# Assessment of Malaysian ICU Staff Perceptions Towards STAR Glycaemic Control Protocol

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*Abstract*—**A good glycaemic control protocol requires an assessment feedback from clinical side for improvement to reduce dysglycaemia (hyper or hypo) and most importantly mortality in critically ill patients. This includes medical doctors and nurses' perceptions on glycaemic control protocol clinical feasibility where a good protocol needs to be simple, effective, efficient and safe to be used on critically ill patients in the intensive care unit. This paper assessed medical doctors and nurses' perceptions on the implementation of Stochastic Targeted (STAR) glycaemia control protocol pilot trial through survey questions. Medical doctors and nurses at International Islamic University Malaysia Medical Centre (IIUMMC) were given 13 questions to investigate their perceptions of STAR protocol monitoring and patient's outcome. The results survey is important for sustainability of a good blood glucose management and prolonged used of STAR protocol. The results of this survey showed that 50% of the participants found that STAR protocol is easy to be used, 62.5% agreed on its performance with low risk and 87.5% approved that STAR protocol improves patient's outcome. In conclusion, the survey results showed that the staff are favorable towards STAR control to replace the usage of sliding scale protocol for glycaemic control in their ICU.**

*Keywords—glycaemic control, hyperglycaemia, STAR Protocol, survey, model-based protocol*

## I. INTRODUCTION

Critically ill patients in the intensive care unit are commonly diagnosed with hyperglycaemia where patient's blood glucose gets higher than 11.1 mmol/L [1]. Hyperglycaemia is associated with high risk of premorbid diabetes, hypertension and worst mortality [2]. A few controls have been developed to reduce the hyperglycaemia, but resulted in higher hypoglycemia incidences [3]–[5]. Thus, a simple, safe, effective and efficient glycaemic control protocol is needed to reduce hyperglycaemia, hypoglycaemia, morbidity and mortality in critical care patients. A standardized glucose measurements with hourly identified time-varying insulin sensitivity ($S_I$) parameter is necessary for successful control [6] and this is possible with the implementation of a model-based stochastic targeted (STAR) glycaemic protocol control [7].

STAR protocol uses model-based glycaemic control which was tested and structured from basic glucose-insulin model [8] and improvised to ICU model which is the predecessor for clinically validated Intensive Control Insulin-Nutrition-Glucose (ICING) model [9]. The idea behind STAR is different than any other invasive or conventional insulin therapy [4], [10] because STAR protocol uses a stochastic prediction to recommend 1-3 hourly next input of insulin and nutritional regimes that correlates with patients output (safety, protocol risk, reduce hyper and hypo glycaemia) from 5% to 95% model prediction variations [11]. Through $S_I$-based protocol, management of hyper and hypoglycaemia incidences can be improved, and cost can be reduced [12].

STAR glycaemic protocol control is implemented in a tablet PC to provide user-friendly interface to give automated variation of selection for insulin and nutrition administration. This protocol sets default maximum risk of 5% in mild hypoglycaemia (BG less than 4.0 mmol/L) and severe hypoglycaemia (BG less than 2.2 mmol/L), but this percentage of risks are flexible following ICU practice. STAR protocol was proven to be effective in virtual simulations setting where interpolated hourly result of glycaemic control management shows that 80% of patient's BG were within normoglycaemia band of 4.4 to 8.0 mmol/L [13].

Analysis on perceptions of a new glycaemic control protocol is important to investigate and assess protocol performance in real clinical setting for a smoother operation in blood glucose management. This assessment provides an early indication if STAR protocol is suitable to be used on Malaysian patients specifically and Asean countries globally. The nutritional and insulin regime for glycaemic control protocol in their hospitals are different if compared to other non-Asian countries where the glycaemic control were developed. In Malaysia, intensive insulin therapy using sliding scale protocol is extensively used in most government hospitals [14]. If an automated model-based glycaemic control like STAR protocol is used, real-time patients outcomes can be improved [15], but it is challenged by the trust of clinical staffs on new protocol, especially fully automated ones.

This paper investigates the perceptions from medical doctors and nurse's involvement on STAR glycaemic control protocol where our first pilot trial was implemented since January 2017 at International Islamic University Malaysia

Medical Centre (IIUMMC) [5]. From the pilot trial, the level of usability for STAR protocol on current critical care practice in the ICU can be determined to improve its compliance.

## II. METHOD

STAR control protocol pilot trial is currently being carried out at IIUMMC as a collaborative research from International Islamic University Malaysia (IIUM) and Universiti Tenaga Nasional (UNITEN) with Universiti Malaysia Pahang (UMP), Universiti Sains Malaysia (USM) and University of Canterbury (UC). STAR protocol is used in the form of a tablet to help the nurses' record patient data faster and receive recommendation according to per-patient conditions. Current practice of STAR developed in Christchurch New Zealand required insulin bolus, but in Malaysia critical care practice, insulin infusion is commonly used with sliding-scale insulin control. One of STAR advantage is its adaptability towards insulin infusion therapy where it gives early predictions on blood glucose reading for the next hour and give various recommendations of insulin and nutrition administrations. There were 3 tablets available at the intensive care units. Patients were asked for consent under IIUM ethics prior to their STAR protocol glycaemic control management.

The STAR protocol was launched in Malaysia on January 2017 and selected staff received the first and only official training on December 2016. To put into context, IIUMC is a newly operated hospital with relatively small number of patients and staff. The survey was conducted from 4th July 2017 till 15th August 2017 and received 8 participants. This survey was generated using Google form.

The survey consisted of participants' background and 13 questions of STAR protocol. For background surveys, questions included; age, gender, user role in the ICU, users' scope of practice, number of experience in clinical job and lastly number of years in the ICU service. For the usage part of questions, participants were asked mainly on their perceptions based on STAR protocol application on real patients. Overall, the survey questions for STAR protocol asked for participant familiarization while using the tablet on real-time clinical trial. The first question asked was on their STAR training experiences followed by the used of STAR protocol tablet. Then the survey question asked on how easy the STAR protocol to be used followed by the advantages of the technology that participant experienced on the patients. Lastly, the users were asked for their monitoring experiences on patient's safety and observed outcome from STAR protocol.

The pilot trial using a model-based glycaemic control protocol was under clinically trial approved ethics from IIUM and National Institute of Health Malaysia [16]. For standard operation procedure (SOP), daily ICU chart was still used to keep tracked on patient's records.

## III. RESULTS

### A. Participants Background

Table 1 shows the participants demographic where 50% of the participants were between 20 to 30 years old. Female nurse and medical doctors were dominating with 75%. Half

of the participants were medical officer (MO), 3 were medical specialist and 1 was a nurse. There were four different subgroups scope of practice which includes 25% in Anesthesiology, 37.5% in ICU & Medical, 12.5% in Clinical and 25% in Nursing. As for the number of years in clinical job and number of years in the ICU, there were 3 groups categorized by 0 to 10 years, 11 to 20 years and more than 20 years. Exactly 62.5% of participants have been working in clinical and in the ICU for 0 to 10 years. There were 25% and 12.5 % of participants who have been working in clinical job from 11 to 20 years and more than 20 years respectively.

TABLE I.     BACKGROUND OF SURVEY PARTICIPANTS

| Category | Groups | | | |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| **Age (years old)**<br>Group 1 - 20-30<br>Group 2 - 30-40<br>Group 3 - 40-50 | 3 | 4 | 1 | - |
| **Gender**<br>Group 1 - Female<br>Group 2 - Male | 6 | 2 | - | - |
| **Role in the ICU**<br>Group 1 - Medical Officer<br>Group 2 - Intensivist<br>Group 3 - Nurses | 4 | 3 | 1 | - |
| **Scope of Practice**<br>Group 1 - Anesthesiology<br>Group 2 - ICU & Medical<br>Group 3 - Clinical<br>Group 4 - Nursing | 2 | 3 | 1 | 2 |
| **Num. of years in clinical job (years)**<br>Group 1 - 1-10<br>Group 2 - 11-20<br>Group 3 - > 20 | 5 | 2 | 1 | - |
| **Num. of years in the ICU (years)**<br>Group 1 - 0-10<br>Group 2 - 11-20<br>Group 3 - >20 | 5 | 3 | 0 | - |

### B. Usage Perceptions

Table 2 shows the 8 questions with selective answers and the associated results. Questions number 1, 3 and 7 required the participants to choose between yes or no. Meanwhile, questions number 2, 4, 5, 9, and 12 provided 5 different selective answers, based on Likert scale. For question number 6, 8, 10, 11 and 13, the questions are subjective which require explanations and participants opinions. It covers participants' perceptions for STAR room of improvements.

Since STAR protocol was new and implemented in a tablet, nurse and doctors were supposed to be trained first to optimize its usability. However, 6 out of 8 participants have never received the STAR training, nevertheless they responded positively with comments such as able to learn quickly from the medical doctors and specialist in-charged of STAR insulin therapy. 75% of them have been using STAR tablet and used it on real patients. 62.5% users agreed STAR protocol was easy to use. The usage of STAR protocol implemented will lessen nurse and doctor's burden where 50% users agreed with automated model-based glycaemic control protocol, their workload were reduced. This protocol also improved patient outcome and 87.5% of the protocol users agreed that STAR protocol was effective

and efficient in improving patient's outcome. The stated patient's outcome includes patient's safety (reducing hyperglycaemia and hypoglycaemia), reduced nurse and doctor's workload, time saving and most importantly improved patient monitoring. Lastly, results from survey question number 12 showed 75% users agreed that STAR protocol have lowered the risk in hypoglycaemia incidents or any other worst outcomes.

TABLE II.    SURVEY RESULTS BY QUESTIONS

| Question No (1,3,7) | Answer | | | | |
|---|---|---|---|---|---|
| | Yes | | No | | |
| 1.  Have you received STAR Training? | 2 | | 6 | | |
| 3.  Have you been using the STAR tablet? | 6 | | 2 | | |
| 7.  Have you ever used the tablet on real patients? | 6 | | 2 | | |
| **Question No (2, 4, 5, 9, 12)** | **1** | **2** | **3** | **4** | **5** |
| 2.  If yes, how would you rate the training provided (1-Very good, 2-Good, 3-Bad, 4-poor) | - | 2 | - | - | - |
| 4.  Is STAR Tablet easy to use? (1-Very easy, 2- Somewhat easy, 3- Not too easy, 4- Hard, 5- Not applicable for me) | 1 | 4 | 1 | - | 1 |
| 5.  How well do you agree of the advantages in using the technology? (1- Strongly agree, 2-Agree, 3-Neutral, 4- Disagree, 5- Not applicable to me) | 1 | 3 | 4 | - | - |
| 9.  How well do you agree that STAR improves patient's outcome? (1- Very good, 2- Good, 3-poor, 4- No experience yet) | - | 7 | - | 1 | - |
| 12. How would you rate the risk associated in terms of patients outcome when we use the STAR protocol? Please elaborate (1- No risk, 2- Small risk, 3-Neautral, 4- Risky, 5- Very risky) | 1 | 5 | 2 | - | - |

Figure 1 displays the results in a graph of number of participants versus the answers for each question. Answers range positively to negatively in the ascending order. From the graph, it is clear that the glycaemic control protocol was perceived positively, from easy to be used, effective and efficient in improving patient's outcomes, and most importantly, comes with low or no risk.

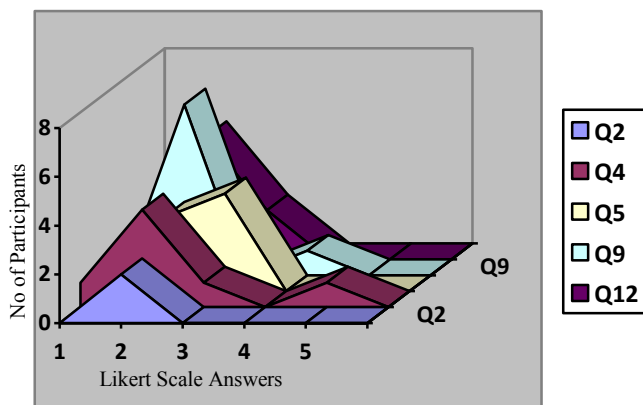**Number of Participants Versus Likert Scale Answers**



Fig. 1. No of participants versus the answers to questions no 2, 4, 5, 9 and 12 answers.

Question number 6 discussed suggestions for improvements on the tablet based on training received by the participants. 37.5% of the participants responded more training was needed if new incoming staff to use the STAR protocol. 12.5% specifically suggested for a tutorial inside the STAR application tablet. Meanwhile, 12.5% have concerned on insulin regime given to the patient and 12.5% have not used the tablet yet. Question number 8 was correlated to question number 7 where the question asked the participants whether they have used the tablet on real patient or not and if the answer was yes or no, provide an explanation. 62.5% of the participants said yes and they did used STAR tablet protocol while managing patients in the ICU. Another participant responded that he/she used STAR tablet depending only on the medical doctor instruction followed by the patient's conditions.

Question number 10 was correlated to question number 9 where participants stated the benefit of STAR protocol. 87.5% of participants agreed that STAR protocol enable to avoid hypoglycaemia and hyperglycaemia, improved monitoring and outcome, better insulin proposition, time saving, and act as alarm system to avoid delay BG checking which also trigger nurse critical thinking when a few options were given to run the insulin and check the next BG reading. For question number 11, participants were asked to state if they encountered any problem while using STAR tablet. One participant pointed out that STAR tablet order sometimes did not correlate to sugar level and another participant experienced system crashed. Lastly, the tablet did not save the options selected which made the patients hypoglycaemic. It is arguable that the two faulty experiences may came from the tablet or the STAR system itself as every system needed constant updates. It is independent on the training to use it.

Lastly, question number 13 asked the participants on what they perceived as a problem in current sliding scale protocol that can be improved with further STAR research. One participant suggested if capillary BG measurements can be replaced with arterial blood's for patient's comfort, especially those who have trouble sleeping. Sliding scale also perceived to consume time and does not take insulin sensitivity into account. This is supported by another suggestion if $S_I$-based STAR can be used based on Asian population validation. Finally, a feedback stated that there are rooms for improvement in sliding scale approach to get better glucose control and prevent hypoglycemia. This last feedback hinted that he/she was somehow satisfied with STAR performance.

IV.  DISCUSSION

The STAR protocol survey was conducted on users where majority were medical doctors with more than 5 years of experiences. From the survey questions, doctors and nurse's perceptions on STAR protocol includes efficiency, safety, feasibility, complexity, and patient's outcomes. Table 2 shows that STAR is positively acceptable and easy to be used which was agreed by 50% of the users. This is important as nurses' perception are skewed towards the intensivists and medical doctor opinions.

Since STAR implementation is still new, there are prone to problems despite countless simulation assessment prior to

the launch of STAR protocol. To counter, the early stage of pilot trial problems, STAR required improvement for troubleshooting with less tight BG range target and the nutritional or feeding type input because nutrition type given are different in every critical care setting. Question 11 collected the problems encountered where STAR tablet did not correlate to current sugar reading level. However, STAR gave an instruction after selection of insulin and nutrition was done, STAR protocol will correlate to the nurse's selection. In this case, the faults arise and sometimes the system may crash mainly because the tablet system problem not due to STAR protocol.

Extensive studies and various simulation trials were done before pilot trial of STAR protocol is inaugurated in Malaysia with BG target of 4.4.to 8.0 mmol/L. However, there were hypoglycemia cases upon using this target range, and through collaborative discussions with medical doctors in-charged, IIUMMC BG target was changed to 6.0 to 10.0 mmol/L. Criteria behind the decisions were difference in insulin regime, critical care setting environment, inter and intra patients variability and feeding intake [13], [16]. This survey was filled  around July to August 2017 where there were less than 10 person in-charged with the STAR tablet, and after we have settled down with our second phase of clinical trial at IIUM Medical Centre which followed Malaysian Society of Intensive Care [17] current BG target of 6.0 to 10.0 mmol/L. From the survey results showed, STAR protocol is safe to be used. Even though this protocol did have low hypoglycemia incidence, BG measurement was still in controlled and below maximum risk of 5% [18].

In addition, few feedbacks and answers from question number 6 showed, STAR training needs to be provided from time to time to equip staff with its optimized functions. STAR training was executed before the protocol implementation, and the next training are continued within the nurse's staff which were done after the protocol launched. However, for future reference, more training will be done if new procedures are required for STAR protocol.

From question number 9 in Table 2 shows, STAR protocol has few benefits in patient's outcome and monitoring which is agreed 87.5% by surveys participants. In conclusion, the user's adaptability and perceptions on STAR protocol is good to an extent which is feasible in patient's monitoring blood glucose management for hyperglycaemia patients in the ICU. STAR protocol is efficient, effective and safe for glycaemic control.

## V.  CONCLUSION

In conclusion, from this survey, practitioner's perceptions on STAR glycaemic control protocol is rather efficient, feasible, and improves patient's outcome. Few patients have hypoglycemia but patient safety was below maximum risk of 5% for hypoglycaemia episodes. The current number of participants are limited but the results showed that STAR protocol are promising and sustainable to be used in Malaysian critical care setting.

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