MOH/S/IPSK/160.19(BUL)

KEMENTERIAN KESIHATAN MALAYSIA
INSTITUT PENYELIDIKAN SISTEM KESIHATAN

Q BULLETIN

Ministry of Health Malaysia

VOLUME 1, NO. 35,
JAN-DEC 2026
ISSN: 1985-0131

Journal for Quality Assurance/
Quality Improvement in Healthcare

Q BULLETIN

Ministry of Health Malaysia

VOLUME 1, NO 35, JAN-DEC 2026



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Nurhidayah Mohamad Som and Fatimah Amirah Zakaria. Reducing Protein Wastage Among Surgical and Oncology Patients on High-protein Diet in Hospital Pakar Sultanah Fatimah, Muar, Q Bulletin, 2026; 1 (35): 11-27

ISSN: 1985-0131
e-ISSN: 2716-6554

The Q Bulletin of the Ministry of Health Malaysia is a peer-reviewed journal addressing quality assurance/improvement study related to health care. The journal welcomes original contribution from representatives of all health professions from health-related backgrounds in the discipline of quality assurance/quality improvement

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The views expressed in the articles are those of the authors and do not necessarily reflect the views of the Institute for Health Systems Research.

Acknowledgements

The Editorial Board Q Bulletin Journal would like to thank the Director General of Health, Malaysia for the permission to publish the articles in this journal. We would like to convey our gratitude to all **reviewers** for their time and contributions towards the publication of this issue.

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Our heartfelt appreciation to the **proofreaders** below for proofreading of the manuscript.

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EDITOR'S NOTE

Dear Quality Alliance Readers,

Welcome to another edition of **Q Bulletin**.

One of the strengths of quality improvement is that it can begin almost anywhere a gap in care is recognised. This edition showcases projects across hospital and primary care settings – spanning nutrition, medication safety, appropriate use of high-cost therapy, anticoagulation management, dental radiography, and timely oral healthcare for older adults with contributions from medical, pharmacy, allied health and dental teams.

The project addressing **protein food wastage among patients requiring a high-protein diet** is a particularly refreshing example. Hospital food waste is more than an operational issue – it is a **nutritional quality issue**. When patient requiring a high-protein diet don't consume their meals, their recovery is compromised. The project therefore invites us to look beyond the amount of food discarded and ask a more patient-centred question: *Is the nutritional care provided actually reaching and benefiting the patient?*

Medication-related quality projects in **antibiotic renal dosing, intravenous immunoglobulin (IVIG)** use, and **warfarin Time in Therapeutic Range (TTR)** show how pharmacists drive clinical quality beyond traditional supply roles. By collaborating across specialties—including neurology, renal, and primary care teams–these initiatives demonstrate a shift from isolated departmental projects towards co-designed and co-created solutions for shared clinical problems.

Oral health projects in this edition highlight how technical efficiency directly improves patient care. Reducing **intra-oral periapical radiograph rejection** prevents redundant radiation, delays, and wasted resources. Similarly, **streamlining denture provision** for older adults goes beyond meeting waiting-time targets- it delivers timely care that directly *improves function, nutrition, communication, and overall quality of life.*

Perhaps the most encouraging message from this collection is the growing emphasis on **working together**. Sustainable improvement relies on multidisciplinary collaboration, co-design, co-creation, and ultimately co-production, shifting the mindset—from *"my project" towards "our system and our patients*." From meal trays and prescriptions to radiographs and dentures, these six studies show that everyday clinical touchpoints offer vital opportunities to enhance healthcare delivery.

Let us explore how these teams identified quality gaps in their settings, united their diverse expertise, and translated original ideas into measurable improvement.

Enjoy your reading!

Dr Samsiah Awang

Editor-in-chief

REDUCING PROTEIN WASTAGE AMONG SURGICAL AND ONCOLOGY PATIENTS ON HIGH-PROTEIN DIET IN HOSPITAL PAKAR SULTANAH FATIMAH, MUAR

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Abstract

Surgical and oncology patients with ongoing treatment require a high-protein diet (HPD). Traditionally, in *Hospital Pakar Sultanah Fatimah* (HPSF), an indicated HPD patient was served up to four types of protein food (PF) per serving, leading to high food waste. In hospital settings, food wastage signifies inadequate nutrient intake and is linked to the cost and environmental impact. In HPSF, 63.5% PF wastage was recorded in 2019. A two-cycle-quality improvement study was conducted between January 2019 and February 2020 among all eligible surgical inpatient and oncology daycare patients prescribed HPD. The indicator was the percentage of protein wastage, with the standard set at 26% or less based on established evidence. A survey collecting demographic data and food satisfaction surveys was conducted. Pre and post-meal PF were weighed and recorded in a log sheet. The results, analysed using SPSS version 23, showed a protein wastage reduction from 63.5% to 56.8% and then further reduced to 27.5%. Associated factors were excessive PF servings, hospital food rejection, unstandardised HPD, missed updated diet order, limited acceptance, and mealtime duration. The strategy in the first cycle involved the reduction of PF from four to two types per meal, the development of a standard recipe, and training for food services staff. During the second cycle, PF was distributed evenly between four mealtimes. Dietitian assessment and evaluation were made compulsory for HPD prescription before ordering. Oral nutrition supplements were offered as meal replacements for patients with eating difficulties. The remedial measures were expanded to all wards in HPSF. Future efforts may include software usage to standardise HPD preparation, online diet ordering, diet cancellation stickers on patients' bed head tickets, development of a menu book, and compact meal development.

KEYWORDS: Protein, high-protein diet, hospital food waste, dietitian, quality improvement study

Problem

A high-protein diet (HPD) supplies more than 20% of total daily calories (1) and is a key Medical Nutrition Therapy (MNT) component for surgical and oncology patients to support wound healing, prevent malnutrition, and preserve muscle mass (2,3). In Malaysian government hospitals, daily diets follow the Hospital Diet Manual 2016, providing 40g (low-protein), 60g (standard), or 90g (high-protein) options tailored to meet patient needs based on dietitian assessments (4). This aligns with the European Society for Clinical Nutrition and Metabolism (ESPEN)'s guideline recommending a daily protein intake of 1.0 to 1.5 g/kg ideal body weight (60–90g/day minimum) during illness or stressed conditions (5,6).

However, translating these clinical recommendations into daily practice presents significant challenges. A verification study conducted in January 2019 at *Hospital Pakar Sultanah Fatimah* (HPSF) revealed that 63.5% of the protein served to high-risk patients was unconsumed and discarded, with 53.0% of patients eating either nothing or only up to one-third of their meals. This high HPD wastage signifies inadequate protein intake, which compromises individualised MNT plans (7) and results in an inefficient use of government resources (8,9).

This clinical and operational gap directly impacts HPSF in Muar, Johor, a 550-bed specialised district hospital with 22 multidisciplinary wards. High-protein meals are heavily utilised in HPSF's surgical wards and its daycare unit, the *Pusat Rawatan Onkologi Yayasan* (PROY), which delivers chemotherapy to Northern Johor oncology patients from Tangkak and Segamat.

These specialised meals are managed by HPSF's Dietetic and Food Service Department (DFSD), which consists of the Dietetic Services Unit and the Food Services Unit, staffed by eight dietitians, one catering officer (CO), five assistant COs (ACO), and 28 *Pembantu Penyediaan Makanan* (PePM). Dietetic Services manages therapeutic diets, diet consultations, and enteral nutrition while Food Services operates eight cycle menus. Inpatients receive four meals daily, and daycare patients receive one main meal. While normal diets provide 14g of protein per main meal, HPD patients receive three to five protein-based foods (PF) per meal (delivering up to 35g of protein). PF served are chicken, fish, egg, tofu, fermented soybean (tempeh), fried potato patty (*begedil*), and protein jelly. Due to these additional PFs, HPD meals incurred higher production costs; in 2018, DFSD served 17,264 HPD meals totalling MYR120,848 (USD27,319.19 as of January 2019).

To address this significant gap between meal production expenditure and actual patient consumption, this quality improvement study aimed to reduce protein wastage in our setting to equal to or less than 26% (≤26%) in accordance with ESPEN guidelines (10).

Background

Protein is a macronutrient that plays a significant role in cell and tissue repair (1). It can be divided into HBVP and low biological value proteins (LBVP). The higher biological value indicates better efficiency in being turned into body tissues once absorbed from the gastrointestinal tract (1). Protein consumption is essential for wound healing (2), supporting muscle synthesis in cancer patients, and reducing malnutrition risk (11). Inadequate intake can increase muscle loss, higher infection rates, slower wound healing, and extended hospital stays (12,13). These repercussions of malnutrition significantly influence hospital resources and healthcare expenses (14).

In a hospital setting, the type of protein prescribed varies depending on the individual patient's medical condition, nutritional needs, and dietary restrictions. It included lean meats, fish, dairy products, eggs, legumes, nuts and seeds, tofu and tempeh, protein powders, protein-enriched foods, and oral nutrition supplement (ONS) (4,15). Protein-enriched foods may include specialised enhanced foods like protein bread, bars, ice cream, jelly, or snacks designed for patients with high protein needs (15). ONS is a multi-nutrient liquid, semi-solid, or powder product that contains macronutrients and micronutrients (16).

Food waste refers to the uneaten food that remains after being served to patients in a hospital (8,10). A recent systematic review reported that hospital food waste can account for 20–74% of all hospital trash (17). Data from two Malaysian public hospitals in 2018 indicate that the

problem may be even greater locally, with up to 86.7% of meals served being discarded (18). According to Barton et al. (19), food waste exceeding 40% was associated with lower protein energy intake and weight loss during hospitalisation, highlighting the nutritional risks of excessive plate waste.

Hospital plate waste is a multifactorial problem influenced by patient-related factors, poor meal experiences, large meal portion size, limited menu variety and patient choice, inadequate staff training and resources, and lack of staff engagement in optimising patient meal care (20,21). In cancer patients, Nurshariza et al. (17), reported that nausea, vomiting, loss of appetite, and swallowing difficulties have been shown to significantly increase food wastage.

To address these issues, a variety of strategies have been implemented. Standardising meal portions can better align meals with patients' appetites and improve acceptance. Jonathan et al. (22) demonstrated that implementing portion size standardisation in the inpatient setting reduced mean plate waste from 70.2% to 65.8%, a reduction of 4.4%. In addition, providing protein and energy-fortified snacks in between meals has been shown to significantly increase daily intake among hospitalised patients, with protein intake rising from 49% to 88% of individual requirements, suggesting that targeted nutritional strategies beyond main meals can further support intake and potentially reduce plate waste (23).

Furthermore, staff training has been identified as a key strategy, with healthcare professionals emphasising the importance of formal training in plate waste assessment, accurate diet ordering, and management of therapeutic diets to prevent errors and ensure that meals meet patients' nutritional needs (21).

Measurement

This quality improvement study was conducted between January 2019 and February 2020 in two selected surgical wards (Ward 4 and Ward 5) and a daycare (PROY). All patients intended for HPD orally were included, as the number of patients requiring HPD is a small and well-defined population. Patients with communication barriers, unwillingness to participate, less than 18 years old, and requiring a combination route of feeding via enteral or parenteral were excluded.

The indicator used was the percentage of protein wastage, with the standard set at ≤26% based on a narrative review carried out in 2011 that summarises the results of 32 studies across 29 countries over the past 50 years and published as ESPEN guidelines (10).

The indicator formula is below:

$$\textit{Percentage of protein wastage} = \frac{\textit{Amount of protein content in PF wastage from HPD}}{\textit{Amount of protein content in PF from HPD served}} \times 100$$

The wasted PF value was obtained from a few weighing steps. At baseline, cooked PFs for every HPD were weighed pre-meal, using a digital scale in the kitchen, and labelled with the patient's name before serving to the patients. The weight of the different types of PF was recorded separately, such as the weight of chicken, fish, egg, etc. Post-meal, the labelled meal trays were collected. Then, the non-edible and edible parts were separated before being weighed. Wasted PFs were obtained by subtracting the weight of non-edible parts in the leftovers from the weight of the pre-meal PF serve. The protein content of each protein food type was estimated by referring to the Malaysian Food Composition Database (24). Data analysis was performed using SPSS version 23. Findings from the verification study involving 48 subjects revealed that the percentage of protein wasted was 63.5%, which warranted intervention.

Data on contributing factors were collected using a content-validated questionnaire adapted from the Patients' Diet Satisfaction (KKP) form by the Ministry of Health (25), administered by dietitians and COs. The questionnaire (Appendix 1) consisted of three parts. The first part gathered information on patient admission and demographic data. The second part explored patients' disease, treatment, nutrition impact symptoms, ONS consumption, food intakes other than hospital meals, and knowledge of HPD, such as the type of meals served and their importance. The third part consisted of patient satisfaction with HPD using a 5-point Likert Scale, with five denoting the highest

satisfaction. In addition to the KKP survey, an audit of compliance with the standard recipe preparation was conducted by senior dietitians and COs during food preparation at DFSD to determine conformance to the criteria set in the Model of Good Care (MOGC). Data was captured in the Standard Recipe Compliance Audit (*Audit Pematuhan Resipi Piawai*) form (Appendix 2) developed by the DFSD's Menu Committee.

Following that, strategies for change in the first cycle were implemented from February until April 2019, followed by data collection post remedial in May - Jun 2019 with 180 subjects. Remedial action in Cycle 2 was started in July until December 2019, followed by the post-remedial data collection with 152 subjects using the same method in January - February 2020.

Initial Assessment of the Problem

The process of care on HPD distribution initiated with the doctor's assessment and plan for HPD once the patient was admitted to the ward (Figure 1). HPD were ordered by nurses based on the doctors' plan or automatically based on patients' medical diagnoses, such as cancer, head injury, post-operation, or burn, or even the dietitian's assessment. This had led to excessive PF being served despite patients' inability to consume their meals accordingly, as they were not properly assessed by the dietitian. For example, in the verification study, HPD patients received a double portion of PF (two pieces of chicken) or multiple PF in a meal, such as one piece of chicken, one piece of tofu, one whole egg, and a cup of protein jelly for lunch, which led to difficulty in finishing the bulky or multiple meals.

The printed or hand-written diet order forms were sent to DFSD before 8 am. Any changes to the diet throughout the day will be informed through a phone call or submission of a new diet order form. However, updates of patients who required diet changes, such as Nil by Mouth (NBM) and discharged, were seldom reported to DFSD.

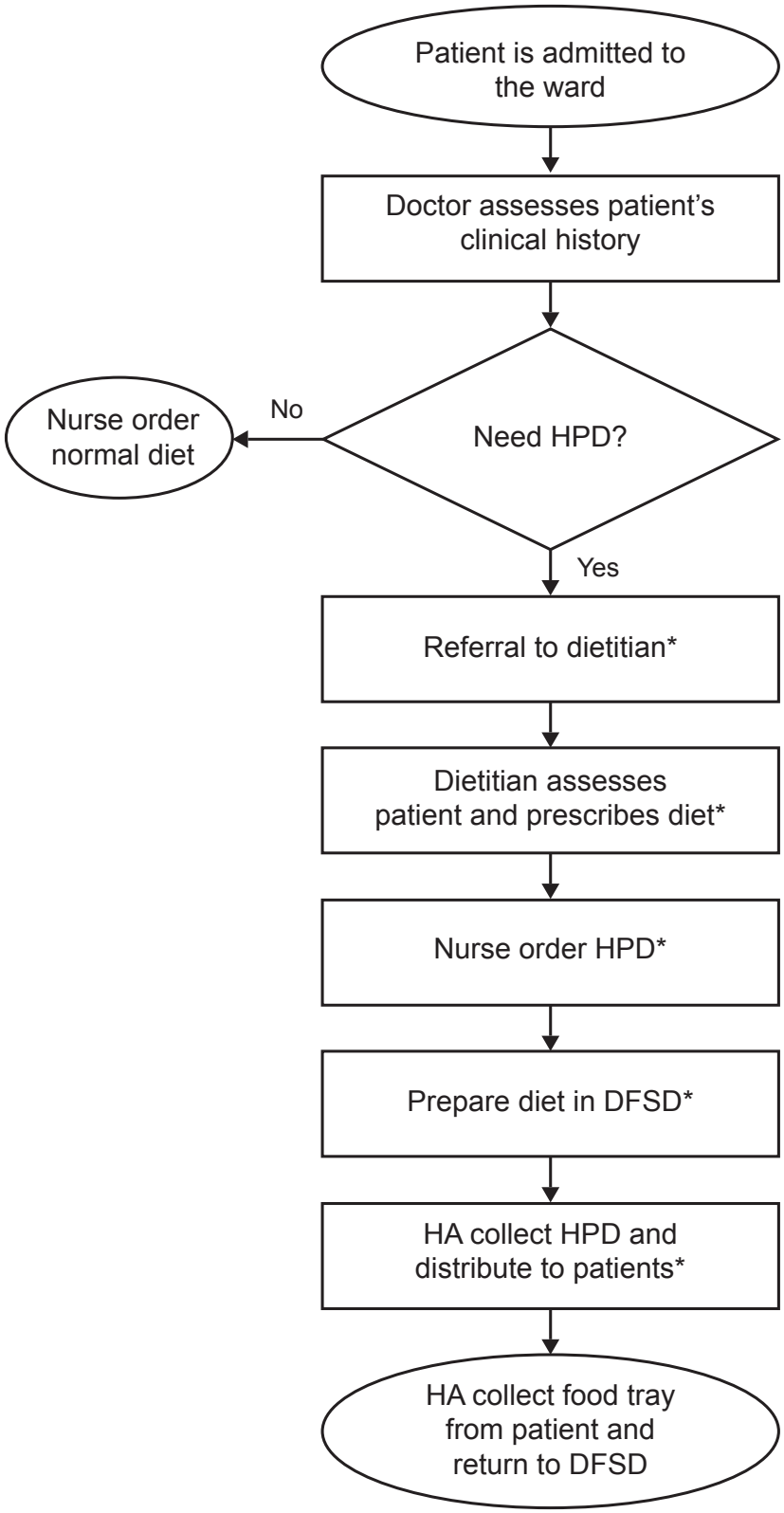
Once an order is received, DFSD staff will prepare HPD. The food preparation method differs for every PePMs as some do not comply with the standard menu, resulting in different tastes or results of the same menu. HPD were distributed based on the patient's diet tagging, and hospital attendants (HA) will transfer the meals by trolley from DFSD to wards and serve them to the patient. Patients were given around one hour to finish their meals, but the food trays were always taken away early to return to DFSD.

During dietitians' ward rounds in the surgical ward and PROY, it was observed that some HA placed food trays on the side table without alerting sleeping patients. If the meal was overlooked, it was subsequently return uneaten to the DFSD. Consequently, patients missed their meal upon awakening or returning from medical procedures. In addition, patients requiring feeding assistance sometimes experienced inadequate support likely due to competing demands in the busy ward environment.

MOGC, shown in Table 1, were developed from the critical steps in the process of care. From the audit, only 80.0% of patients receiving HPD were referred to a dietitian. Patients with ongoing chemotherapy were automatically enrolled on HPD after assessment by the doctor. Thus, the remaining 20.0% of patients were not assessed and not provided with suitable nutritional intervention by a dietitian. Only 50.0% of the indicated patients received ONS, while this patient still received a normal diet or HPD, even though they could not finish the meals.

Compliance with HPD standard recipes was limited, given that the recipes were rigidly documented in standard recipe books. Besides that, based on the dietitians' audit, only 60.0% of the hospital meals were distributed accurately by the HA. There were incidents where HA swapped patients' meals as requested by patients, causing the wrong meals to be served to the remainder of the patients.

The problem analysis chart in Figure 2 showed factors that can contribute to the high percentage of protein wastage among surgical and oncology patients.



*indicates critical steps

Figure 1: Process of care for HPD serving

Table 1: MOGC of HPD serving

No.	Proses	Criteria	Standard	Pre-remedial phase	Post remedial study (Cycle 1)	Post remedial study (Cycle 2)
1.	Referral to a dietitian	The doctor referred all patients who needed dietary support for individualised advice	100%	80.0%	100%	100%
2.	Dietitian assesses patients and prescribes a diet	The dietitian does a nutrition assessment and prescribes HPD if required	100%	100%	100%	100%
		Dietitian gives ONS as a meal replacement (as needed/if required/as indicated)	100%	50.0%	50.0%	100%
3.	Nurses order HPD	Nurse orders HPD based on the dietitian's prescription in the diet order form and send to DFSD	100%	87.5%	No data	91.0%
		Nurses update diet order for NBM or discharged patients	0.0%	100%	100%	95.0%
4.	Prepare the diet in DFSD	PePM prepare food based on a standard recipe	100%	0.0%	0.0%	64.0%
5.	HA collect HPD and distributes it to patients	Diet is distributed based on tray tagging	100%	60.0%	No data	95.3%

The first factor involved patients' difficulty in finishing excessive PF servings in a meal. Excessive PF means patients receive two or more servings of PF. In the verification study, it was found that on average, HPD with two PF had a wastage rate of 68.0%, while HPD with more than two PF recorded higher wastage at 74.0%. They were 12.5% HPD ordered without a dietary assessment by the dietitian.

The second factor was patients' condition with limited food acceptance due to symptoms of disease, including altered gastrointestinal function, such as loss of appetite (36.0%), nausea (18.0%), and early satiety (12.0%), was observed. No caregiver to assist with feeding, symptoms of disease, side effects of medication, an unconducive ward environment, and unfavourable PF selection caused the patient's limited food acceptance.

The third factor was patients refusing hospital food. Patients refusing hospital food had significantly consumed outside food (x^2=27.4, p<0.01). It was found that many patients' carers brought outside food from home or restaurants. The verification study found that 75.8% (n=36) of patients' carers brought food from outside, and 64.0% (n=22) of patients did not eat the respective meals during the study, either lunch or dinner. The other contributing reasons were unfavourable protein selection, less encouragement to consume the hospital diet, missed food allergy notification, negative perception of hospital diet, and lack of knowledge of HPD.

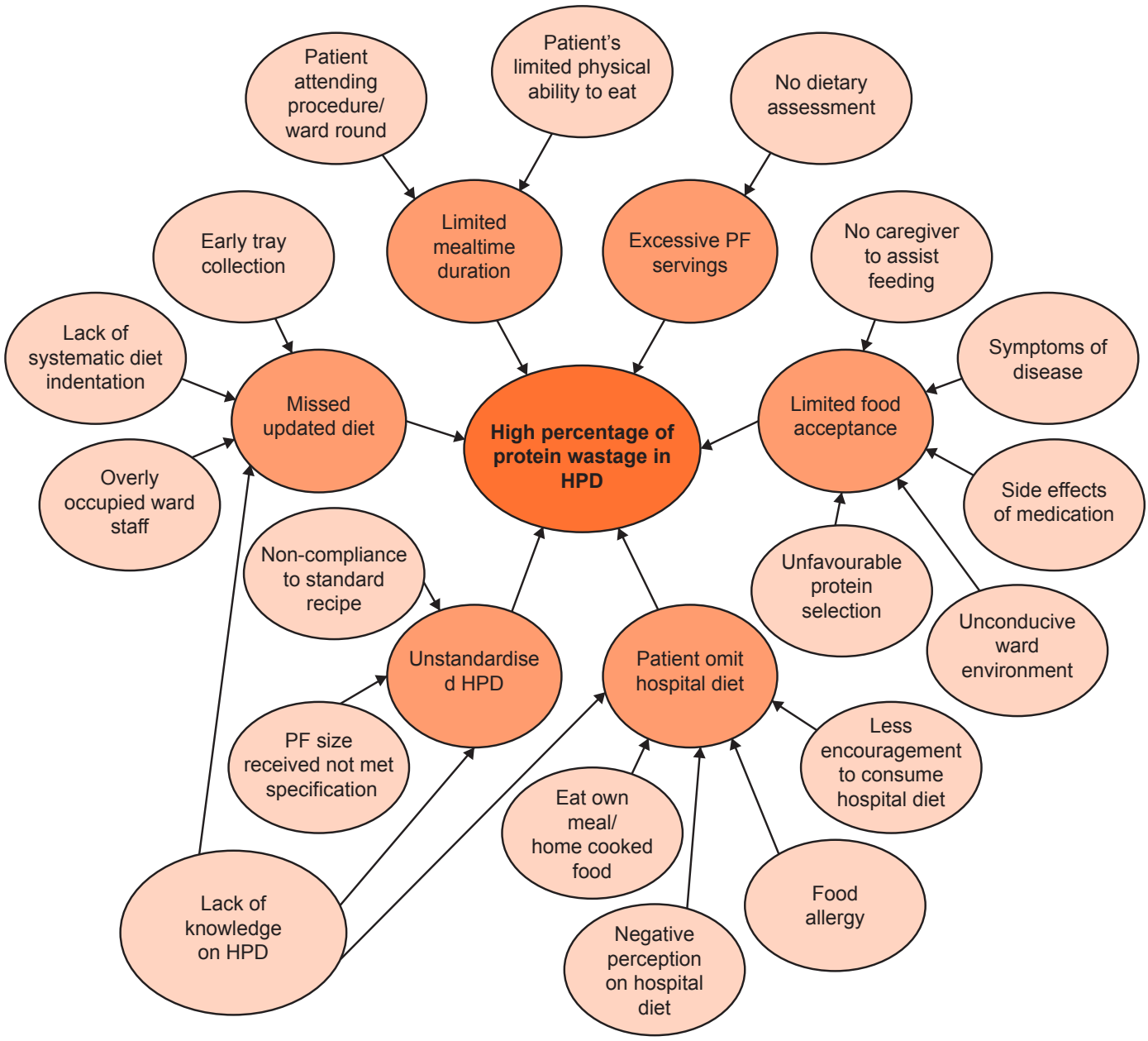


Figure 2: Problem analysis chart of contributing factors to high percentage of protein wastage in HPD

The fourth factor looked at the meals that were not prepared as specified due to non-compliance with standard recipes or the method of cooking used, which contributed to the low quality of HPD. The customer satisfaction scale showed taste, aroma and portion less than standard (<2.5). The PF portion size received from vendors did not meet the specification. The size of the cut chicken received was inconsistent, with 30.0% of the pieces being larger than the standard. Lack of PePM knowledge (57% pre-test mark) also led to improper giving of the PF portion during food plating.

The fifth factor was the failure to update the diet order. We observed a lack of HPD knowledge among ward nurses from the assessment during nursing training sessions (pre-test mark 58.0%). During random interviews in the ward, nurses complained of being overly occupied with patient care, leading to failure to update diet orders before every meal, especially for NBM, discharged or deceased patients. In our hospital, diet orders were processed manually with only two times of form submission per day. Any diet changes require nurses to inform DFSD within the allocated time. Lack of a systematic ordering system contributed to this factor.

The sixth factor was limited patient mealtime duration. Patients with limited physical ability to eat require longer mealtime. The standard eating time is one hour. Earlier tray time collection reduced meal duration to approximately 30 minutes. Mealtime was also disrupted for patients who had to undergo procedures such as blood tests and X-rays.

Strategy

The strategies were carried out in two cycles: four in Cycle 1 and five in Cycle 2. In overcoming patients' limited ability to finish a meal set with multiple PFs, the first strategy we looked at was modifying the number of PFs served. We reduced the amount of PF from multiple types to two different types only and avoided giving a double portion of PF. It suits the condition of surgical and cancer patients on treatment who are unable to consume large amounts of food (26).

The second strategy was the innovation of Jelly Hi-Pro, a protein-dense jelly. From the unstandardised and plain jelly, we improved the presentation, taste and provided a standard recipe. We changed the preparation step by adding 5g of whey protein powder in the last step after the mixture was distributed into the mould to avoid a total protein content reduction in total protein intake for HPD. Therefore, the quality and quantity of the protein were maintained and standardised. The flavour was enhanced with corn, pandan and *gula melaka* flavours to increase patients' tolerance. Jelly Hi-Pro is a protein-dense meal that helps patients meet their protein requirements more efficiently and avoid inefficient PF costs (27). Jelly Hi-Pro cooking demonstrations were organised for other PePMs to ensure preparation as per the standard recipe. Jelly Hi-Pro is served during afternoon tea as a supplement/additional PF to complement the first strategy.

The third strategy was the production of a standard recipe for HPD and increased compliance towards standard preparation by PePMs. A series of high-protein recipe modification meetings was held among dietitians, COs, and senior PePMs to develop standard recipes and protocol to monitor compliance of PePMs in HPD preparation. Among the HPD recipe modifications were *roti john*, egg sandwich, bread pudding, mushroom soup, egg casserole, and mung bean porridge, added with protein powder.

The fourth strategy was Continuous Catering Education (CCE) on HPD preparation among DFSD staff. The four sessions of CCE involved all PePM and were essential to explain HPD benefits and encourage compliance towards standardised recipes and protocol. PePM were emphasised to use ingredients measured by the catering officer for each menu and refer to the standard recipe book during meal preparation. PePM were also trained on the correct PF portion size and the importance of serving the diet correctly. A dietitian and a catering officer also conducted a monthly standard recipe compliance audit for HPD preparation using the form as in Appendix 2.

In the second cycle, the fifth strategy was strengthened due to minimal reduction of protein wastage during the Cycle 1. Instead of two different types of PF given in each lunch and dinner, in the fifth strategy, only one PF type or portion was served during the main meal, and we also distributed PF during breakfast and afternoon tea. Appendix 3 showed, a patient received one serving of shredded chicken for breakfast, a piece of chicken for lunch, one serving of scrambled egg for afternoon tea, one piece of fish for dinner and 1 sachet of low-fat milk as a drink for breakfast and afternoon tea. It contains 14g of protein in each meal time, with a total of 56g of protein in PF. The total estimation of protein served is 78g per day for HPD.

Our sixth strategy in Cycle 2 was making nutritional assessment compulsory for each patient requiring HPD. Thus, doctors are required to refer to a dietitian for nutritional assessment and appropriate high-protein dietary modification. Furthermore, the practice of automatic HPD indentation for chemotherapy patients was discontinued. Based on nutrition assessment, patients were given the chance to choose either chicken, fish, egg, or vegetarian for their next meal based on their preference. Patients who had difficulty finishing the food served were offered ONS. A circular letter endorsed by the hospital director regarding this new procedure on management of patients requiring HPD in surgical wards and PROY was distributed to all respective heads of department and nursing units.

The seventh strategy in Cycle 2 was complementing patients with limited food acceptance during chemotherapy at PROY. Those who were unable to tolerate food due to altered patient's smell and taste, and altered GI function were offered ONS as a meal replacement during their day care treatment. High-protein and calorie-dense ice cream was provided together with meals to all patients who received HPD.

The eighth strategy involved HPD training and education for nurses and HAs given by dietitians. They were educated on the importance of HPD for patient outcomes, as well as the need to encourage patients to finish their HPD meals. Mealtimes should be prioritised over other procedures to minimise protein wastage. HAs was instructed to avoid collecting food trays earlier. The training also highlighted the importance of ward staff in ordering HPD correctly after being prescribed by a dietitian. Objectives were to improve understanding of diet as part of treatment, and to increase awareness about updating dietary changes for patient discharge and NBM. The percentage of attendees with good HPD knowledge improved from 49.0% (pre-test) to 77.0% (post-test).

The ninth strategy was conducting "Eating Hospital Diet" Awareness Campaign, which was launched during the Dietitian Day celebration on 26th September 2020 at the foyer, HPSF Muar. The awareness campaign was organised to tackle the public's perspective on avoiding eating hospital food and patients' practice of bringing outside food found in our verification study. During the campaign, 200 participants including caregivers, hospital staff and the public had the opportunity participate in a hospital food tasting on the breakfast and lunch menus. The visitors gave positive feedback, and this campaign changed the misconception that hospital food is tasteless or has medication added to it.

Results

Our main outcome measure on the percentage of protein wastage was successfully reduced from 63.5% (n=48) to 56.8% (n=180) and 27.5% (n=152). The Achievable Benefit Not Achieved (ABNA) results are shown in Figure 3.

Following the remedial measure, MOGC in Table 1 showed that the results of dietitian referral by doctor were achieved 100% with all patients' needs HPD was referred or informed through phone call or an indent form. Nutrition assessment had been performed for all referred patients,

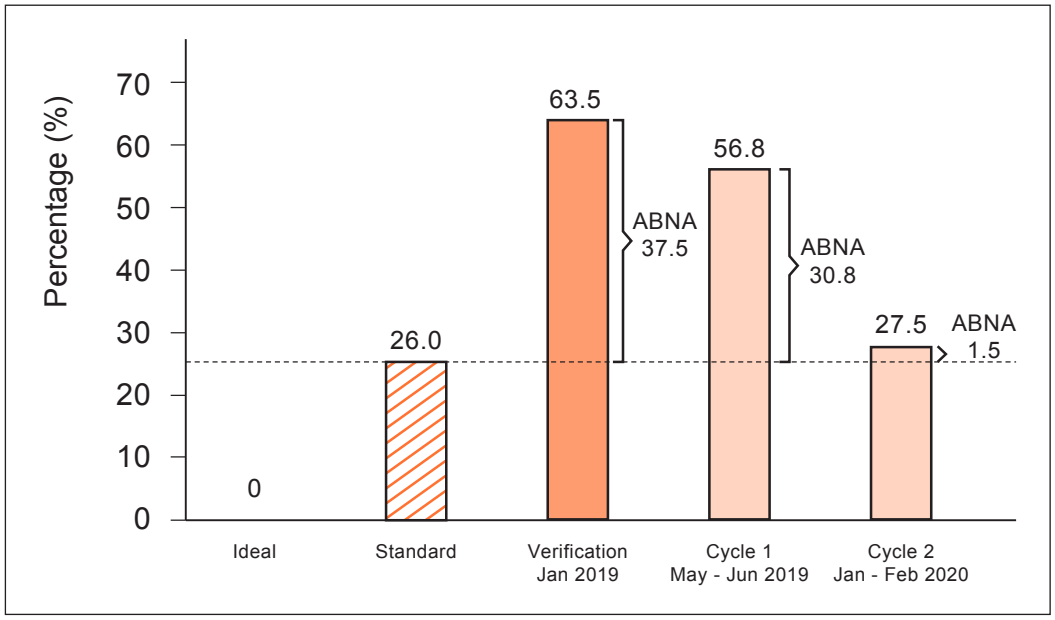


Figure 3: The trend of the percentage of food wastage and the ABNA gap across the cycles

and ONS prescription as a complementary or meal replacement was achieved. Nurses' compliance with HPD ordered as prescribed by the dietitian was improved to 91.0%, but a few nurses did not adhere, as the information provided during training sessions was not fully disseminated. PePM compliance with the standard recipe and protocol was improved to 64.0%. A food satisfaction survey on patients also showed improvement. Smell, taste, and portion size had a low score (scale <2.5) and were improved in Cycle 2, with all criteria having a score >3.0 except smell. Portion size, food temperature, freshness, presentation, food variety, texture, taste, and meal serving time achieved an excellent rating (score=5.0). Criteria for diet served based on tray tagging had nearly achieved the standard (95.3%).

Lessons and Limitations

This study taught us that reducing PF wastage is possible by improving the work process involving food preparation staff, dietitians, and ward staff. Distributing PFs to four mealtimes throughout the day helped patients with limited food acceptance and early satiety to appreciate smaller protein food portions at four separate mealtimes. Dietitians individualised nutritional assessments and interventions also played a role in suitable diet orders and helped reduce PF wastage.

Creating a standard recipe and a modified type of protein received, provision of ONS as a meal replacement, and continuous training sessions to staff dealing with PF from preparation until serving may further contribute to the reduced PF wastage. Reduced PF wastage was achieved through the commitment and cooperation of the hospital management, DFSD staff and ward staff. Awareness of the importance of nutrition in the recovery process is important at every level of staff and not only at the dietitian's role. All hospital workers must play a role to ensure adequacy of food intake and thus reduce food wastage among patients.

We conducted a universal sampling due to the limited number of the population of HPD patients in our hospital. This approach allowed us to include all available cases, ensuring comprehensive data collection while minimising potential sampling bias. However, the findings may have limited generalisability to broader populations, and future studies with larger, more diverse samples are recommended to validate our results. Another limitation was that in the study, we encountered several problems when using the HPD menu. With the new creation of the menu, some of the menu items cannot be sustained due to the unavailability of raw food. Therefore, it was challenging to create an HPD menu within the available raw food storage. Due to a lack of exposure and experience in QA activity, we failed to measure the magnitude of the critical steps of nurses ordering HPD, HA collecting HPD and distributing it to patients. In order to understand the root cause of each problem, we did not verify the criteria in MOGC during the first cycle. In the future, we should get proper guidance from the QA/QI committee to prevent a shortfall in the study.

Findings from this study were presented during Dietitian Day at HPSF in 2020, Johor Innovation and Quality Convention 2021 and National Quality Assurance Convention 2022. This quality study suggests that dietary assessment before HPD indentation is critical, standard preparation and appropriate PF distribution in meal planning, as well as ONS prescription for limited acceptance patients are among the main key findings.

Conclusion and the Next Steps

Hospital food wastage, specifically protein wastage, is common and has been reported to occur in all hospitals. The percentage of protein wastage in HPSF found during the verification study was high (63.5%). With multiple strategies, protein wastage was reduced to 27.5%, close to the standard aimed at ≤26%, and the ABNA was reduced from 37.5% to 1.5%, as in Figure 3. Several main contributing factors were identified, which were excessive PF servings, patients' limited food acceptance, avoiding hospital diet, unstandardised HPD preparation, missed updated diet order, and limited mealtime duration. Thus, we executed several strategies within two cycles. Remedial actions focused on dietary adjustments, including increasing serving sizes, distributing PF throughout the day, and introducing Jelly Hi-Pro and new HPD

recipes. Additionally, we strengthened operational standards by enforcing cook compliance with new protocols and providing continuing education (CCE/CNE) for DFSD staff and nurses. Furthermore, automatic HPD ordering was discontinued. All HPD orders, meal replacements with ONS, and other dietitian-planned MNT strategies now require a prior dietitian referral for nutritional assessment.

For this study to be more clinically significant, we would like to suggest that other researchers conduct a clinical study. It is important to assess the 24-hour dietary intake of patients as well as their muscle strength and the length of hospital stay. Furthermore, it will allow us to compare any association between protein wastage, protein intake and the clinical outcomes.

In future, we plan a few strategies to sustain the result. Currently, our department is developing an innovation project, a software that could automatically calculate the quantity of ingredients required in preparing daily meals for real patients. Therefore, we hope that compliance of PePMs with the HPD standard recipe will improve.

Secondly, online diet ordering should be developed to manage diet changes easily, e.g. diet indent cancellation upon patient's discharge. Third, a sticker should be placed on the bed head ticket of patients to alert doctors and ward staff to cancel their diet if the patient has NBM or is discharged. Fourth, we would like to develop a menu book as a reference for patients to choose their food. A patient can request PF depending on their tolerance based on the daily menu. Fifth, we plan to standardise our dietary plan and create options of small-sized meals or compact meals for patients who refuse to eat hospital food or receive ONS more than 70.0% of their daily energy requirements. However, monitoring by a dietitian is required to ensure the patient receives adequate nutrition.

Continuous cooperation between multidisciplinary teams involving DFSD staff, doctors, nurses and HAs is important to sustain all the remedial action. Regular training and continuous education also play a big role, especially for the new members to ensure they practice the remedial action. This study can be applied to the whole ward in HPSF and further to all hospitals.

Acknowledgements

The authors would like to thank the Director-General of Health, Malaysia, for his approval to publish this work. We also wish to thank our head of department, Mrs Nik Mahani Binti Nik Mahmood, for her support in this study, our QA team project for their hard work to make this project successful and gratefulness to our QA facilitators for sharing and giving ideas as well as comments in the process of this study. Finally, to those who were involved in the study location, Ward 4, Ward 5, PROY and DFSD, HPSF Muar.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the conduct of this study.

Funding

The authors received no financial support for the conduct of this study.

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Appendix 1: Questionnaire adapted from Patients' Diet Satisfaction (KKP)

BAHAGIAN A: MAKLUMAT UMUM DAN DEMOGRAFI		
A1	*Tarikh Kajian Dijalankan*	/ /
A2	*Tarikh masuk wad*	/ /
A3	*Kali ke berapa masuk wad tahun ini*	
A4	*Nama Wad*	
A5	*Disiplin Klinikal*	
A6	*Kelas Wad*	*1 Kelas 1* *2 Kelas 2* *3 Kelas3*
A7	*Jantina*	*1 Lelaki* *2 Perempuan*
A8	*Umur (tahun)*	
A9	*Bangsa*	*1 Melayu* *2 Cina* *3 India* *4 Lain-lain*
A10	*Taraf Akademik*	*1 Tiada Pendidikan Formal* *2 Sekolah Rendah* *3 Sekolah Menengah* *4 Kolej/Universiti*
BAHAGIAN B : MAKLUMAT PENYAKIT DAN RAWATAN		
B1	*Diagnosis*	
B2	*Rawatan*	*1 Pembedahan* *2 Kemoterapi/Radioterapi* *3 Paliatif* *4 Lain-lain prosedur*
B3	*Keadaan semasa pesakit yang menganggu pengambilan makanan. (sekiranya ada)*	*1 Tiada selera makan* *2 Loya* *3 Muntah* *4 Cirit-birit* *5 Sembelit* *6 Sakit mulut/ulcer* *7 Sukar menelan* *8 Cepat kenyang*
B4	*Pesakit menerima* oral nutrition supplement (ONS)	*1 Ya* *2 Tidak*
	Jika Ya, *Bancuhan_____scoop + air= ____mls* *Kekerapan minum sehari: _____*	
B5	*1 2 3 4 5 6 7 8 9 10* *Skala kesakitan:*	
B6	*Pengambilan ONS oleh pesakit:* *Jenis produk susu:_____* *Bancuhan: _____scoop + air=_____mls* *Tambahan protein modular:_____* *Jumlah yang dihabiskan: _____mls, Kekerapan minum sehari:_____*	
B7	*Ketepatan diet mengikut preskripsi:*	*1 Ya* *2 Tidak*
B8	*Adakah pesakit makan makanan hospital yang dihidangkan*	*1 Ya* *2 Tidak*
	Jika tidak, nyatakan alasan: _____	
	*Jika **Ya, sila jawab Bahagian C***	

BAHAGIAN C: MAKLUMAT KEPUASAN DIET TINGGI PROTEIN

1 Sangat tidak memuaskan	2 Tidak memuaskan	3 Sederhana	4 Memuaskan	5 Sangat memuaskan

C1	Adakah anda berpuas hati dengan **kepelbagaian** makanan berprotein yang dihidang?	(1) (2) (3) (4) (5)	
C2	Adakah anda berpuas hati dengan **porsi (saiz)** makanan yang dihidang?	(1) (2) (3) (4) (5)	
C3	Adakah anda berpuas hati dengan **persembahan** (gaya/hiasan) makanan yang dihidang?	(1) (2) (3) (4) (5)	
C4	Adakah anda berpuas hati dengan **kesegaran** makanan yang dihidang?	(1) (2) (3) (4) (5)	
C5	Adakah anda berpuas hati dengan **aroma (bau makanan)**yang dihidangkan?	(1) (2) (3) (4) (5)	
C6	Adakah anda berpuas hati dengan **tekstur (kelembutan)** makanan yang dihidang?	(1) (2) (3) (4) (5)	
C7	Adakah anda berpuas hati dengan **rasa makanan** yang dihidang	(1) (2) (3) (4) (5)	
C8	Adakah anda berpuas hati dengan **waktu makanan** dihidangkan?	(1) (2) (3) (4) (5)	
C9	Adakah anda berpuas hati dengan **suhu makanan** yang dihidang?	(1) (2) (3) (4) (5)	
C10	Adakah anda berpuas hati dengan **kebersihan makanan** yang dihidang ?	(1) (2) (3) (4) (5)	
C11	Adakah anda berpuas hati dengan **kebersihan peralatan** hidangan ?	(1) (2) (3) (4) (5)	
C12	Adakah anda berpuas hati dengan **layanan anggota** yang menghidang makanan?	(1) (2) (3) (4) (5)	
C13	Adakah anda: **Alergi/Vegetarian**	1	Ya
		2	Tidak
C14	Adakah anda **maklum** pada anggota wad mengenai masalah ini?	1	Ya
		2	Tidak
C15	Adakah anda **tahu** jenis diet yang dibekalkan?	1	Ya
		2	Tidak
C16	Jika ya, nyatakan **kepentingan** diet ini: _____		
C17	Adakah anda mendapat hidangan makan tengahari atau malam dari luar? (Contoh: bekalan makanan dari rumah atau makanan yang dibeli)	1	Ya
		2	Tidak

DIISI OLEH PIHAK JDS

Data dikumpul oleh: Tandatangan:……... Nama :……... Jawatan :……... Tarikh : ……...	Disahkan oleh: Tandatangan:…… Nama:…….. Jawatan:…….. Tarikh:……

Appendix 2: Standard Recipe Compliance Audit Form

AUDIT PEMATUHAN RESIPI PIAWAI
JABATAN DIETETIK DAN SAJIAN
RESIPI PIAWAI HOSPITAL KKM

NAMA PRODUK :
KAEDAH MEMASAK : PANGGANG / REBUS / GORENG
TITIK KAWALAN KRITIKAL : KAWALAN SUHU TENGAH PRODUK (>70°C) NYATAKAN:.....

TEMPOH MEMASAK : NYATAKAN :..... MULA:.....TAMAT:.....
PENGGUNA : K1 / K3 / SD / HPD / TERAPUTIK
WAKTU HIDANGAN : SARAPAN / MAKAN TENGAHARI / MINUM PETANG / MAKAN MALAM
PORSI HIDANGAN : 100 LAIN-LAIN:.....

SIFAT-SIFAT PRODUK :

KRITERIA	TANDAKAN (/)
LEMBAB DAN BERKUAH	
LEMBAB TIDAK BERKUAH	
TIDAK BERKUAH/KERING	
WARNA (NYATAKAN)	

BIL	BAHAN	KUANTITI MASAK(GM)	KUANTITI PIAWAI	NILAI ITEM (RM)	NILAI ITEM SEBENAR (RM)	PEMATUHAN (√ / X)	UJIRASA & KOMEN PENAMBAHBAIKAN	
1							PEGAWAI UJIRASA 1 : (COP)	
2								
3								
4								
5								
6								
7								
8								
9							PEGAWAI UJIRASA 2: (COP)	
10								
11								
12								
13								
14								
15								
16								
17								
18								

BIL	KAEDAH PENYEDIAAN
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

KANDUNGAN NUTRISI HIDANGAN:	KARBOHIDRAT (GM)	PROTEIN (GM)	KALORI (KCAL)	SODIUM (mg)

DISEMAK: .....

KOS PER MENU:	RM.....	
HASIL PRODUK AKHIR	KUANTITI (KETUL)	LEBIHAN (JIKA ADA)

DISAHKAN

Appendix 3: High-protein Diet Post Remedial Cycle 1 & 2

	Post-Remedial Cycle 1		Post-Remedial Cycle 2	
Meal Time	Menu	Protein content	Menu	Protein content
Breakfast	Fried Meehoon Tea	6 g (LBV)	Fried Meehoon Shredded chicken Low fat milk	6 g (LBV) 7 g (HBV) 7g (HBV)
Lunch	1 small bowl of rice (150g) 1 piece of Chicken Tomyam 1 piece of Stir-Fried Tofu Stir Fried Cabbage	6 g (LBV) 14g (HBV) 7 g (HBV)	1 small bowl of rice (150g) 1 piece of Chicken Tomyam Stir Fried Cabbage	6 g (LBV) 14g (HBV)
Afternoon Tea	2 slices of bread Tea	4 g (LBV)	2 slices of bread Scramble egg Low fat milk	4 g (LBV) 7 g (HBV) 7 g (HBV)
Dinner	1 small bowl of rice (150g) 1 piece of *Asam Pedas* Fish 1 nos of hardboiled egg Stir Fried Cabbage 1 piece of watermelon	6 g (LBV) 14g (HBV) 7g (HBV)	1 small bowl of rice (150g) 1 piece of *Asam Pedas* Fish Stir Fried Cabbage 1 piece of watermelon	6 g (LBV) 14 g (HBV)
Total Protein Served		64 g	Total Protein Served	78g

INCREASING THE PERCENTAGE OF OLDER ADULTS RECEIVING DENTURE WITHIN EIGHT WEEKS IN PARIT RAJA DENTAL CLINIC

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Abstract

Timely denture delivery is essential for restoring oral function, aesthetics, and quality of life among older adults. However, a verification study in Parit Raja Dental Clinic revealed that only 38.4% of older adults received dentures within eight weeks, below the Ministry of Health's Key Performance Indicator target of ≥50%. This quality improvement project aimed to increase the percentage of older adults receiving dentures within eight weeks by identifying contributing factors and implementing targeted interventions. A problem analysis chart identified five main contributing factors, with the most significant being repetition of critical denture fabrication stages, particularly the bite registration and impression stages, due to varying levels of skill and experience among dental officers. Interventions were implemented from February 2021 to December 2023, including a denture workshop, a supervised tagging system between senior and new dental officers, and an innovative tool, the Burner Box, complemented by a quick guide to improve bite registration efficiency. The percentage of older adults receiving dentures within eight weeks increased from 38.4% (2020) to 66.7% (2021), 84.5% (2022), and 82.4% (2023). Continuous supervision and training fostered confidence and competence among dental officers, reducing repetition frequency and ensuring better patient outcomes. The initiative has since been expanded to all dental clinics in Batu Pahat District and will be replicated across Johor state with an elevated standard of 80% set for 2025.

KEYWORDS: Denture, older adult, quality improvement study, bite registration, dental public health

Problem

Edentulism contributes substantially to the global oral disease burden and significantly affects older adults' oral function and quality of life (1). Timely denture provision is essential to restore mastication, nutrition, and psychosocial well-being. However, delays in denture delivery can compromise dietary intake, general health, and dignity among older adults (2). With Malaysia's ageing population projected to increase (3), the demand for timely prosthodontic care in public clinics is expected to rise, highlighting the need to address inefficiencies in denture service delivery (4).

Systemic service disruptions and workflow bottlenecks have severely impaired delivery timelines, causing the proportion of older adults receiving dentures at Parit Raja Dental Clinic within the standard eight-week period to drop sharply from 82.8% in 2018 to 38.4% in 2020. A verification study in January 2021 confirmed that only 38.4% of older adults received their dentures within eight weeks of request falling below Key Performance Indicator (KPI) standard of ≥50%. Given the multi-stage nature of denture fabrication, these delays worsen functional and psychosocial outcomes, highlighting a critical gap in service efficiency, resilience, and patient-centered care.

To address this gap, a quality improvement (QI) initiative was undertaken at Parit Raja Dental Clinic, a public facility under the Batu Pahat District Dental Office, Johor State Oral Health Department, Ministry of Health Malaysia. The clinic is operated by 17 staff members (five permanent dental officers, two contract dental officers under the New Dental Officer Programme, one dental technician, two dental therapists, four dental surgery assistants, two healthcare assistants, and one driver).

Historically, the clinic experienced rising overall attendances from 5,050 new and 1,853 repeat visits in 2017 to 6,331 new and 2,958 repeat visits in 2018, before COVID-19 Movement Control Order (MCO) restrictions caused attendances to fall to 794 new and 156 repeat visits in 2019. In 2020, attendances rebounded to 5,612 new and 2,150 repeat visits across all age groups. Among these, older adults (age >60 years) accounted for 273 new cases (4.9%) and 445 repeat visits (20.7%), with 90 complete dentures provided to 52 patients and 41 removable partial dentures provided to 29 patients.

Using the Nominal Group Technique (NGT) guided by SMART criteria, the project team prioritised this service delivery delay due to its direct impact on patient health outcomes and clinic performance. The primary aim was to increase the percentage of older adult patients receiving complete or partial dentures within eight weeks from 38.4% to above 50% at Parit Raja Dental Clinic within a 12-month period (January to December 2021).

Background

Global and national authorities, including the World Health Organization and the Ministry of Health (MOH), have emphasised oral health as an essential component of universal health coverage, highlighting the importance of prevention, early intervention, and intersectoral collaboration to support healthy ageing (5). Edentulism contributes to more than one-third of the global oral disorder disability burden, and timely denture provision plays a vital role in restoring occlusion, aesthetics, and oral health–related quality of life (1). Malaysia's older adult population is projected to reach 15.0% by 2030 (3), increasing demand for prosthodontic care in public clinics. The ageing process increases susceptibility to tooth loss due to cumulative oral disease, systemic health conditions, and medication-induced xerostomia (4). Older adults with poor-fitting or delayed dentures often resort to soft, nutrient-deficient diets, leading to reduced nutritional intake and lower quality of life (1). Dentures improve mastication, digestion, and self-esteem among older adults, and are increasingly recognised as important for maintaining general health and well-being, including prevention of malnutrition, frailty, and cognitive decline (6). However, denture construction is a multi-step procedure involving consultation, impression taking, bite registration, try-in, and issue stages (7). Clinical challenges

such as excessive alveolar ridge resorption may compromise denture fit and retention, necessitating remakes or additional adjustments, which can prolong treatment time and make completion within eight weeks difficult (8).

In this study, the term older adults is used instead of elderly to reflect a more person-centred and respectful terminology that aligns with current public health and gerontology literature (9). The term older adults emphasises active ageing and avoids the potentially ageist connotations associated with the word elderly (9). In Malaysia, individuals aged 60 years and above are classified as older adults, consistent with the definition adopted by the MOH's Health Information System and the United Nations (10,11). This age threshold is widely used in national and international research to represent the ageing population segment. Oral rehabilitation among older adults is recognised as a core service under Malaysia's National Oral Health Strategic Plan (NOHSP) 2022–2030 (12) and the MOH KPI framework, which sets a target of completing at least 50% of denture cases within eight weeks (13). Evidence from local audit data indicated that many clinics fall well below these standards; for example, only about 23.9% of patients in one QI project in Kedah state received removable dentures within eight weeks, far below the KPI target, reflecting systemic delays in prosthesis delivery across settings (14). Furthermore, international experiences with public dental services frequently report prolonged waiting times for basic dental care, with some regions documenting average waits exceeding a year for public dental services (15), underscoring the broader challenge of timely denture completion in resource-limited systems. The MOH KPI benchmark of completing at least 50% of denture cases within eight weeks standardised delivery timelines to ensure functional adaptation, maintain residual ridge integrity, and improve clinical outcomes. These efforts align with Malaysia's ageing policy frameworks, such as the National Policy for Older Persons (2011) and the National Action Plan for Healthy Ageing (2018–2023), both emphasising independence, nutrition, and psychosocial well-being (16,17). The project also supports Sustainable Development Goals 3 and 10, which promote healthy ageing and reduce inequalities through equitable oral health access (18). Timely denture provision contributes directly to these goals by restoring oral function and promoting social participation among older adults.

However, delays in denture issuance often arise from multiple factors, including operator skill, laboratory workflow, and patient compliance. The fabrication process requires precision at every stage, and errors or repetitions, particularly during impression taking and bite registration, result in time wastage and poor-fitting dentures (19). Previous studies from Croatia, Jordan, and the United Kingdom have shown that operator experience, guided supervision, and adherence to standardised procedures significantly influence denture quality and completion time (19–21).

This quality improvement project aligns with the MOH's strategic objective to strengthen service efficiency and workforce competency while advancing sustainable quality improvement (18). In addition, NOHSP Priority Area Five emphasises digital innovation and capacity-building, such as skill enhancement programmes and the integration of digital records, as key enablers for sustaining improvements (12). International studies, such as those from the United Kingdom, have proposed several strategies to improve the efficiency of denture service delivery in response to similar challenges (22,23). These include simplified denture fabrication techniques, such as reduced-visit or two-visit complete denture protocols, which shorten treatment duration without compromising patient satisfaction or clinical outcomes; strengthening operator competency through structured training, supervision, and adherence to standardised protocols to reduce procedural errors and remakes; improvements in laboratory workflow and coordination between clinics and technicians, including the adoption of digital technologies such as computer-aided design and manufacturing; and patient-focused strategies, including appointment compliance monitoring and oral health

education to minimise delays from missed visits or poor adaptation. Leveraging these strategies ensures equitable service delivery despite human resource and infrastructure limitations, particularly in rural settings.

Measurement

This QI study was conducted from January 2021 to December 2023, encompassing three annual Plan–Do–Study–Act (PDSA) cycles (verification, intervention, and post-intervention/ sustainability phases). The duration of each PDSA cycle was 12 months, allowing sufficient time for planning, implementation, evaluation, and refinement of interventions. Although PDSA cycles are commonly conducted over six months, a twelve-month cycle was deliberately adopted in this project. Denture provision involves a multistage clinical and laboratory process with variable case complexity, requiring a longer period to capture sufficient cases for stable measurement. In addition, monitoring of denture timeliness is aligned with the MOH annual KPI reporting framework, making a yearly cycle more appropriate. The extended cycle also allowed adequate time for training, supervision, and consolidation of skills among newly posted dental officers, as well as assessment of sustainability beyond short-term improvements.

The study team consisted of seven dental officers, one dental technician, and four dental surgery assistants in Parit Raja Dental Clinic. The dental officers were responsible for all clinical procedures, including patient assessment, impression taking, try-in, and denture issues. The dental technician carried out the denture fabrication process in the dental laboratory, while the dental surgery assistants supported the clinical workflow through patient clerking, preparation of impression materials, and chairside assistance. The project was led by the Supervising Dental Officer, who coordinated implementation, data verification, and adherence to MOH KPI reporting standards. Oversight and technical guidance were provided by the Dental Public Health Specialist in Batu Pahat District Office.

The key indicator followed MOH KPI No. 10 (2021):

$$\textit{Percentage of older adults receiving dentures within 8 weeks} = \frac{\textit{Number of older adults receiving dentures within 8 weeks}}{\textit{Total number of older adults receiving dentures}} \times 100$$

The standard set was ≥50% of older adults should receive dentures within eight weeks of being fit for fabrication. In this context, the eight-week period covers the complete denture fabrication process, including consultation, primary and secondary impressions, bite registration, try-in, and delivery of the completed denture. This indicator was selected as it represents national KPI No. 10, 2021 under the Primary Oral Healthcare Programme, MOH Malaysia. This KPI is set by the MOH as the national benchmark for timeliness of denture service delivery and is used by all public sector dental clinics (13). Monitoring this KPI allows clinics to track service efficiency, identify bottlenecks, and support timely functional oral rehabilitation among older adults. The indicator aligns with national priorities to improve functional oral rehabilitation and access to prosthodontic care in the ageing population (12).

Data sources included LP8-2 PIN.8/2019 cards, and PG207 reports from 2020-2023 (13). Data collected comprised the number of older adults receiving dentures, the date of fit for fabrication, and the date of denture issue, which allowed calculation of the time interval of eight weeks between the point when the denture was deemed fit for fabrication (following consultation and initial assessment) and the completion and delivery of the denture. Cases where patients defaulted on appointments were excluded. All data were verified by cross-checking LP8-2 PIN.8/2019 cards, and PG207 reports to ensure completeness and accuracy before analysis.

A verification study in 2020 showed that 38.4% of older adults received dentures within the stipulated timeframe. To identify potential contributing factors, a brief internal online questionnaire was developed by the Quality Assurance team and distributed to

seven dental officers in Parit Raja Dental Clinic. The tool, created using Google Forms, consisted of three structured questions exploring factors affecting confidence and competency in denture fabrication, as well as stages most frequently repeated. The questionnaire was reviewed by the clinic's Supervising Dental Officer and the District Dental Officer, who is also a Dental Public Health Specialist, to ensure appropriateness to the project objectives. The questionnaire is presented in Appendix 1.

No patient-level data collection or work process audit was conducted, as the project focused primarily on identifying provider-related factors contributing to delays in denture completion. The problem analysis chart revealed five main contributing factors:

1. Increased demand for new denture cases
2. Repetition of complicated fabrication steps
3. Lengthy procedure time
4. Differences in operator skill and experience
5. Low dental technician-to-patient ratio

The most actionable factors were selected for intervention.

Initial Assessment of the Problem

The potential factors contributing to the low percentage of older adults receiving dentures within eight weeks in Parit Raja Dental Clinic are shown in Figure 1.

Increased demand for dentures among older adults, due to poor denture maintenance, loss of functional teeth, and patient preference for spare or lower-cost prostheses, has led to a heavier workload. The proportion of edentulous patients aged 60 years and above attending Parit Raja Dental Clinic increased from 20.8% in 2019 to 28.0% in 2020, indicating a rising demand for denture services at the clinic. Limited manpower, particularly the reliance on a single dental technician and the need to coordinate both clinical and laboratory stages, further extended turnaround time. The multi-stage denture fabrication process, involving several personnel, was also prone to procedural delays. Communication gaps between dental officers and technicians, as well as the complex steps required for full dentures, often led to repetition of work. Baseline service data from 2020 revealed 29 denture cases requiring repetition of one or more fabrication stages, with eight cases involving repeated impression taking, 18 cases involving repeated bite registration, and three cases requiring a denture re-try. In addition, variations in clinical skills and experience among dental officers, coupled with inadequate guidance for new officers, contribute to inefficiencies. Analysis of operator experience showed that 27 of these cases were managed by dental officers with less than two years of experience, while only two cases involved operators with more than two years of experience, suggesting a possible correlation between operator experience and procedural repetition. Overall, these organisational, technical, and human factors collectively delayed completion and reduced the proportion of older adults receiving dentures within the target period.

Figure 2 shows the standard process of care of denture fabrication in Parit Raja Dental Clinic. On the other hand, Table 1 shows the Model of Good Care (MOGC), which outlines each critical step and the corresponding criteria that support high-quality denture fabrication.

Retrospective data extracted from clinical records and performance reports were analysed descriptively to determine the proportion of cases requiring repetition at each denture fabrication stage. Results showed that 50.0% (29/58) of cases involved repetition of one or more denture fabrication stages, predominantly the bite registration stage (62.0%). A simple correlation analysis indicated an inverse relationship between years of working experience and repetition frequency, particularly at the impression and bite registration stages, suggesting that the need for repetition decreased with increasing working experience. Findings from the internal staff questionnaire were analysed using frequency distribution, revealing critical factors affecting performance: lack of knowledge in impression-taking (28.6%), inadequate bite registration skills (71.4%), complexity of the bite registration technique (85.7%), and lengthy procedures (57.1%). A majority of the dental officers (71.0%) had

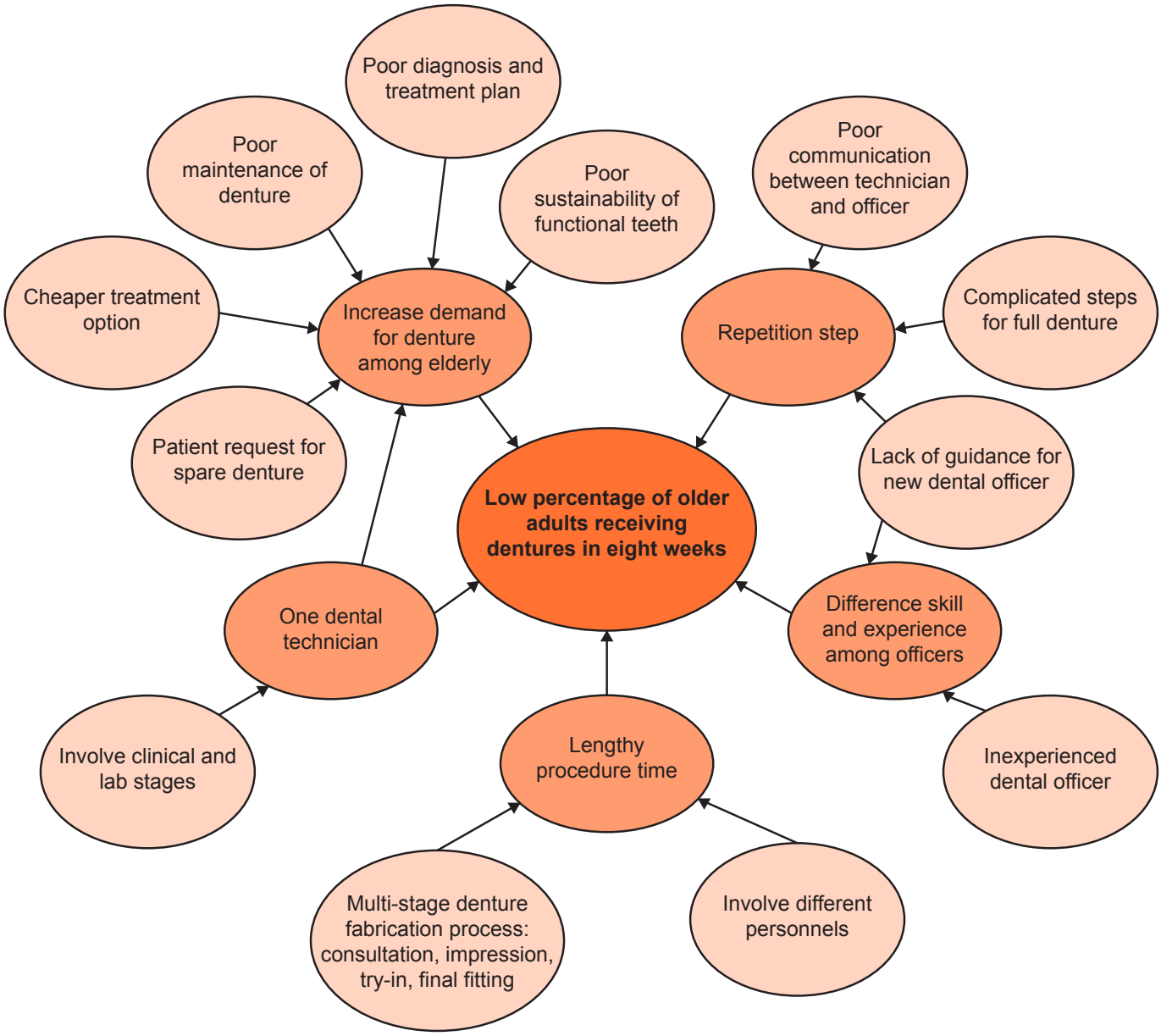
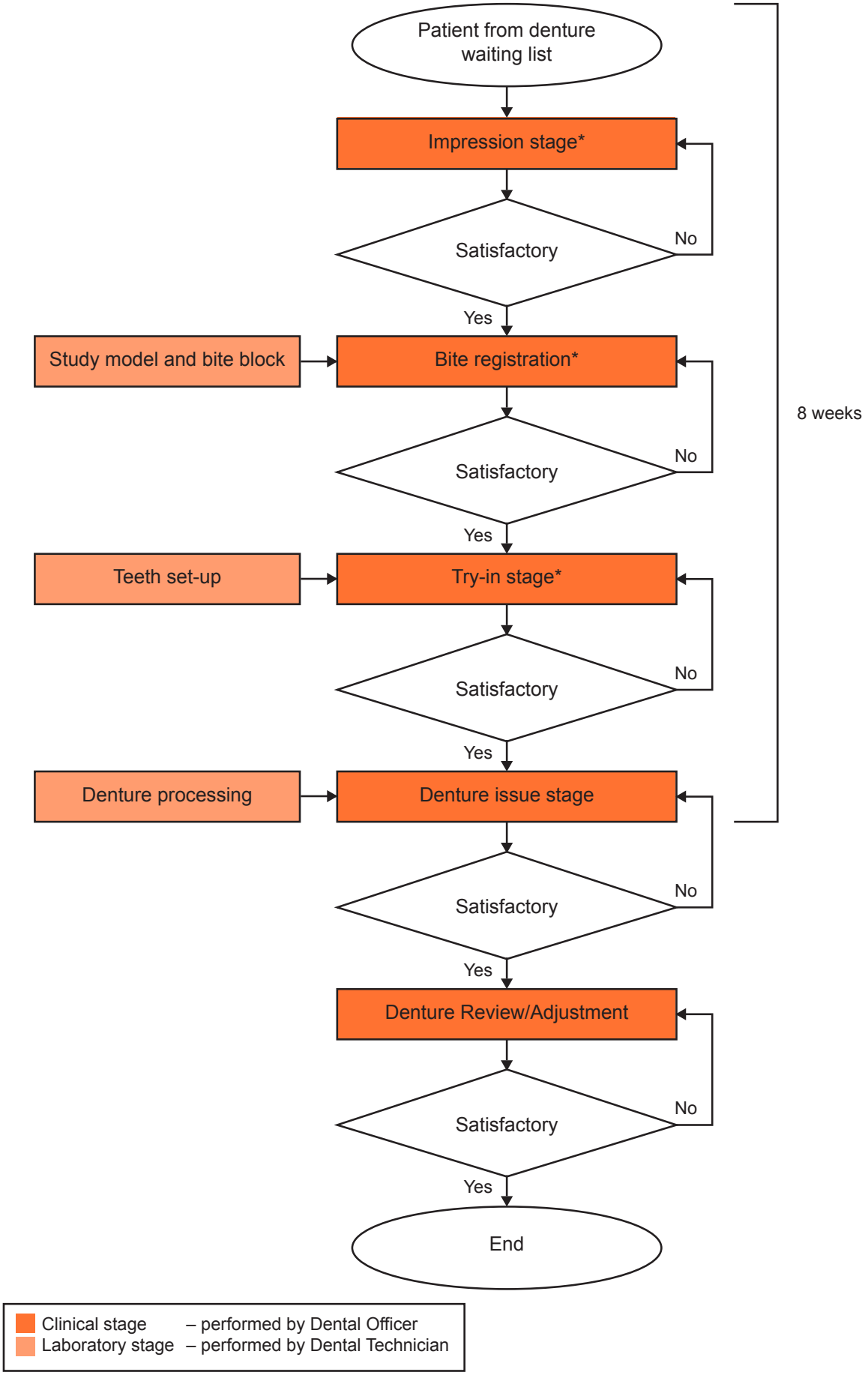


Figure 1: Problem analysis chart on the low percentage of older adults receiving dentures within eight weeks in Parit Raja Dental Clinic



* indicates critical steps

Figure 2: Standard process of care for denture fabrication in Parit Raja Dental Clinic

less than two years of experience, indicating a need for supervision and structured skill development. This assessment also identified system-level factors, including limited dental technician support and constrained laboratory capacity. These findings were consistent with national trends, where infrastructure limitations and human resource shortages remain key barriers to achieving timely denture completion (24,25).

Strategy

The MOGC (Table 1) outlines each critical step and the corresponding criteria that support high-quality denture fabrication. The improvement process was guided by the PDSA framework and implemented over three annual cycles from 2021 to 2023. Each cycle lasted 12 months and applied the same set of interventions: training and skill enhancement, guided supervision, and innovation with process optimisation. These interventions were continuously refined based on performance results and feedback from the previous cycle. This approach allowed the team to plan, implement, review, and adjust strategies in a systematic and sustainable manner while maintaining consistency with annual MOH KPI reporting.

Cycle 1 (January to December 2021): Initial Implementation

The first cycle focused on capacity building. Cycle 1 consisted of three-phased interventions: (Phase 1) hands-on workshop, (Phase 2) supervised tagging, and (Phase

Table 1: MOGC for improving the percentage of older adults receiving dentures within eight weeks in Parit Raja Dental Clinic

Step	Process of Care	Criteria	Standard	Verification	Cycle 1	Cycle 2	Cycle 3
1.	Impression stage	Ensure all anatomical landmark recorded adequately	100%	70.0%	100%	100%	100%
		To ensure suction is present upon removal	100%	90.0%	100%	100%	100%
2.	Bite registration stage	To ensure a bite with stable occlusion is achieved	100%	70.0%	100%	100%	100%
		To ensure the centric relation is recorded	100%	70.0%	100%	100%	100%
3.	Try-in stage	To ensure the patient is satisfied with the denture's appearance	100%	100%	100%	100%	100%
		To confirm the bite achieved as the previous bite registration	100%	80.0%	100%	100%	100%

3) introduction of the Burner Box and quick guide. All dental officers attended a hands-on denture workshop that emphasised impression-taking and bite registration (Phase 1). They were subsequently paired with senior mentors through a tagging system for guided supervision (Phase 2). An innovative tool, the Burner Box, and a quick guide for bite registration (Figure 3) were introduced (Phase 3) to improve efficiency and reduce procedural errors. The Burner Box was developed by the Innovation Team from the Batu Pahat District Dental Health Office. It consists of a metal box that securely houses essential instruments for denture fabrication, including a wax knife, wax scraper, Fox plane, divider calliper, wax sheet, fire lighter, ruler, pencil, Bunsen burner, rubber mixing bowl, gauze, and stapler bullets. The design allows the Bunsen burner to be safely enclosed, preventing accidental flame extinguishing and reducing fire hazards. It also helps maintain workspace cleanliness by containing melted wax and facilitates easier cleaning and disinfection after patient treatment. The tool was primarily intended for dental officers performing chairside denture fabrication, particularly during the bite registration and try-in stages. While the Burner Box was not formally endorsed, verbal feedback from users indicated that it improved workflow organisation and shortened procedural time, enhancing overall efficiency in denture fabrication.

Cycle 2 (January to December 2022): Refinement and Reinforcement

The second cycle emphasised refinement of the same interventions. Refresher workshops were conducted for newly posted dental officers, followed by a structured tagging system in which each junior officer was paired with a senior permanent officer for real-time supervision during denture fabrication. The supervision was carried out by senior dental officers within the clinic, coordinated by the Clinic Head, to ensure consistent application of standardised clinical techniques and to provide immediate feedback during key stages such as impression taking and bite registration. Although no formal pre- and post-assessment was conducted, this hands-on mentorship allowed ongoing evaluation through direct observation and feedback. Routine audits were conducted monthly as part of the clinic's internal quality review process. These audits were separate from the supervision activities and involved reviewing denture case records, tracking completion timelines, and verifying adherence to the MOGC criteria. The audits also examined the frequency of case repetitions and documented reasons for delays, enabling the team to identify workflow bottlenecks and implement corrective actions promptly. Findings from the audits were discussed during monthly review meetings, where progress was evaluated, and further improvements were planned collaboratively by the clinic team.

Cycle 3 (January to December 2023): Consolidation and Sustainability

The third cycle aimed to sustain improvements and institutionalise the MOGC (Table 1). Peer coaching and periodic evaluations were introduced to maintain performance standards despite staff rotation, with each senior officer supervising two junior officers at key stages of denture fabrication. Continuous monitoring through PG207 reporting ensured that the improvements were maintained and aligned with the MOH KPI standard.

Each PDSA cycle concluded with an end-of-year review to evaluate progress, measure outcome indicators, and plan adjustments for the following cycle.

Results

Post-intervention outcomes showed marked improvement over three consecutive PDSA cycles. Each annual cycle reflected the impact of the corresponding strategies implemented that year.

Cycle 1 (January–December 2021): Initial Implementation

Following the introduction of training workshops, guided supervision, and the Burner Box innovation, procedural efficiency improved significantly. Repetition rates in the bite registration stage decreased from 62.0% to 28.6%, indicating improved operator skill and reduced procedural errors. The percentage of older adults receiving dentures within eight weeks increased from 38.4% in 2020 (pre-intervention) to 66.7% in 2021. The Achievable Benefit Not Achieved

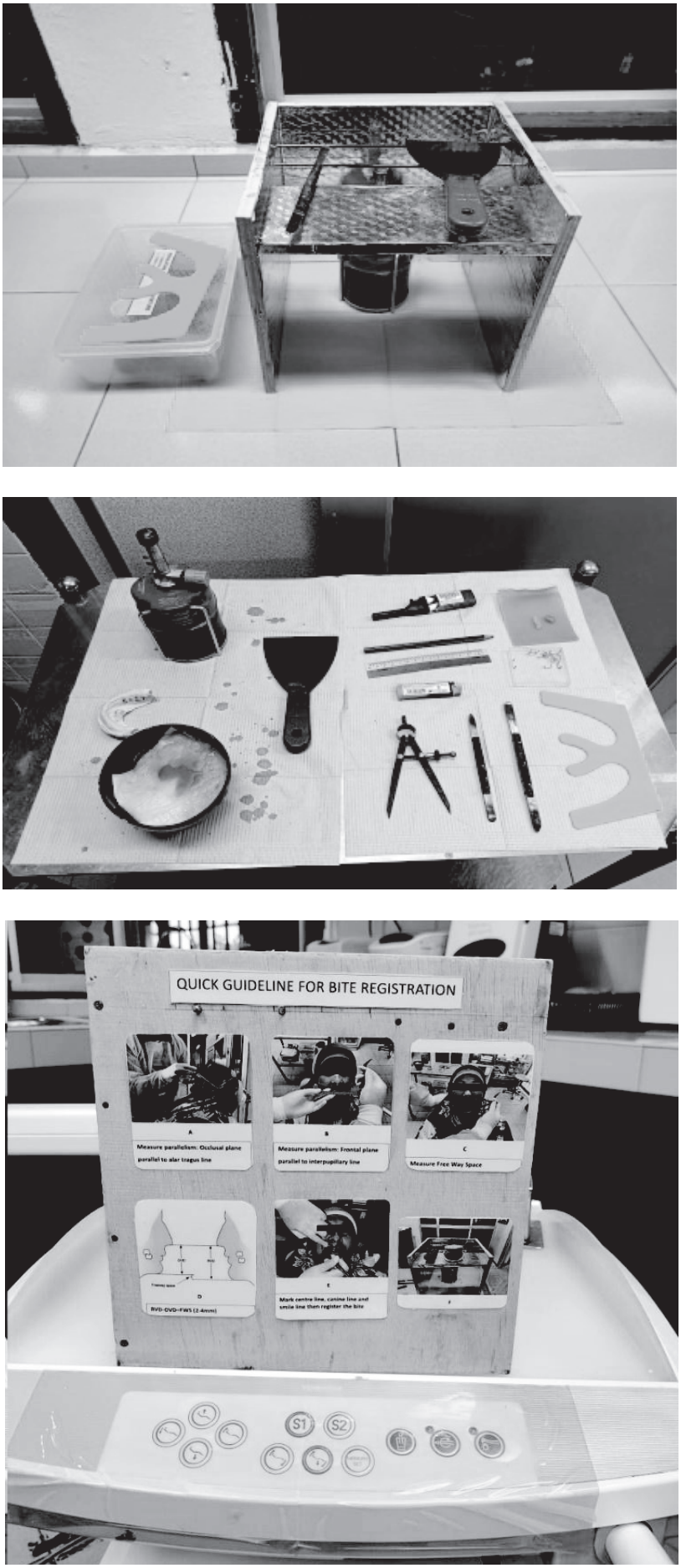


Figure 3: Burner box and quick guideline to improve efficiency during bite registration

(ABNA) improved from 11.6% to –16.7% (Figure 4), showing substantial progress toward the MOH target.

Cycle 2 (January–December 2022): Refinement and Reinforcement

During the second cycle, continuous supervision, refresher workshops, and workflow refinement were emphasised. These strategies led to further improvements, with 84.5% of older adults receiving dentures within eight weeks. This represented a 17.8% increase from the previous year, confirming that reinforcement and standardisation enhanced consistency and maintained skill levels among new officers.

Cycle 3 (January–December 2023): Consolidation and Sustainability

In the third cycle, peer coaching and continuous monitoring ensured sustained adherence to the MOGC. Despite staff rotation and varying case complexity, performance remained high at 82.4%. The slight reduction from 84.5% in 2022 may be attributed to the onboarding of new officers and a higher proportion of complex edentulous cases requiring additional clinical adjustments. Nevertheless, the sustained outcome beyond the MOH KPI target of 50% demonstrated that the improvements were institutionalised and resilient to workforce changes. Overall, the number of older adults receiving dentures within eight weeks rose from 42 out of 63 in 2021 to 70 out of 85 in 2023. Staff feedback highlighted improved clinical confidence, shorter procedural time, and reduced workload stress, confirming the positive impact of skill enhancement, supervision, and innovation on service quality.

Figure 4 shows the percentage of older adults receiving dentures within eight weeks at Parit Raja Dental Clinic from 2020 to 2023. The year 2020 served as the baseline before any intervention. The following three years correspond to three PDSA cycles, each lasting one year. Progressive improvement was observed after each cycle, increasing from 38.4% in 2020 (baseline) to 66.7% in 2021 (Cycle 1), 84.5% in 2022 (Cycle 2), and 82.4% in 2023 (Cycle 3). These findings demonstrate that repeated implementation and continuous refinement of interventions across three annual cycles effectively improved and sustained performance above the MOH KPI target of 50%. In addition to improved timeliness, the reduction in procedural repetition and remakes contributed to lower material costs, decreased laboratory burden, better utilisation of manpower, and reduced patient visits, thereby enhancing overall service efficiency and cost-effectiveness.

Lessons and Limitations

This project demonstrated that guided training, procedural innovation, and mentorship can effectively improve clinical efficiency. However, limitations included dependence on senior officers' availability for supervision, varying patient cooperation levels, and laboratory workload that occasionally delayed completion. The project also relied on internal motivation rather than external incentives, which may affect sustainability without continuous monitoring.

Conclusion and the Next Steps

The interventions significantly improved denture delivery timelines, surpassing the national KPI. The success of this project demonstrates that structured training, mentorship, and procedural innovation can meaningfully improve oral healthcare service quality and patient outcomes in the public sector. Sustained adherence to the MOGC ensures continuity of these gains. By aligning with the National Oral Health Strategic Plan (2022–2030) and the global Vision 2030 for Oral health (12), this initiative supports Malaysia's commitment to provide equitable, efficient, and person-centred care for its ageing population. Continued monitoring and district-wide implementation will further contribute to achieving Sustainable Development Goals 3 (Good Health and Well-Being) and 10 (Reduced Inequalities). Sustaining this improvement requires continued supervision, periodic workshops, and adherence to the standardised workflow. The project has been expanded to all dental clinics in the Batu Pahat District as of 2024, with plans for replication across Johor. Aggregated data from the participating clinics show that the percentage of older adult patients receiving dentures within eight weeks consistently met or

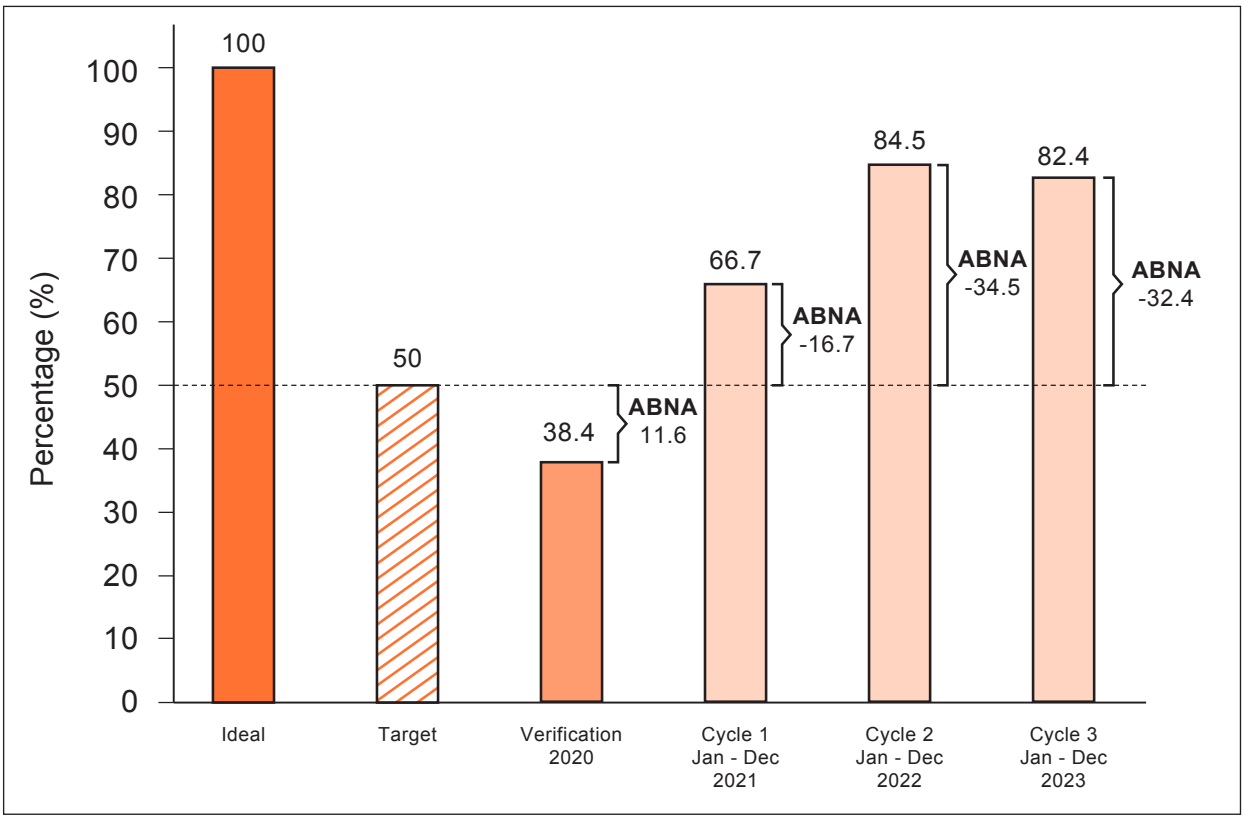


Figure 4: Percentage of older adults receiving dentures within eight weeks in Parit Raja Dental Clinic from 2020 to 2023

exceeded the original KPI, with individual clinics achieving between 53.5% and 92.7% completion rates. For 2025, the district raised the KPI standard to 80% and plans to patent the Burner Box design through Intellectual Property Corporation of Malaysia (MyIPO) to facilitate nationwide adoption as a practical tool in public dental clinics. The project successfully achieved and exceeded its original SMART aim of increasing the percentage of older adult patients receiving dentures within eight weeks from 38.4% to above 50%, demonstrating sustained improvement over three consecutive years.

Acknowledgements

The authors thank the Director General of Health Malaysia for permission to publish this article. Appreciation is extended to all staff of Parit Raja Dental Clinic, Batu Pahat District Dental Health Office, and Johor State Dental Health Division for their continuous support.

Conflict of Interest

The authors declare that there was no conflict of interest.

Funding

No specific funding was received for this project.

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Appendix 1: Online Questionnaire for Assessment of Dental Officers' Perspectives on Denture Fabrication Challenges

Online Questionnaire KP Parit Raja

Increasing the Percentage of Elderly Patients Receiving Denture Within 8 Weeks in

Klinik Pergigian Parit Raja

Name: _____

Working experience

☐ Less than 2 years
☐ 2 years and above

What are the factors affecting your confidence and competency in denture fabrication?

☐ Lack of knowledge in impression taking
☐ Lack of skill in conducting bite registration
☐ Complicated technique of bite registration stage
☐ Lengthy procedure time

Which denture fabrication stage that you have repeated?

☐ Impression taking
☐ Bite registration
☐ Denture try in
☐ Denture issue

REDUCING THE PERCENTAGE OF ANTIBIOTIC PRESCRIPTIONS WITH PRESCRIBING ERRORS RELATED TO RENAL-DOSE ADJUSTMENT IN THE ORTHOPAEDIC WARD, HOSPITAL MELAKA

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Abstract

Prescribing antibiotics with the appropriate dose according to the patients' renal profile is crucial due to the variability of pharmacokinetics and pharmacodynamics. Failing to adjust the antibiotics dosage according to patients' renal profile is considered a prescribing error, and may lead to treatment ineffectiveness or toxicity. A verification study conducted in the orthopaedic ward, *Hospital Melaka*, from November 23, to December 27, 2020, revealed that 9.1% of prescriptions had prescribing errors involving antibiotics requiring renal-dose adjustment. This quality improvement study aimed to achieve zero percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment in the orthopaedic ward in *Hospital Melaka*, within a year. A self-administered questionnaire was developed and distributed among 40 healthcare professionals to identify contributing factors. Through Pareto analysis, three major contributing factors to the prescribing errors involved antibiotics requiring renal-dose adjustment, incomplete local drug policy, and different practices among doctors. Two interventional cycles with remedial actions were formulated and implemented from December 2020 to April 2021. The remedial actions developed were the formulation of the Antimicrobial Renal Adjustment quick guide (Am-Read), continuous medical education for doctors and pharmacists, and amendments to the prescriptions column. Data were collected using data collection forms throughout the study period. The Achievable Benefit Not Achieved was reduced from 9.1% to 5.9% post remedial actions Cycle 1, then to 2.9% post remedial actions Cycle 2. In Cycle 2, the prescribing error was detected early during the screening stage by a pharmacist. We believed that the remedial actions implemented in the study could further reduce the prescribing error to zero and could be replicated in other healthcare settings.

KEYWORDS: Antibiotics, renal-dose adjustment, prescribing error, quality improvement study

Problem

Medication error (ME) is defined as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is controlled by healthcare professionals, patients, or consumers (1,2). At *Hospital Melaka*, reported ME cases showed an upward trend, surging from 1,061 in 2017 to 2,184 in 2019. Prescribing errors were the most predominant type, accounting for over 90% of all reported MEs in 2019. Prescribing error refers to any ME initiated during the prescribing process, including incorrect medications, incorrect dose (over- or under-therapeutic dosing), wrong frequency, inappropriate route of administration and inappropriate dosage form (3).

Antibiotics, such as intravenous amoxicillin/clavulanate for diabetic foot infections, are routinely used in orthopaedic wards. Appropriate dosing and frequency are crucial for safety and efficacy, as individual pharmacokinetics and pharmacodynamics vary. In patients with kidney impairment, antibiotics eliminated by the kidneys carry a significant risk of accumulation and toxicity if regimens are not properly adjusted. Getachew et al. (4) demonstrated that 51% of prescriptions requiring dose adjustments including antibiotics such as ceftazidime, vancomycin, and co-trimoxazole were inappropriate. Given that Kateros et al. (5) reported an 8.7% incidence rate of kidney disease among orthopaedic patients, failure to make accurate dose adjustments may causes medication errors.

Hospital Melaka is a state government tertiary facility with 1,091 beds providing diverse clinical specialties. Orthopaedic Department had four adult wards in Block D managed by 14 specialists and 40 medical officers, offering specialty services across operating theatres, outpatient clinics, and inpatient wards. However, unlike medical wards, orthopaedic wards lack dedicated ward pharmacists to provide direct clinical input and interventions during daily rounds. All warded patient medications are handled centrally by the Inpatient Pharmacy Unit, where pharmacists screen prescriptions, dispense drugs, and provide drug information. There were 12 pharmacists at the Satellite 5 Inpatient Pharmacy manage prescriptions across 21 wards, including orthopaedics. Consequently, prescribing errors can only be identified after prescriptions reach the pharmacy.

Pharmacists in Satellite 5 had observed a significant number of prescribing errors specifically involving antibiotics requiring renal-dose adjustment in orthopaedic patients. A verification study conducted in the orthopaedic ward, from November 23, to December 27, 2020, revealed that 9.1% of prescriptions have prescribing errors involving antibiotics requiring renal-dose adjustment. Therefore, this study aimed to reduce the percentage of prescribing errors involving antibiotics requiring renal-dose adjustment in the orthopaedic wards of *Hospital Melaka* to 0.0% within one year.

Background

Medication safety is one of the most crucial aspects of patient safety. Globally, medication-related harm accounts for more than half of the overall preventable harm in medical care, which costs approximately EURO4.5 – 21.8 billion (~MYR21.2 - 102.7 billion, as of August 2026) in Europe annually (1). A study in England estimated that there were 237 million MEs yearly, of which 66 million were potentially clinically significant. These MEs were estimated to incur GBP98,462,582 (~MYR505 million) to the healthcare system and cause 1,708 deaths per annum (6).

In Malaysia, the number of nationwide MEs reported to the Ministry of Health has been rising, from 26,056 in 2017 to 47,251 in 2019 (7). A meta-analysis in Africa reported 13.7% of MEs involved inappropriate drug dose adjustment among renal impairment patients (8). A study in a tertiary hospital in India reported 45.9% MEs out of 427 cases, with prescribing errors being the most frequent MEs (70.4%), and approximately 16.0% of the reported prescribing errors involved patients from orthopaedic surgery disciplines (9).

The antibiotic group was found to be one of the common ME-related pharmacological groups, which resulted in significant morbidity and mortality among patients. More than 50% of prescribing errors involved the wrong doses, in which

the antibiotic group recorded the highest risk of ME at 79.6% (9,10). The death-related rate associated with ME of antibiotics was recorded at 7.5% (11). Likewise, a local study reported that the anti-infective group is one of the most common categories involved in MEs, in which the anti-infective group consists of a quarter of the reported MEs and 19.5% of the actual MEs (12).

Generally, MEs can be attributed to factors related to healthcare professional staff, healthcare system, the working environment, tasks and technology, and others (13,14). Yatim et al. (12) showed that the contributing factors to ME were mainly staff factors (79.4%), including inexperienced personnel, lack of knowledge, or distraction. Besides, tasks and technology, which consisted of failure to adhere to work procedure, incomplete information, illegible prescriptions, and wrong labelling, were reported as other main attributing factors of MEs.

The medication use process involves prescribing, dispensing, administration, and monitoring. Prescribing was shown to be one of the important stages, accounting to 51.0% of all MEs reported in the Ministry of Health Malaysia (3). The contributing factors of prescribing errors are usually multifactorial, consisting of inadequate knowledge of the drug, skills-based slips, inadequate training or experience, fatigue, stress, high workload for the prescriber, inadequate or poor access to patient information, inadequate communication between healthcare professionals, reluctance or fear to question senior colleagues, over-trusting the specialists, improper selection from a computer operator list, pre-printed medication orders, noise working environment, distraction and frequent interruption of prescriber, no or ambiguous guidelines and protocols (13,15-17).

A study conducted at a tertiary hospital in Ipoh found that the prescribing process accounted for 97.4% of all MEs (12). Apart from prescribing, medication administering and dispensing processes were demonstrated to cause 46.2% and 23.1% of all actual MEs, respectively (12).

Multiple strategies to reduce the incidence of prescribing error have been advocated, including the implementation of a ME reporting system (18); the application of error-detecting tools; organising continuous education on medication safety (19); creating a framework for action aimed at healthcare professionals to facilitate improvements in prescribing, dispensing, administration, and monitoring practices; developing guidance and tools to fill the knowledge gap of healthcare professionals; raising awareness among staff regarding medication safety; establishing of electronic medical records providing real-time patients' information, laboratory investigations, and medication profiles; adopting computerised order entry which enables prompt warnings on drug overdose, allergy, drug interaction as well as involving pharmacists for dose calculation and drug administration (20–22).

A comparison of the effectiveness of various interventions in reducing ME was done. Meta-analyses showed that prescribing errors were reduced by pharmacist-led medication reconciliation, computerised medication reconciliation, medication reconciliation by trained mentors, computerised physician order entry as a single intervention, pharmacist partnership, and prescriber education (23,24). The combination of these strategies has also successfully reduced the prescribing or administration of ME, including the combination of prescriber education and pharmacist-led medication reconciliation (23). Grimes et al. (25) also assessed the effectiveness of pharmacist-led medication reconciliation and pharmacist partnership in acute medical units and found a lower prescribing error rate.

Measurement

This quality improvement study was conducted in one orthopaedic ward (Ward D4) and Satellite 5 Inpatient Pharmacy at *Hospital Melaka* from November 2020 to April 2021. In this study, injectables and oral antibiotic prescriptions for patients aged 18 years and above who were admitted to the orthopaedic ward of *Hospital Melaka* that reached Satellite 5 Inpatient Pharmacy during office hours were screened by pharmacists. Prescriptions of antibiotics that were given as 'STAT' doses and antibiotics that did not need renal-dose adjustment at the point of prescribing were excluded.

The 'renal-dose adjustment' in this study refers to the antibiotic dose adjustment for patients with any severity of kidney impairment. Some examples of these antibiotics include amoxicillin-clavulanate, meropenem, and piperacillin-tazobactam. In this study, the patients' latest serum creatinine (SCr) prior to antibiotics initiation was assessed via the 'I-lab system'. The latest SCr level, the patient's body weight, age, and gender will be used to calculate the patient's creatinine clearance (CrCl). Based on the calculated CrCl, the prescribed antibiotic dose will be checked using references such as Malaysia National Antibiotic Guideline 2019, Micromedex Drug Reference, or UpToDate.

Any of the following scenarios was considered as a prescribing error: 1) a normal dose was prescribed to patients with renal impairment; 2) a renal-adjusted dose was prescribed to patients with normal renal function; and 3) an inappropriate renal-adjusted dose was prescribed. For example, IV amoxicillin-clavulanate 1.2g TDS was prescribed to a patient with CrCl 20ml/min, in which the correct dose should be 1.2g STAT, then 600mg BD. The percentage of prescriptions with prescribing errors reported in this study included all prescriptions with errors initiated by the prescriber and detected either during the screening process or counter-checking by pharmacists.

The percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment was used as the indicator for improvement. The percentage was calculated using the formula below:

$$\textit{Percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment} = \frac{\textit{Number of prescriptions of antibiotics requiring renal-dose adjustment, with ≥1 prescribing error}}{\textit{Number of prescriptions of antibiotics requiring renal-dose adjustment}} \times 100$$

For example: (1) If ten antibiotic prescriptions requiring renal-dose adjustment are screened, and two prescribing errors are detected in two prescriptions, then the percentage of prescriptions with prescribing errors is 20% (2). If ten antibiotic prescriptions requiring renal-dose adjustment are screened, and two prescribing errors are detected from one prescription, then the percentage of prescriptions with prescribing errors is 10% (4). In view of the possible harm of a wrong dose of antibiotics requiring renal dose adjustment, our group consensus was to set the standard at zero percentage of prescriptions with prescribing errors. The standard for the study aligns with Goal 3 of the Malaysian Patient Safety Goals 2.0 that set zero number of MEs resulting in severe damage or death for medication safety (2).

A brainstorming session was conducted among five pharmacists and a doctor to identify all the possible contributing factors leading to the prescribing error. Then, a self-administered questionnaire consisting of the possible contributing factors was developed. The questionnaire was reviewed by a senior pharmacist and the head of unit of the Inpatient Pharmacy. A total of 40 healthcare professionals, including 33 pharmacists and seven doctors, were approached to respond to the self-administered questionnaire. Each responder could choose more than one contributing factor. Subsequently, the data were converted into a Pareto chart to identify the major factors causing the prescribing errors involving antibiotics requiring renal-dose adjustment.

A dedicated pharmacist with four years of working experience at Satellite 5 Inpatient Pharmacy was chosen as the data collector. Data collection form (Appendix 1) was used throughout the study to collect data on all the critical steps involved. Part A of the data collection form consists of information regarding prescriptions for antibiotics requiring renal-adjusted doses. Part B of the data collection form comprised the following information: whether the ME reached the patient; the outcome of the ME; the contributing factors of the ME; the process by which the ME occurs; and the staff involved in the ME.

Two pharmacists were involved in the data management. One pharmacist was responsible for data entry and the other for data analysis. Microsoft Excel was used for data storage and analysis in a local computer. The file was kept confidential and with restricted access. The data were tabulated, and the categorical data were presented in percentages.

Initial Assessment of the Problem

The process of care, from prescribing to dispensing antibiotics, is shown in Figure 1. The critical steps where prescribing errors commonly happen and are not being detected before reaching the patient (identified with asterisks) include: (1) antibiotics prescribing by the doctor; (2) prescription screening by the pharmacist; (3) prescription counter-checking by the pharmacist.

Antibiotic prescribing starts when the doctors prescribe the drug for the treatment or prophylaxis of infection (if the patient is undergoing an operation with high-risk contamination). The choice of antibiotics will be based on the type of infection, site of infection, and patient comorbidity. At the same time, the dose of antibiotics will be decided based on references such as Malaysia National Antibiotics Guidelines 2019, Micromedex Drug Reference, or UpToDate. For some of the antibiotics that are excreted renally, such as IV piperacillin-tazobactam, the dose should be reduced in patients with renal impairment. After the prescription is endorsed, it will be sent to the Satellite 5 Inpatient Pharmacy by the ward nurses. In the pharmacy, the pharmacists will screen through the prescription. A query will be made to the prescriber if the prescription needs clarification. The process will be followed by medication filling, labelling, and counter-checking before it is dispensed and collected by the nurses for antibiotic administration to patients.

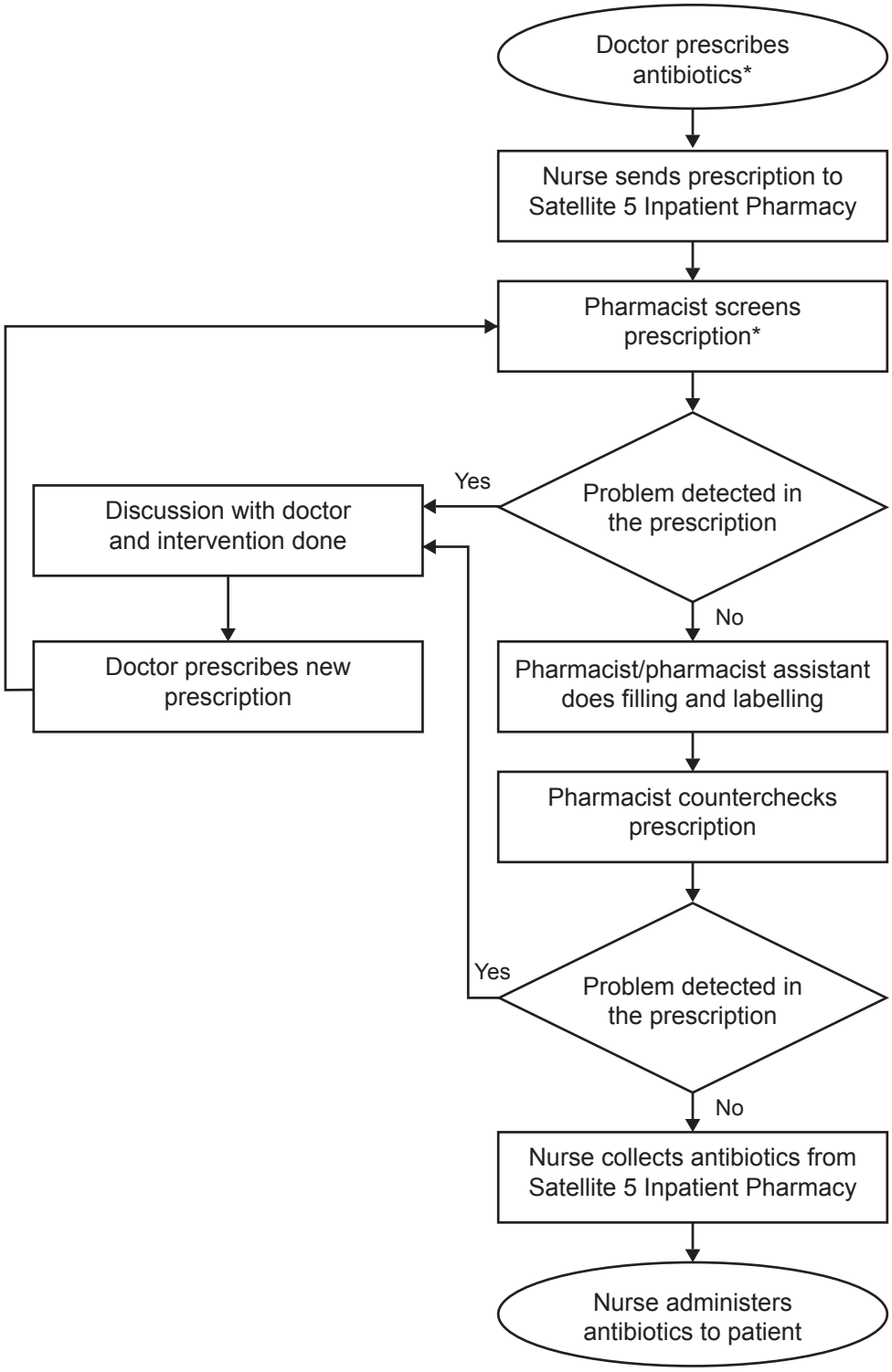
The Model of Good Care (MOGC), as outlined in Table 1, highlights the critical steps in the care process, from prescribing to dispensing antibiotics. During the verification study, 55 prescriptions with antibiotics involving renal-dose adjustment were screened. A total of five prescribing errors were detected therefore resulting in 9.1% of the prescribing errors. The Achievable Benefit Not Achieved (ABNA) was 9.1%. The verification study highlighted that none of the prescribers wrote or indicated the patients' calculated CrCl or the dialysis status on the prescription. Besides, only 70.9% of the prescriptions screened by pharmacists were checked on the patients' renal status. This indicated poor awareness or knowledge among doctors and pharmacists regarding the importance of checking patients' renal status before prescribing antibiotics and screening antibiotic prescriptions.

A few contributing factors were identified during the brainstorming session, as demonstrated in Figure 2. There were five presumed factors to contribute to the high percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment, which include: different practices among doctors, non-adherence to SOP (Standard Operating Procedure), incomplete local prescribing policy and failure to include patient renal status in prescription, lack of awareness and knowledge among doctor and pharmacist and unclear prescription.

A Pareto analysis of the data from the survey administered among pharmacists and doctor was then carried out to identify the main contributing factors as per Figure 3. The three major contributing factors to the high percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment, including: (A) lack of awareness and knowledge among doctors and pharmacists; (B) incomplete local prescribing policy and failure to include patient renal status in prescription; and (C) different practices among doctors.

Before this quality improvement study, doctors and pharmacists lacked awareness that certain antibiotics required dose adjustments based on patients' renal profiles, which may lead to medication errors. The low awareness among doctors and pharmacists was due to inexperienced personnel and a lack of educational programmes to increase awareness and knowledge among the healthcare personnel.

Prior to this study, the prescribing



*indicates critical steps

Figure 1: Process of care from prescribing to dispensing antibiotics

Table 1: MOGC in reducing prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment in the orthopaedic ward

No.	Proses	Criteria	Standard	Verification (n=55)	Cycle 1 (n=34)	Cycle 2 (n=35)
1.	Doctor prescribes antibiotics	Prescribe to the right patient	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Prescribe the right antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Prescribe the right route of antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Prescribe the right dose of antibiotics	100%	90.9% (50/55)	94.1% (32/34)	97.1% (34/35)
		Write the patient's calculated CrCl or the dialysis status	100%	0.0% (0/55)	91.2% (31/34)	97.1% (34/35)
2.	Pharmacist screens prescription	Ensure the right patient	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Ensure the right antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Ensure the right route of antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Check the patient's CrCl or the dialysis status	100%	70.9% (39/55)	97.1% (33/34)	100% (35/35)
		Ensure the right dose of antibiotics	100%	94.5% (52/55)	97.1% (33/34)	100% (35/35)
3.	Pharmacist counter-checks prescriptions	Ensure the right patient	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Ensure the right antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Ensure the right route of antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Check the patient's CrCl or the dialysis status	100%	100% (55/55)	100% (34/34)	100% (35/35)
		Ensure the right dose of antibiotics	100%	100% (55/55)	100% (34/34)	100% (35/35)

policy was found to have a critical gap. The prescriber was not required to include the patient's renal status. Therefore, the Satellite 5 Inpatient Pharmacist, who screened the prescription unable to determine whether a patient has renal impairment, and consequently undermine the possibility for ME. The lack of a standardised local reference to guide doctors on the renal dosing of antibiotics has been another cause for ME. Doctors may refer to different references based on their previous working experiences and trainings. The other two smaller proportions of contributing factors include non-adherence to SOP (11.5%) and unclear prescription (0.0%).

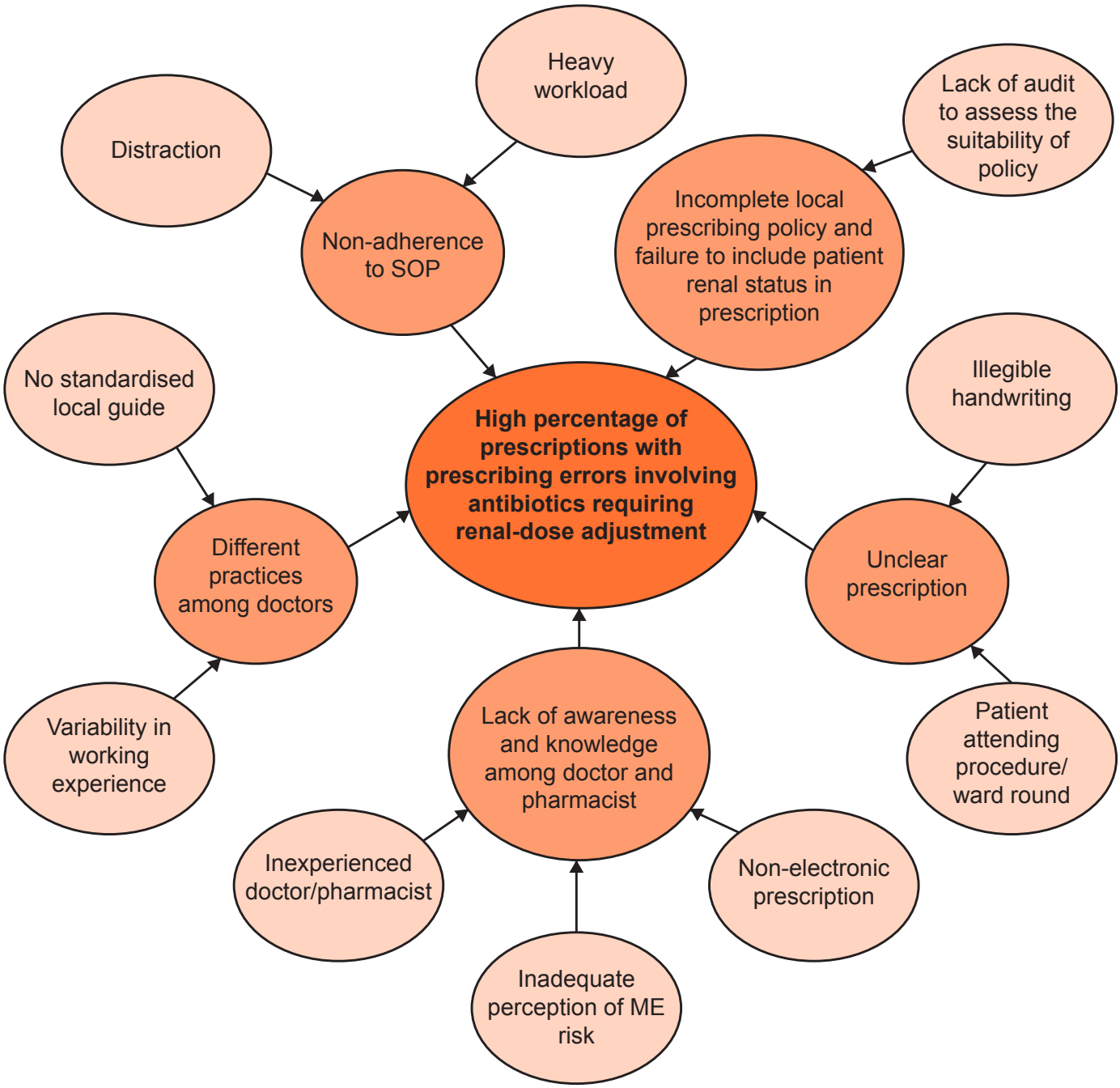


Figure 2: Problem analysis chart of the high percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment

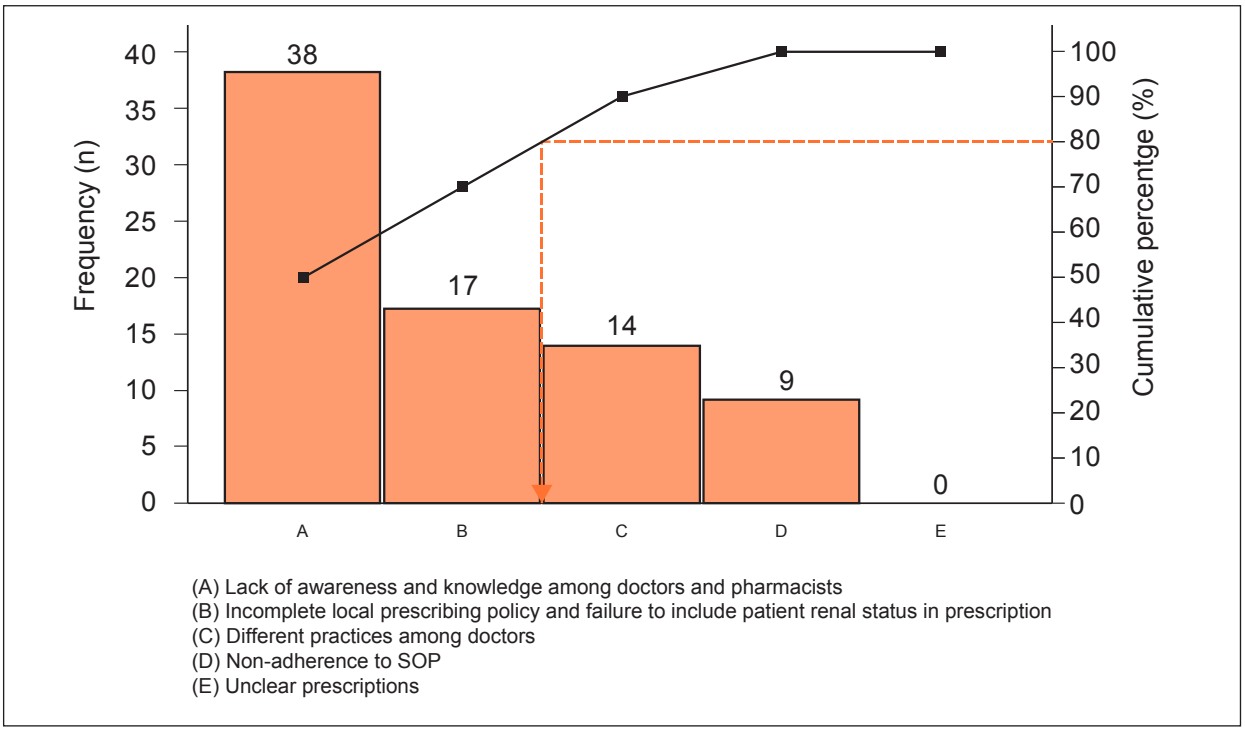


Figure 3: Contributing factors to the high percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment

Strategy

Following the identification of the contributing factors, there were two intervention cycles with five remedial actions implemented to reduce the percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment in the orthopaedic ward of *Hospital Melaka*. Cycle 1 involved three remedial actions and was implemented from December 2020 to March 2021. During Cycle 1, remedial actions were carried out for eight weeks (December 28, 2020, till February 21, 2021); followed by three weeks of post-remedial data collection (February 22, till March 14, 2021) then two weeks of data analysis (March 15 till March 31, 2021). Subsequently, Cycle 2 involved two remedial actions were conducted in the month of April 2021. During Cycle 2, the remedial actions were implemented for one week (April 1, 2021 till April 7, 2021), followed by three weeks of post-remedial data collection (April 8, 2021 till April 28, 2021). The data collected during the post-remedial periods were analysed to determine the effectiveness of the interventions.

Cycle 1 focused on tackling the issue of inadequate knowledge and awareness among doctors, and incomplete drug policy. The first remedial action for Cycle 1 was taken by developing an Antimicrobials Renal Adjustment quick guide (Am-Read) (Appendix 2) based on the National Antimicrobial Guidelines 2019, Micromedex and UpToDate to tackle inadequate or varying references used by doctors. Am-Read listed all the antibiotic doses for normal kidney function and adjusted the dose based on the patients' CrCl. It was then distributed to the orthopaedic ward and placed in every patient's medication file. The second remedial action was done by amending the inpatient prescriptions by adding a temporary column for renal profile-related data which were the patient's latest CrCl and dialysis status. A stamp chop with two columns 'CrCl' and 'PD/HD/No' was made and it was stamped on all the empty medication charts. Then, the medication charts were distributed to the orthopaedic ward. Continuous medical education via virtual sessions with doctors and nurses was carried out as the third remedial action to create awareness regarding the importance of renal-dose adjustment for antibiotics. The availability of an Am-Read quick guide in every patient's medication file was notified

during the session. Doctors were informed of the necessity of filling in the patients' latest CrCl and dialysis status upon prescribing.

Although the three remedial actions in Cycle 1 showed improvement in overcoming the contributing factors, the ABNA achieved in Cycle 1 was 5.9% (Figure 4). It was noticed that there was a lack of knowledge and awareness among the pharmacists, besides the doctors. Many of the Am-Read quick guides that were placed in the patients' medication files during the remedial action, were noticed to be misplaced.

Hence, the fourth and fifth remedial actions in Cycle 2 involved providing education sessions to pharmacists and doctors and the redistribution of the Am-Read quick guide. Both the pharmacists working in Satellite 5 Inpatient Pharmacy and the doctors in the orthopaedic ward had received the education session that emphasised the importance of checking through patients' renal profiles and to use the Am-Read quick guide upon prescribing and screening. The Am-Read quick guide that was found missing from the patient's medication file also got replaced. Moreover, the Am-Read quick guide was also placed on the Satellite 5 Inpatient Pharmacy notice board. After the remedial actions in Cycle 2 were done, the reported prescriptions with prescribing errors were reduced to 2.9% with the ABNA achieved in Cycle 2 was 2.9%.

Results

During the verification study, 5 out 55 (9.1%) antibiotic prescriptions screened were detected to have prescribing errors. Three of the prescribing errors involved wrong frequency at which the first dose was served but the second dose was managed to be corrected. Another prescribing error involved wrong dose while the third prescribing error involved both wrong dose and frequency. In the post-remedial actions of Cycle 1, it was found that two out of 34 (5.9%) antibiotic prescriptions screened had prescribing error. One of the prescribing errors involved wrong frequency of antibiotic while the other prescribing error involved wrong dose of antibiotic. After post-remedial actions of Cycle 2, one prescribing error was detected out of 35 prescriptions (2.9%). The prescribing error involved wrong frequency but was detected at the very early stage during initial pharmacist screening, which was a near-miss error. The ABNA showed a reduction in the percentage of prescriptions with prescribing errors detected i.e., from 9.1% during verification study, to 5.9% in

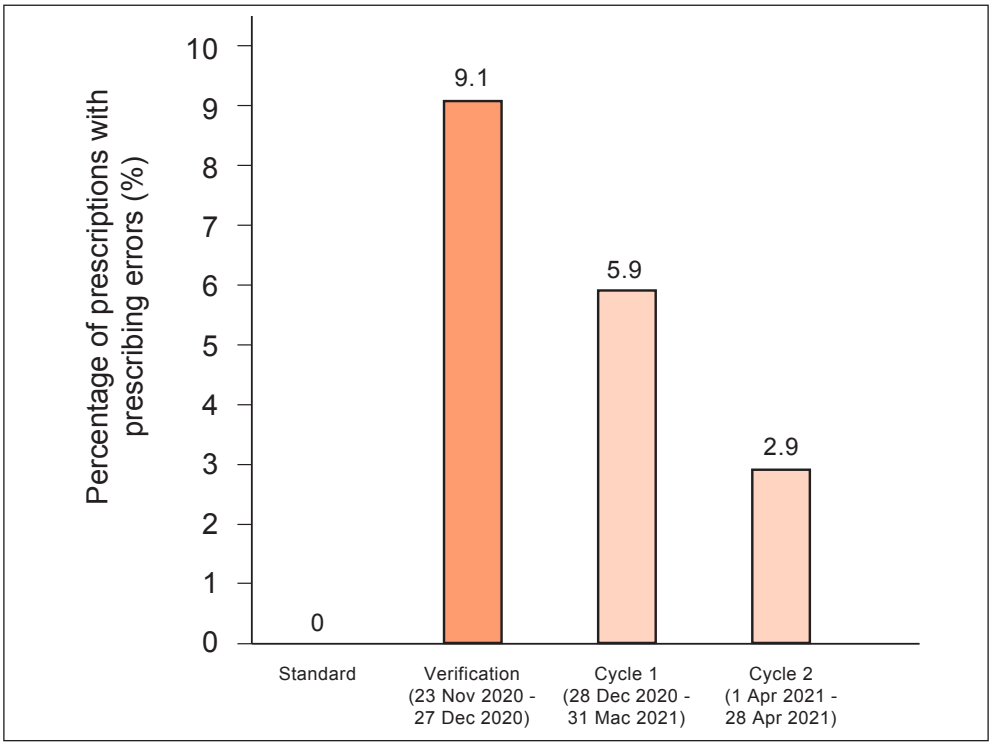


Figure 4: Achievement of the indicator by cycles

Cycle 1, and to 2.9% in Cycle 2. Even though the standard set is yet to be achieved, the remedial actions implemented were shown to be effective in reducing the percentage of prescribing error as the error was managed to be detected at the initial screening stage by pharmacist in Cycle 2.

From this study, we identified the lack of renal-profile information in the prescription. Therefore, we added a temporary column on the prescription, requiring the doctor to fill up the patients' renal profile (CrCl or dialysis status). Through these strategies, the awareness among prescribers to fill up the renal-profile information improved from 0.0% during verification study to 91.2% during Cycle 1 and 97.1% during Cycle 2. The effectiveness of this strategy was proposed to the management level, in order for a permanent addition of a renal-status column in the inpatient prescription.

Lessons and Limitations

Several lessons were learned from this study. Firstly, it is important to raise the awareness of doctors and pharmacists on the need for renal-dose adjustment of certain antibiotics in renally-impaired patients. Hence, a scheduled continuous education session should be done to ensure all the healthcare providers are updated and well-equipped with the latest antibiotic dosage adjustment knowledge. This session, also should emphasise healthcare professionals on adherence to SOP so that prescribing errors can be prevented.

However, this study findings are limited due to the sample collection from the orthopaedic ward in *Hospital Melaka*. The sample size collected was small. The COVID-19 pandemic wave has posed a huge challenge for the study in terms of implementing and evaluating the effectiveness of the proposed remedial actions. Before the pandemic, four orthopaedic wards were in Block D of *Hospital Melaka*. Three wards were shut down and changed to COVID-19 wards, leaving only one orthopaedic ward with 30 beds daily, continuing the service since early 2020.

On top of that, the manpower during the pandemic was affected with constant changes in ward staff rotation involving housemen and medical officers. As the orthopaedic wards were shifted to COVID-19 wards, the housemen initially under orthopaedic rotation relocated to other postings while the medical officers were reassigned as frontliners. It was challenging to deliver the education session to all the orthopaedic ward staff members simultaneously. Thus, our study resorts to a virtual education session. However, those who had attended our education session may not remain in the same ward. In the second cycle, the issue was overcome by conducting a physical education session at Ward D4.

In addition, during the ward relocation, it was noticed that the Am-Read quick guide attached to the patients' medication files, as well as the stamped inpatient medication prescription, were missing. We have to inspect regularly and redistribute both materials as necessary. To ensure the patients' CrCl and dialysis status were consistently available on the inpatient medication prescriptions, a practical and low-cost stamp was designed to be applied to every prescription in the orthopaedic ward.

Lastly, our study only focused on detecting prescribing errors, particularly the dosage and frequency. The study design was unable to screen for medication's administration or any omission errors. Both types of MEs can only be detected if a designated ward pharmacist is assigned to the ward to inspect from time to time.

Despite the limitations, we identified the factors contributing to a high percentage of prescribing errors and formulated remedial actions that were cost-saving. This is the pioneer project in *Hospital Melaka* in reducing the percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment, and successfully won the first prize during poster presentation at the state level. The collective efforts of the team members in this study should be acknowledged.

Conclusion and the Next Steps

This study reduced the percentage of prescriptions with prescribing errors involving antibiotics requiring renal-dose adjustment from 9.1% in the verification study to 5.9% in Cycle 1 and then to 2.9% in Cycle 2 through the remedial actions formulated and implemented. We believed that the remedial actions implemented

in the study could be replicated in other healthcare settings, including wards of different disciplines, government clinics, and hospitals. This is because the Am-Read quick guide developed in this study includes the antibiotics commonly prescribed in oral and injectable forms. It can be expanded to include other antimicrobials, such as antifungal and antiviral, as well as further details on the hemodynamic status of the patient. Most importantly, it should be reviewed regularly to keep it up to date and distributed to all healthcare providers to reduce ME. In addition, a standardised prescription form with additional columns for CrCl and dialysis status for all wards in *Hospital Melaka* and eventually nationwide can be made available.

Acknowledgements

The authors would like to thank the Director General of Health Malaysia for his permission to publish this work. The authors would also like to thank the hospital director, department head and staff of *Hospital Melaka* for supporting this study.

Conflict of Interest

The authors declare that there was no conflict of interest.

Funding

This study received no specific grants from any funding agencies from the public, commercial or non-profit sectors.

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Appendix 1: Data Collection Form (Part A: Antibiotic prescriptions screened)

Date of data collection:			**Ward:**	
Remarks: For all ME detected, please fill up Part B with the serial number. Format of the serial number: *yymmdd/ward/no* (e.g. 201123/D4/A2).				
No	Route	Antibiotic required renal-adjusted dose	Medication Error (Yes/No)	Serial number Part B
A1				
A2				
A3				

Data Collection Form (Part B: Medication error form)

ME serial number:			
Date of detecting ME:			
Date of event:			
Medication involved:			
For the questions below, tick (/) in the relevant column			
Location of event	Ward D4		
	Satellite 5 inpatient pharmacy		
In which process the ME occur? (can choose more than 1)	Prescribing		
	Dispensing		
Did the ME reach patient?	Yes		
	No		
ME outcome category	A	Potential error, circumstances/ events have potential to cause incident	
	B	Actual Error - did not reach patient	
	C	Actual Error - caused no harm	
	D	Additional monitoring required - caused no harm	
	E	Additional monitoring required - caused no harm	
	F	Initial/ prolonged hospitalization - caused temporary harm	
	G	Caused permanent harm	
	H	Near death event	
	I	Death	

Contributing factors (Can choose more than 1)			
Staff factor	a	Inexperienced personnel	
	b	Inadequate knowledge	
	c	Distraction	
Medication related	a	Sound alike medication	
	b	Look alike medication	
	c	Look alike packaging	
Work and environment	a	Heavy workload	
	b	Peak hour	
	c	Stock arrangements/ storage problem	
Task and technology	a	Failure to adhere to work procedure	
	b	Use of abbreviations	
	c	Illegible prescriptions	
	d	Patient information/ record unavailable/ inaccurate	
	e	Wrong labeling/ instruction on dispensing envelope or bottle/ container	
	f	Incorrect computer entry	
Others			
Which category made the initial ME?	a	Specialist	
	b	Medical officer	
	c	Houseman medical officer	
	d	Pharmacist	
	e	Provisional Registered Pharmacist	
	f	Nurse	
	g	Nurse trainee	
	h	Pharmacist Assistant	
	i	Others	

Appendix 2: Part of Antimicrobials Renal Adjustment (Am-Read) quick guide

Antimicrobial Renal Adjustment Quick Guide for Adult in Hospital Melaka

<table>
<tr><th>Antibiotics</th><th>Renal Dosage Adjustment</th><th>Ref.</th></tr>
<tr><td>Amoxicillin</td><td>CrCl 10-30 ml/min : 250-500mg BD
CrCl <10 ml/min : 250-500mg OD-BD
HD : 250-500mg OD-BD, serve post HD on HD day
PD : 250-500mg BD</td><td>1</td></tr>
<tr><td></td><td><u>H. pylori eradication therapy (1g BD):</u>
CrCl <30 ml/min or HD : 500mg BD</td><td>8,9</td></tr>
<tr><td>Amoxicillin/ clavulanate (IV)</td><td>CrCl 10-30 ml/min : 1.2g stat, then 600mg BD
CrCl <10 ml/min : 1.2g stat, then 600mg OD
HD : 1.2g stat, then 600mg OD, serve post HD on HD day</td><td>1, 5, 12</td></tr>
<tr><td>Amoxicillin/ clavulanate (PO)</td><td>CrCl 10-30 ml/min : usual dose BD
CrCl <10 ml/min : usual dose OD
HD : usual dose OD, additional dose after HD</td><td>2</td></tr>
<tr><td>Ampicillin</td><td><table><tr><th>CrCl (ml/min)</th><th>Usual dose of 1-2g QID</th><th>Usual dose of 2g 4H</th></tr><tr><td>50 - 129</td><td>1-2g QID</td><td>2g 4H</td></tr><tr><td>30 -49</td><td>1-2g TDS</td><td>2g QID</td></tr><tr><td>15 - 29</td><td>1-2g BD</td><td>2g TDS</td></tr><tr><td>< 15 / HD / PD (serve post HD on HD day)</td><td>1-2g OD</td><td>2g BD</td></tr></table></td><td>1</td></tr>
<tr><td>Ampicillin/ sulbactam (IV)</td><td>CrCl 15-29 ml/min : 1.5-3g BD
CrCl 5-14 ml/min : 1.5-3g OD
HD : 1.5-3g OD-BD, serve post HD on HD day
PD : 1.5g BD, or 3g OD</td><td>1</td></tr>
<tr><td></td><td><u>High dose Sulbactam dose in Acinetobacter sp MDR:</u><table><tr><th>CrCl (ml/min)</th><th>> 50</th><th>20-50</th><th>< 20</th><th>HD</th></tr><tr><td>Sulbactam</td><td>9g/ d</td><td>6g/d</td><td>4g/d</td><td>4g/d</td></tr><tr><td>Ampicillin/ Sulbactam</td><td>9g TDS</td><td>6g TDS</td><td>6g BD</td><td>6g BD</td></tr></table></td><td>3</td></tr>
<tr><td>Ampicillin/ sulbactam (PO)</td><td>CrCl <30 ml/min : should be administered less frequently</td><td>6</td></tr>
</table>

INCREASING THE PERCENTAGE OF WARFARIN-TREATED PATIENTS WITH GOOD TTR CONTROL IN SULTAN ISMAIL HEALTH CLINIC

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Abstract

Time in therapeutic range (TTR) for warfarin measures the percentage of time the patient's International Normalised Ratio (INR) is within the therapeutic range, reflecting the quality of anticoagulation control. Poor TTR control increases patients' risk of thromboembolic events, bleeding, hospitalisations, and mortality. A pre-remedial study revealed that only 58.8% of patients in Sultan Ismail Health Clinic achieved good TTR control (TTR>60%). This study aimed to increase the percentage of patients with good TTR control to 65% within six months, which is the standard set in the Quality Assurance Programme Indicators Manual 2023. In this quality improvement study, patients' INR levels were collected via Chemolims to assess TTR control, while questionnaires were disseminated to doctors, pharmacists, and patients to study the contributing factors. The contributing factors identified were incomplete patient history-taking by prescribers (80.0%), lack of pharmacist counselling (50.0%), non-compliance with the warfarin diet (60.0%), and dosage regimen (20.0%). In Cycle 1, the Warfarin checklist (Warf-Check) was developed to streamline the process of taking patients' history and the Express Warfarin Calculator (E-Warf) was introduced to expedite the calculation of dosage adjustments. Warfarin extended counselling (Warf-EC) was established to provide more focused counselling sessions for high-risk warfarin patients. Educational sessions were conducted for doctors and pharmacists to enhance their knowledge. In Cycle 2, the Klinik Warfarin Protocol (K-WARF) was developed to guide the management of warfarin therapy. Post-interventional results showed that the percentage of patients achieving good TTR control increased from 58.8% to 68.6% in Cycle 1, and improved to 69.3% in Cycle 2. The Achievable Benefit Not Achieved decreased from 6.2% to -3.6% in Cycle 1 and to -4.3% in Cycle 2. The average number of visits for INR monitoring per patient decreased from six to three visits within six months. We plan to expand our strategies and promote our K-WARF protocol nationwide.

KEYWORDS: Warfarin, time in therapeutic range, international normalised ratio, quality improvement study

Problem

Warfarin, a vitamin K antagonist, is commonly used as an anticoagulant in patients with atrial fibrillation, atrial or mitral valve replacement, venous thromboembolism, or antiphospholipid syndrome. Patients receiving warfarin therapy require routine International Normalised Ratio (INR) blood monitoring to ensure their INRs are within the therapeutic range. To monitor the quality of anticoagulation control, Time in Therapeutic Range (TTR) is preferred as it measures the percentage of time the patient's INR is within the therapeutic range. The minimum TTR that international guidelines have adopted to define good INR control typically ranges from 60% to 70% (1-3).

However, achieving these target standards in clinical practice remains a challenge. A verification study conducted in Sultan Ismail Health Clinic (KKSI) from September 2022 to February 2023 revealed that only 58.8% of warfarin-treated patients achieved good TTR control (TTR >60%), highlighting a notable gap in meeting recommended international benchmarks for safe anticoagulation management.

Maintaining optimal anticoagulation control is particularly crucial for primary care facilities like KKSI in the Johor Bahru district. Serving a population of 143,113 with daily patient visits ranging from 1,200 to 1,500, KKSI operates diverse departments such as the outpatient, maternal and child health, pharmacy, laboratory, dental services, dietetic services, and physiotherapy staffed by three Family Medicine Specialists, 26 medical officers, 20 pharmacists, and allied health staff.

Among its outpatient services covers acute care, chronic disease clinics, and specialised wellness program. Currently, KKSI manages 128 active patients on warfarin therapy. INR monitoring for patient on warfarin therapy is handled by a multidisciplinary workflow where laboratory staff conduct point-of-care testing (POCT) every Friday. Following the testing, medical officers adjust dosage regimens, and pharmacists provide individualised counselling alongside prescription refills.

To bridge this clinical gap and align patient outcomes with national standards, this quality improvement project aimed to increase the percentage of warfarin-treated patients with good TTR control at KKSI from 58.8% to 65% within six months, following the target set in the Manual for Quality Assurance Program Indicators 2023 (4).

Background

Warfarin remains the most commonly used anticoagulant to prevent thromboembolic events despite the emergence of direct oral anticoagulants (DOACs) due to its availability and cost. Due to its narrow therapeutic index, it is important to ensure the patients' INR is maintained within their therapeutic range. A good TTR control ensures the safety and efficacy of the warfarin therapy. However, several Asian studies have shown that the mean TTR achievements were generally lower. For example, in a study in Korea, the TTR was 49.1%, while in Singapore it was reported to be slightly higher at 58.0% (4,5). A retrospective observational study carried out in a cardiology referral centre in Selangor, Malaysia, revealed that the mean TTR was 60.6% over 5 years. During the study period, only slightly more than half of the patients (57.6%) achieved good INR control (TTR>60%) (6).

Patients with poor INR control experienced a higher risk of ischaemic strokes or thromboembolic events and had higher mortality risks associated with intracranial bleeding, strokes, and cardiovascular events (7-9). A British study has shown that a 10% increase in time when INR is deranged is linked with a 29% increase in mortality risk and a 12% increase in the risk of suffering from strokes or thromboembolic events. Poor INR is also associated with an increased hospitalisation rate (10). Increased hospitalisation and strokes or thromboembolic events would, in turn, lead to an increase in healthcare costs. Several factors may contribute to the poor INR control among patients treated with warfarin. A study conducted by Alphonsa and colleagues (11) reported that 50% of the patients had a poor knowledge level. Most patients (62.9%) on oral anticoagulation therapy were unaware of their INR targets, and only 30% of them had their INRs within range. Poor knowledge level in most patients

taking warfarin was also documented in other studies (12-14). The lack of knowledge regarding their condition and warfarin treatment may lead to intentional non-compliance.

A doctor's knowledge of oral anticoagulant therapy is also crucial in ensuring optimal therapeutic effect. Despite that, a few studies in China have reported that the doctors' knowledge of oral anticoagulants is inadequate, and huge gaps exist between regions, hospitals, and departments. Multiple studies in China showed that less than 50% of patients on oral anticoagulants were prescribed an appropriate dose according to recommended guidelines (15). According to the China National Stroke Registry, out of 96 nonvalvular atrial fibrillation patients with stroke who were taking warfarin, only one was admitted with an INR between 2 and 3 (16). A single-centre study in 2020 from Fuwai Yunnan Cardiovascular Hospital showed that the prevalence of inappropriate anticoagulant prescriptions was 46.3% (17).

To address this problem, the involvement of pharmacists in the management of patients treated with warfarin has been practised in both local and international healthcare settings. In pharmacist-led warfarin clinics, patients who receive more comprehensive counselling have achieved better INR control (18,19). A study in Kajang Hospital, Malaysia, showed that the TTR was significantly higher in the Warfarin Medication Therapy Adherence Clinic (MTAC) (66.6%), compared to usual medical care patients (45.5%) (20). The Warfarin MTAC is a pharmacist-led clinic where pharmacists take an active role in managing and monitoring warfarin patients. During each INR follow-up visit, pharmacists assess the patient's overall anticoagulation control and provide individualised counselling. They are responsible for making dosage adjustments, monitoring drug-drug or drug-food interactions, counselling on compliance, and detecting adverse events (21-22).

In addition, the provision of educational interventions for patients by pharmacists has also shown positive results in improving patient knowledge and their INR control (13,23). These materials can range from physical information booklets, DVDs as visual aids, and self-monitoring diaries. Besides patients, the MTAC pharmacists concurrently conduct periodic training, guidance, and establish a local network for sharing clinical decision-making. Such efforts are necessary to improve medical staff knowledge and to strengthen their clinical management ability (15).

A scoping review by Omer et al. (24) has shown that 81.6% of the studies on Vitamin K Antagonists (VKAs) reported at least one statistically significant positive outcome from pharmacist-led education on VKAs. Specifically, 31 out of 38 studies on VKAs demonstrated significant improvements in patient knowledge, INR control, TTR, and medication adherence. Even though the role of pharmacists in patient education on VKAs has been widely studied globally, a significant gap persists in the local literature. While pharmacists are identified as a key part of the solution, their own baseline knowledge and competency in managing complex warfarin therapy have not been systematically evaluated, particularly outside of specialised clinic settings like MTACs. The existing research assumes pharmacists are already fully equipped to bridge the knowledge gaps of both patients and other clinicians. Consequently, there is a lack of studies investigating the effectiveness of a targeted educational program designed specifically to standardise and enhance pharmacists' clinical skills in this critical area.

Measurement

This quality improvement study adopted a universal sampling approach. The indicator used was the percentage of warfarin-treated patients with good TTR, and it was calculated as follows:

$$\text{Percentage of warfarin-treated patients with good TTR control} = \frac{\text{Number of warfarin-treated patients with good TTR}}{\text{Total number of warfarin-treated patients}} \times 100$$

The study was conducted in two phases: Cycle 1 from March 2023 to August 2023 and Cycle 2 from September 2023 to February 2024. This study included all active warfarin-treated patients with valid prescriptions and ongoing doctors' appointments in KKSI throughout the study

period. However, patients who collected their medicines using the Integrated Drug Delivery Service (SPUB) were excluded. The SPUB is a medication supply system through which patients can have their medicines refilled at other healthcare facilities within the Ministry of Health via prescription referrals. These SPUB patients were excluded because they do not undergo INR monitoring at KKSI, and their warfarin dosage regimens are maintained according to the original prescription throughout the supply period. In addition, patients who missed their INR appointments or switched to alternative oral anticoagulants were excluded.

TTR for each patient was calculated using the Rosendaal method based on their INR results from each visit, retrieved from Chemolims, a laboratory review system (25). By determining each patient's TTR, the percentage of warfarin-treated patients with good TTR can be calculated. The standard was set as 65%, which was aligned with the Quality Assurance Programme (QAP) Indicators Manual 2023 standard (4).

Self-administered questionnaires were additionally used to collect data regarding factors contributing to the problem. The questionnaires (Appendix 1) were distributed among all doctors (n=26) and pharmacists (n=20) to assess their knowledge level in managing warfarin-treated patients, as well as to the patients (Appendix 2) (n=30) to assess their understanding of warfarin treatment. Furthermore, all warfarin prescriptions received by the pharmacy during 12-15 February 2023 (n=30) were reviewed to check the appropriateness of the warfarin dosing regimen.

Data collected from September 2022 to February 2023 in the verification phase showed that only 58.8% of the patients treated with warfarin achieved good TTR control. The Achievable Benefit Not Achieved (ABNA) was 6.2%.

Initial Assessment of the Problem

The factors contributing to the low percentage of warfarin-treated patients with good TTR were analysed using a problem analysis chart as depicted in Figure 1.

The existing process of care (Figure 2) was reviewed to determine the critical steps involved in ensuring better INR control. During each visit for INR monitoring, doctors will review patients' INR results and identify possible factors affecting their INRs. They will then make appropriate dose adjustments based on guidelines. When patients go to the pharmacy for a medicine refill, pharmacists screen the warfarin prescriptions to ensure the dose regimens are appropriate based on the patients' current INR and target ranges. They will make interventions if the dose adjustments are inappropriate. Pharmacists will then dispense warfarin and counsel the patients.

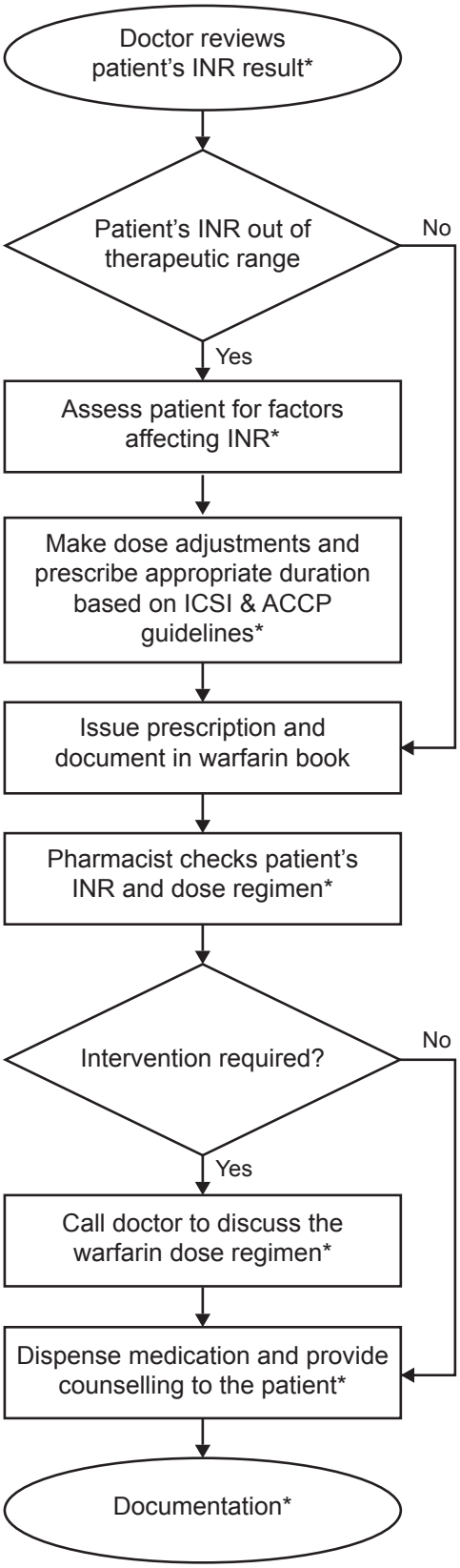
Upon reviewing this process of care, we identified two main contributing factors: inappropriate dose adjustment and duration prescribed by prescribers, and inadequate pharmacist counselling. Analysis of all the warfarin prescriptions collected over one week (12-15 February 2023) during the verification study has shown that only 70.0% (n=21) of patients seen by the doctor had their warfarin indication and INR target appropriately documented. Moreover, a comprehensive history assessing all factors influencing INR was obtained in only 20.0% (n=6) of patients. Dose adjustments adhered to the Institute for Clinical Systems Improvement (ICSI) guideline (26) in 50.0% (n=15) of cases, whereas 70.0% (n=21) of patients received treatment durations consistent with the American College of Chest Physicians (ACCP) guideline (27). Pharmacist review was conducted in 60.0% (n=18) of patients who underwent dose adjustments and had treatment durations prescribed. Additionally, counselling records in the Pharmacy Information System (PhIS) revealed that only half of the patients received counselling on factors affecting INR, with corresponding assessments of their understanding and medication compliance. Notably, no follow-up appointments were scheduled for patients whose INR values fell outside the therapeutic range.

A self-administered questionnaire among 30 warfarin patients identified lack of patient engagement as another contributing factor. Based on the questionnaire findings, 60.0% (n=18) of them were not compliant

with the warfarin diet, and 20.0% (n=6) of them were not compliant with the warfarin dosage regimen. Additionally, 70.0% (n=21) reported that the waiting time for doctor consultations and medication refills was long. These highlighted that it was possible to improve patients' compliance with the warfarin regimen by implementing suitable strategies. The pre-test (Appendix 3) revealed that only 19.2% (n=5) of doctors and 30.0% (n=6) of pharmacists demonstrated adequate knowledge (scoring ≥7) in managing patients on warfarin.



Figure 1: Problem analysis chart of the low percentage of warfarin-treated patients with good TTR control in KKSI



* indicates critical steps

ICSI = Institute for Clinical Systems Improvement
ACCP = American College of Chest Physicians

Figure 2: Flow chart of the process of care of doctors' consultation sessions and management of warfarin-treated patients in the pharmacy

Strategy

In this study, four strategies were introduced in Cycle 1 (March to August 2023). All these strategies were reinforced in Cycle 2 (September 2023 to February 2024), along with the development of the *Klinik Warfarin* (K-WARF) Protocol (28).

During Cycle 1, the first strategy was the implementation of a warfarin checklist (Warf-Check). Warf-Check was developed for doctors to provide a structured and standardised patient history taking. The two-page checklist was formulated in a table form, which allowed a clear and concise presentation of information. The first page gathered general information such as the indication of warfarin, target range, dose regimen, and compliance, while the second page included all the possible factors affecting the patient's INR. This checklist guides the doctors to interview patients when reviewing their INR results. Subsequently, the information documented by the doctors on the checklist can be passed on to the pharmacists, who then counsel patients based on the factors identified by the doctors. Overall, this checklist has eased communication between doctors and pharmacists and has been time-saving.

Secondly, an express warfarin dose calculator (E-Warf) was introduced in March 2023 to assist doctors in calculating warfarin dose adjustments. This calculator is a Microsoft Excel file with pre-included formulas that help to simplify the dose adjustment and calculation process. The recommended dose adjustments and regimens are based on the Anticoagulation MTAC (AC-MTAC) Protocol (24). By just entering the patient's current INR value and dose, this calculator instantly suggests a new warfarin dose regimen with an estimated INR value based on the percentage of weekly dose increase/decrease required. Using E-Warf has accelerated the calculation process and shortened the consultation time by five minutes.

Thirdly, warfarin extended counselling (Warf-EC) was established to focus on high-risk warfarin-treated patients. Before this quality improvement study, all of the warfarin-treated patients were counselled over the counter, and there were no proper follow-up appointments. With this patient-focused intervention, patients who had two consecutive INRs out of the therapeutic range or those with extreme INRs (INR<1.5 or INR>4) were sent to the counselling room for extended counselling. The pharmacist-in-charge reviewed the factors affecting the patients' INR and provided relevant counselling to the patients. The pharmacist also ensured that the doctors' dose adjustments were appropriate, and interventions were made if necessary. In addition, patients were followed up during their subsequent visits for INR monitoring until their INRs were stable (within range for two consecutive visits). This strategy allowed more comprehensive care to be delivered to the patients to improve their understanding and compliance.

The fourth remedial strategy was focused on improving the knowledge level of doctors and pharmacists. Three face-to-face educational sessions were conducted by trained pharmacists to enhance their knowledge of warfarin dose adjustment and patient counselling. The topics delivered include pharmacological action of warfarin, warfarin-food interactions, warfarin-drug interactions, and guideline-based dosage adjustment. The teaching materials were prepared based on the anticoagulant MTAC training modules developed by the warfarin MTAC Task Force, Pharmaceutical Services Division, Ministry of Health. After the one-hour educational sessions, all participants were given the same set of questions as the pre-test to reassess their level of understanding. Comparison between pre-test and post-test showed improvement in their knowledge level.

In Cycle 2, all strategies introduced in Cycle 1 were continued with some reinforcements. To improve accessibility to the E-Warf, we upgraded it to online mode, in which it can be accessed easily by scanning the QR code. QR codes for the E-Warf calculator were generated and pasted on the desks in consultation rooms and pharmacists' stations. Moreover, another CME session was held in January 2024 to introduce Warf-Check and E-Warf to new doctors and pharmacists. It allowed doctors and pharmacists to refresh their knowledge on warfarin management.

In addition, the *Klinik Warfarin* (K-WARF) Protocol was developed by

our team in Cycle 2. K-WARF Protocol is a documented protocol summarising the overall work process that was developed by pharmacists in collaboration with Family Medicine Specialists in managing warfarin-treated patients in KKSI. The protocol highlights the new standard operating procedures of the Warfarin Clinic that include the process of reviewing patients, prescribing, screening, intervention, counselling, and documentation (26). This protocol enables the standardisation and sustainability of our project.

Results

Following the implementation of the above strategies, the percentage of warfarin-treated patients with good TTR increased from 58.8% to 68.6% in Cycle 1, then to 69.3% in Cycle 2, which was both better than our standard of 65%. The ABNA was successfully reduced from 6.2% to -3.6% and finally to -4.3% (Figure 3).

All criteria in the Model of Good Care (MOGC) had improved following interventions (Table 1). For instance, the implementation of the warfarin checklist ensured that 100% of the patients were interviewed on all the possible factors affecting INR results before dose adjustment. However, there was a decline in the percentage of appropriate dose adjustments and duration of warfarin based on recommended guidelines, possibly due to a high turnover rate among doctors.

Doctors' (n=26) and pharmacists' (n=20) knowledge levels in managing warfarin-treated patients also improved after attending educational sessions. Analysis of post-test results showed that the percentage of doctors with excellent knowledge (score 10 out of 10) has increased from 0% to 42.3% (n=11) in Cycle 1 and further increased to 46.1% (n=12) in Cycle 2. Likewise, the same improvement trend was observed for pharmacists. In Cycle 2, only 14 pharmacists answered the post-test, as some of them had transferred to other health facilities. The percentage of pharmacists with excellent knowledge has improved from 0% to 35.0% (n=7) in Cycle 1 and 57.1% (n=8) in Cycle 2. Improved knowledge levels have enabled them to manage warfarin-treated patients with higher competency.

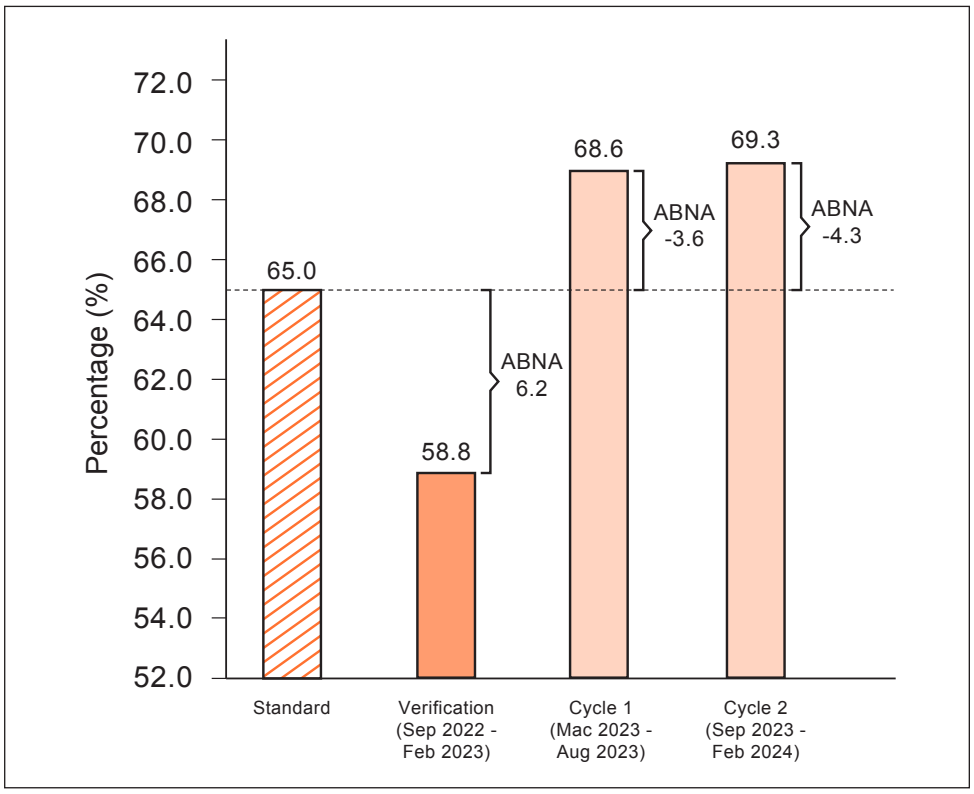


Figure 3: Percentage of warfarin-treated patients with good TTR in KKSI

Concurrently, we managed to improve patients' compliance levels with warfarin dose and diet following the establishment of warfarin extended counselling. The percentage of patients with good adherence to warfarin dose increased from 80.0% to 88.5% in Cycle 1 and 94.1% in Cycle 2. The percentage of patients with good compliance to the warfarin diet had also doubled from 40.0% in the verification study to 82.4% in Cycle 2. With a better understanding of the importance of compliance with warfarin and warfarin diet, patients were more cooperative in adhering to warfarin treatment and diet consistency to ensure good TTR control.

Another important result was that the average number of visits for INR monitoring per patient was reduced from six visits as documented in the pre-remedial study to three visits per half a year post Cycle 1. The number of visits was the same post Cycle 2. Fewer patient visits also implied less clinic workload and a reduction in the cost of INR monitoring.

Table 1: MOGC to increase the percentage of warfarin-treated patients with good TTR in KKSI post-intervention (Cycle 1 and Cycle 2)

No.	Proses	Criteria	Standard	Verification (n=30)	Cycle 1 (n=102)	Cycle 2 (n=111)
1.	The doctor reviews patient's INR result	Check warfarin indication	100%	70.0%	100%	100%
		Check INR target	100%	70.0%	100%	100%
2.	Assess the patient for factors affecting INR	History taking for all factors which may affect INR	100%	20.0%	100%	100%
3.	Make dose adjustments and prescribe appropriate duration based on ICSI and ACCP guidelines	Make dose adjustments based on ICSI guidelines	100%	50.0%	80.4%	75.7%
		Prescribe appropriate duration based on ACCP guidelines	100%	70.0%	90.2%	90.1%
4.	Pharmacist checks patient's INR and dose regimen	Ensure the correct INR targets and indications are written on the prescription	100%	100%	100%	100%
		Ensure the dose adjustment and duration prescribed are appropriate based on guidelines	100%	60.0%	100%	100%
5.	Call the doctor to discuss the warfarin dose regimen	Discuss with prescribers if the dose adjustment or duration prescribed is inappropriate	100%	80.0%	100%	100%

6. Dispense medication and provide counselling to the patient	Counsel patients on relevant factors that affect their INRs	100%	50.0%	100%	100%
	Assess the patient's understanding and compliance	100%	50.0%	100%	100%
	Ensure patients who require additional counselling are referred to the counselling room	100%	0.0%	100%	100%
7. Documentation	Document the counselling session	100%	50.0%	100%	100%
	Arrange for a follow-up appointment	100%	0.0%	100%	100%

Lessons and Limitations

The implementation of all the remedial strategies had led to a successful improvement in TTR control among our warfarin-treated patients. The strength of this study was that it showed the potential of pharmacists' involvement in the management of warfarin-treated patients even in a health clinic setting. Currently, the warfarin MTAC run by pharmacists is mostly available in hospital settings, and may not be feasible in health clinic settings. Multidisciplinary collaboration between doctors, pharmacists, and laboratory staff, as portrayed in our study, showed a positive impact on patients' treatment outcomes. These strategies can be applied to other health clinics in Malaysia to improve the safety and efficacy of warfarin treatment.

In this study, we also learnt that patient empowerment was crucial to achieving better treatment outcomes. With proper education and guidance, patients could recognise the importance of compliance with warfarin treatment and diet and be more empowered in their treatment.

Despite the success, our study had several limitations. Our quality improvement study only calculated TTR based on patients' INR within a six-month period, which might be insufficient to present the full anticoagulation profile of the patients. Additionally, although we showed that the number of visits for INR monitoring had reduced, there was no cost analysis study on the total amount of spending saved on INR testing.

Conclusion and the Next Steps

The percentage of warfarin-treated patients with good TTR increased to 68.6% in Cycle 1 following the implementation of strategies and further improved to 69.3% in Cycle 2 with strategy reinforcement. To date, we had presented our study at the Johor State Health Department Pharmacy Practice Meeting and the National Family Medicine Scientific Conference 2024. In February 2024, a standardisation letter was also issued, mandating the implementation of this QA project across all primary health clinics in the Johor Bahru district to ensure a standardised approach to improving the safety and quality of care for patients receiving warfarin therapy (Appendix 4). Our remedial strategies in this study had great potential to be adopted and adapted by other health clinics in Johor state.

Recognising the improvements and benefits of our study, we plan to publish our protocol online and to upgrade our E-Warf to a mobile application so that our strategies can reach out to more health facilities throughout Malaysia. With that, beneficial treatment outcomes in terms of warfarin efficacy and patient safety can be achieved nationwide. From here, we also plan to continue our study for more study cycles and focus on the cost aspect to study the long-term benefit of improving patients' TTR.

Acknowledgements

The authors would like to thank the Director General of Health Malaysia for his approval to publish this article. Our appreciation also goes to Dr. Hj. Mohtar Bin Pungut @ Hj. Ahmad, Dr. Hj. Haidar Rizal Bin Toha, Dr Rohayah Binti Abdullah, Dr Fajaratunur Binti A. Sani, Dr. Dewi Juliana Binti Mohd. Namsah and others who supported our study.

Conflict of Interest

The authors declare that there was no conflict of interest.

Funding

This study received no specific grants from any funding agencies from the public, commercial, or non-profit sectors.

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Appendix 1: Questionnaire for doctors and pharmacists

1. Year of practice
   a) Less than 5 years
   b) 5 to 10 years
   c) 10 years and above

2. How confident are you in interviewing warfarin-treated patients?
   1 2 3 4 5 6 7 8 9 10
   Low High confidence

3. How confident are you in doing dose adjustments for patients' warfarin regimens?

   1 2 3 4 5 6 7 8 9 10
   Low High confidence

4. What is the biggest challenge, in your opinion, when managing warfarin-treated patients?
   a) Time constraints, heavy patient load
   b) Uncooperative patients
   c) Language barrier and poor communication with patients
   d) Others please state:_____

5. Have you ever been to any courses/ seminars related to the management of warfarin-treated patients?
   a) Yes
   b) No

6. Would you like to attend courses related to the management of warfarin-treated patients?
   a) Yes
   b) No

7. Do you think educational sessions, e.g. CME will help to improve your knowledge and confidence level in managing warfarin-treated patients?
   a) Yes
   b) No

Appendix 2: Questionnaire for patients

1. Are you aware of your current warfarin dose, in mg?
   Yes No

2. Do you remember to take warfarin every day?
   Yes No

3. Are you aware that a change in vegetable intake (Vitamin K) may affect INR readings?
   Yes No

4. Do you keep your vitamin K intake constant?
   i) Yes, I follow a consistent warfarin diet every day
   ii) No, I find it hard to keep my vitamin K intake consistent
   iii) I follow most of the time, but there are days that I take more/less vitamin K food

5. Do you face any communication problems during a doctor's consultation?
   i) Yes, I do not understand BM/BI
   ii) No

6. Do you think you receive clear instructions and counselling from the pharmacist when the pharmacist dispenses the medication to you?
   Yes No
7. Do you think the waiting time to see a doctor and to receive medication is long?
   Yes No

8. Based on the consultation session just now, were you asked about:
   □ Current dose regimen
   □ Missed dose or compliance
   □ Diet pattern
   □ Changes in medicines or recent supplement/herbal medicine intake
   □ Change in physical activities
   □ Smoking or alcohol intake
   □ Body discomforts
   □ Others

Appendix 3: Pre-test & post-test knowledge questions for doctors and pharmacists

1. Warfarin is indicated in which of the following:
   A) Atrial fibrillation
   B) LV clot
   C) Antiphospholipid syndrome (APLS)
   D) All of the above

2. In which situation below would you expect a **decrease** in patient's INR result
   A) Patient A, who went hiking with friends last weekend
   B) Patient B, who has consumed papaya for past 2 days
   C) Patient C, who recently just completed a course of amoxicillin following dental surgery
   D) Patient D, who has just started on fish oil supplement last week
   E) None of the above

3. Which of the following drug interferes with warfarin and result in an **increase** in patient's INR
   A) Rifampicin
   B) Propylthiouracil
   C) Gemfibrozil
   D) Metformin

4. When calculating dosage adjustment, how many % of the total weekly dose change of warfarin is expected to result in a change of INR by 1
   A) 10
   B) 1
   C) 0.1
   D) 0.01

5. The following food/vegetable is expected to decrease patient's INR when consumed in large amounts, **except:**
   A) Kale
   B) Broccoli
   C) Cabbage
   D) Bell pepper
   E) None of the above

6. Patient A was a 55-year-old Chinese lady with a history of DVT and PE. Her INR was found to be 3.6 (target 2-3) today. She claimed no changes in diet or physical activities. She started taking tonic soup with ginseng weekly since a month ago. She noticed herself getting more energetic after started on the ginseng tonic soup. In fact, she enthusiastically informed you that she shall keep the ginseng tonic drink as her weekly routine. one day before warfarin clinic, she was also given Metronidazole 400mg TDS by O&G as her PAP smear showed signs of infection

   Choose the CORRECT statement below:

   i) Metronidazole decreases warfarin metabolism, leading to an increased risk of bleeding
   ii) Advise patient A to stop ginseng soup even though she intends to continue as her weekly routine
   iii) Withhold the warfarin dose until she completes the course of antibiotics
   iv) Advise on the consistency if she insists on taking the tonic soup with ginseng weekly

A) i only
B) i, ii
C) iv only
D) i, iv

7. Patient B was diagnosed with AF and his current INR was 1.7 with warfarin dose of 2.5mg OD. He claimed that he did not take any green leafy vegetables. Neither any supplement. During this visit, patient was diagnosed with hypothyroidism. Hence, he was newly added with levothyroxine 50mcg. Choose the **CORRECT** management(s) of this patient with the newly added medication?

   i) Explain the interaction of levothyroxine with warfarin
   ii) Advise to withhold levothyroxine until his INR is stable
   iii) Maintain patient on 2.5mg OD for this visit & repeat INR after 2 weeks
   iv) Watch out for bleeding symptoms due to increased risk of bleeding

   A) i only
   B) ii only
   C) iii and iv
   D) i, iii, iv

8. Which of the following combinations is FALSE?
   A) Acute alcohol intake + warfarin: increase INR
   B) Dong quai (Chinese herb) + warfarin: decrease INR
   C) Cranberry juice + warfarin: increase INR
   D) Green tea + warfarin: decrease INR

9. Warfarin tablets are available in the following strengths, except
   A) 1mg
   B) 2mg
   C) 3mg
   D) 4mg

10. Patient INR today was 4.1. His target INR is 2-3. Which of the following is the most appropriate management for this patient supposing all parameters are as usual/ no changes
    A) Maintain current dose and recheck INR in 1 week time
    B) Withold warfarin for 1 day and decreases 10% of weekly dose and recheck INR after 1 week
    C) Increase dose by 5% of weekly dose
    D) Decrease 5% of weekly dose and review INR after 2 weeks

Appendix 4: Memo of standardisation of the QA project across all facilities in Johor Bahru District Health Office

MEMO DALAMAN
PEJABAT KESIHATAN JOHOR BAHRU

☎ Telefon : 07 - 2224711/4818 ✉ Email : pkdjb@moh.gov.my

Ruj Kami : PKJB.QLAT/100-8/4/1 (84)		Tarikh: 27 Februari 2024
Kepada	**SEPERTI SENARAI EDARAN**	**Salinan kepada :** Unit Kualiti Dan Latihan
Daripada	**PEGAWAI KESIHATAN DAERAH**	
Perkara	**PENYERAGAMAN PROJEK QA"*INCREASING THE PERCENTAGE OF WAFARIN PATIENTS WITH GOOD TIME IN THERAPEUTIC RANGE (TTR)* IN KK SULTAN ISMAIL" DISEMUA FASILITI PEJABAT KESIHATAN DAERAH JOHOR BAHRU (PKDJB)**	

Tuan,

Saya dengan segala hormatnya merujuk perkara di atas.

2 Sukacita dimaklumkan bahawa Inovasi Projek QA "*Increasing The Percentage Of Wafarin Patients With Good Time In Therapeutic Range* (TTR) In KKSI" adalah projek QA yang dijalankan di KKSI adalah untuk meningkatkan kualiti rawatan warfarin dan menjamin keselamatan pesakit.

3 Mesyuarat Jawatankuasa Pemilihan Kategori Produk QA,KIK dan Inovasi yang terpilih mewakili PKDJB yang telah diadakan pada 4.2.2024 telah memutuskan untuk membuat penyeragaman p rojek QA ini ke semua Klinik-klinik Kesihatan Daerah Johor Bahru.

4 Pematuhan dan penyeliaan akan dibuat oleh Unit Kualiti dan Latihan dari masa ke semasa.

Sekian, terima kasih.

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah

(DR. HAIDAR RIZAL BIN TOHA)
(No. Pendaftaran MMC:36541)
Pakar Perubatan Kesihatan Awam
Pegawai Kesihatan Daerah
Pejabat Kesihatan Daerah Johor Bahru

Kami Sedia Membantu
Penyayang • Profesionalisme • Kerja Berpasukan

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

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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.

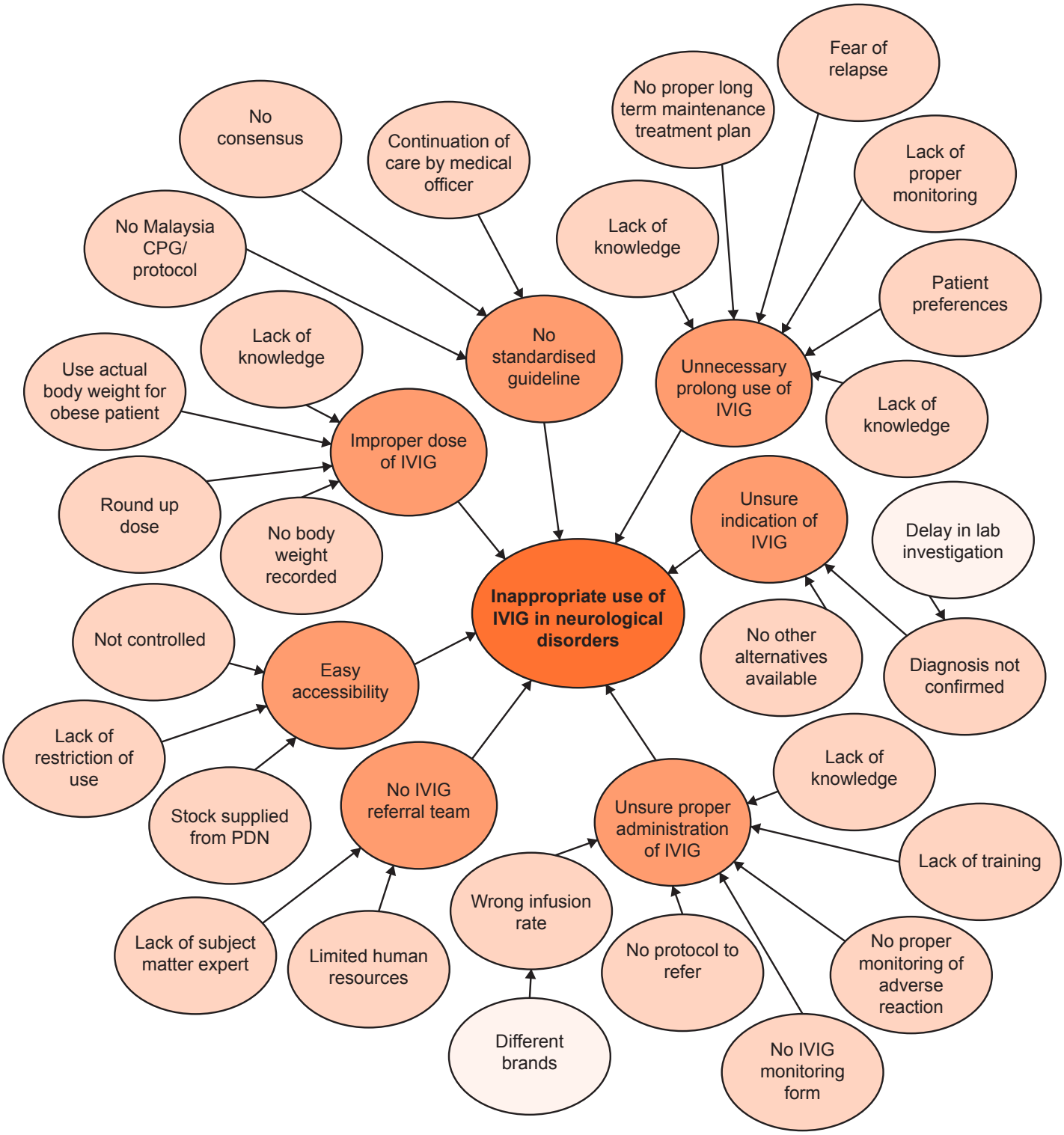


Figure 1: Problem analysis chart of factors contributing to inappropriate use of IVIG in neurological disorders at HKL

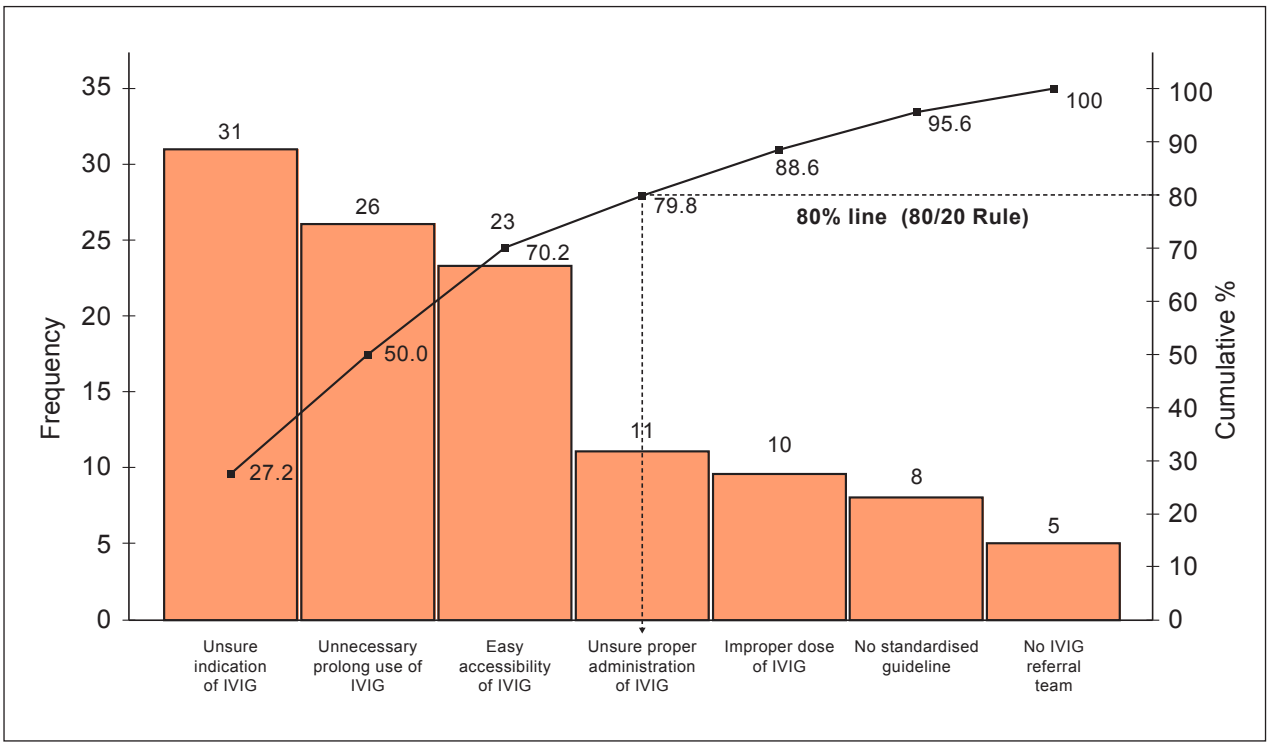


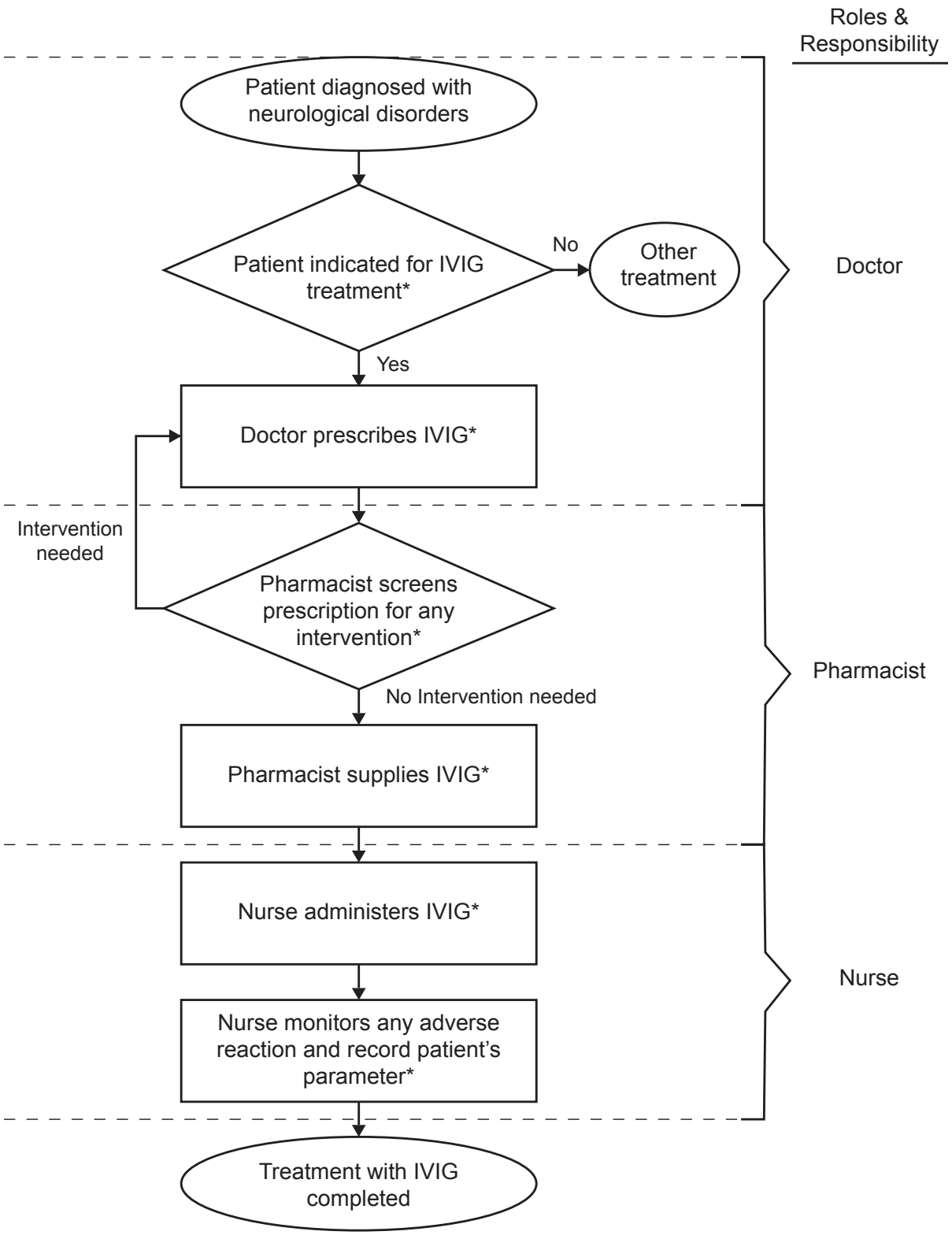
Figure 2: Pareto chart illustrating the factors contributing to inappropriate use of IVIG in neurological disorders

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%.

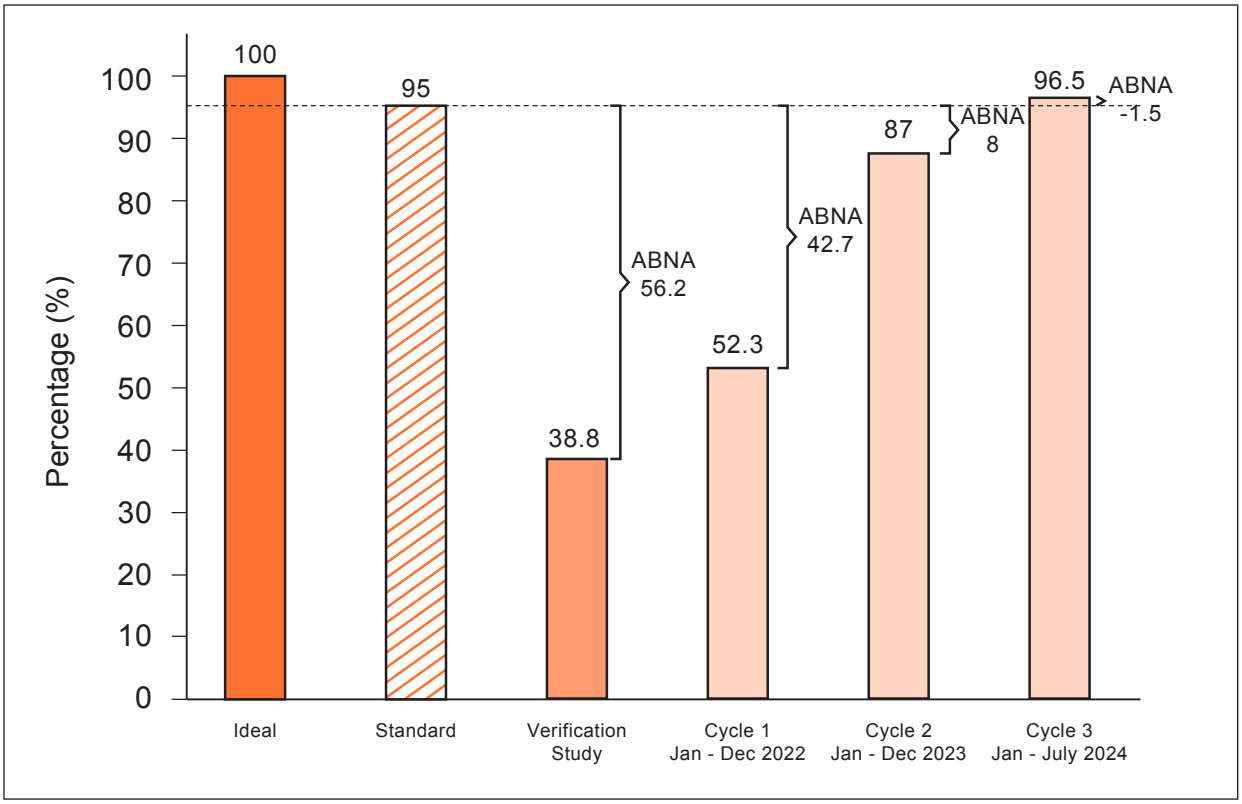


Figure 4: Percentage of appropriate use of IVIG in neurological disorders

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.

Acknowledgements

The authors would like to thank the Director-General of Health Malaysia for approving the publication of this manuscript. The authors are grateful for all the support and involvement of the Hospital Director and the head of the Pharmacy Department of *Hospital Kuala Lumpur*, the Head of the Neurology Subspecialty Ministry of Health Malaysia, the Head of the Neurology Department and the Quality Unit at the *Hospital Kuala Lumpur*.

Conflict of Interest

The authors declare that there was no conflict of interest.

Funding

This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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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 &
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(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
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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

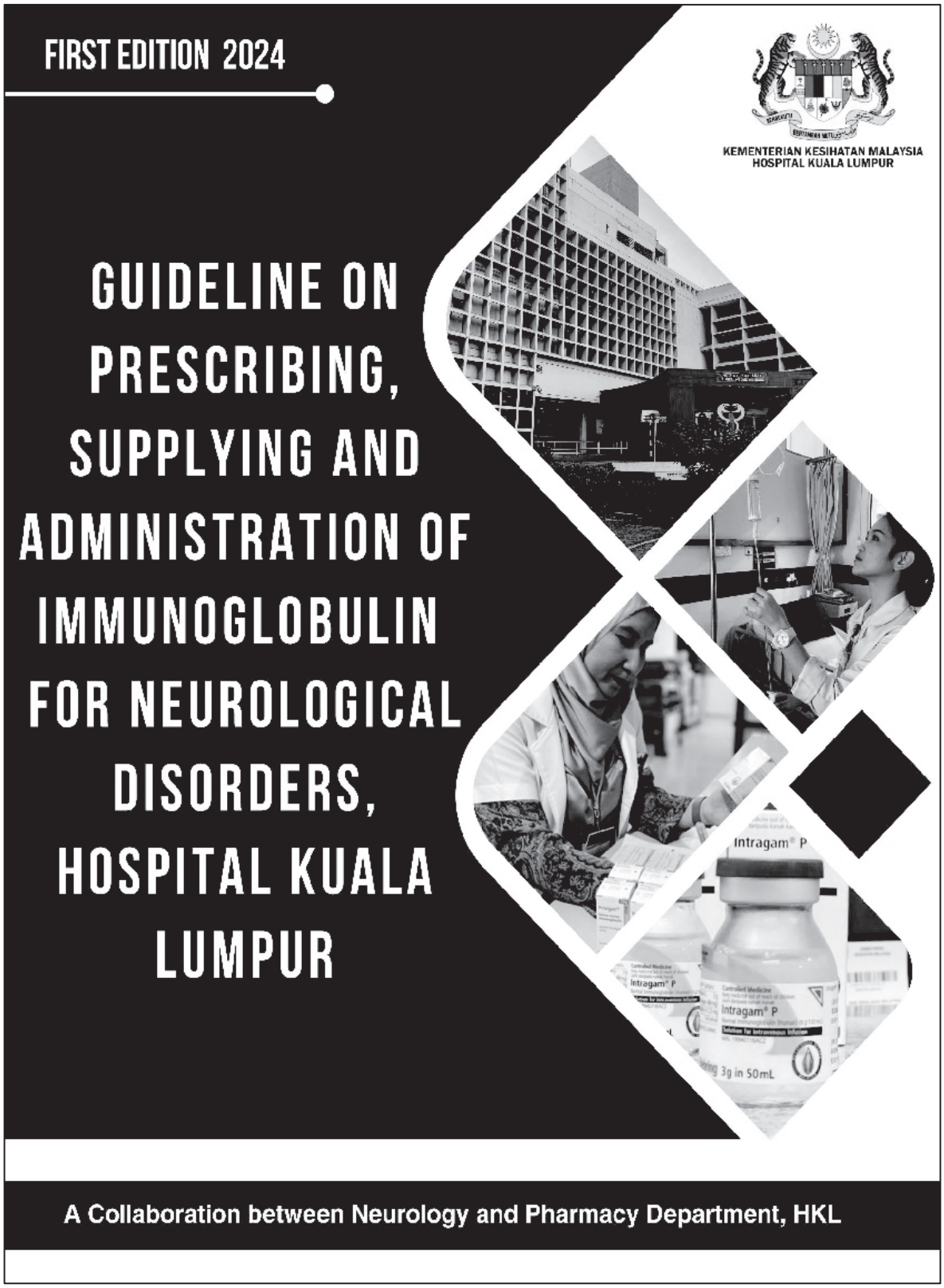
Intravenous Immunoglobulin (IVIg) Administration Chart (10%)
Neurology Department, HKL
[Intragam® NexGen 5g/50ml (10%) / Privigen® 2.5g/25ml (10%) / Gamunex®-C 2.5g/25ml (10%) or 5g/50ml (10%)]

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)



REDUCING THE REJECTION RATE OF INTRA-ORAL PERIAPICAL RADIOGRAPH AT TENGKERA DENTAL CLINIC

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Abstract

Intra-oral periapical (IOPA) radiograph is a crucial adjunct in diagnosing dental diseases. Obtaining diagnostically acceptable radiographs on the first attempt is vital, as rejected radiographs lead to time and resource wastage. At Tengkera Dental Clinic (TDC), the rejection rate of IOPA radiographs showed a concerning increase, rising from 6.4% (2021) to 7.0% (2022). This quality improvement study aimed to reduce the rejection rate to <5% within a year. The indicator used was the percentage of rejected IOPA radiographs. The standard was set at <5%, based on the Quality Objective of the Melaka Oral Health Division in 2022. This study was conducted in TDC from April 2023 to March 2024. Data were retrieved from the monthly report (BK13). A clinical audit and a survey were conducted among 25 operators to assess their knowledge, experience and skills in radiograph taking and processing. The verification study revealed a rejection rate of 5.9%. The main contributing factors identified include poor knowledge and skills among operators, inappropriate methods for taking and processing radiographs, and patient movement during radiation exposure. In Cycle 1, the strategies implemented were converting the current guideline into infographic posters, conducting hands-on training and clinical audits to improve operators' knowledge and skills. In Cycle 2, a demonstration video and an innovative tool were created to help patients stay still during radiograph acquisition. After two cycles, the rejection rate was reduced to 2.2%, with an Achievable Benefit Not Achieved of -2.8%. All criteria in the Model of Good Care were increased from 95 to 100%. Moreover, the cost was reduced by MYR104.40 (≈USD25.93 as of August 2026) (43%) within a year. Patients also reported increased satisfaction, decreased pain and reduced anxiety during radiograph acquisition. Remedial measures have been introduced to two other dental clinics (Ayer Molek Dental Clinic and Cheng Dental Clinic).

KEYWORDS: Periapical disease, radiography, dental, digital, quality improvement study

Problem

Intra-oral periapical (IOPA) radiographs are crucial diagnostic adjuncts, but their operator-dependent nature makes image quality prone to technical errors during acquisition (1-4). Obtaining high-quality IOPA images requires precise film positioning, beam alignment, and patient positioning (5). Rejected non-diagnostic radiographs require repeat exposure (6). To adhere to the As Low As Reasonably Practicable (ALARP) principle and ensure patient safety, repeated exposures must be minimised (7-9). Additionally, rejected radiographs increase treatment costs, patient waiting times, and operator workload (10,11).

Highlighting this issue, Tengkera Dental Clinic (TDC) recorded a concerning upward trend, rising from 6.4% in 2021 to 7.0% in 2022 (12). Out of 966 IOPA radiographs produced in 2022, 68 were rejected based on monthly logs in BK13 reports, exceeding the Melaka OHD quality objective of maintaining a rejection rate below 5%.

These rejections compromised clinical efficiency and resource utilisation at TDC, a primary government dental clinic in the Melaka Tengah district. In 2022, the facility served a total of 15,333 patients, providing services ranging from scaling and restorations to extractions, root canal treatment, and minor oral surgeries. It was staffed by 16 Dental Officers (DOs) and nine Dental Surgery Assistants (DSAs), who were responsible for taking and processing radiographs. Unlike facilities with a digital imaging system, TDC relies on a conventional dental radiographic system that involves exposing IOPA radiograph films to radiation and subsequently developing the film manually through chemical processing to produce visible images.

To address the gap, this quality improvement study aimed to reduce the rejection rate of IOPA radiographs at TDC to below 5% by implementing a few local interventions within a year.

Background

Radiographic imaging is an essential aid for oral diagnosis, treatment planning and carrying out specific dental procedures (1,2,13). Among the available imaging modalities, IOPA radiographs are one of the most commonly used because they provide detailed two-dimensional images of individual teeth and their surrounding structures (14). They come in multiple sizes, with 30 x 40 mm being the most commonly used, as it offers an optimal balance between coverage and patient comfort (6). Reducing unnecessary repeat exposures is important because the stochastic effects of ionising radiation are cumulative, and even small doses may pose a potential risk (8,16).

Despite its importance, the high rejection rate of IOPA radiographs poses a challenge to many dental practitioners worldwide. A review by Yeung et al. (17) reported an average IOPA radiograph rejection rate of 16.4% across multiple studies. In Saudi Arabia, 16.7% of IOPA radiographs were deemed unacceptable from an audit involving dental operators (13). This outcome is parallel with the findings of Salami et al. (18) from a postgraduate paediatric dental clinic in Dubai, which had 14.0% of radiographs categorised as unacceptable.

Several factors contribute to high IOPA rejection rates, which can be categorised as operator- or patient-related. The most frequent factors include incorrect film or X-ray tube positioning, angulation errors, processing errors and patient movement. Multiple studies revealed improper film and X-ray tube positioning as the most prevalent cause for IOPA radiograph rejection (17,19-22). The higher incidence of IOPA radiograph rejection has been linked to deep placement of the IOPA film within the oral cavity. In order to obtain a clear image of the root apices within the alveolar bone, the film often contacts the floor of the mouth or the palatal vault, causing patient discomfort and potentially triggering the gag reflex (17). Aside from positioning errors, studies by Patankar et al. (22) and Zewdeneh et al. (16) identified incorrect exposure settings and patient movement as common reasons for film rejection.

In order to obtain a diagnostically acceptable IOPA radiograph on the first attempt, film holders with guidance rings

should be used to hold the IOPA films in place and to align them precisely with the X-ray beam (13,17). Besides that, staff who undergo regular training and have excellent clinical experience generally contribute to lower IOPA radiograph rejection rates (17). Hence, periodic training and continuous professional education are recommended for all dental personnel to reduce the frequency of radiographic errors, notably when new techniques or equipment are introduced in a facility (13,17,22–24).

Implementing Quality Assurance (QA) initiatives is another effective strategy to reduce radiographic errors. These projects offer valuable insights into error prevention, contributing to cost reduction and minimising patient exposure to unnecessary radiation (16,18,25). The significance of integrating QA measures into clinical practice is parallel to the requirements of Ionizing Radiation (Medical Exposure) Regulations and the Ionizing Radiation Regulations 2017 (26,27).

Measurement

According to the Guidelines on Radiation Safety in Dentistry published by the Malaysian Dental Council in 2010 (7), corrective measures should be carried out if the radiograph rejection rate exceeds 10%. While the national guidelines established this threshold for corrective action, the criteria for analysing the rejection rate may vary depending on standards set by the state level or a specific dental facility.

Although the IOPA rejection rate at TDC was considerably lower than reported in the literature, it still exceeded the local benchmark of <5% set by the State OHD, thereby necessitating targeted interventions to achieve the required standard. A quality improvement study was conducted over the span of 12 months in TDC, from April 2023 to March 2024. Our inclusion criteria consisted of all IOPA radiographs with no exclusion criteria. An IOPA radiograph was considered acceptable if it provided diagnostic information by capturing the full length of the tooth with at least 3 mm of tissue surrounding the root tip (13). Conversely, a radiograph was classified as rejected if it exhibited image distortion (foreshortening or elongation), improper film exposure (poor contrast), failure to capture the area of interest (cone cut, image cut or contact overlap), image blurring or the presence of stains and fingerprints on films which hindered clear visualisation of the tooth (3,13, 28). The indicator for this study was the rejection rate of IOPA radiographs at TDC, obtained from the monthly BK13 report. The formula used to calculate the indicator is as follows:

$$\textit{Percentage of rejected IOPA radiographs} = \frac{\textit{Number of rejected IOPA radiographs}}{\textit{Total number of IOPA radiographs taken}} \times 100$$

A verification study conducted from May to June 2023 revealed that 10 out of 169 IOPA radiographs were rejected, resulting in a rejection rate of 5.9%. Following the verification study, the remedial measures and re-evaluation were implemented in two cycles: (i) Cycle 1: July – September 2023 and (ii) Cycle 2: October – December 2023.

Initial Assessment of the Problem

The initial process of care related to radiograph taking and processing was reviewed and outlined based on the Operating Procedure 4 (29). Six critical steps were identified:

i) Choosing the appropriate mode for the area/ tooth of interest;
ii) Positioning of patient;
iii) Choosing the appropriate X-ray film holder;
iv) Positioning of X-ray film;
v) Positioning of X-ray tube; and
vi) Processing X-ray film

The contributing factors to the high rejection rates of IOPA radiographs at TDC were outlined in the problem analysis chart in Figure 1. Among the five main factors identified, patient movement during radiation exposure, inappropriate methods for radiograph taking and processing, and lack of knowledge among operators were the

only three factors which could be remedied. Whereas unfavourable patient anatomy for proper placement of films and unfavourable materials available were the factors beyond our control and therefore not addressed in our study.

A few verification tools were used to identify the contributing factors causing increased rejection rates of IOPA radiographs. Firstly, a self-administered questionnaire was distributed among a total of 25 operators, comprising 16 DOs and nine DSAs. The questionnaire for DO consists of ten sections with 24 questions, whereas the questionnaire for DSA consists of ten sections with 23 questions. Both questionnaires were used to evaluate the operator's knowledge, training experience and difficulties faced during IOPA radiograph taking and processing. The results indicated that 32.0% (n=8) of the operators demonstrated poor knowledge in taking and processing IOPA radiographs, which corresponds to scoring less than 50% in the knowledge section of the questionnaire. Additionally, 56.0% (n=14) of them claimed that they lacked formal radiograph-taking training at work. While 20.0% (n=5) felt that the current guideline was overly wordy and difficult to be referenced during radiograph procedures, and eight per cent (n=2) of the operators were unaware of the Operating Procedures 4. Sixty-nine per cent (n=17) of the operators also felt that the rubber dam clamps obstructed the proper placement of the film in patients' mouths.

Our questionnaires revealed that unfavourable patient anatomy for proper placement of the film, such as a small mouth, presence of tori, and shallow palate, was rated as the top contributing factor at 92.0%. Patient movement during exposure was agreed by 84.0% (n=21) of our respondents. In addition to that, 28.0% (n=7) of the operators did not provide a clear explanation of the radiograph-taking procedure to patients beforehand, resulting in patient movement during radiography acquisition and subsequently causing rejection of radiographs. Operators also claimed gag reflex (96.0%), uncooperativeness (88.0%) and anxiety (28.0%) were causing the patient movement during the procedure. They also reported that the availability of only one film size at TDC contributed to the difficulty in taking IOPA radiographs.

Secondly, a clinical audit form (Appendix 1) was established based on the Operating Procedure 4, which included all the critical steps in our Model of Good Care (MOGC). It was conducted by two senior dental officers between May and June 2023 to evaluate the DO's and DSA's skills in taking and processing IOPA radiographs. The results from the audit showed that only the selection of the appropriate X-ray holder achieved 100% compliance, while the compliance for the remaining steps ranged from 45.0% to 95.0%. Twenty-six per cent (n=6) of the operators did not adhere to the Operating Procedure and were deemed to use inappropriate techniques during IOPA radiograph acquisition and processing. Both the questionnaires and clinical audit forms were validated by a dental restorative specialist from the Ayer Keroh Dental Clinic.

Strategy

Following the verification study, five strategies for change were implemented and re-evaluated after three months. There were two cycles of remedial actions implemented. Cycle 1, conducted from July to September 2023, included three strategies to improve operators' knowledge and skills. In Cycle 2, from October to December 2023, two strategies were added that focused on reducing patient movement during radiograph taking while reinforcing the strategies from Cycle 1. Although patient movement was the main contributor to the high percentage of rejected IOPA radiographs, operator factors were targeted in the first cycle as it is more predictable and manageable.

Cycle 1: July – September 2023

In Cycle 1, the guideline was converted into infographic posters for convenient reference during radiograph taking and processing (Appendix 2). This strategy addressed feedback from operators in the verification study, who found the current guideline to be too wordy and lengthy. The newly designed infographics provided clear, concise instructions with engaging visuals, allowing operators for a quick reference

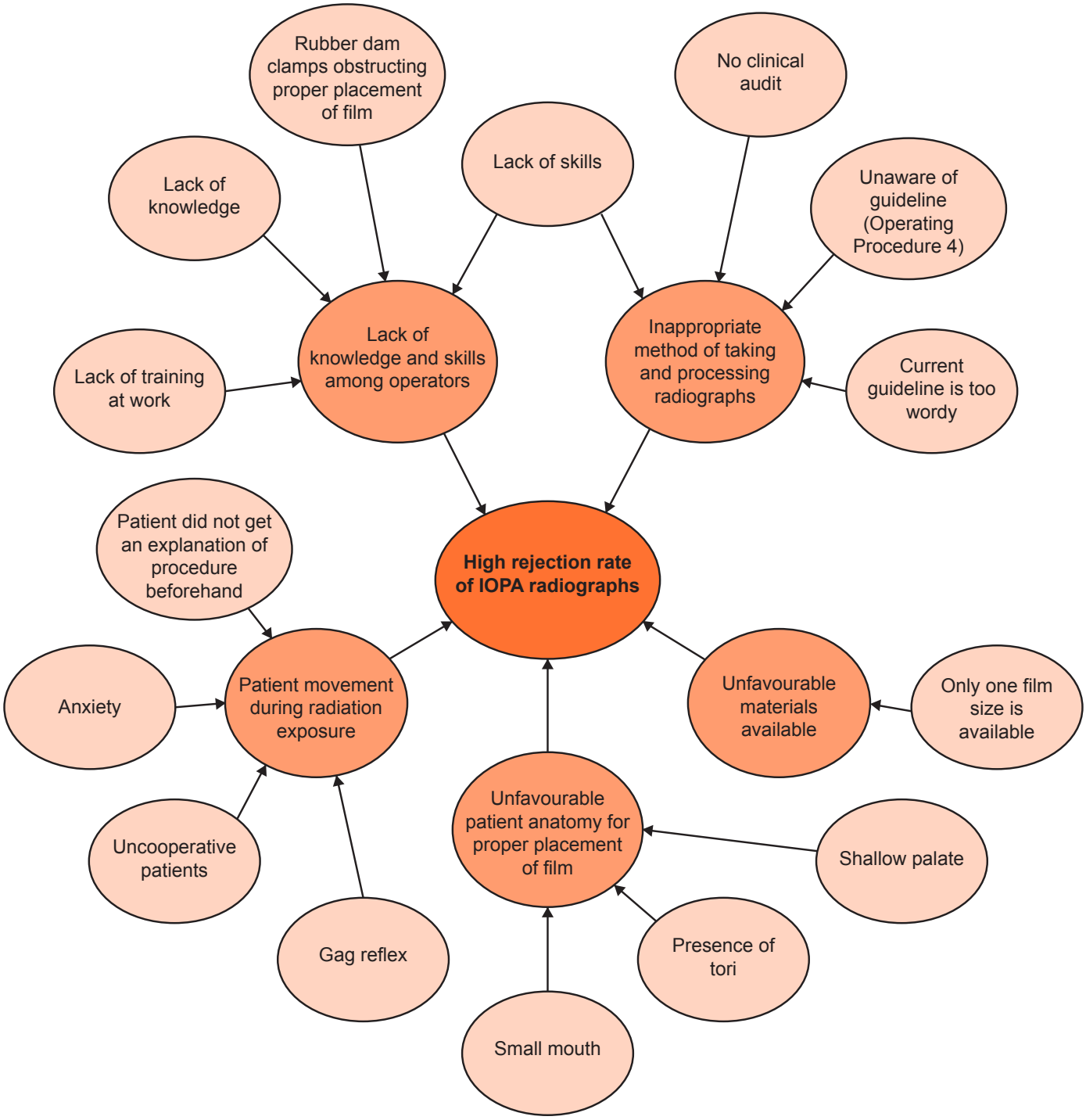


Figure 1: Problem analysis chart showing the factors contributing to the high rejection rate of IOPA radiographs

during procedures. The effectiveness was gauged based on operator feedback, which revealed a significant improvement in adherence to the recommended steps.

Secondly, a comprehensive hands-on workshop led by a restorative specialist was conducted to enhance operators' knowledge and skills in radiograph taking and processing. The workshop included a pre-assessment, theoretical lesson, practical session, and post-assessment. The pre- and post-workshop assessment was conducted using a self-administered questionnaire, made available to all operators via an online platform. The theoretical lesson comprised a lecture delivered by the specialist, covering key principles and protocols. During the practical session, operators practised

placing X-ray films and holders on each other, simulating real-life scenarios. The restorative specialist provided individualised advice and guidance throughout both lessons to ensure effective learning. At the end of the workshop, each operator was required to achieve a minimum score of 80% on the post-assessment.

Finally, a clinical audit in radiograph taking and processing was conducted by the DO in charge of TDC to closely assess and monitor all operators' skills. The DO observed each operator during the procedures, with their performance systematically cross-checked against an audit form outlining critical steps. Operators who failed to fully comply with the critical steps received tailored feedback aimed at preventing future errors. This hands-on monitoring and feedback approach helped to reinforce best practices and contributed to a notable reduction in the rejection rate.

Cycle 2: October – December 2023

Following the successful implementation of Cycle 1, Cycle 2 was introduced to address patient-related factors. By including strategies to reduce patient movement and anxiety, Cycle 2 aimed to further reduce the rejection rate of IOPA radiographs while maintaining the progress achieved in the first cycle.

Apart from implementing the strategies from Cycle 1, Cycle 2 introduced a two-minute demonstration video in Malay explaining the radiograph-taking procedure and safety measures. The video featured a detailed explanation of the IOPA radiograph safety and a simulation of the procedure. The video was shown to patients before the radiograph procedure to familiarise them with the process, reduce anxiety, and minimise movement.

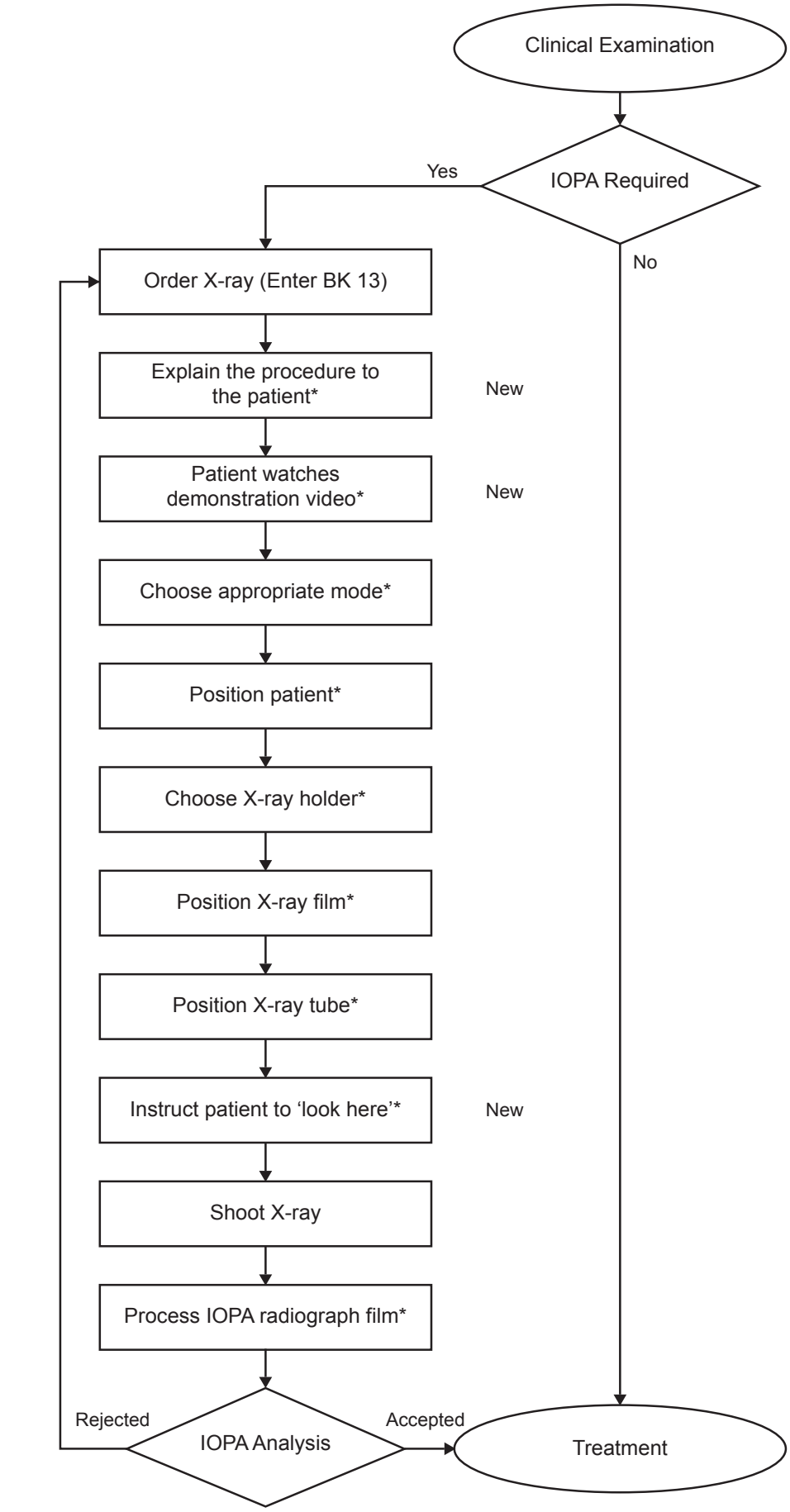
Additionally, a portable and affordable tool featuring a 'look here' sign was developed to assist patients in stabilising their heads during radiograph taking. The tool consists of a mobile phone holder and a customisable printed sign, which can display messages such as 'look here' or 'do not move'. It can be securely attached to the armrest of the radiograph chair, helping patients maintain a fixed head position by focusing on the sign during the procedure. With a cost of only MYR9.90 (USD2.43 as of September 2026), this tool is both practical and easily replicable for use in other dental facilities.

The process of care (Figure 2) was enhanced by adding three new critical steps: explaining the procedure to patients, ensuring patients watch the demonstration video and requesting patients to focus on the 'look here' sign before X-ray was radiated.

Results

The rejection rate was reduced from 5.9% to 3.9% in Cycle 1 and further to 2.2% in Cycle 2. Comparing the final rejection rate to the standard of <5%, the final Achievable Benefit Not Achieved (ABNA) was -2.8% (Figure 3). The percentage of operators with good knowledge in radiography, defined as scoring more than 50% in the knowledge section of the questionnaire, increased from 68.0% to 80.0%, achieving an average score of 90.5% in the post-workshop assessment. Clinical audits conducted before and after the implementation of remedial actions revealed that adherence to the original six critical steps ranged from 45.0% to 100% prior to the intervention. Following the remedial measures after Cycle 1, compliance improved significantly, reaching 95.0% to 100% across all steps, including full adherence to the three newly introduced critical steps. The detailed percentage improvement for each step is illustrated in Table 1. Beyond these outcomes, the project also yielded cost savings. The cost for purchasing IOPA radiograph film and developing chemicals was reduced by 43.0% (MYR104.40 ≈ USD25.85 as of August 2026) in 2023 (MYR144.40) compared to 2022 (MYR244.80), due to fewer retakes. A patient satisfaction survey was distributed to two separate groups of patients, with 21 patients in the pre-remedial phase and 21 in the post-remedial phase. The survey consisted of eight questions, which assessed the patients' pain experience, anxiety levels, and overall satisfaction with IOPA radiograph procedures at TDC. The feedback obtained indicated increased satisfaction, decreased pain and reduced anxiety among patients during radiograph taking.

In April 2024, our strategies were expanded to other dental clinics in Melaka. Endorsed by the Melaka Tengah District



*indicates critical steps

Figure 2: Revised process of care showing the process of radiograph taking and processing at TDC based on Operating Procedure 4

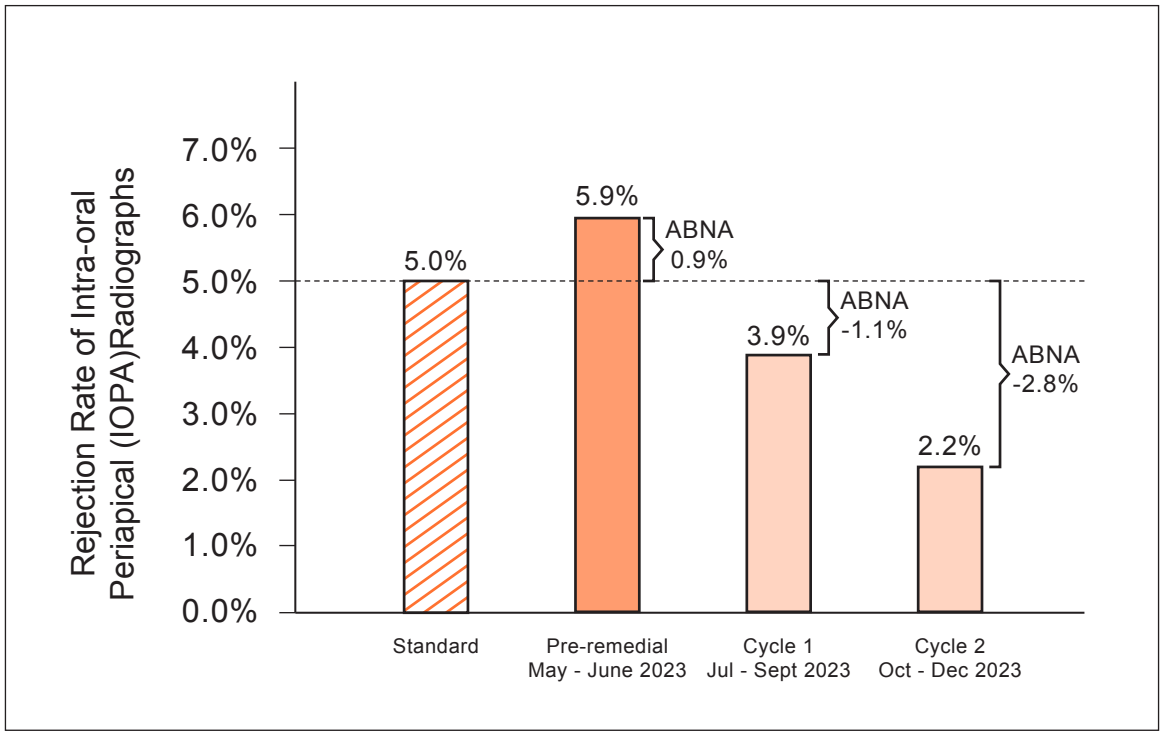


Figure 3: Percentage rejection rate of IOPA radiographs at TDC during pre-remedial and post-remedial phases

Table 1: Model of Good Care to reduce the rejection rate of IOPA radiographs at TDC

No.	Critical Step	Criteria	Standard (%)	Verification Study (%)	Cycle 1 (%)
New	Explaining the procedure to the patient	Explain the procedure to the patient verbally	100	0.0	100
New	Ensuring the patient watches the demonstration video	Ensure the patient watches the demonstration video before entering the X-ray room	100	0.0	100
1	Choosing the appropriate mode for the area/tooth of interest	Choose the correct exposure setting according to the type of area/tooth of interest and the patient's size	100	60.0	95.0
2	Positioning of the patient	Ensure the patient sits upright and does not move during the shooting of the X-ray	100	45.0	95.0
3	Choosing the appropriate X-ray film holder	Choose the appropriate X-ray film holder according to the area/ tooth of interest	100	100	100

4	Positioning of X-ray film	Position the X-ray film as close as possible to the area/ tooth of interest	100	95.0	100
5	Positioning of X-ray tube	Ensure the X-ray tube is parallel to the X-ray paralleling kit	100	95.0	100
New	Instructing the patient to 'look here' sign	Move the 'look here' sign to the patient's eye level and remind the patient to stay still throughout the procedure	100	0.0	100
6	Processing X-ray film	Inject the correct amount of DQE solution into the corner of the x-ray film packet	100	100	100
		Agitate the injected packet for more than 30 seconds	100	0.0	100
		Immerse the x-ray film in the hardening solution	100	100	100
		Wash the hardened film in running water for 15 seconds	100	0.0	90.0
		Drying film at the shade and good ventilation not more than 25°C	100	50.0	100

'New' indicates new critical steps added as part of the remedial actions taken

Dental Office, they were introduced at Ayer Molek Dental Clinic and Cheng Dental Clinic, both of which had the highest rejection rates within the first quarter of 2024, at 7.0% and 6.4% respectively. Following the implementation of remedial actions, the average rejection rates from May to July 2024 dropped to 5.2% at Ayer Molek Dental Clinic and 3.3% at Cheng Dental Clinic.

Lessons and Limitations

Despite the success, several challenges were identified. This includes limited availability of real patients for hands-on workshops, lack of time and supervision for regular clinical audits, and insufficient basic knowledge and training in quality assurance projects. Clinical audits were therefore not extended to Cycle 2 due to the unavailability of supervisors to oversee the process. Addressing these challenges is crucial for the sustained implementation of these strategies. Support from the OHD of Melaka and cooperation among all dental operators are imperative in minimising the rejection rate of IOPA radiographs in Melaka. Periodic discussions between management and dental staff are required to streamline the process of care, ensuring consistent improvement and adherence to the new guidelines.

Conclusion and the Next Steps

The remedial actions at TDC have been maintained throughout 2024. As of July 2024, the average rejection rate of IOPA radiographs at TDC was 2.2%. The success of these interventions at TDC has paved the way for their sustained implementation and expansion to all government dental clinics in Melaka. Following the introduction of remedial actions, the average rejection rate at Ayer Molek Dental Clinic dropped to 5.2%, whereas Cheng Dental Clinic was 3.3%. These results indicate that the strategies are effective and sustainable, supporting continued efforts to maintain rejection rates below the 5% standard.

Based on patient feedback, the demonstration video will be produced in multiple languages, including English, Chinese, and Tamil, to cater to a broader patient population. Discussions with the OHD of Melaka are underway to enhance the current dental radiography guidelines and establish a revised standard rejection rate. From a multidisciplinary perspective, these strategies have the potential to be scaled and adopted by the medical radiology department in Melaka.

In conclusion, the successful reduction of IOPA radiograph rejection rates at TDC from 5.9% to 2.2% highlights the effectiveness of our remedial measures. By expanding these strategies to other clinics and continuously refining our approach based on feedback and challenges, we can improve the quality of dental radiography across Melaka, benefiting both patients and dental practitioners.

Acknowledgements

We sincerely thank the Director General of Health Malaysia for approval to publish this article. Our gratitude also extends to the Deputy State Health Director (Dental), Dr. Rosdayana Binti Ibrahim - Restorative Specialist of Ayer Keroh Dental Clinic, as well as the officers and staff members of Tengkera Dental Clinic for their unwavering support. On top of that, we deeply appreciate the invaluable guidance given by our facilitator, Dr. Quake Puay Tin. Lastly, we would like to extend our heartfelt thanks to the patients who generously spared their time to participate in our study.

Conflict of Interest

The authors declare that there was no conflict of interest.

Funding

This study received no specific grants from any funding agencies from the public, commercial, or non-profit sectors.

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Appendix 1: Clinical audit form to evaluate DO and DSA's skills in dental radiography

LAMPIRAN A

BORANG PEMANTAUAN PENGAMBILAN X-RAY INTRA-ORAL UNTUK PEGAWAI PERGIGIAN (BERASASKAN AK 4 PENGAMBILAN X-RAY)

Nama Klinik: _____
Nama Auditor: _____
Tarikh Pemantauan: _____

KATEGORI	NO	VARIABEL	PESAKIT	1	2	...	20
			ID PESAKIT				
			SN XRAY				
Pengambilan Xray Intra Oral (Jenis Konvensional)	1	Pastikan bahagian mulut yang hendak di x-ray					
	2	Berikan penerangan tentang prosedur pengambilan x-ray kepada pesakit					
	3	Gunakan jenis filem x-ray yang sesuai					
	4	Rekod dalam Bk-13					
	5	Pasangkan suis lampu amaran radiasi					
	6	Pastikan mesin xray berfungsi					
	7	Pilih program x-ray yang sesuai mengikut bahagian mulut					
	8	Minta pesakit duduk di atas kerusi					
	9	Pasangkan apron pelindung sinaran x-ray pada pesakit					
	10	Letakkan filem x-ray di sebelah dalam bahagian mulut yang hendak di x-ray					
	11	Pastikan filem kekal pada bahagian yang hendak di x-ray					
	12	Tujukan tiub x-ray dengan betul pada bahagian mulut yang berkenaan					
	13	Gunakan x-ray parelling kit sekiranya ada dan mengikut keadaan					
	14	Minta pesakit jangan bergerak semasa pengambilan x-ray					
	15	Mulakan pancaran sinaran x-ray					
	16	Keluarkan filem dari mulut pesakit					
	17	Padamkan suis mesin x-ray dan lampu amaran radiasi					
	18	Minta pesakit menunggu di ruang menunggu/ bilik rawatan					

Kod skor diisi sebagai	
0	: Tidak Tepat
1	: Tepat
TB	: Tidak Berkaitan

PENGIRAAN SKOR				
KATEGORI	1	2	...	20
N (Jumlah skor)				
D (Jumlah variabel diperiksa)				
Peratus skor (N / D) x 100				
PURATA SKOR				

LAMPIRAN B

BORANG PEMANTAUAN PENGAMBILAN X-RAY INTRA-ORAL UNTUK PEMBANTU PEMBEDAHAN PERGIGIAN (BERASASKAN AK 4 PENGAMBILAN X-RAY)

Nama Klinik: _____
Nama Auditor: _____
Tarikh Pemantauan: _____

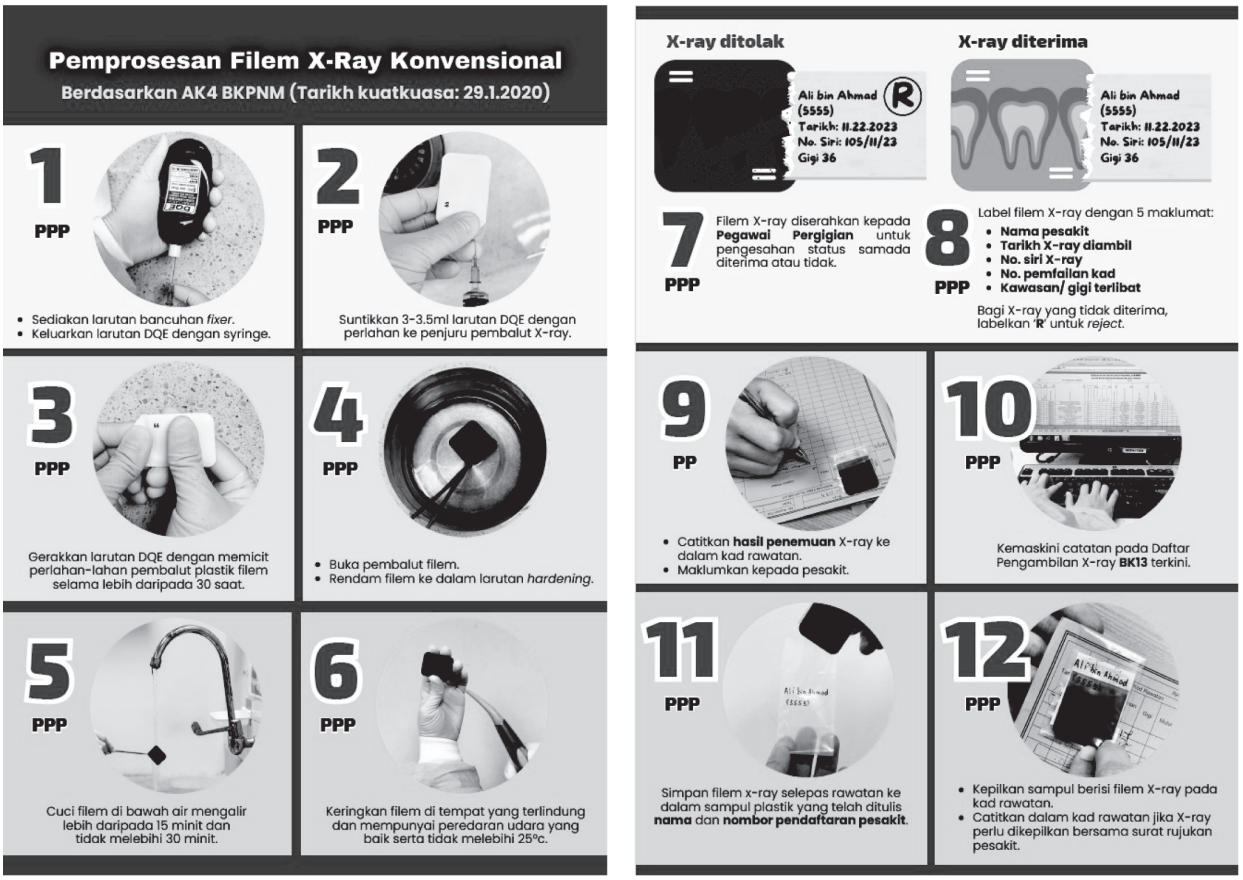
KATEGORI	NO	VARIABEL	PESAKIT	1	2	...	20
			ID PESAKIT				
			SN XRAY				
Pemprosesan Filem X-ray (Jenis Konvesional) dengan menggunakan X-ray Instant Hanshin	1	Sediakan larutan bancuhan fixer mengikut arahan pada kotak pembungkusan x-ray (100ml larutan air)					
	2	Keluarkan larutan DQE dengan syringe					
	3	Suntikan larutan DQEdengan perlahan ke penjuru pembalut x-ray mengikut sukatan yang detetapkan: Dental size: 3-3.5ml Junior size: 2-2.5ml Occlusal size 9-9.5ml					
	4	Gerakan larutan DQE dengan memicitkan perlahan-lahan pembalut plastik filem selama lebih dari 30 saat					
	5	Buka pembalut filem					
	6	Rendam filem ke dalam larutan 'hardening' yang telah disediakan					
	7	Cuci filem di bawah air lebih dari 15 minit dan tidak melebihi 30 minit					
	8	Pengeringan dibuat pada tempat yang terlindung dan mempunyai peredaran udara yang baik serta tidak melebihi 25°c					
	9	Filem X-ray diserahkan kepada PP untuk pengesahan status samada diterima atau tidak					
	10	Label filem x-ray (Nama pesakit/tarikh/SN/IC/kawasan terlibat) dan kepilkan					
	11	Bagi x-ray yang tidak memuaskan/tidak diterima, label 'Reject'					
	12	Catitkan hasil penemuan x-ray ke dalam kad rawatan dan maklumkan kepada pesakit					
	13	Kemaskini catatan pada BK-13					
	14	Ulang semula langkah pengambilan xray jika x-ray tidak diterima/reject					
	*	Jumlah masa yang digunakan untuk pengambilan x-ray					

Kod skor diisi sebagai	
0	: Tidak Tepat
1	: Tepat
TB	: Tidak Berkaitan

PENGIRAAN SKOR				
KATEGORI	1	2	...	14
N (Jumlah skor)				
D (Jumlah variabel diperiksa)				
Peratus skor (N / D) x 100				
PURATA SKOR				

Appendix 2: Infographic posters based on the Operating Procedure 4 guideline





Quality Improvement Report (QIR) for Q Bulletin Guideline for Authors

Your manuscript should include:

1. Abstract (up to 300 words)
2. Main text (up to 5000 words; excluding abstracts, tables, and figures)
3. Maximum of 5 tables and/or figures.
4. Please use Font Arial, Size 12, double spacing.
5. Maximum of 5 pages allowed for the supplementary files; however, all supplementary materials should be relevant, concise, and directly support the content of the manuscript

Subheading	Description
Title	Indicate that the article concerns an initiative to improve healthcare.
Abstract	This is a summary of your work and is the most important section to attract a reader's attention. Please ensure you include: a) A brief background to the problem, b) The method for your quality improvement project, c) The overall results and d) The conclusion Keep it succinct and factual. Please include 3 – 5 appropriate keywords for your manuscript.
Problem	Summarise your problem and the focus of your project. Give some details about your local context including; a) The type of organisation you work in, b) The size of your organisation, c) Details about the staff members who work there and d) Perhaps a little bit about your local patient population. Include here the SMART aim of your project (for example; the aim was to reduce medication errors from 15% to 5% across six elderly care wards in three months).
Background	This section gives the reader background information about the problem and provides up-to-date, research and knowledge from the literature. Summarize the literature you have found on the background to your problem here. a) What existing literature is there that this problem exists? b) What existing literature is there on the factors contributing to the problem? c) What literature is there that other people have tried to solve this problem in the past? d) Is there any literature for what works and what doesn't to solve your problem?
Measurement	Describe which measures/indicator you selected for studying processes and the outcomes of the intervention(s), including: a) Rationale for choosing them, b) Their operational definitions, c) Inclusion and exclusion criteria, d) The standard and how you determine it Describe how you planned to collect the data for indicator, contributing factor and/or MOGC throughout your project. Include here the results of your baseline measurement/indicator (verification study).

Initial assessment of the problem	Describe what processes are involved in your problem including the critical steps in the processes that will contribute to the achievement of your final goal. Describe the perceived factors that could contribute to the problem and how you quantify them. Include here the results of the study that you conducted to identify the contributing factors to the problem. Include the Model of Good Care (MOGC) as appropriate.
Strategy	In this section you should explain your strategy for improvement to the reader and discuss how you implemented your improvement cycles. In most cases you will have tried several progressive improvement cycles, some of which will not have been successful. It is important that you also share these to help others avoid similar difficulties. Remember that data should be collected continuously throughout your project. This is a difficult section to document and will contain a lot of information. For each PDSA cycle you should describe your aim, your change hypothesis and strategy for change. a) Describe how you implemented the change and the data you collected. b) Describe your key learning from each cycle of change, and discuss how this learning impacted on your change process. c) How well did your predictions of what change was needed match your outcomes? d) What worked more effectively than anticipated and what had less effect than predicted?
Results	Provide a summary of what your results using appropriate chart or diagram. a) Describe the variation in your data. b) Were the interventions you made responsible for any improvements? c) Describe how contextual elements interacted with the intervention(s) and affected your results. d) Compare your results to your baseline measurement. Comment on how you assessed whether the data was complete and accurate- was there any missing data? Please comment on whether there were any unintended consequences such as unexpected benefits, problems, failures, or costs associated with the intervention(s). Were there any financial savings that your project made? Being able to demonstrate that your intervention delivered savings really helps to add value.
Lessons and Limitations	In this section, discuss the lessons you learnt from the project and its limitations. Comment on the strengths of the project. Describe any problems you faced and how you navigated these. If you were to undertake this project again, what would you do differently? Reflect on your project's limitations. Were efforts made to minimize/adjust for any limitations? For example, did you realise as the project was implemented that your results would be affected by unforeseen factors such as a small sample size or the turnaround of patients or staff? Are more data points/cycles required? Comment on the limits of generalisability. Describe whether chance, bias, or confounding have affected your results and whether there was any imprecision in the design or analysis of the project.

Conclusion and the next steps	You should reflect on your background research, noting what is already known on this topic and what your project adds. You should refer back to your aims statement – did your project achieve its aims?-Was it a useful project? Give an assessment of whether you think your project is sustainable – do you have enough data? What have you done to try to ensure that your work continues? Comment on how you would spread your project and whether it could be replicated elsewhere. Discuss what your next steps will be and whether further study in the field is required. Were your measures appropriate and did you use balancing measures?
Acknowledgements	Please include here the names of anyone who is not on the author list but whose input you wish to acknowledge.
AI use Acknowledgement	Please declare the use of AI in the project/writing
Conflict of Interest	Please declare any conflict of interest, if any.
Funding	Please declare any source of funding, if any.
Contribution	Please declare the contribution or role of each author. The common roles include (but not limited to) writing the manuscript, reviewing and editing the manuscript, data collection, and analysis.
Data availability	State: The dataset that supports the findings of this article is not publicly available. Request for data can be obtained from the corresponding author upon reasonable request and with permission from the Director General of Health, Malaysia.
References	In this section, you should record any references to published material that you refer to elsewhere in your project. This is particularly likely to include material from background reading or from your conclusions. Use the Vancouver style for referencing.



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