Glycaemic control in a cardiothoracic surgical population: Exploring the protocol-practice gap

D Maharaj,[1] MB BCh, DA, MMed (Anaesth), FCA; **H Perrie**,[1] MSc; **J Scribante**,[1] MCur; **F Paruk**,[2] MB ChB, FCOG, Cert Crit Care, MD

[1] *Department of Anaesthesiology, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa*
[2] *Department of Critical Care, Faculty of Health Sciences, University of Pretoria, South Africa*

Corresponding author: *D Maharaj (maharajdyuti@gmail.com)*

Background. Glycaemic control constitutes an important component in the management of critically ill patients. As such, all healthcare workers involved in the management of critically ill patients need to ensure that it is achieved adequately. To avoid glucose variability and to maintain normoglycaemia, evidence-based protocols are implemented to guide clinical care. However, it has been suggested that with the use of protocol-directed therapy, protocol-practice gaps are common and therefore protocol adherence must be audited regularly. The aim of this study was to evaluate adherence to the glucose control protocol by nurses in the cardiothoracic intensive care unit (ICU) at a tertiary academic hospital.

Methods. A retrospective study involving the review of ICU charts of all post-cardiac surgery patients ≥16 years admitted to the cardiothoracic ICU during March 2011. A convenience sampling method was used.

Results. A total of 741 glucose readings for 22 patients were evaluated. The median (interquartile range) glucose reading was 7.8 mmol/L (6.7 - 9.3 mmol/L). Overall, 411 (55.5%) protocol violations were recorded and 629 (84.9%) of the total readings were abnormal. Protocol violations were similar between the day and night staff; 188 (54.7%) and 223 (58.5%) were recorded, respectively (p=0.256). Of the readings, 464 (62.6%) were conducted by ICU-trained nurses and 245 (33.2%) by non-ICU-trained nurses. There were fewer protocol violations recorded by the ICU-trained nurses compared with the non-ICU-trained nurses, i.e. 53.3% and 63.7%, respectively (p<0.05).

Conclusion. Adherence to the glucose-control protocol was suboptimal. These results may suggest that the training and education of healthcare workers in implementing protocols is an ongoing and dynamic process, and that there is a need for the regular evaluation of protocol adherence in order to identify protocol-practice gaps.

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Landmark studies conducted within the last two decades have been instrumental in informing the critical care discipline regarding the importance of glycaemic control.[1-4] While it is evident that optimal glucose targets remain undetermined, it is clear that specific patient populations do require meticulous glycaemic control. The cardiothoracic population is a classic example where perioperative hyperglycaemia has been clearly demonstrated to be associated with an increase in both morbidity and mortality.[5,6] As such, cardiothoracic units emphasise the importance of postoperative glycaemic control and, in particular, the avoidance of a glucose level >10 mmol/L.

In the intensive care unit (ICU) setting, adherence to protocols is often suboptimal. This has been borne out in numerous studies assessing adherence to nutrition and sedation protocols.[7] The use of protocols simplifies processes, standardises care, facilitates patient safety, and reduces costs. The lack of adherence can hinder the success of any protocol.[8]

In the resource-constrained South African context, adherence to protocols may also be influenced by the shortages of ICU-trained nurses, as well as the high workload burden. Taking these factors into account, and considering the importance of adherence to glucose control protocols – its impact on morbidity and mortality – as well as the recognised occurrence of protocol-practice gaps, we undertook a study to evaluate the adherence to the glucose control protocol in a cardiothoracic ICU setting.

Methods

A retrospective, contextual, single-centre, descriptive design was used in this study. The study was conducted in the cardiothoracic ICU of a quaternary, academic hospital. At the time of the study, an average of 21 cardiac operations were performed monthly (>16-year age group) and the nurse-to-patient ratio was 1:1 in the ICU. Nurses allocated to patient care were from all nursing categories, including agency nurses – enrolled, registered, and registered critical care nurses. A consecutive, convenience sampling method was used. The ICU charts of all post-cardiac surgery patients who were ≥16 years old and who had been admitted to the ICU during March 2011, as well as the demographics of the nurses working in the ICU at the time, were analysed. At the time of the study, the glucose control protocol defined a target blood glucose range of 4.1 - 6 mmol/L (Table 1). The exclusion criteria were children <16 years old, and post-thoracic surgery patients. Therefore, 14 patients were excluded from the study: 12 paediatric cardiac, and 2 thoracic patients. Approval to conduct this study was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (ref. no. M120109) and other relevant authorities.

The data collection procedure involved the utilisation of two data collection sheets; one for the collection of data from the ICU charts, and another to capture the demographics of the nurses assigned to patient care during the research period. Both the ICU charts and nurses received study numbers, and no identifiable information was recorded.

The ICU unit manager allocated study numbers to the nurse and therefore the authors were blinded to the nurses' identification. Only the authors had access to the raw data. Anonymity, confidentiality, and privacy of patients and nurses were therefore maintained.

Data were manually entered into a Microsoft Excel 2010 spreadsheet, and subsequently analysed STATA 11 (STATA Corp., USA). The results of the study were analysed using descriptive and inferential statistics. Comparisons were made using the χ^2 test and p-values <0.05 were considered statistically significant. Missing data were included in the analysis and were recorded as 'unknown'.

Results

During the data collection period, 22 patients were admitted, of whom 13 (59.1%) were male and 9 (40.9%) were female. The mean age of patients was 48.5 years and the age range was 17 - 76 years. The median (interquartile range (IQR)) length of stay in ICU was 4 (3 - 5) days, with 2 patients staying in the ICU for >20 days. The surgical procedures performed included 17 (77.3%) valvular procedures, 3 (13.6%) coronary artery grafts, and 2 (9.1%) 'other' procedures. The median (IQR) blood glucose concentration was 7.8 (6.7 - 9.3) mmol/L (Fig. 1). The glucose readings ranged from 3.1 to 17.8 mmol/L. Table 2 shows the number of glucose readings obtained within the different glucose ranges. According to the glucose control protocol in place at the time of the study, 629 (84.9%) of the readings were abnormal, i.e. outside the required glucose range. The target range of 4.1 – 6.0 mmol/L was only observed in 112 (15.1%) of the glucose readings.

Hypoglycaemia, defined at the time of the study as a glucose value of <4.0 mmol/L, was observed in 7 (0.9%) readings. Interestingly, had the results been analysed using the currently employed glucose control protocol, 279 (37.7%) readings would have been within the target range, which is presently defined as 6.1 - 8.0 mmol/L.

During the study period, a total of 741 glucose readings were recorded, of which 411 (55.5%) readings were in violation of the glucose control protocol.

Eighteen (2.4%) readings were never recorded. Fig. 2, which does not include the unknown readings, shows the number of glucose readings obtained for each patient and the proportion of protocol violations per patient. Unknown values are not shown on this figure.

Among the 411 protocol violations, the daytime nursing staff violated the protocol 188 (54.7%) times, and the night-time nursing staff violated the protocol 223 (58.8%) times ($\chi^{22}(1)=1.29$; $p=0.26$) (Table 3). There were 16 (2.1%) unknown values for this variable.

The ICU-trained nursing staff recorded 464 (62.6%) readings, while the non-ICU-trained nursing staffed recorded 246 (33.2%) readings. ICU-trained nursing staff violated the protocol 247 (53.4%) times and the non-ICU-trained staff violated the protocol for 156 (63.7%) glucose

Table 1. Glucose control protocol in ICU

Blood glucose (mmol/L)	Rapidly acting insulin (U)
<4	Nil. Treat as hypoglycaemia: 1. Call medical doctor 2. Administer 25 mL of DW50% 3. Recheck BG every 15 min until >5 mmol/L 4. Thereafter recheck BG hourly
4.1 - 6.0	0
6.1 - 8.0	1
8.1 - 10.0	2
10.1 - 12.0	4
12.1 - 14.0	6
14.1 - 16.0	8
16.1 - 18.0	10
18.1 - 20.0	12
>20	12 (Call medical doctor)

ICU = intensive care unit; U = unit(s); DW50% = 50% dextrose water; BG = blood glucose.

Table 2. Glucose results by category (N=741)

Glucose category (mmol/L)	Number of glucose readings, n (%)	Normal range
<4	7 (0.9)	No
4.1 - 6.0	112 (15.1)	Yes
6.1 - 8.0	279 (37.7)	No
8.1 - 12.0	300 (40.5)	No
12.1 - 14.0	26 (3.5)	No
14.1 - 16.0	6 (0.8)	No
16.1 - 18	11 (1.5)	No
>18	0 (0)	No

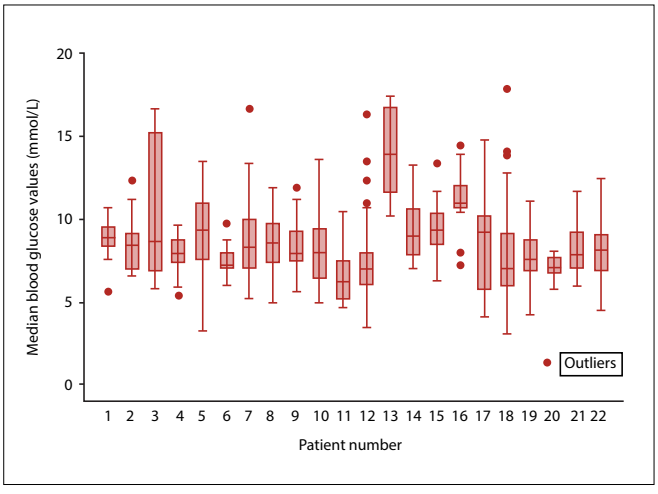

Fig. 1. Median (interquartile range) glucose value per patient.

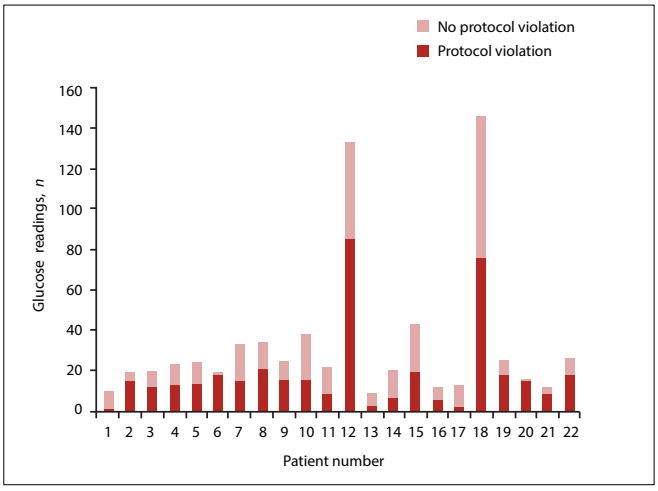

Fig. 2. Protocol violations with respect to number of glucose readings per patient.

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Table 3. Association between nurse shift and ICU training in protocol violations

Variable	Glucose readings, *n* (%)	No protocol violations, *n* (%)	Protocol violations, *n* (%)	*p*-value
Nurse shift				
Day	345 (46.6)	156 (45.4)	188 (54.7)	0.26
Night	380 (51.2)	156 (41.2)	223 (58.5)	
ICU-trained	464 (62.6)	216 (46.7)	247 (53.3)	0.008
Non-ICU-trained	245 (33.2)	89 (36.3)	156 (63.7)	

readings ($\chi^2(1)=6.97$; $p=0.008$) (Table 3). There were 31 (4.2%) unknown values for this variable.

Discussion

In this study, there were 411 (55.5%) protocol violations. This value is higher than that reported by Taylor *et al.*[9] and Rood *et al.*,[10] who reported glucose protocol violations of 47% and 44%, respectively. A study by Oeyen *et al.*,[11] as well as the NICE-SUGAR trial[13] reported a much lower protocol violation rate of 29%. Possible reasons for the lower proportion of violations are that, compared with our setting, these were large-centre trials conducted in developed countries that had adequate resources. It has also been shown that patients enrolled in prospective research studies receive a higher standard of care, which may influence protocol adherence. Shift work, and in particular working night shifts, is recognised as a source of distress for nurses.[12] In a study of 23 Australian nurses, getting less sleep was significantly related to an increased likelihood of nursing error and a decreased likelihood of identifying colleagues' errors.[13] However, in this study, there was no statistically significant difference between day and night staff violations ($p=0.26$).

According to the South African National Audit of Critical Care Resources in 2007, there is a national shortage of critical care nurses.[14] As a result, there is a risk of increased workload and burnout.[15] Furthermore, with staff shortages and the implementation of many protocols in ICUs, critical care nurses are under constant pressure to deliver safe and effective care to critically ill patients, as well as to impart their skills and knowledge to non-ICU-trained nurses. It is important to note that, although there was a nurse patient ratio of 1:1 during the study period, these nurses were from all nursing categories, including agency staff — enrolled nurses, registered nurses, and registered critical care nurses are allocated to patients. In this study, we also compared protocol violations between ICU-trained and non-ICU-trained nurses and, after reviewing the literature, were not surprised to find that there were more protocol violations by the non-ICU-trained nurses ($p=0.008$) included in our study.

For a protocol to be efficiently developed and implemented, its feasibility should be tailored according to resource availability within the specific setting. All healthcare workers involved in patient care need to work together in order to facilitate this process.

Protocol violation may, or may not, compromise patient care. According to Wong *et al.*,[16] 'one of the cardinal concepts (borrowed from industry), in patient safety, is systems analysis. This is the concept that system failure, not individual human failure, is to blame for many of the adverse events occurring in healthcare. The problem is not "bad people"; the problem is that the system needs to be made safer ... To err is human.'

Cabana *et al.*[17] assessed the knowledge, attitude, and behaviour of physicians, and identified barriers to adherence to practice guidelines. In their model, barriers to knowledge included lack of awareness and familiarity with guidelines. Barriers to attitude included lack of agreement with guidelines, lack of self-efficacy, lack of outcome expectancy, lack of motivation, and resistance to changing previous practice. The behaviour attributes included external barriers with factors related to patients (e.g. patient expectation), the practice environment (e.g. lack of time and resources) and the guidelines themselves (e.g. conflicting recommendations).

One of the most consistent findings in research on health services is the gap between evidence and practice.[17] Evidence-based protocols and guidelines are utilised to assist not only with patient clinical management and to reduce the guess-work from patient care, but also to reduce the workload on nursing staff as a short-term solution to skilled staff shortages.[17] The finding of a substantial proportion of protocol violations in the ICU highlights the necessity of further education and ongoing assessments of implemented protocols by all healthcare workers involved in patient care. Education of healthcare workers and follow-up questionnaires on the understanding and implementation of local protocols should also be considered.

Evaluation and identification of the factors responsible for protocol violations, and the subsequent targeting of the identified factors, are imperative to improve adherence to any protocol. As proposed by Cabana *et al.*[17] the knowledge, attitudes and behaviour of healthcare workers should also be evaluated when implementing a protocol. Furthermore, a systems analysis approach should be considered for implementation of future protocols.[15]

Despite emphasis on the need for protocol-driven ICUs to reduce the work burden, standardise care, and avoid delay in treatment to allow for better communication and improved outcomes, it remains unknown whether the protocols and protocol adherence translate into improved clinical outcomes.

According to Kollef,[18] who conducted numerous studies on the potential of protocols to improve outcomes in ICUs, although the overall quality of evidence supporting the efficacy of protocols may be less than ideal, the reported success following their implementation supports the use of this tool in critically ill patients. Complex critical illnesses, such as sepsis, require multiple therapies and interventions to optimise clinical outcomes, and protocols appear to deliver recommended therapies and possibly improve patient outcomes. A large number of studies involving computerised and closed-loop protocol implementation showed improved adherence to the protocol. This should guide future research into protocol implementation.[9]

The results of this study must be interpreted with caution. The study was conducted contextually – in an academic institute in a cardiothoracic ICU with the study population being cardiac patients – and our results may not be extrapolated to the general population.

A retrospective research design, although it can offer valuable results, has limitations: the study design does not allow for the determination of causation, only association, and the quality of the data cannot be controlled by the researcher.

Conclusion

This study explored the protocol-practice gap in a single ICU and found that, as has been observed elsewhere, adherence to protocols was poor. Further studies should be designed to explore the reasons for the gap in adherence and non-compliance. An understanding of the underlying reasons would allow for the implementation of strategies to reduce the gap in practice. The training and education of healthcare workers in implementing protocols is an ongoing and dynamic process, and regular evaluation is essential in identifying the protocol-practice gap.

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