IMPROVING APPROPRIATE USE OF INTRAVENOUS IMMUNOGLOBULIN IN NEUROLOGICAL DISORDERS AT HOSPITAL KUALA LUMPUR

Tan Ai Leen[1], Ziran Nadiah Ghazali[1], Dhayalen Krishnan[2], Yeak Chee Yan[1], Hazrin Mohamed Radzi[1], Wan Noor Hazimah Wan Harun[1], Mohd Izwan Che Nuddin[2], Farizan Abdul Ghaffar[1], Shanthi Viswanathan[2]

[1] Department of Pharmacy, Hospital Kuala Lumpur, Ministry of Health Malaysia

[2] Department of Neurology, Hospital Kuala Lumpur, Ministry of Health Malaysia

Corresponding Author: Tan Ai Leen
Email: aileentan@moh.gov.my

Abstract

Intravenous Immunoglobulin (IVIG) therapy is used in various immune-mediated, inflammatory and immunodeficiency disorders. The appropriate use of IVIG can be defined as its correct indication, dose, frequency, duration and administration. A verification study conducted between October and December 2021 revealed that 61.2% of IVIG usage in neurological disorders was inappropriate, potentially exposing patients to unfavourable clinical outcomes and risk of adverse events. This study aimed to increase the percentage of appropriate IVIG use in neurological disorders, setting a standard of 95%. A quality improvement study was conducted from 2021 to 2024, involving all IVIG cases initiated at neurology wards and clinics. Patients receiving IVIG treatment were assessed for its appropriateness. Findings from the survey among healthcare workers showed that the contributing factors to inappropriate IVIG use were easy IVIG accessibility, uncertainty of indications, unsure proper administration and dose, prolonged treatment duration and the absence of standardised local guidelines. In Cycle 1, indications were streamlined by prioritising peripheral nervous system disorders and limiting treatment initiation to consultants. The IVIG infusion guide was developed to educate nurses. During Cycle 2, an IVIG indication priority table was established by classifying neurological disorders into four classes of priority based on clinical evidence. An electronic spreadsheet-based IVIG dose calculator and administration chart facilitated accurate dosage calculations and appropriate monitoring. Lastly, in Cycle 3, an IVIG guideline for neurological disorders was developed, intended as a standard guide in *Hospital Kuala Lumpur*. The proportion of appropriate IVIG use increased from 38.8% at baseline to 52.3% in Cycle 1, 87.0% in Cycle 2 and 96.5% in Cycle 3. Conversely, Achievable Benefit Not Achieved decreased from 56.2% to 42.7% in Cycle 1, and was further reduced to 8.0% in Cycle 2 and -1.5% in Cycle 3. Additionally, proper monitoring allows early detection of infusion-related reactions. The IVIG guideline will be further promoted to other departments within HKL and to neurology centres throughout Malaysia.

KEYWORDS: Intravenous immunoglobulin (IVIG), neurological disorders, appropriate use, drug utilisation, quality improvement study

Problem

Intravenous Immunoglobulin (IVIG) is an essential yet limited and costly therapeutic resource, widely utilised across various medical specialities. It is listed in the Ministry of Health (MOH) Drug Formulary as an immunomodulatory or replacement therapy with various brands and strengths available in MOH facilities (1). At *Hospital Kuala Lumpur* (HKL), IVIG is used primarily for neurological disorders, followed by other disciplines such as internal medicine, pediatrics and nephrology. IVIG is used in both acute neurological emergencies and as induction and maintenance therapy for chronic neurological disorders. It is primarily indicated for conditions such as Guillain-Barré Syndrome (GBS), Chronic Inflammatory Demyelinating Polyneuropathy (CIDP), Myasthenia Gravis (MG) and Autoimmune Encephalitis (AE) (2).

However, appropriate utilisation remains a critical challenge, accompanied by massive financial expenditure and widespread off-label indication. In 2021, IVIG was the second most procured item at HKL, with a total expenditure of MYR10,173,111.20 (USD2,490,286.06 as of August 2026). Of this amount, MYR8,335,249.80 (USD2,040,394.13 as of August 2026) was spent on IVIG for neurological disorders. Despite this high expenditure, an estimated 97.0% (n = 67) of total IVIG use was for off-label indications such as Acute Disseminated Encephalomyelitis (ADEM), AE, and MG in 2021. In this study, off-label indication is defined as an indication that is not listed in the MOH Drug Formulary. A verification study was conducted between October and December 2021 in HKL's Neurology wards and clinics showed that 38.8% of IVIG prescriptions for neurological disorders were appropriate. The appropriate use of IVIG can be defined as its correct indication, dose, frequency, duration and administration (3,4).

This significant gap between resource consumption and appropriate clinical IVIG utilisation directly impacts HKL. As the flagship tertiary referral hospital under MOH Malaysia, HKL operates 83 wards with 2,300 beds and manages complex cases from public and private healthcare facilities nationwide. Neurological care is centered within the Neurology Department at the Tunku Abdul Rahman Neurology Institute (*Institut Kajisaraf Tunku Abdul Rahman* [IKTAR]), Malaysia's first and largest neuroscience centre and also at the Specialist Complex and Ambulatory Care Centre (SCACC). The service manages two neurology wards (52 beds) and a high-volume outpatient clinic treating 200–300 patients daily. Care delivery and medication management are led by 40 doctors (medical officers, specialists, and consultants), 69 staff nurses, two ward pharmacists, and two pharmacy supply units staffed by 28 pharmacists.

In addressing the practice gap, this quality improvement project aimed to increase the percentage of appropriate IVIG use for neurological disorders at HKL from 38.8% to the target standard of 95% (3,4) within a three-year timeframe.

Background

Immunoglobulins are fractionated blood products derived from pooled human plasma of over a thousand healthy blood donors. The end products primarily consist of immunoglobulin G (IgG) molecules (>90%), along with trace amounts of other immunoglobulins and excipients such as stabilisers and sodium (5,6). Immunoglobulin is an effective anti-inflammatory and immunomodulatory therapy for various immune-mediated or inflammatory disorders, and is also used as replacement therapy for immunodeficiency disorders. It is most commonly administered via the intravenous (IV) route.

A study conducted by Lee et al. (5) on prescribing practices of IVIG in government tertiary care hospitals in Malaysia found that the highest usage of IVIG was for neurological conditions (47.9%), followed by immunological conditions (27.5%) and haematological conditions (20.0%). The common neurological conditions that required IVIG therapy were GBS, CIDP, MG and AE. The study also reported that 79.0% of the prescriptions analysed had appropriate dosing (5).

This local finding highlights a gap with previous studies, such as Foster et al. (3), who reported that 93.1% of IVIG use was for appropriate indications in intensive care units across five community and academic hospitals in Canada, and Fakhari et al. (4), who found that 96.0% of IVIG administrations were appropriate in one of the largest referral hospitals in Iran.

Inappropriate use of IVIG in neurological disorders can lead to poor clinical outcomes, increase treatment costs and a higher risk of adverse events from improper administration (7,8). Several factors may have contributed to this issue, including the lack of standardised protocols, easy access to IVIG, and the absence of interdisciplinary referral teams.

Despite its clinical benefits, global demand for IVIG has consistently outpaced supply. In 1997, demand for IVIG surpassed supply by 20.0%, rising to 30.0% in 1998 (9). In 2019, the United States faced an insufficient supply of IVIG, resulting in local shortages and rationing. The unprecedented coronavirus disease 2019 (COVID-19) pandemic further exacerbated pressure on the IVIG supply. This global health crisis has not only reduced the donor pool (10), but also increased demand due to the off-label use of IVIG as an adjunctive treatment for COVID-19 infection and its related complications (11–13).

In Malaysia, concerns about IVIG utilisation extend beyond supply shortages. A study found that 57.5% of IVIG prescriptions in government tertiary care hospitals in Malaysia were for FDA off-label indications, such as ADEM, AE and MG (5). This finding highlights a critical need to assess the appropriateness of IVIG therapy for off-label indications. In 2023, the National Blood Centre of Malaysia issued a directive to restrict the use of IVIG for off-label indications, citing severe disruption to IVIG supply due to a shortage of plasma.

Similarly, a study by González-Guerrero et al. (14), which included 100 patients treated with IVIG for inflammatory systemic diseases, found that 59.0% of IVIG therapies should have been reviewed, as they were prescribed for non-evidence-based indications or in cases with an unclear diagnosis. The inappropriate use of IVIG was mainly attributed to the physician's individual discretion and the absence of local consensus guidelines, leading to potentially questionable IVIG prescriptions (14).

Solís-Díez et al. (15) further suggested that the increasing use of IVIG was likely to persist in the absence of robust clinical evidence to clarify its appropriateness and to establish a framework for prioritising access to IVIG. There is also a need to emphasise the importance of dose optimisation. Adjusting the IVIG dose based on ideal body weight is a preferable strategy. As biological agents primarily distribute within the central compartment, it is appropriate to account for excess adipose tissue, which is poorly perfused, when determining weight-based dosing. This approach not only strengthens the pharmacokinetic rationale but also reduces IVIG consumption, thereby promoting both efficacy and cost-effectiveness in therapy (15).

In Malaysia, while many institutions may have created local policies to monitor and control the IVIG dispensing process (15,16), there were no authorised policies governing its use. This gap in policy oversight may help explain the numerous conditions receiving unnecessary IVIG prescriptions (16). Hence, a national IVIG guideline is needed to ensure practices on IVIG use are standardised across all institutions in the country.

Efforts to optimise IVIG utilisation have shown promising outcomes. A multifaceted intervention conducted by Solís-Díez et al. (15) in Spain assessed clinical adequacy, optimised indications and dosing, and ensured equitable supply across centres. The study demonstrated a significant reduction in IVIG consumption within a short period following the intervention. These findings underscore the importance of an evidence-based and systematic approach to ensuring appropriate use of IVIG. Additionally, the establishment of a standardised consensus protocol is crucial for improving and regulating IVIG utilisation effectively (17).

With the growing clinical utilisation of IVIG for both approved and off-label indications, concerns are rising over potential supply shortages that could significantly impact patient care. Furthermore, Malaysia currently lacks locally tailored clinical guidelines and a robust surveillance system to monitor IVIG administration, including infusion practices, dosing regimens, and the management of adverse events. Therefore, it is crucial to establish regulations and to promote the rational use of this valuable medication to ensure its sustainable and effective utilisation (16).

The financial burden of inappropriate IVIG use is significant. A study by Dawoud et al. (18) in Abu Dhabi estimated the annual cost of IVIG at USD1.25 million, of which USD0.7 million was attributed to inappropriate indications. Similarly, a Malaysian cost analysis by Choo et al. (19) reported that 47.4% of cases involved IVIG use for indications with a lower evidence category and 66.7% were supported by a lower strength of recommendation. Over two years, the total cost of IVIG use was MYR695,426.36 (USD170,234.11 as of August 2026), with MYR267,993.40 (USD65,598.36 as of August 2026) (38.5%) spent on indications with a lower evidence category. Notably, immunoglobulin use in rheumatology and neurology cases was significantly associated with a lower evidence category ($p < 0.001$).

Measurement

A quality improvement study was initiated by a team comprising consultant neurologists, pharmacists and a neurology registered nurse dedicated to improving the appropriate use of IVIG in neurological disorders at HKL. The study was conducted from October 2021 to July 2024 using a universal sampling, in which all patients receiving IVIG for neurological disorders at two neurology wards and the Neurology Clinic were assessed for appropriateness of use.

The appropriate use of IVIG is defined as the following (3,4):

a) Correct indication - Indicated for GBS, CIDP, Multifocal Motor Neuropathy (MMN), MG crisis, AE and ADEM.
b) Correct dose - Dose is based on actual body weight or adjusted body weight for patients with BMI >30 kg/m^2.
c) Correct frequency - Once daily dosing.
d) Correct duration - Five days treatment duration for acute indication and cyclical regimen every 3-6 weeks, then slowly titrate according to patients' response for chronic indication.
e) Correct administration - Correct IVIG infusion rates, monitoring and documentation of vital signs and any adverse reactions during IVIG infusion were ensured and counterchecked by two personnel (a nurse and/or a pharmacist).

All five of the above-mentioned criteria had to be met throughout the treatment period for IVIG use to be considered appropriate. The key indicator for improvement was measured using the percentage of appropriate use of IVIG for neurological disorders. The target standard was set at 95%, derived and determined from two studies. Foster et al. (3), reported that 93.1% of IVIG use in intensive care units was for appropriate indications, while Fakhari et al. (4) reported that 96% of IVIG administrations were appropriate in one of the largest referral hospitals in Iran.

$$\textit{Percentage of appropriate use of IVIG in neurological disorders} = \frac{\textit{Number of patients with appropriate use of IVIG for neurological disorders}}{\textit{Total number of patients treated with IVIG for neurological disorders}} \times 100$$

A verification study was carried out from October to December 2021 using universal sampling to measure the percentage of appropriate IVIG use for neurological disorders. Indications, dose, frequency, duration, and administration of IVIG were analysed using patients' medical records, IVIG usage records, and the IVIG Assessment Form. Medical records were

retrieved with permission from the Medical Records Department and reviewed by the team members. Results from the verification study showed that among 67 patients treated with IVIG for various neurological disorders in the wards and clinics over the three months, only 26 patients (38.8%) received IVIG appropriately for neurological disorders. Additionally, monitoring of infusion-related reactions and other adverse events during IVIG infusion was not documented in a standard format for all cases of IVIG therapy. This implies a lack of effective monitoring during IVIG administration. Problem analysis, formulation and implementation of remedial measures, as well as data collection and analysis, were implemented from January to December 2022 (Cycle 1), January to December 2023 (Cycle 2), and January to July 2024 (Cycle 3). Following Cycles 1 and 2, re-evaluation and refinement of remedial measures were conducted to achieve the established standard. The same sampling technique and data collection tools were used throughout the study. Data analysis was performed using Microsoft Excel.

Initial Assessment of the Problem

A problem analysis diagram was developed to identify factors contributing to the inappropriate use of IVIG in neurological disorders (Figure 1). A questionnaire-based survey using convenience sampling was conducted among 114 healthcare providers (HCPs), including doctors, pharmacists, and nurses working in the neurology wards, neurology clinic, and two pharmacy units at HKL. The purpose of the survey was to assess perceived factors contributing to inappropriate IVIG use.

The analysis revealed four main perceived factors contributing to inappropriate use of IVIG in neurological disorders: unsure indication of IVIG (27.0%, n=31), unnecessary prolonged use of IVIG (22.8%, n=26), easy accessibility of IVIG (20.2%, n=23), and unsure proper administration of IVIG (9.6%, n=11) (Figure 2).

The process of care for the use of IVIG was reviewed, and the critical steps for improvement were identified, as shown in Figure 3. Six critical steps were identified; (i) Patient indicated for IVIG treatment (establishment of a neurological diagnosis to be treated with IVIG); (ii) Doctor prescribes IVIG; (iii) Pharmacist screens prescription for any intervention; (iv) Pharmacist supplies IVIG; (v) Nurse administers IVIG; and (vi) Nurse monitors any adverse reaction and record patient's parameter. All critical steps were objectively measured in our study. A Model of Good Care (MOGC) was developed, incorporating criteria and standards for all critical steps identified, as shown in Table 1.

Strategy

Several strategies were developed with input from doctors, pharmacists and nurses. The remedial measures were implemented in three cycles, with five strategies in Cycle 1, six in Cycle 2, and three in Cycle 3.

In Cycle 1, the first strategy involved a series of meetings and discussions among consultant neurologists and pharmacists to prioritise the use of IVIG for peripheral nervous system disorders such as GBS, CIDP, MMN and for life-saving indications such as ADEM, MG crisis and AE. During the verification study, 41.8% of IVIG cases in neurological disorders in 2021 were utilised for indications not specified in internationally established guidelines (20–24).

The second strategy was to address the unnecessary prolonged use of IVIG. Consultant neurologists and pharmacists reviewed all IVIG cyclical cases in chronic neurological disorders. During Cycle 1, 79 stable CIDP and MMN patients from the ward and clinic were identified to be on cyclical IVIG as maintenance treatment. Thirty-nine of 79 patients (49.0%) had their treatment cycles reduced from 12 IVIG cycles per year to six cycles per year in accordance with the European Federation of Neurological Societies/Peripheral Nerve Society (EFNS/PNS) guideline (25). Patients' symptoms and progress were closely monitored using the nerve conduction studies at each IVIG cycle change.

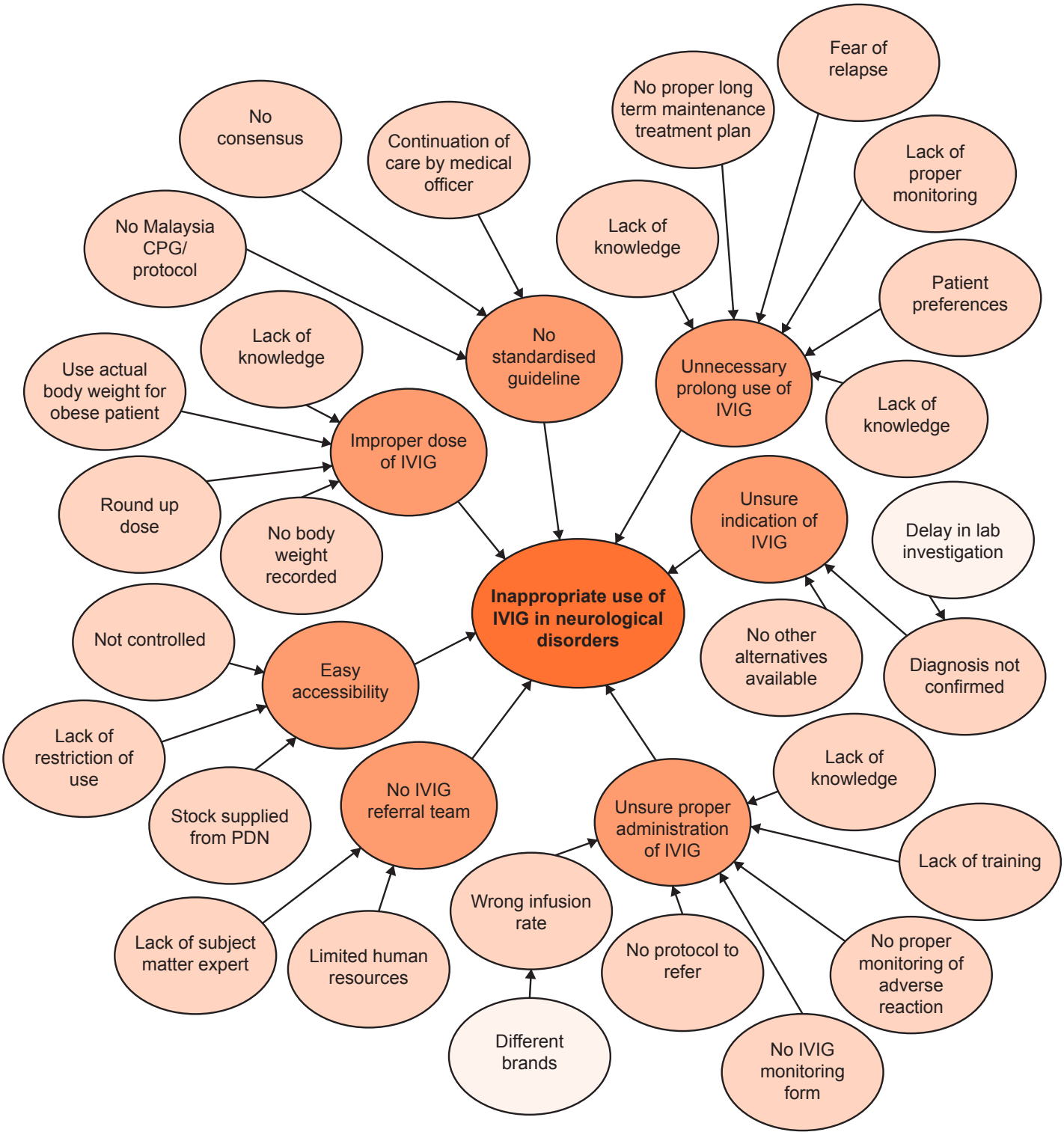


Figure 1: Problem analysis chart of factors contributing to inappropriate use of IVIG in neurological disorders at HKL

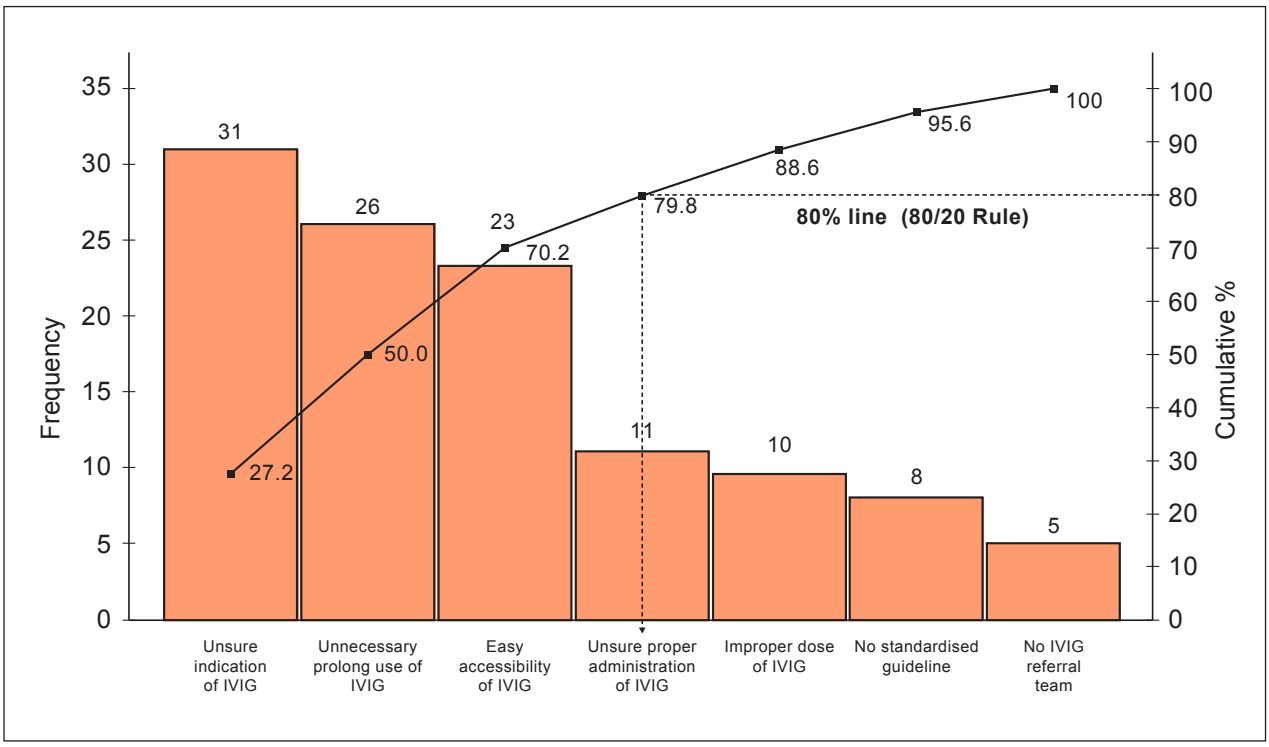


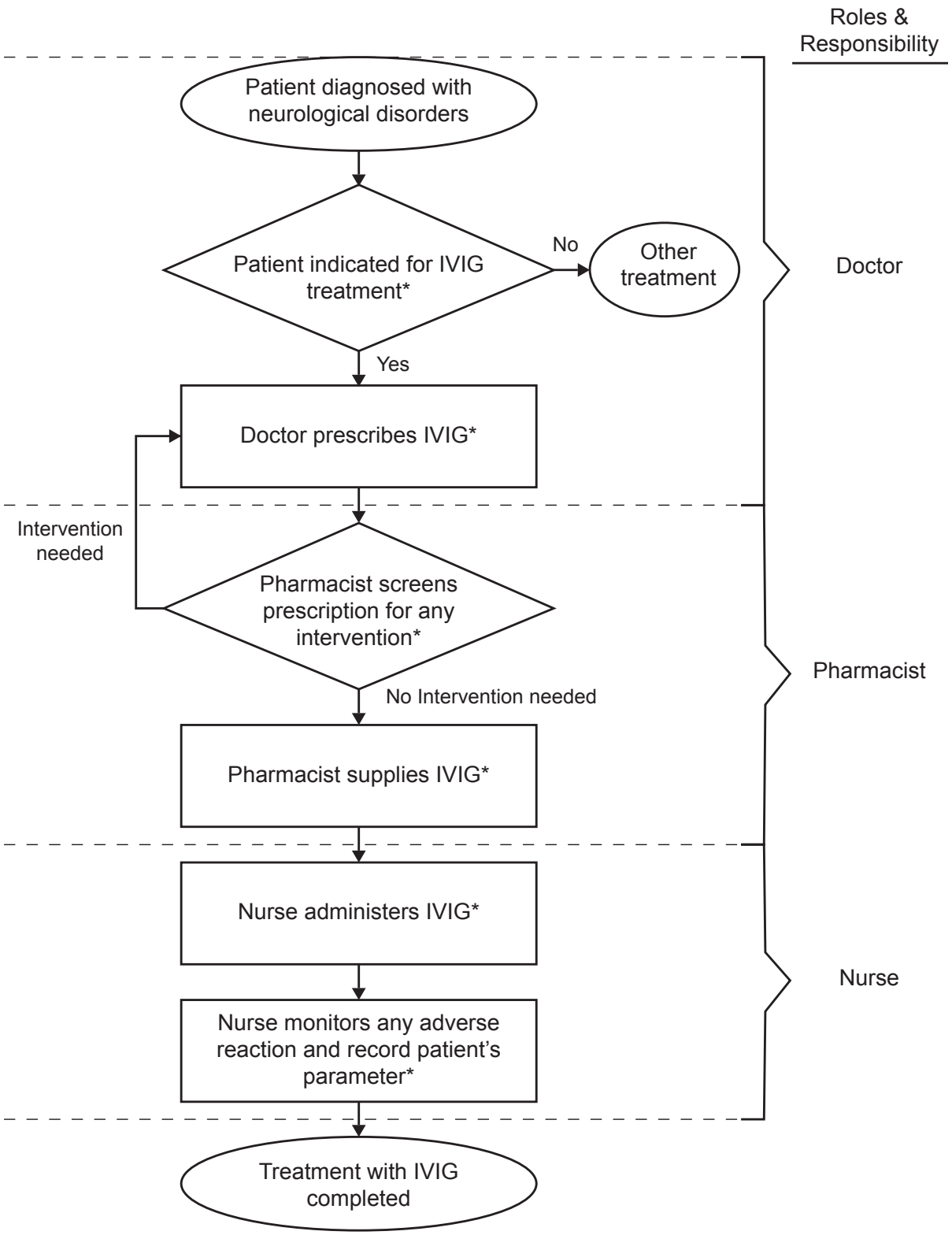
Figure 2: Pareto chart illustrating the factors contributing to inappropriate use of IVIG in neurological disorders

Thirdly, IVIG was listed in the HKL Controlled Drug List starting 31st January 2022 as a control mechanism to address the issue of easy accessibility. A circular from the Deputy Director (Pharmacy) HKL was issued to all clinical head of departments on 27 January 2022. All IVIG treatment in neurological disorders must be initiated and reviewed by a Consultant Neurologist.

The fourth remedial measure targeted nurses and addressed uncertainty regarding the proper administration of IVIG. Before the study, nurses were confused about the infusion rates, brands, and strengths of IVIG available in HKL and were uncertain about the common side effects associated with IVIG infusion. An IVIG Administration Guide (Appendix 1) was developed, containing information such as the strength and brand of IVIG available at HKL, infusion rate and common adverse effects (26). This guide was distributed to all neurology wards and clinics along with hands-on teaching sessions for nurses.

Throughout Cycle 1, two continuous medical education (CME) sessions were conducted in April 2022 for doctors and pharmacists, with 44 participants. The content of the CME sessions covered key aspects of IVIG, including its formulations, brands and strengths, clinical indications, appropriate dosing and administration practices, and essential monitoring parameters. Pre-test and post-test were performed to assess understanding and knowledge regarding IVIG. Pre-test showed an average score of 63.2%, while all participants scored above 90.0% in the post-test. Awards were given to the top scorers to encourage participation and learning. Two sessions of continuous nurse education (CNE) were conducted to train nurses on the correct administration and the need for proper monitoring during IVIG infusion. Pre-test showed an average score of 59.3%, while all participants scored above 85.4% in the post-test.

After completion of Cycle 1, ABNA reduced by 13.5% from 56.2% to 42.7%. However, the goal for improvement was to increase the proportion of appropriate IVIG use for neurological disorders to 95%. Hence, more strategies were implemented in Cycle 2 to address the gaps between the results of Cycle 1 and the standards set by the MOGC (Table 1).



*indicates critical steps

Figure 3: Flowchart of the process of care for the use of IVIG in neurological disorders at HKL

The sixth strategy focused on the establishment of an IVIG Indication Priority Table (Appendix 2) (26). Although IVIG were required for other neurological disorders, prioritisation of IVIG use for these indications had not been addressed in the previous cycle. A series of discussions among consultant neurologists and pharmacists was conducted to comprehensively review all existing local and international guidelines, consensus, and relevant journals related to IVIG treatment in neurological disorders. Twenty indications that require IVIG treatment in neurological disorders are categorised and colour-coded to reflect their prioritisation and mechanism of approval upon initiation of treatment based on:

- High Priority (Red Colour) - Approved indications listed in the registered product insert or indications listed in any local/international guideline
- Medium Priority (Blue Colour) - Indications are based on studies from an uncontrolled trial
- Low Priority (Grey Colour) - Indications are based on observational studies or expert consensus
- With little evidence (Black Colour) - Indications based on case reports or case series

This is also in line with the National Health Service (NHS) Intravenous Immunoglobulin (IVIG) prescribing guidance (21), which recommends prioritising IVIG indications supported by a higher level of clinical evidence and specified in established guidelines (22–24,27).

To address the absence of an IVIG referral team, the IVIG Neurology Panel Group was established as a platform to evaluate and approve low-priority indications with limited supporting evidence, as outlined in the IVIG Indication Priority Table (26). Additionally, the panel serves to disseminate updates on the latest information regarding IVIG supply. The group comprises nine members, including the Head of the Neurology Department, consultant neurologists, pharmacists and a neurology registered nurse at HKL.

The eighth strategy focused on the invention of a smart IVIG dose calculator (Appendix 3) to automate the calculation of the required IVIG dose for each patient, which can be easily accessed through Linktree. A QR code linked to the smart IVIG dose calculator was displayed at the neurology wards and clinic for easy accessibility. This calculator has been tested and validated by 44 healthcare professionals, including consultant neurologists, medical officers, and clinical pharmacists. The calculator accommodates various IVIG strengths, including 2.5g, 3.0g, and 5.0g, providing precise dosage calculation. The dosage for each patient can be entered into the orange cells, as indicated (Appendix 3), and the tool will automatically calculate the daily IVIG dose, thereby facilitating prescribing for clinicians.

To address issues related to the proper administration and monitoring of IVIG infusions, a standardised IVIG administration chart (Appendix 4) detailing infusion rates for different strengths of IVIG and infusion-related reactions was developed to ensure proper documentation and practice (28,29). This administration chart is kept in the patient's medical record for easy traceability. Hands-on training was conducted by ward pharmacists to raise awareness among nurses about the importance of close monitoring and documentation during IVIG infusion.

The CME in Cycle 1 covered only 40.0% of the targeted HCPs (n=73). Hence, two additional CME sessions were held at the HKL Auditorium, targeting all HCPs from other departments as well and reaching a total of 153 attendees. The content of the CME sessions covered all key aspects of IVIG therapy.

Cycle 3 was implemented with strategies bridging the gaps identified in Cycle 2. We had another discussion among the IVIG neurology panel group members to focus on other indications that were not specified in the IVIG priority table or with inappropriate treatment duration. The IVIG Neurology Panel Group reviewed and established the following additional criteria for other indications not specified in the priority table to be deemed as appropriate use of IVIG:

a) Patient failed/unable to tolerate first and second line treatment (plasma exchange/steroid/immunosuppressant).
b) Treatment duration – a fixed number of cycles must be decided upon initiation of treatment.

Taking a step further, the e-Guideline on Prescribing, Supplying and Administration of Immunoglobulin for Neurological Disorders in Hospital Kuala Lumpur (GPS-IG) (Appendix 5) (26) was developed and successfully published, with the Deputy Director (Pharmacy) of HKL and the Head of the Neurology Department as advisors. GPS-IG was also reviewed by subject matter experts to ensure its accuracy and clinical applicability. This is the first IVIG guideline in Malaysia and provides comprehensive guidance on the prescribing, supplying, and administration of IVIG for neurological disorders, aiming to guide healthcare personnel toward appropriate IVIG use. A QR code linking directly to GPS-IG on the Linktree page was displayed throughout all neurology wards, clinics, and pharmacy units to facilitate quick and easy access. Additionally, the GPS-IG is also accessible via the HKL website. Training sessions regarding GPS-IG were conducted by a pharmacist to all neurology wards, clinics, and pharmacy units. Finally, to promote the GPS-IG, the Deputy Director of Pharmacy formally introduced it at the HKL Neurology Workshop 2024, marking a significant milestone in advancing the appropriate use of IVIG. Attended by leading neurology experts, clinicians, and healthcare professionals, this workshop provided an ideal platform to showcase the guideline's value in optimising patient outcomes.

Results

Following the implementation of several strategies, the percentage of appropriate use of IVIG in neurological disorders increased from 38.8% (26/67) to 52.3% (126/241) in Cycle 1, 87.0% (194/223) in Cycle 2 and further to 96.5% (111/115) in Cycle 3. Correspondingly, the ABNA decreased from 56.2% to 42.7% in Cycle 1 and further reduced to 8.0% after Cycle 2 and finally to -1.5% in Cycle 3 (Figure 4).

All standards set in the MOGC showed improvements from the verification study to Cycle 3 (Table 1). With the establishment of the IVIG indication priority table, the appropriate indication for IVIG usage improved from 46.3% to 96.5%.

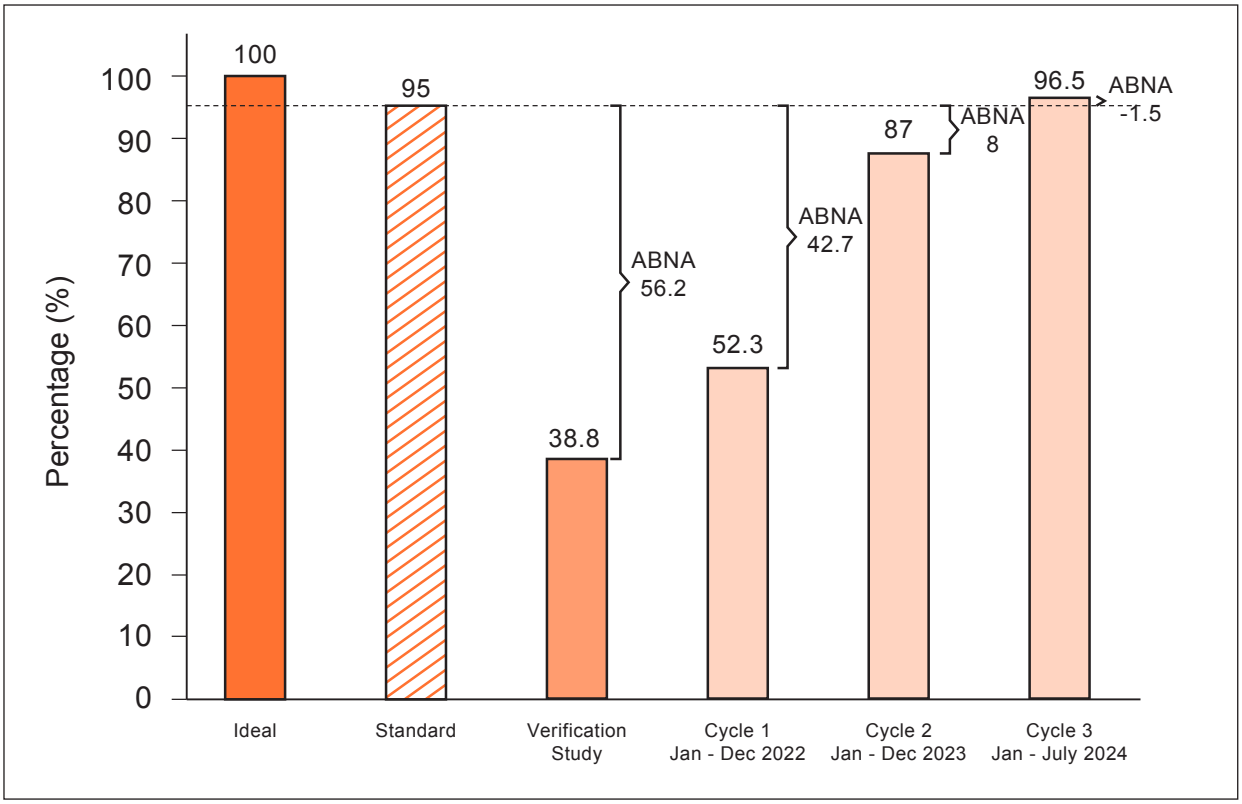


Figure 4: Percentage of appropriate use of IVIG in neurological disorders

The utilisation of the smart IVIG dose calculator ensured 100% appropriateness in IVIG dosing by the end of the Cycle. Additionally, by fixing the treatment duration upon initiation, the appropriateness of IVIG therapy duration for patients improved from 56.7% to 100%.

With close monitoring of vital signs and infusion-related reactions during administration of IVIG, 48hr infusion-related reactions were detected, and because of early detection and prompt management, all reactions were resolved. Patients' safety during IVIG administration had improved after Cycle 2. The correct IVIG infusion rate increased from 81.0% to 100% after the implementation of a more structured IVIG administration chart in Cycle 2. Moreover, monitoring of infusion-related reactions was well documented by nurses, with the documented rate increasing from 74.0% to 100% (Table 1).

The strategy implemented to address the inappropriate duration of IVIG treatment in Cycle 1 had benefited 39 stable CIDP and MMN patients (in remission), as patients' length of stay in the ward had reduced from 60 days (12 cycles) to 30 days (6 cycles) per year. During each IVIG treatment cycle, patients were required to be admitted to the ward for five days. Out-of-pocket expenses were also reduced, as the annual admission cost per year per patient decreased from MYR180 (USD44.14 as of August 2026) per year; MYR3 [USD0.73] per day x 60 days) to MYR90 (USD22.07 per year; MYR3 [USD0.73] per day x 30 days). In addition, the annual travel cost per patient was reduced from MYR480 (USD117.71; MYR20 [USD4.90] per trip x 24 trips) to MYR240 (USD58.86; MYR20 [USD4.90] per trip x 12 trips). Hence, the implementation of this quality improvement project successfully reduced patients' total out-of-pocket expenses (n=39) by up to MYR12,870.00 (USD3156.47 as of August 2026). Furthermore, with the appropriate use of IVIG in neurological disorders, the total number of IVIG vials used decreased from 14,066 vials in 2022 to 12,272 vials in 2023. This resulted in a substantial cost savings of MYR1.39 million (USD340,897.01 as of August 2026). A total of 1,794 IVIG vials saved were especially valuable during periods of severe supply disruption and could have been used to treat 38 patients with GBS or myasthenic crisis.

Table 1: MOGC for the use of IVIG in neurological disorders at HKL

Step	Critical Step	Criteria	Standard	Verification	Cycle 1	Cycle 2	Cycle 3
1.	Patient indicated for IVIG treatment	Doctor established a neurological diagnosis to be treated with IVIG	100%	46.3%	63.1%	88.3%	96.5%
2.	Doctor prescribes IVIG	Doctor prescribes correct dose of IVIG	100%	70.1%	73.4%	100%	100%
		Doctor prescribes correct frequency of IVIG	100%	100%	100%	100%	100%
		Doctor prescribes correct duration of IVIG	100%	56.7%	80.5%	92.8%	100%

3.	Pharmacist screens prescription for any intervention	Pharmacist screens prescription for correct indication of IVIG	100%	46.3%	73.4%	96.4%	96.5%
		Pharmacist screens prescription for correct dose of IVIG	100%	70.1%	88.0%	100%	100%
		Pharmacist screens prescription for correct frequency of IVIG	100%	100%	100%	100%	100%
		Pharmacist screens prescription for correct duration of IVIG	100%	56.7%	85.1%	98.7%	100%
4.	Pharmacist supplies IVIG	Pharmacist supplies correct drug and strength	100%	100%	100%	100%	100%
		Pharmacist supplies correct dose of IVIG	100%	100%	100%	100%	100%
		Pharmacist supplies correct frequency of IVIG	100%	100%	100%	100%	100%
		Pharmacist supplies correct duration of IVIG	100%	100%	100%	100%	100%
5.	Nurse administers IVIG	Nurse administers correct IVIG infusion rate	100%	81.0%	92.1%	100%	100%
6.	Nurse monitors any adverse reaction and records patient's parameter	Nurse monitors & documents vital signs during infusion of IVIG	100%	68.0%	78.0%	100%	100%
		Nurse monitors & documents for any adverse reactions	100%	74.0%	86.0%	100%	100%

Lessons and Limitations

This study demonstrated that problem verification and analysis were essential for identifying the main contributing factors and the gaps between current practice and established standards. The formulation of strategies should target these factors and address the identified gaps. The effects of change are most evident, with multidisciplinary involvement being vital towards shared goals. Multidisciplinary collaboration between doctors, pharmacists, and nurses is crucial for safe and appropriate use of IVIG in neurological disorders. Collaborative decision-making enhances understanding of IVIG's role, reduces overuse, and fosters team accountability.

Besides that, a standardised IVIG guideline was essential to advocate appropriate use of IVIG, reduce variability in clinical decisions, and ensure therapy is reserved for appropriate indications. By aligning practice with the latest evidence, the IVIG guideline helps ensure that IVIG is used for indications with proven efficacy while avoiding unsupported uses. Moreover, clear dosing protocols in guidelines prevent overuse, such as administering higher-than-recommended doses or prolonged IVIG courses without proven clinical benefit. This minimises the financial burden of inappropriate treatments and frees resources for patients with high-priority neurological disorders.

Despite the success, this study had its limitations and challenges. This study focused exclusively on the use of IVIG for neurological disorders at HKL. As such, the findings and strategies may not be generalisable to other medical specialities or conditions requiring IVIG therapy. By concentrating solely on neurology patients, the interventions and strategies implemented were tailored specifically to the needs and practices within this group of patients. While this approach allowed for targeted improvements, it did not address broader issues or potential areas for optimisation in IVIG use across other specialities, which may have different prescribing patterns or challenges.

Conclusion and the Next Steps

The study successfully achieved its goal of improving the appropriate use of IVIG for neurological disorders at HKL. The verification study revealed that IVIG was used appropriately in only 38.8% (n=26) of patients with neurological disorders, compared to the standard of 95%. The main contributing factors identified included unsure indication of IVIG, unnecessary prolonged use of IVIG, easy accessibility of IVIG, unsure regarding proper administration of IVIG, incorrect dose of IVIG, and the absence of a standardised guideline. Strategies formulated include prioritisation of IVIG indication, prolonged duration of cyclical IVIG treatment, list IVIG as control drug item in HKL, development of IVIG administration guide, establishment of IVIG indication priority table, formation of IVIG neurology panel group, invention of smart IVIG dose calculator, development and distribution of IVIG administration chart with hands-on teaching, CME & CNE, additional criteria for other indications of IVIG, publication and promotion of IVIG guideline (GPS-IG). Following three cycles of remedial measures, the percentage of appropriate IVIG use in neurological disorders improved from 38.8% at baseline to 52.3% in Cycle 1, increased to 87.0% in Cycle 2, and ultimately surpassed the target standard, reaching 96.5% in Cycle 3.

The appropriate use of IVIG also resulted in a reduction of 1,794 vials from 2022 to 2023, generating total cost savings of MYR1.39 million (USD340,897.01 as of August 2026). These conserved vials were particularly valuable during periods of severe IVIG supply disruption and could have been used to treat additional patients with GBS or myasthenic crisis. This suggests the potential positive impact of expanding the study to other departments at HKL, such as the medical and nephrology departments, as well as the sustainability of the project outcomes. At the same time, a discussion was held with the Head of Service (Neurology) at the national level, resulting in support to extend GPS-IG to other MOH and MOE facilities that provide IVIG therapy for neurological disorders. By expanding the

guidelines, more patients across Malaysia can benefit from evidence-based, optimised IVIG treatment. Standardised protocols for patient selection, dosing, and monitoring are expected to promote appropriate use of IVIG and potentially improve clinical outcomes.

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Conflict of Interest

The authors declare that there was no conflict of interest.

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Appendix 1: IVIG Administration Guide

Human Normal Immunoglobulin Solution for Infusion (IVIG) – NEUROLOGY CASES

Strength		**2.5g in 25mL & 10g in 100mL (10%)** 	**3g in 50mL (6%)** 	**2.5g in 50mL (5%)** 
Location	Farmasi Neurosains IKTAR (Ward N5A & N5B)	√	√	X
	Farmasi Klinik Pakar II SCACC (Klinik Neurologi)	X	√	√
	Farmasi Bekalan Wad (main block wards)	X	√	X
Supplying criteria		For Neurology wards **DURING office hours**	– Patients **allergic to IVIG 2.5g** (5% or 10%) – For Neurology clinic – For Neurology wards **AFTER office hours**	– For Neurology clinic
Run rate		25ml/hr (if needed, increase slowly to 50ml/hr	100ml/hr (50mL in 30 mins)	
Adverse reactions		Common: headaches, fatigue, backache, leg cramps, lightheadedness, fever, urticaria, flushing, slight elevation of blood pressure, nausea, vomiting. Serious side effects (rare): hypotension, angioedema, bronchospasms, dyspnea, renal failure, aseptic meningitis, transfusion-related lung injury, thrombotic events and anaphylaxis.		

n.b:

1. All IVIG JKUTs to be signed by consultant in-charge after verifying clearly the indication, calculating the dose and duration to be used.
2. All infusions (especially elective cases) preferably to be started during office hours.
3. Premedication to be used in patient on case-to-case basis

Verified by:

DR SHANTHI VISWANATHAN
(MMC 33569
MBBS (INDIA), FRCP (IRE)
Fellowship in Neurologi (Msia)
Pakar Perunding Kanan Neurologi &
Ketua Jabatan Neurologi
Jabatan Neurologi
Hospital Kuala Lumpur

(DR SHANTHI VISWANATHAN)
Pakar Perunding dan
Ketua Jabatan Neurologi HKL

Date: 31/8/2012

Prepared by Farmasi Neurosains, Jabatan Farmasi HKL

Appendix 2: IVIG Indication Priority Table

IVIG INDICATION PRIORITY TABLE
NEUROLOGY DEPARTMENT
HOSPITAL KUALA LUMPUR

Red (High Priority)	Blue (Medium Priority)	Grey (Low Priority)	Black (Little Evidence)
Guillain-Barre syndrome (GBS)	Paraneoplastic Neurological Syndrome	Cerebral infarction with antiphospholipid antibodies	Neuromyelitis optica spectrum disorder (NMOSD)
Chronic inflammatory demyelinating polyneuropathy (CIDP)	Inflammatory Myopathy	Chronic relapsing inflammatory optic neuritis (CRION)	New Onset Refractory Status Epilepticus (NORSE)
Multifocal motor neuropathy (MMN)	Myasthenia gravis (MG)	CNS vasculitis	Multiple sclerosis (MS)
Myasthenic crisis	Myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD)	Fulminant atypical demyelinating disease	Neuronopathy
Acute disseminated encephalomyelitis (ADEM)	Neuromyotonia	Stiff person syndrome	
Autoimmune encephalitis (AE)			

Verified by,

(DR SHANTHI VISWANATHAN)
Head of Neurology Department
Hospital Kuala Lumpur

DR SHANTHI VISWANATHAN
(MMC 33569)
MBBS (INDIA), FRCP (IRE)
Fellowship in Neurologi (Msia)
Pakar Perunding Kanan Neurologi &
Ketua Jabatan Neurologi
Jabatan Neurologi
Hospital Kuala Lumpur

Appendix 3: Smart IVIG Dose Calculator

Smart Intravenous Immunoglobulin (IVIg) Dose Calculator

Key in or select patient details in orange box:

Gender	Female
Height (m)	1.5
Actual Body Weight (kg)	80.0
	*BMI>30kg/m2, the calculator will use Adjusted Body Weight (ABW) to determine the IVIG dose
IVIg dose (g/kg per treatment course)	2
No. of days per cycle	5
Strength & Brand of IVIg	3g Intragam-P 6% (3g/50ml)

Auto-generated by the calculator:

Weight for IVIg dose calculation (kg)	58.2
	*BMI>30kg/m2, the calculator will use Adjusted Body Weight (ABW) to determine the IVIG dose

IVIg Prescription:

IV Immunoglobulin (IVIg)	Intragam-P 6% (3g/50ml)	**21**	**g**	**(Day 1)**
		21	**g**	**(Day 2)**
		24	**g**	**(Day 3)**
		24	**g**	**(Day 4)**
		24	**g**	**(Day 5)**

Prepared by Neuroscience Pharmacy HKL

Appendix 4: IVIG Administration Chart

Intravenous Immunoglobulin (IVIg) Administration Chart (10%)
Neurology Department, HKL
[Intragam® NexGen 5g/50ml (10%) / Privigen® 2.5g/25ml (10%) / Gamunex®-C 2.5g/25ml (10%) or 5g/50ml (10%)]

Patient Name		Ward/Clinic		Brand & Strength	
I.C No.		Body Weight		Batch number	

Date	Dose (g)	Infusion Rate (ml/kg/hr)	Infusion Rate (ml/hr)	Start Time	End Time	Reactions (if any)	Staff Nurse Name
		☐ 0.3 ml/kg/hr					
		☐ 0.6 ml/kg/hr					
		☐ 0.9 ml/kg/hr					
		☐ _____ ml/kg/hr *					
		☐ 0.3 ml/kg/hr					
		☐ 0.6 ml/kg/hr					
		☐ 0.9 ml/kg/hr					
		☐ _____ ml/kg/hr *					
		☐ 0.3 ml/kg/hr					
		☐ 0.6 ml/kg/hr					
		☐ 0.9 ml/kg/hr					
		☐ _____ ml/kg/hr *					
		☐ 0.3 ml/kg/hr					
		☐ 0.6 ml/kg/hr					
		☐ 0.9 ml/kg/hr					
		☐ _____ ml/kg/hr *					
		☐ 0.3 ml/kg/hr					
		☐ 0.6 ml/kg/hr					
		☐ 0.9 ml/kg/hr					
		☐ _____ ml/kg/hr *					

*State infusion rate if > 0.9ml/kg/hr

Appendix 5: Guideline on Prescribing, Supplying and Administration of Immunoglobulin for Neurological Disorders in Hospital Kuala Lumpur (GPS-IG) (First Edition 2024)(26)

