IMPROVING THE PERCENTAGE OF DIABETES MELLITUS PATIENTS ON INSULIN WITH A GOOD UNDERSTANDING AND PRACTICE OF INSULIN INJECTION TECHNIQUES IN THE OUTPATIENT PHARMACY OF TELUK INTAN HOSPITAL

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Abstract

Poor understanding of insulin injection techniques contributes to poor glucose control and disease risk. The objective of this study was to improve the percentage of diabetes mellitus patients on insulin with a good understanding and practice of insulin injection techniques in the Outpatient Pharmacy of Teluk Intan Hospital. A quality improvement cohort study was conducted from January 2017 to June 2019. The result showed that only 5.1% (n=7) of the 137 recruited patients had a good understanding and practice of insulin injection techniques in the pre-remedial phase. Through the face-to-face interview and live demonstration conducted, the contributing factors identified were language barriers (48%), absence from counselling sessions (24%) and showing up during peak hours for the counselling session (15%). The incorrect practice of insulin injection techniques like improper disposal of used needles (92.4%), leaving used needles attached to insulin pens (89.8%) and incorrect priming of insulin pens (81.9%) were commonly observed. During the first interventional cycle, the workflow of insulin injection counselling was improved, pharmacists' training was enhanced and multilingual counselling sessions aided with audio-visual tools and live demonstrations were provided. In the second cycle, patients were given pictorial pamphlets, injection site rotation charts and containers for storage and disposal of used needles. The percentage of patients with a good understanding and practice of insulin injection techniques improved from 5.1% to 72.3% and 88.3%. During the sustainability phase (March 2018 to June 2019), the percentage decreased to 73.7% at two-year post-remedial due to skipping steps for convenience (65%), change of caretakers (21%) and poor memory (14%). Upon re-education, the percentage improved to 83.5% in May 2019. In conclusion, counselling delivery language and technique, live demonstration, effective counselling aids and re-education by trained pharmacists are essential in improving understanding and practice of insulin injection techniques among diabetic patients.

KEYWORDS: Insulin injection technique, Diabetes mellitus, Insulin counselling

Problem

Teluk Intan Hospital (HTI) is a specialised district hospital in Malaysia that covers Hilir Perak, Sabak Bernam, Batang Padang, Selatan Manjung and Perak Tengah. It also acts as a referral hospital for Tengku Ampuan Jemaah Hospital, Tapah Hospital, Slim River Hospital and part of Manjung Hospital and Changkat Melintang Hospital. The Outpatient Pharmacy of HTI caters to about 6,000 diabetes mellitus patients from the primary care and General Medicine Specialist Clinic for their monthly medical supply. Insulin users comprise about 10% of the total number of diabetes mellitus patients. Most of them are between the ages of 40 to 60, speak only their mother tongue and have long-standing diabetes mellitus.

A study conducted in the Outpatient Pharmacy at HTI in January 2017 showed that among all diabetes mellitus patients on insulin, 94.9% of them did not have the correct understanding and practice of insulin injection techniques. The incorrect techniques identified included injecting the wrong insulin dose, wrong timing or method of insulin injection, lacking priming and mixing, improper storage of insulin cartridges and insulin pens and improper storage or disposal of insulin needles. Lacking good understanding and practice of insulin injection techniques would result in uncontrolled sugar levels due to the wrong insulin dosage injected, which can increase the risk of target organ damage and complications of the heart, kidney, eyes, blood vessels and nerves and subsequently increase the rate of hospital admissions. In other words, improving patients' understanding of insulin injection techniques will help them control their blood sugar levels, reduce injection-related complications, reduce complications caused by uncontrolled diabetes and subsequently reduce hospital admission rates.

This study aimed to improve the percentage of diabetes mellitus patients on insulin with a good understanding and practice of insulin injection techniques from 5.1% to 80% within three months.

Background

Type 2 diabetes mellitus (T2DM) is a progressive disease characterised by worsening glycaemia due to a progressive decline in beta cell function (1). Continuous deterioration of beta cell function will ultimately render oral glucose-lowering drugs ineffective, hence, the reason why most patients with T2DM will require insulin therapy (2). The addition of insulin therapy is customary when glycaemic control is suboptimal (3). Insulin therapy is suitable at all stages of T2DM for all ages and comes with a wide range of treatment options and regimes (2). It can be initiated safely in outpatient settings and has the advantage of lowering glucose in a dose-dependent manner to almost any glycaemic target. Insulin pens are convenient, safe to use and accurate in dose delivery when used correctly (2). However, poor understanding and practice of insulin injection techniques are common among diabetic patients, and they can impede the patients from achieving their targeted haemoglobin A1C (HbA1c) level.

Based on the literature, poor understanding and practice of insulin injection techniques are common among diabetes mellitus patients worldwide. A study conducted in Turkey reported that 79.5% of the 200 participants were using expired insulin pens or cartridges, 70.5% did not rotate the injection site and 63% massaged the injection site after insulin injection (4). Also, a research carried out by the Outpatient Pharmacy of Batu Pahat Hospital showed that 90% of patients had poor knowledge and practice of insulin injection techniques and required re-education by pharmacists (5). A multi-centre study in Belgium among 4352 diabetic patients reported that 21% of the diabetes mellitus patients admitted injecting insulin on the same site over the entire day for a few days (6).

Patients who do not perform insulin injection techniques correctly have been shown to have a higher prevalence of insulin-related complications and hospitalisation rates (7). The study of Gentile et al. (8) showed a linear relationship between HbA1c levels and

the number of errors during insulin injection among T2DM patients, i.e., more errors during insulin injection would result in higher HbA1c values. Aside from a higher HbA1c level, improper insulin injection techniques may also cause other complications like lipodystrophy, bleeding and bruising at the injection site (9), as well as both severe and transient hypo- or hyperglycaemia, wide glycaemic excursions and diabetic ketoacidosis (10). Based on the 2007 - 2011 United States national surveillance data, Geller et al. (11) reported that insulin-related hypoglycaemia was the cause of an estimated 97,648 emergency department visits annually, with almost one-third of the visits ending up as hospital admission. Severe neurologic sequelae occurred in 60.6% of these visits, and blood glucose levels of less than 50mg/dL were documented in 53.4% of the cases (11).

Insulin injection errors may occur in any of the steps of the medication use process, including prescribing, transcribing, dispensing and administration steps, even though most of the errors were observed during administration (7). A study conducted in the United States showed that lacking education on operating an insulin pen is one of the common reasons for improper insulin injection (7). Regarding this matter, a global survey done by Frid et al. (12) showed that fewer than 40% of patients on insulin worldwide received proper counselling in the last six months, and 10% of the patients said that they had never received training on how to inject insulin correctly despite injecting for a mean of nearly nine years.

Truong et al. (7) have reinforced the need for repeated insulin education and continual assessment of insulin administration. Patient counselling on proper insulin injection techniques is essential to ensure they receive the prescribed insulin dose and prevent injection-related complications due to improper injection (13). Also, a teach-back method is an approach that can be used to assess patients' techniques and re-educate them at every available opportunity to reduce the risk of administration errors (7). Patients are also more likely to rotate injection sites correctly if they received injection instructions from their healthcare provider in the past six months. Moreover, community pharmacist-led educational interventions in multidisciplinary group sessions on self-care for diabetic patients have also been proven to have long-lasting benefits on glycaemic control (14). Besides that, the findings from another study conducted on 87 patients on insulin showed improvement in glycaemic control after re-education of insulin injection techniques based on the result of HbA1c, especially in those with a poor understanding of insulin injection techniques (15).

Measurement

The indicator of this study was the percentage of diabetes mellitus patients on insulin with a good understanding and practice of insulin injection techniques in the Outpatient Pharmacy of HTI with a standard of at least 80%. The percentage was calculated using the formula below:

$$\textit{Percentage of diabetes mellitus patients on insulin with good understanding and practice of insulin injection techniques} = \frac{\textit{Number of diabetes mellitus patients on insulin with good understanding and practice of insulin injection techniques}}{\textit{Total number of diabetes mellitus patients on insulin who are recruited for insulin injection technique reassessment and counselling}} \times 100\%$$

A questionnaire to measure patients' understanding of insulin injection techniques was developed based on the 5-steps of Correct Use of Medicine (16), the Step-by-Step Counselling Guideline Checklist by the Pharmaceutical Services Division, Ministry of Health Malaysia (17), and also updates and recommendations from the Forum for Injection Technique Malaysia (FIT-MY) (18).

The developed questionnaire consisted of 3 parts, with a total of 34 questions. The first part of the questionnaire included three questions on demography: age, race and gender. The second part of the questionnaire explored specifically patients' correct use of the prescribed insulin regimen, such as the

type of insulin, the type of insulin pen, the dose of insulin injection, the frequency of the insulin regime, the timing of insulin administration and the rotation pattern of the injection sites. The third part of the questionnaire consisted of a simplified checklist of 28 items to assess patients' practice through injection technique demonstration, which was based on the combined step-by-step counselling guideline and recommendations by the FIT-MY. A higher weightage was given to critical steps that determined the correct understanding, such as correct priming, dialling and injection site rotation, considering the importance of the steps in the treatment. Each question in Parts 2 and 3 carried 1 point if answered correctly, with a maximum score of 28 points per patient. Patients who scored a minimum of 23 points out of 28 points or 80% passing mark were considered to have a good understanding and practice of insulin injection techniques.

A pre-remedial study was conducted from January to February 2017 to verify the existence of poor understanding and practice of insulin injection techniques in diabetes mellitus patients on insulin in the Outpatient Pharmacy of HTI, as well as to identify the contributing factors with a questionnaire survey. All adult diabetes mellitus patients on insulin who visited the Outpatient Pharmacy of HTI between January and February 2017 were scheduled for an appointment to assess their insulin injection techniques. Patients who turned up for the appointment were recruited into this study until the required sample size was achieved, which was a minimum of 137 samples. The inclusion criterion for this study was all adult type 1 or type 2 diabetes mellitus patients who were using insulin pen injections. The primary caretaker who helped with insulin injecting were assessed if the patient was not self-injecting. Patients using insulin syringes, inpatients with cognitive dysfunction or psychiatric patients and absentees were excluded from this study. The questionnaire was administered in a face-to-face interview, which included patients' demonstration of insulin injection techniques. During the interview session, patients were also asked about the reason for their poor understanding and practice of insulin injection techniques. The pre-remedial study showed that only 5.1% of the patients had a good understanding and practice of insulin injection techniques. It was also noted that the hospital recorded 203 admissions due to hypoglycaemia from January until December 2016.

Remedial measures were implemented from March to June 2017 in two cycles: the first cycle was from March to April 2017, and the second cycle was from May to June 2017. The same patients were evaluated before and after the intervention to measure the effectiveness of the remedial measures. The post-remedial evaluation was conducted in the subsequent month after implementing the remedial measures. Patients who scored less than 80% in the assessment on their understanding and practice of insulin injection techniques during the first cycle were required to undergo the second cycle with enhanced remedial measures to ensure they could achieve the target standard.

The measurement was continued in subsequent years to determine the sustainability of the intervention. The first sustainability cycle was from March to April 2018, and the second cycle was from April to May 2019, with reinforcement of remedial measures. The reinforced remedial measures were re-evaluated between May and June 2019 to re-evaluate the effectiveness of the remedial measures implemented. The same methodology was used for the assessment during the sustainability cycle.

Initial Assessment of the Problem

The initial process of care for insulin counselling for diabetes patients is shown in Figure 1. Before this study, patients who were newly started on insulin therapy had to obtain their insulin pen supply and counselling from the Diabetes Education Centre located in another building before heading to the Outpatient Pharmacy for the supply of insulin cartridges and medications. It was observed that patients with mobility difficulties, time constraints and poor sense of direction would often omit going to the centre and directly proceed to the pharmacy for their medications, only to be asked to return to the centre for their insulin pen supply.

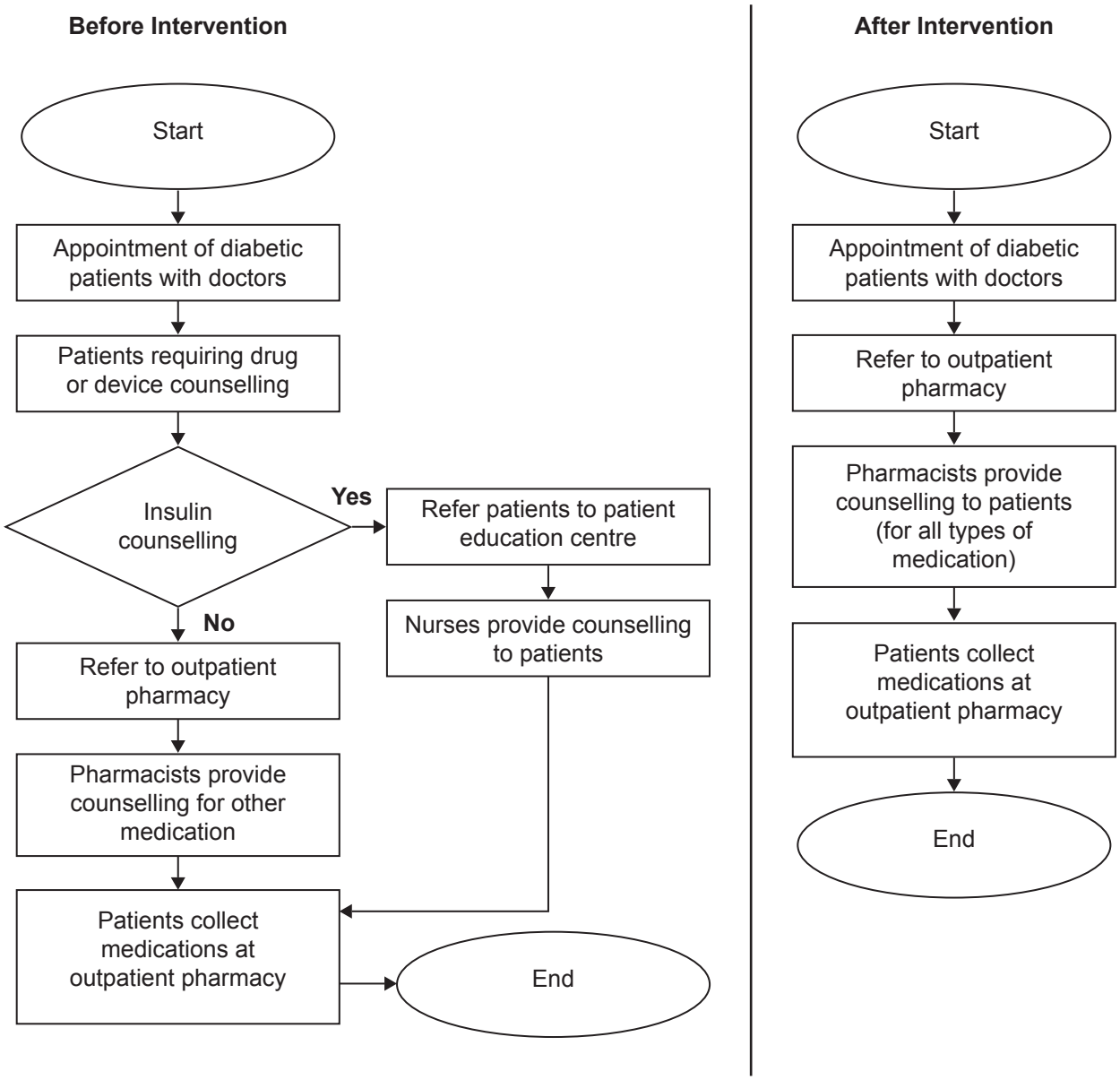


Figure 1: Process of care for insulin counselling before and after intervention

It was also noticed that there was only one diabetes educator available at the Diabetes Education Centre, who was required to handle an array of tasks, including supplying new insulin pens to patients, counselling patients who were newly started on insulin, counselling ward-discharged diabetes patients, providing foot care, educating patients on the use of glucometer device and self-monitoring blood glucose counselling, as well as selling insulin needles and glucometers on behalf of the Teluk Intan Branch of Malaysian Diabetes Society. During peak hours, the quality of the insulin pen counselling was often compromised due to time constraints; the service was sometimes interrupted because the diabetes educator was unavailable.

Moreover, replacement insulin pens and cartridges were supplied to patients during a shortage of insulin pens or insulin cartridges, which occasionally resulted in a mismatch of insulin pen and cartridge as the pen and cartridge were supplied from two different locations. Mismatched insulin pens and cartridges can compromise the fixing of the insulin pens and the accuracy of insulin delivery. Hence, the insulin pen and cartridge mismatching issue were also included in this study for remediation.

Initial assessment of patients' correct use of the prescribed insulin regimen

discovered poor understanding in two main areas: the timing of administration of insulin injection (38.8%) and the rotation pattern of injection sites (21.4%). On the other hand, correct insulin dose (63.3%) and correct frequency of insulin injection (57.1%) scored fairly.

Initial assessment of the patients' demonstration of insulin injection techniques based on the checklist of 28 items revealed below the satisfactory score for the priming of insulin pen (18.1%), dialling of insulin dose (48.3%), reusing of insulin needles (35.3%), leaving the needle attached to the insulin pen (10.2%) and correct disposal of insulin needles (7.6%). Meanwhile, patients scored fairly in the techniques of assembly of insulin cartridge and pen (63.7%), preparation of insulin (58.9%), fixing the insulin needles (58.9%), injection of insulin at 90 degrees angle (68.2%), storage of insulin (69.1%) and storage of insulin pen (62%).

A total of 142 diabetes mellitus patients were recruited for this study. Five patients were excluded as they were unable to attend the re-evaluation session. The results showed that 94.9% (n=130) of the insulin users did not have a good understanding and practice of insulin injection techniques. In other words, only 5.1% (n=7) of the insulin users demonstrated a good understanding and practice of insulin injection techniques during the assessment.

The identified main contributing factors to the low percentage of insulin users with correct understanding and practice of insulin injection techniques were the language barrier between the counselling provider and the recipient (48%), patients absent from counselling sessions (24%), patients attending counselling sessions during peak hours (15%), patients rejecting counselling sessions (8%), no brochure (4%) and no leaflet in multiple languages (1%).

Strategy

In the first cycle of the remedial phase, the issues of heavy workload and time constraints of the diabetes educator were addressed by revising the process of care for insulin counselling (refer to Figure 1). The new process of care allowed outpatient patients who needed insulin injection counselling to be directly referred to the Counselling Unit of the Outpatient Pharmacy. The change in the workflow enabled the patients to receive counselling and medical supply at the same location simultaneously and hence, saved time and reduced the chances of patients not attending the counselling session.

A training workshop on insulin injection techniques by the Perak State Diabetes Mellitus Medication Therapy Adherence Clinic (DMTAC) preceptor was organised to evaluate, train and re-evaluate insulin injection techniques among pharmacists involved in insulin injection counselling. All outpatient pharmacists were required to attend the training workshop to ensure the information delivered to patients was aligned and complete. The technique for delivery of counselling was also taught in the workshop to ensure that the counselling given was effective.

Remedial measures targeting the main contributing factor to poor understanding and practice of insulin injection techniques, i.e., language barrier, were also developed and implemented in the first cycle of the remedial phase. The insulin injection counselling was prepared in four different languages: Malay, English, Mandarin and Tamil. The counselling sessions in different languages were held daily from Monday to Thursday every week at 9.00 am, 11.00 am, 2.30 pm and 3.45 pm. A schedule with date, time and officer on duty was released at the beginning of each month for patients or primary caretakers to plan and register for a counselling session based on their preferred date, time and language. Every counselling session was limited to a maximum of eight patients. Reminder messages were sent upon patients' registration to remind them of the date, time and equipment required on the counselling day. Patients who were absent on the registered counselling day were contacted via phone calls, and they were rescheduled to a new date and time if they could not attend the session.

The counselling sessions were also enhanced with audio-visual aids and hands-

on practices. During the counselling session, short videos on each step of insulin injection were played to the patients, followed by a live demonstration and explanation by a pharmacist on the steps and a step-by-step practical session for the patients. At the end of the session, patients were required to re-demonstrate the whole insulin injection process to the pharmacist so that mistakes and confusion were addressed and corrected on the spot. Patients who required extra guidance were counselled individually.

In the second cycle of the remedial phase, patients were re-counselled on specific insulin injection techniques that they could not perform correctly. Pictorial brochures and infographics were given to patients as a reminder to strengthen their understanding and memory of what they were taught and counselled. Supporting tools such as a rotation chart for injection sites and containers to store and discard used needles were also provided to patients to encourage correct practice and hygiene of insulin injection.

Revision counselling was implemented between April and May 2019 as a decline was noticed in the percentage of patients with a good understanding and practice of insulin injection techniques two years after the patients underwent their first counselling session in 2017. During the revision counselling session, their weak points were identified, and the patients were re-educated on the correct insulin injection techniques.

Results

After the first cycle of remedial actions, the percentage of diabetes mellitus patients on insulin with a good understanding and practice of insulin injection techniques increased from 5.1% (n=7) to 72.3% (n=99). Patients' adherence to the timing of administration of insulin injection improved to 82.4%, the rotation pattern of injection sites improved to 52.6%, the correct dose of insulin improved to 89.8% and the frequency of insulin injection improved to 87.3%. Also, increments in the percentages of patients with correct practices of insulin injection techniques were observed, i.e., priming insulin pen (72.4%), dialling insulin dose (92.3%), changing insulin needles (66.7%), leaving the needle attached to the insulin pen (63.2%), disposal of insulin needles (55.9%), assembly of insulin cartridge and pen (89.7%), preparation of insulin (89.7%), fixing the insulin needles (92.6%), injection of insulin at 90 degrees angle (88.2%), storage of insulin (92.4%) and storage of in-use insulin pen (81.8%).

For the remaining 27.7% (n=38) of the patients who still could not master the correct insulin injection techniques after the first cycle of remedial actions, the reasons identified included having difficulty in visualising the injection site rotation (47.4%, n=18), lack storage and disposal containers for used needles (36.8%, n=14) and weak memory (15.8%, n=6). Hence, the counselling strategies were reinforced and enhanced in the second cycle of the remedial phase, with new remedial measures implemented on top of the existing remedial measures implemented in the first cycle.

After the second cycle of remedial measures, the percentage of insulin users with a good understanding and practice of insulin injection techniques increased to 88.3% (n=121), surpassing the target of 80%. For the patients who did not achieve the 80% passing mark of the assessment in the second cycle, improvement was still observed in their overall understanding of insulin injection techniques as compared to their achievement in the first cycle. In the sustainability phase one year later, 81.1% of the insulin users maintained a good understanding and practice of insulin injection techniques. Also, the number of admissions to the hospital due to hypoglycaemia dropped to 160 from January to December 2017.

However, the percentage of patients with a good understanding and practice of insulin injection techniques dropped to 73.7% two years post-remedial study. Further exploration of the reasons for the percentage drop revealed three contributing factors, i.e., skipping steps for convenience (65%), change of caretakers (21%) and poor memory (14%). Patients who did not achieve the 80% passing mark in the sustainability assessment were re-educated on the correct insulin injection techniques and re-evaluated after one month.

The percentage of insulin users with a good understanding and practice of insulin injection techniques increased to 83.5% in May 2019.

The achievable benefit not achieved (ABNA) results for the pre-remedial phase, the first and second cycles in the remedial phase, and the three cycles in the sustainability phase are shown in Figure 2.

Lessons and Limitations

The ability of healthcare professionals to provide sufficient and complete education to patients is pivotal to ensure patients are equipped with a good understanding and the right techniques to perform insulin injections at home. It was evident from this study that counselling and re-education are essential to improve patients' insulin injection techniques.

The main challenge of this study was patients' attendance at the scheduled counselling sessions, assessments and re-evaluations. All efforts to remind patients to attend the sessions are crucial to ensure they make time to have an effective counselling session provided by the team. Besides, arranging the schedule of counselling sessions was another challenge faced in this study, as the availability of specified pharmacists with respective language specialty and fixed counselling schedules needed to be considered simultaneously.

The limitation of this study was that only patients from the Outpatient Pharmacy were recruited into the study, while patients from other settings, such as inpatients, were omitted.

Conclusion and the Next Steps

This study found that language, counselling techniques, live demonstrations and teaching aids are essential in providing a good foundation for good understanding and practice of insulin injection techniques among diabetes patients. Continuous training for pharmacists and paramedics who provide insulin injection counselling is also essential

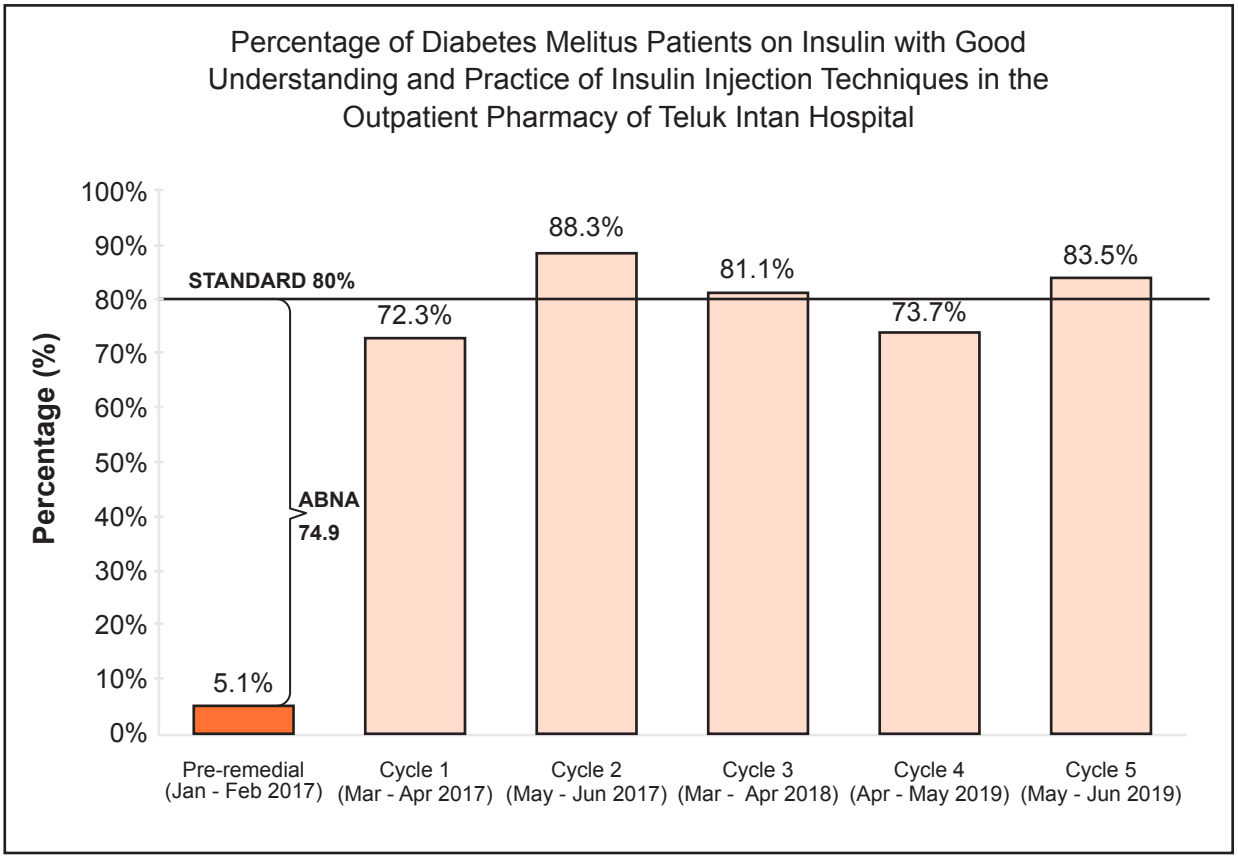


Figure 2: Achievement of Percentage of Diabetes Mellitus Patients on Insulin with Good Understanding and Practice of Insulin Injection Techniques Pre and Post Remedial Phases

to ensure updated, standardised information is delivered to patients. Also, the counselling skills of pharmacists should be enhanced to boost the effectiveness of each counselling session.

Reassessing patients' insulin injection techniques every two years is critical in sustaining a good understanding and practice of insulin injection techniques in patients on insulin. Besides, a yearly assessment will allow early detection of a decline in the understanding of insulin injection techniques so that remedial actions can be taken to maintain a good understanding level. If a decline is detected, patients should be re-educated through revision counselling to refresh their memory on the correct insulin injection techniques. Empowerment of caregivers through education and training should also be emphasised for patients with memory impairment.

To overcome the limitation of human resources in providing insulin injection counselling in four different languages, a QR code system was developed to direct patients to pre-recorded videos on insulin injection technique demonstrations for teaching, revision and assessment purposes. Furthermore, the videos have been made available to inpatient patients and widened to include other types of counselling. The QR code link and re-education system have now been applied to inhalers.

Once patients can sustain their good understanding and practice of insulin injection techniques for an extended time, the authors will explore the impact of having a good understanding and practice of insulin injection techniques on patients' glycaemic control. In future studies, the percentage standard for patients with a good understanding and practice of insulin injection techniques can be further increased, and additional indicators of fasting blood sugar and HbA1c can be added. The impact of having an improved understanding of insulin injection techniques on blood sugar control can be explored as well.

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Conflict of Interest

The authors declare that there was no conflict of interest.

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