitalarias: un estudio prospectivo sobre la exposición clínica del residente y las oportunidades educativas.

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Recibido: 1/5/26; Aceptado: 15/5/26; Publicado: 18/5/26

Abstract.

Objective. To evaluate in-hospital neurological consultations as a potential workplace-based learning environment and to analyze clinical exposure, case complexity, and care processes relevant to neurology residency training. **Methodology.** Prospective observational study of in-hospital consultations attended during regular working hours by a fourth-year neurology resident over a 6-month period (July–December 2025). Clinical and care-related variables were analyzed. **Results.** A total of 239 consultations were included. Cerebrovascular disease was the most frequent diagnosis (25.1%), followed by encephalopathy/confusional states (15.1%) and epilepsy (12.6%). Median time to evaluation was 0.20 hours (IQR 0.90) and was significantly shorter in urgent consultations ($p < 0.001$). Follow-up was required in 12.6% of cases, and 30.1% were classified as complex. Cerebrovascular disease was independently associated with hospital admission (OR 6.36; 95% CI 2.77–14.61; $p < 0.001$), whereas origin from the Emergency Department did not remain significant after adjustment. The model showed good discriminative performance (AUC 0.826; 95% CI 0.759–0.894). The estimated total workload reached 587 neurological evaluations. **Conclusions.** In-hospital neurological consultations represent a high-workload activity with substantial educational value. Cerebrovascular disease was the main determinant of hospital admission, whereas case complexity was mainly related to the underlying neurological condition. These findings highlight in-hospital consultations as a high-value workplace-based learning setting, offering broad clinical exposure and potentially supporting experiential learning during neurology residency training.

Keywords: In-hospital consultations, Neurology, Tertiary hospital, Neurology residents, Medical training.

Resumen.

Objetivo. Evaluar las interconsultas neurológicas intrahospitalarias como un posible entorno de aprendizaje basado en el trabajo (workplace-based learning) y analizar la exposición clínica, la complejidad de los casos y los procesos asistenciales relevantes para la formación de los residentes de Neurología. **Métodos.** Estudio observacional prospectivo de las interconsultas intrahospitalarias atendidas durante el horario laboral habitual por un residente de neurología de cuarto año a lo

largo de un periodo de 6 meses (julio–diciembre de 2025). Se analizaron variables clínicas y asistenciales. **Resultados.** Se incluyeron un total de 239 interconsultas. La enfermedad cerebrovascular fue el diagnóstico más frecuente (25.1%), seguida de encefalopatía/estados confusionales (15.1%) y epilepsia (12.6%). El tiempo mediano hasta la valoración fue de 0.20 horas (RIC 0.90), siendo significativamente menor en las interconsultas urgentes ($p < 0.001$). Se requirió seguimiento en el 12.6% de los casos y el 30.1% se clasificaron como complejos. La enfermedad cerebrovascular se asoció de forma independiente con el ingreso hospitalario (OR 6.36; IC 95% 2.77–14.61; $p < 0.001$), mientras que la procedencia desde Urgencias no se mantuvo significativa tras el ajuste. El modelo mostró una buena capacidad discriminativa (AUC 0.826; IC 95% 0.759–0.894). La carga total estimada alcanzó 587 valoraciones neurológicas. **Conclusiones.** Las interconsultas neurológicas intrahospitalarias representan una actividad de alta carga asistencial con un importante valor educativo. La enfermedad cerebrovascular fue el principal determinante del ingreso hospitalario, mientras que la complejidad de los casos se relacionó fundamentalmente con la patología neurológica subyacente. Estos hallazgos destacan las interconsultas intrahospitalarias como un entorno de aprendizaje de alto valor, ofreciendo una amplia exposición clínica y apoyando potencialmente el aprendizaje experiencial durante la formación de los residentes de Neurología.

Palabras clave: Interconsultas intrahospitalarias, Neurología, Hospital de tercer nivel, Residentes de neurología, Formación médica.

1. Introduction

In-hospital neurological consultations represent a high-volume clinical activity in tertiary hospitals and serve as a critical learning environment for neurology residents. While previous studies have primarily examined organizational aspects and workload (1-2), few have explored their educational value as a structured training setting during residency.

Neurology residents frequently manage in-hospital consultations to address acute or complex neurological issues across hospital units, including the emergency department. This activity demands rapid clinical reasoning, prioritization, and interprofessional communication—core competencies in graduate medical education. However, literature on how these consultations contribute to resident skill development remains limited. A prior Spanish longitudinal study (2005–2009) reported 1,458 consultations, with cerebrovascular disease, seizures, and confusional states as the most common reasons. Only 36.8% of cases were resolved after the initial evaluation, highlighting the need for ongoing management and follow-up (1). Similar patterns have been described in other series (2).

Beyond clinical service, in-hospital consultations offer residents valuable opportunities to encounter diverse neurological conditions, refine diagnostic skills, manage clinical uncertainty, and develop therapeutic plans in real-world, high-stakes settings. For senior residents, this experience is particularly important for transitioning from supervised practice to greater autonomy. In contemporary medical education, workplace-based learning and experiential exposure are central to competency development during residency training.

Current frameworks in medical education emphasize the role of experiential learning, supervised autonomy, and workplace-based assessment in the development of clinical competence during residency training. Concepts such as Entrustable Professional Activities (EPAs) (3), cognitive apprenticeship, and situated learning theory highlight the importance of progressive participation in authentic clinical environments⁴ as a mechanism for professional growth and decision-making development. In this context, in-hospital neurological consultations may represent a relevant educational setting for exposure to diagnostic uncertainty, prioritization, interdisciplinary communication, and supervised clinical responsibility.

The aim of this prospective study was to evaluate in-hospital neurological consultations as a clinical learning environment for a fourth-year neurology resident in a tertiary hospital. We analyzed consultation volume, diagnostic diversity, case complexity, and care processes, with particular emphasis on their potential educational value and their role as a workplace-based learning environment during neurology residency training.

2. Methods

This prospective descriptive observational study included all in-hospital consultations attended by a fourth-year neurology resident at a tertiary care center over a 6-month period (July to December 2025). Activity was carried out under the supervision of a senior neurologist, with continuous oversight while allowing a high degree of autonomy appropriate to the resident's level of training. A total of 239 consultations were recorded during regular morning working hours across 63 effective consultation days. The study was designed to also explore the educational implications of clinical exposure during in-hospital consultations.

2.1. Study Population and setting

All in-hospital consultation requests from any hospital department and the Emergency Department were included, provided they were directly evaluated by the neurology resident during regular working hours (08:00–15:00). Requests were submitted either electronically or by telephone paging. Consultations during on-call shifts and those related to the stroke code pathway were excluded. Incomplete or duplicate requests were also excluded.

Patients of any age, sex, or diagnosis were eligible. The unit of analysis was each individual consultation, even if the same patient generated multiple consultations during the study period. Individual consultations were retained as the unit of analysis because they reflect the dynamic and longitudinal nature of in-hospital neurological consultation activity, including continuity of care and repeated neurological evaluations during hospitalization.

2.2. Variables analyzed

For each consultation, the following data were collected: date and time of request, time to neurological evaluation (hours), patient age and sex, requesting department, assigned priority (urgent or preferential), main diagnosis, and whether it was an initial or follow-up evaluation.

Requesting departments were grouped into four categories: Emergency Department, Intensive Care Unit, medical services, and medical–surgical/surgical services. The main diagnosis was recorded as free text and later classified into 15 predefined diagnostic categories (including cerebrovascular disease, epilepsy, encephalopathy/confusional states, neuromuscular disorders, headaches, neuro-oncological conditions, and absence of neurological disease, among others).

Clinical outcome variables included duration of neurological follow-up, need for subsequent in-hospital follow-up by Neurology, and hospital admission to the Neurology Department. Hospital admission was defined as any transfer to the Neurology ward, regardless of the patient's origin.

A composite variable “case complexity” was created, defined as the presence of either hospital admission to Neurology or the need for subsequent in-hospital follow-up. This variable was used to identify consultations requiring greater clinical workload and continuity of care.

2.3. Procedure

All consultations were attended exclusively by a fourth-year neurology resident, under the supervision of attending neurologists when required. Data were collected prospectively using a standardized database specifically designed in Excel format, ensuring patient confidentiality through anonymization of medical record numbers.

2.4. Statistical Analysis

Statistical analysis was performed using SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean \pm standard deviation (SD) or median and interquartile range (IQR), according to normality assessed by the Shapiro–Wilk test. Categorical variables were reported as frequencies and percentages.

Bivariate comparisons were performed using the chi-square test or Fisher’s exact test for categorical variables, Student’s t-test for normally distributed continuous variables, and Mann–Whitney U or Kruskal–Wallis tests for non-parametric data. A p-value \leq 0.05 was considered statistically significant.

Binary logistic regression models (enter method) were constructed to identify independent predictors of hospital admission and subsequent follow-up. Variables were selected based on clinical relevance and univariate significance ($p < 0.10$). Model fit was evaluated with the Hosmer–Lemeshow test and Nagelkerke’s R^2 . Discriminative performance was assessed using the area under the receiver operating characteristic curve (AUC). Collinearity was checked, and the unit of analysis was each individual consultation.

2.5. Ethical Considerations

This study consisted of a prospective observational analysis of routine clinical practice in in-hospital neurological consultations. No intervention was performed, no treatment was modified, and no additional identifiable data were collected. All data were obtained from standard clinical records and recorded in fully anonymized form.

The study was conducted in accordance with the principles of the Declaration of Helsinki and complied with European data protection regulations (Regulation (EU) 2016/679 and Organic Law 3/2018 on Personal Data Protection and Guarantee of Digital Rights). Given the purely observational nature of the study, the use of anonymized data, and the absence of any intervention involving patients, the study was considered to pose minimal risk to participants.

According to institutional policy, formal approval from a Research Ethics Committee was not required for this type of non-interventional observational study using anonymized routine clinical data. Likewise, informed consent was not required because no identifiable patient information was collected or analyzed. Confidentiality and data protection were strictly maintained throughout the study.

3. Results

3.1. General characteristics of the sample

During the study period, a total of 239 in-hospital consultations attended during regular working hours by the fourth-year neurology resident were analyzed. The mean age of the patients was 63.9 ± 17.0 years (95% CI: 61.7–66.0), with a median of 66 years (interquartile range [IQR]: 22). Regarding sex distribution, it was nearly balanced, with 121 women (50.6%) and 118 men (49.4%).

3.2. Diagnostic distribution of consultations

Cerebrovascular disease was the most common diagnosis (25.1%, n = 60), followed by encephalopathy/confusional states/cognitive impairment (15.1%, n = 36), epilepsy (12.6%, n = 30), and absence of neurological disease (14.2%, n = 34). This diagnostic diversity reflects a broad spectrum of clinical exposure relevant for experiential exposure and clinical reasoning during neurology training. Other relevant categories included neurological complications related to onco-hematological therapies (6.7%), neuromuscular diseases (5.9%), headaches (5.0%), and functional neurological disorders (3.3%). The remaining diagnostic categories each represented less than 3% of consultations (table 1).

Table 1. Distribution of in-hospital neurological consultations by main diagnosis (n = 239).

Diagnosis	n	%	Complex cases, n	Complex cases, %
Cerebrovascular disease	60	25.1%	28	46.7%
Encephalopathy / Confusional state / Cognitive impairment	36	15.1%	17	47.2%
Absence of neurological disease	34	14.2%	0	0%
Epilepsy	30	12.6%	8	26.7%
Neurological complications related to onco-hematological therapies	16	6.7%	3	18.8%
Neuromuscular diseases	14	5.9%	7	50%
Headaches	12	5.0%	1	8.3%
Functional neurological disorders	8	3.3%	1	12.5%
Inflammatory / Neuroimmunological diseases	7	2.9%	2	28.6%
Neuro-ophthalmological disorders	7	2.9%	0	0%
Neuro-oncological diseases	4	1.7%	2	50%
Neuro-otological disorders	4	1.7%	0	0%
Central nervous system infections	4	1.7%	3	75%
Movement disorders	2	0.8%	0	0%
Neurological diagnostic and/or procedural activity	1	0.4%	0	0%
Total	239	100%	72	30.1%

3.3. Monthly distribution of clinical activity

The number of consultations varied across the 6-month period, with the highest activity in October (n = 56; 23.4%), August (n = 53; 22.2%), and July (n = 49; 20.5%). Lower volumes were observed in September (n = 21; 8.8%) and November (n = 27; 11.3%). After adjusting for effective working days (63 days total), the mean workload was 3.79 consultations per day, ranging from 2.75 in December to 4.31 in October (figure 1).

Among the 30 patients requiring follow-up, the median duration of neurological follow-up was 7.5 days (IQR 3.25–10). When including both initial consultations and follow-up visits, the

estimated total workload reached 587 neurological evaluations, corresponding to an average of 9.32 evaluations per effective working day.

3.4. Distribution of consultations by requesting department

The Emergency Department accounted for the highest proportion of consultations, representing 51.5% of the total (n = 123). This was followed by Cardiology (7.5%) and Hematology (6.7%), while the remaining departments each accounted for less than 6% of consultations (figure 2-3).

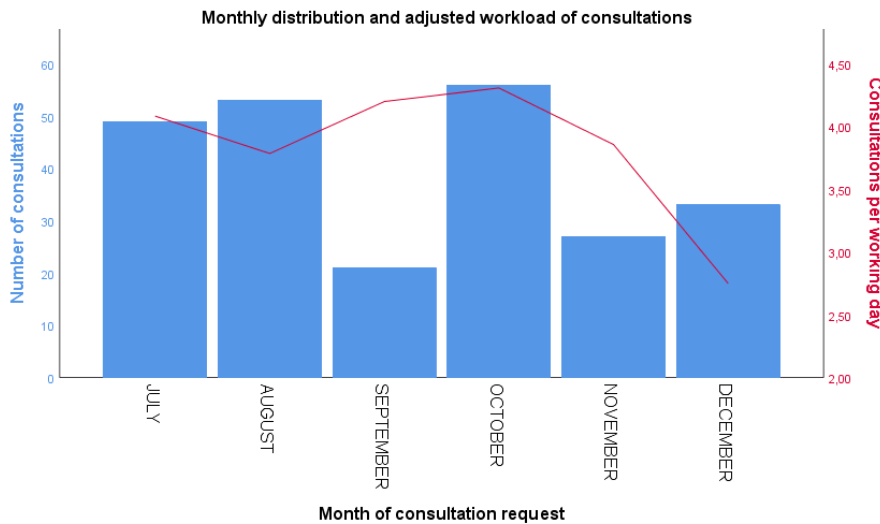


Figure 1. Monthly distribution of the volume and adjusted workload of neurological consultations per working day.

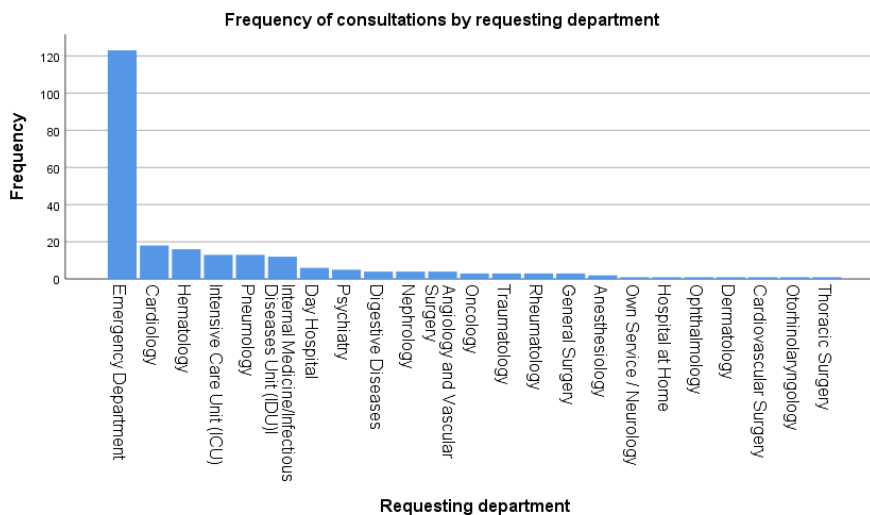


Figure 2. Distribution of neurological consultations by requesting service. Overall distribution including the Emergency Department.

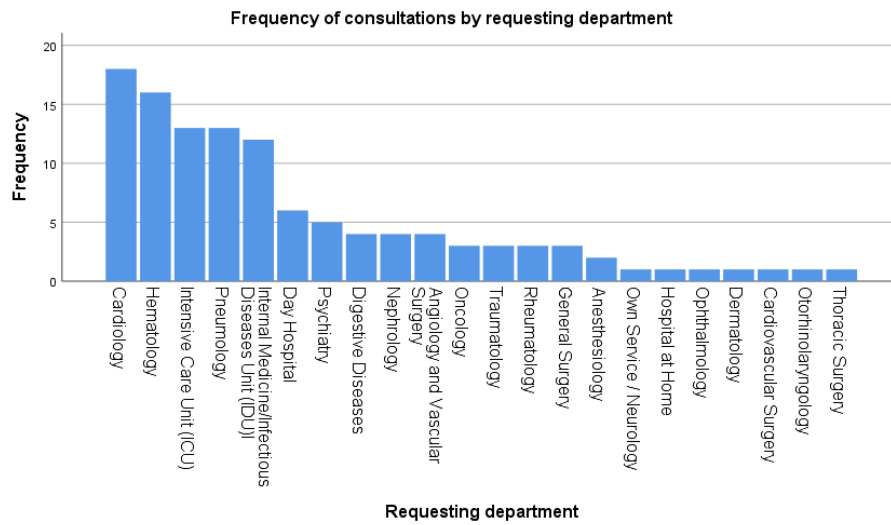


Figure 3. Distribution of neurological consultations by requesting service. Distribution excluding the Emergency Department to improve visualization of less frequent requesting services.

3.5. Independent predictors of hospital admission

Of the 239 consultations, 44 (18.4%) resulted in admission to the Neurology Department, most originating from the Emergency Department (88.6%). In bivariate analysis, urgent consultations (30.8% vs 2.8%; $p < 0.001$) and cerebrovascular disease (OR 6.84; 95% CI 3.38–13.85; $p < 0.001$) were significantly associated with hospital admission. Consultations from the Emergency Department also showed higher admission rates (31.7% vs 4.3%; $p < 0.001$).

Multivariate logistic regression (adjusted for age, priority, and vascular pathology) confirmed that cerebrovascular disease was the strongest independent predictor of admission (OR 6.36; 95% CI 2.77–14.61; $p < 0.001$). Urgent consultations remained strongly associated with admission, while non-urgent consultations had a markedly lower probability (OR 0.084; 95% CI 0.024–0.286; $p < 0.001$). The origin from the Emergency Department lost significance after adjustment, suggesting a confounding effect. The final model showed good discriminative ability (AUC 0.826; 95% CI 0.759–0.894; $p < 0.001$) (figure 4).

3.6. Clinical complexity of neurological consultations

Using a composite variable of case complexity (defined as hospital admission to Neurology or need for subsequent in-hospital follow-up), 72 out of 239 consultations (30.1%) were classified as complex.

Case complexity differed significantly by diagnosis ($\chi^2 = 45.747$; $p < 0.001$). The highest rates were observed in central nervous system infections (75%), neuromuscular diseases (50%), neuro-oncological disorders (50%), encephalopathy/confusional states (47.2%), and cerebrovascular disease (46.7%). In contrast,

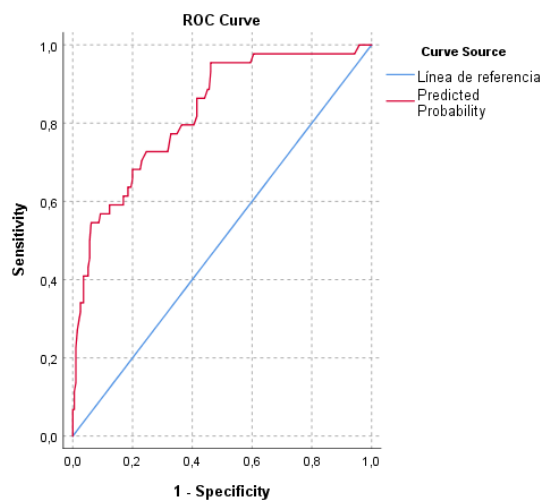


Figure 4. ROC curve of the multivariate model for predicting hospital admission. ROC curve of

headaches (8.3%) and functional neurological disorders (12.5%) were infrequently complex (table 1).

No significant differences in complexity were found between urgent and non-urgent consultations (33.1% vs 26.4%; $p = 0.264$) or between Emergency Department and other services (33.3% vs 26.7%; $p = 0.266$). However, consultations from the Intensive Care Unit showed the highest complexity (61.5%; $p = 0.011$), while those from medical–surgical/surgical services had the lowest (5.9%; $p = 0.024$).

There were no differences in time to evaluation between complex and non-complex cases ($p = 0.913$).

3.7. Response times and factors associated with care delays and hospital outcomes

The median time from consultation request to in-person evaluation was 0.20 hours (IQR 0.90), with a highly skewed distribution (figure 5). A delay longer than one hour occurred in only 11.7% of cases. Urgent consultations were evaluated significantly faster than preferential (non-urgent) ones (median 0.20 h [IQR 0.40] vs 0.50 h [IQR 0.80]; $p < 0.001$). Non-urgent consultations had a higher risk of delays exceeding one hour (OR 2.52; 95% CI 1.11–5.71; $p = 0.024$).

In bivariate analysis, patients who required hospital admission were evaluated earlier ($p = 0.020$). However, this association disappeared in multivariate analysis (OR 0.99; 95% CI 0.78–1.25; $p = 0.959$), indicating that shorter response times were primarily explained by the initial classification as urgent rather than by clinical outcome. Delays greater than one hour were not associated with the need for admission ($p = 0.661$).

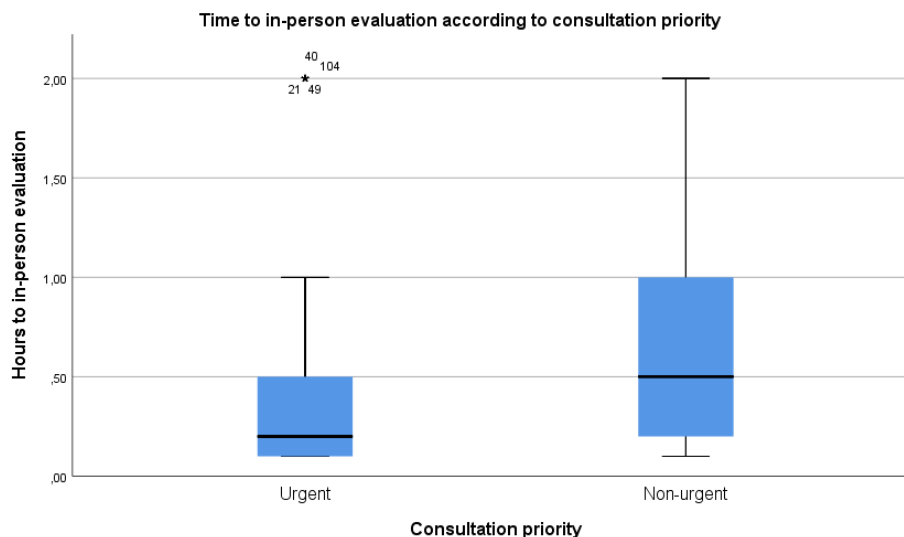


Figure 5. Distribution of time to in-person evaluation according to consultation priority. The Y-axis is limited to 2 hours to facilitate visualization of the main distribution.

3.8. Factors associated with subsequent hospital follow-up response times and factors associated with care delays and hospital outcomes

Of the 239 consultations evaluated, 30 (12.6%) required subsequent in-hospital follow-up. In multivariate analysis, consultation priority was independently associated with the need for hospital follow-up. Consultations classified as urgent showed a lower probability of requiring follow-up

compared to preferential consultations (OR 0.10; 95% CI 0.03–0.31; $p < 0.001$). No statistically significant associations were observed with age (OR 0.996; 95% CI 0.969–1.023; $p = 0.748$) or the presence of cerebrovascular disease (OR 2.55; 95% CI 0.61–10.72; $p = 0.201$).

In an alternative model that included the type of requesting service, consultations from medical–surgical services were independently associated with a higher probability of requiring subsequent hospital follow-up (OR 13.27; 95% CI 1.23–143.07; $p = 0.033$). However, the wide confidence interval reflects the low number of events in some categories.

Among patients who required follow-up ($n = 30$), no statistically significant differences were observed in follow-up duration according to diagnostic category (Kruskal–Wallis $H = 6.66$; $df = 7$; $p = 0.465$). Although some categories showed higher mean ranks, particularly central nervous system infections and conditions related to onco-hematological therapies, the small number of patients per group (in several cases $n \leq 2$) substantially limited the statistical power, preventing detection of potentially relevant differences between diagnostic categories.

4. Discussion

This prospective study describes intrahospital neurological consultations performed by a fourth-year resident in a tertiary hospital, showing a high workload, rapid response times, and a clear association between diagnostic categories and hospital admission or clinical complexity. These findings highlight both the care burden of consultations and their relevance as a potential workplace-based learning environment during neurology residency training.

Cerebrovascular disease was the most frequent diagnosis (25.1%), consistent with previous tertiary care series. Unlike earlier reports where epilepsy ranked second, encephalopathy and confusional syndromes predominated, likely reflecting population aging and increasing multimorbidity, where metabolic, toxic, or systemic disturbances of en present with acute neurological symptoms. Notably, 14.2% of consultations revealed no neurological disorder, underscoring the neurologist's role not only in diagnosis but also in clinical stratification and exclusion of significant pathology, supporting other specialties in complex cases.

Cerebrovascular disease was strongly associated with hospital admission and remained an independent predictor in multivariate analysis, consistent with its clinical severity and need for specialized monitoring. Approximately 30.1% of consultations required greater continuity of care (admission or follow-up). Complexity was mainly associated with specific diagnostic categories, including central nervous system infections, neuromuscular and neuro-oncological diseases, confusional states, and cerebrovascular disease, suggesting that underlying pathology, rather than organizational factors, determines complexity. Complex cases may provide relevant educational opportunities, requiring clinical reasoning under uncertainty, a core competency in medical training⁵. Current educational models emphasize progression from competency acquisition toward expertise through integration of knowledge and clinical judgment (6).

Complex consultations were more frequent in intensive care units, reflecting higher patient severity and comorbidity, whereas medical-surgical services showed lower complexity, of en involving targeted or transient conditions. Response times indicated efficient workflow, with a median below one hour and shorter delays in urgent cases. Although admitted patients were initially evaluated earlier, this association disappeared af er adjusting for priority, indicating that response time was driven by urgency classification rather than outcome. No differences were observed between complex and non-complex cases.

Consultation workload extended beyond initial assessment. Among patients requiring follow-up, median duration was 7.5 days, implying repeated evaluations. Overall activity exceeded nine assessments per working day, highlighting consultation as a dynamic process with significant implications for workload and resource allocation. From an organizational perspective, consultations represent a substantial component of Neurology service activity, particularly in settings with limited staffing.

Educationally, intrahospital consultation may constitute an advanced workplace-based learning environment (7), requiring supervised autonomy, prioritization, management of uncertainty, and inter-specialty communication. For example, the frequent exposure to acute cerebrovascular disease, encephalopathy, and diagnostic uncertainty may facilitate the development of prioritization strategies, rapid clinical decision-making, and diagnostic reasoning under pressure. Likewise, the interaction with multiple hospital departments may reinforce interdisciplinary communication and collaborative clinical management, which are considered essential competencies within contemporary competency-based medical education frameworks. From the perspective of experiential learning and cognitive apprenticeship models⁸, progressive participation in authentic clinical scenarios may facilitate the development of clinical reasoning and decision-making skills in real-world contexts. In this setting, consultations may provide experiential exposure to diagnostic uncertainty and interdisciplinary collaboration during residency training, potentially supporting progressive clinical autonomy.

Strengths of this study include its prospective design, systematic data collection, and consecutive case inclusion, reflecting real-world clinical practice. Limitations include the single-center design, moderate sample size, short recruitment period, and exclusion of on-call and stroke code activity. Additionally, because the unit of analysis was each individual consultation, some patients may have generated multiple consultations during the study period, potentially introducing partial dependence between observations and affecting regression estimates. However, consultations were intentionally analyzed individually because repeated neurological evaluations constitute an inherent component of real-world in-hospital consultation activity and continuity of care. Furthermore, all consultations were performed by a single fourth-year neurology resident, whose level of training and prior clinical experience may have influenced clinical decision-making, perceived case complexity, prioritization, and response times. Consequently, the findings should be interpreted considering these methodological limitations and may not be directly generalizable to residents at earlier stages of training or to other institutional settings. Finally, lack of analysis by consultation reason and the use of hospital admission as a proxy for severity may limit interpretation and underestimate clinical complexity.

5. Conclusions

- Intrahospital neurological consultations represent an essential component of clinical activity and a potentially valuable training environment for residents, providing broad exposure to diverse neurological conditions and real-world clinical decision-making scenarios. Vascular pathology was primarily associated with hospital admission, whereas subsequent follow-up was more closely related to continuity-of-care needs. The prospective quantification of this activity provides relevant insights for workload assessment, resource planning, and a better understanding of the resident's role within the functioning of the Neurology service.
- From an educational perspective, in-hospital neurological consultations may constitute a workplace-based learning environment that offers opportunities for experiential exposure to diagnostic uncertainty, interdisciplinary communication, prioritization, and supervised clinical decision-making. These experiences may potentially support competency-based learning and progressive clinical autonomy during residency training, while also

reinforcing the educational relevance of consultation-based activities within postgraduate neurology curricula.

- The main take-home message is that intrahospital neurological consultations combine substantial clinical workload with unique educational opportunities, making them a potentially essential component of competency-based neurology residency training.

Funding: There was no funding.

Declaration of conflict of interest: The authors declare that they have no conflict of interest.

Author contributions: J.F.G.G. conceived and designed the study, collected the data, performed the statistical analysis, interpreted the results, and drafted the manuscript. A.N.G.H. and F.H.C.N. contributed to study supervision, interpretation of the findings, and critical revision of the manuscript for important intellectual content. All authors reviewed and approved the final version of the manuscript.

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