Attitudes, Knowledge, and Practices Regarding Blood Glucose Control: A Survey of Intensive Care Unit Professionals

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Dysglycemia is a common and independent risk factor for poor prognosis in critically ill patients.[1] Little research on blood glucose (BG) management has been done in Intensive Care Units (ICUs) in China. Understanding current practice patterns, as well as concerns and beliefs surrounding BG control in critically ill patients, is essential for further research on this issue and future medical education in intensive care physicians. Therefore, we designed and conducted this survey of intensive care physicians' attitudes, knowledge, and practices concerning the treatment and prevention of dysglycemia, including hyperglycemia, hypoglycemia, and/or marked BG variability.

This survey was conducted with the approval of the Institutional Review Board of the Affiliated Hospital of Guizhou Medical University, China. The questionnaire was developed based on clinical practices and related articles[2,3] and was validated by a panel of intensivists. The first questionnaire survey was conducted between May 2013 and January 2014 in Guizhou Province and Hangzhou city, Zhejiang Province. The second questionnaire survey was conducted in October 2016 in five different districts (Zhejiang Province, Guizhou Province, Hainan Province, Fujian Province, and Chongqing city). The surveys were distributed to ICU practitioners by field handout, regular mail, or email. We informed the physicians by telephone or WeChat and obtained their consent before the questionnaires were sent via mail or email. We collected the questionnaires 3–4 weeks later.

The results of the questionnaire surveys were summarized and reported using frequency analysis (shown as frequency and percentage). In cases of categorical variables, data were expressed in numbers and percentages, and differences were tested using Fisher's exact test. A two-tailed $P < 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS 20.0 for Windows (IBM SPSS Statistics version 20, USA).

A total of 192 physicians from 57 ICUs (57 hospitals) and 37 physicians from 13 ICUs (12 hospitals) responded to the first and the second questionnaires, respectively. In the first survey, 14 (25%), 7 (12%), 35 (61%), and 1 (2%) were upper first-class hospitals, middle first-class hospitals, upper second-class hospitals, and a middle second-class hospital, respectively. Overall, 50/57 (88%) mixed ICUs participated in the first survey, and 10/13 (77%) mixed ICUs participated in the second survey; 9/55 (16%), and 73/123 (59%) of the respondents had worked in the ICU for 5 years or more in Guizhou Province and Hangzhou city, respectively ($P < 0.001$). Details of the study demographics are presented in Supplementary Table 1.

In the first survey, 46, 53, and 36 of 189 respondents started to use insulin when BG levels exceeded 11.1 mmol/L, 12.0–15.0 mmol/L, and 15.0 mmol/L in nondiabetic patients, respectively; 135/190 (71%) usually chose continuous intravenous infusion of insulin and 72/190 (38%) usually chose subcutaneous administration of insulin to treat hyperglycemia. Only 11/190 (6%) respondents used tight BG targets as with intensive insulin therapy (4.4–6.1 mmol/L), 109/190 (57%) respondents used more liberal targets of 8.0–10.0 mmol/L, and 43/190 (23%) respondents did not use any strict glucose control strategy. Furthermore, 25,

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52, 94, and 19 of 191 respondents defined hypoglycemia as BG levels at 4.4 mmol/L, 3.9 mmol/L, 2.8 mmol/L, and 2.2 mmol/L, respectively; 101/188 (54%) respondents routinely infused 40 ml 50% glucose solution to treat hypoglycemia, and 138/179 (77%) respondents detected BG levels 15 min or longer after glucose infusion. The results of hyperglycemia and hypoglycemia treatment in the second survey are shown in Supplementary Table 2.

The first survey showed that 97/192 (51%) intensive care physicians did not use glucose solution for fluid resuscitation; only 142/188 (76%) respondents paid much attention to suppressing the BG variability; 104/192 (54%) respondents routinely detected BG levels every 4 h in critically ill patients; 159/189 (84%) respondents mixed glucose insulin according to 4−6 g glucose per 1 unit insulin when infusing glucose solution; and 53/190 (28%) respondents determined the dose of regular insulin for treating hyperglycemia based on their experiences. The related results of the second survey were found in Supplementary Table 3.

To the best of our knowledge, this was the first study to describe attitudes, knowledge, and practices regarding BG control in ICUs in China. We found that the methods of infusing glucose and treating hyperglycemia are still controversial, although guidelines for the management of dysglycemia in critically ill patients were published in 2012.[2]

These surveys highlight the gap between what intensive care physicians perceive and what is found in the articles. The definitions of hyperglycemia and hypoglycemia and the ranges of glucose targets vary widely. The results of the surveys showed that most practitioners routinely started to use insulin when BG exceeded 11.1 mmol/L or even higher; however, the guidelines suggest that BG ≥8.3 mmol/L triggers the initiation of insulin therapy for most critically ill patients.[2] In addition, more than half of the respondents defined hypoglycemia as a BG level of <3.0 mmol/L, although BG ≤3.9 mmol/L was associated with increased hospital mortality in critically ill patients.[4] Most of the respondents generally administered 40 ml 50% dextrose to treat hypoglycemia; however, few respondents remeasured BG levels in 15 min, therefore the risk of iatrogenic hyperglycemia may increase.[2]

BG variability is associated with mortality in critically ill patients.[1] This study also showed that 142/188 (76%) and 34/37 (92%) of respondents paid attention to suppressing the BG variability in the first survey and the second survey, respectively. However, in the majority of ICUs and respondents, the timing of BG measurement was unclear, and the BG values were often measured according to a fixed interval (that is, every 4 h). The guidelines suggest that BG should be monitored every 1−2 h for most patients receiving insulin infusion.[2] In addition, <10% of the respondents used insulin according to local strategies in our survey, which may reflect the fact that most ICUs did not develop local strategies for BG management.

The present study has some limitations. The first survey was conducted more than 3 years ago; however, the second survey was conducted in 2016 and showed that most results were similar to those in the first survey. Another limitation was that the sample was small and most respondents worked in Guizhou Province and Hangzhou city, Zhejiang Province. The study may not represent national intensivists' attitudes and practice patterns regarding BG control. A large-scale national survey is needed.

In summary, more education is needed for BG control in intensive care physicians. Furthermore, persistent variation in practice also suggests a need for more clinical trials of BG control in critically ill patients.

Supplementary information is linked to the online version of the paper on the Chinese Medical Journal website.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Description of participating hospitals (ICUs) and survey respondents

Items	First survey			Second survey
	Guizhou	Hangzhou	Total	
Respondents, *n/N*	67/83	125/150	192/233	37/53
Respond rate (%)	81	83	82	70
Hospitals, *n*	36	21	57	12
Rank of hospital, *n* (%)				
Upper first-class	8 (22)	6 (29)	14 (25)	10 (83)
Middle first-class	1 (3)	6 (29)	7 (12)	0 (0)
Upper second-class	27 (75)	8 (38)	35 (61)	2 (17)
Middle second-class	0 (0)	1 (5)	1 (2)	0 (0)
ICUs, *n* (%)				
Mixed ICUs	31 (86)	19 (90)	50 (88)	10 (77)
Medical ICUs	5 (14)	1 (5)	6 (11)	1 (8)
Surgical ICUs	0 (0)	1 (5)	1 (2)	2 (15)
Physicians*, *n* (%)				
Resident physicians	30 (50)	49 (40)	79 (43)	18 (49)
Attending physicians	23 (38)	42 (34)	65 (36)	17 (46)
Deputy chief physicians	6 (10)	26 (21)	32 (18)	1 (3)
Chief physicians	1 (2)	5 (4)	6 (3)	1 (3)
Years of work in ICU*, *n* (%)				
<5	46 (84)	50 (41)	96 (54)	24 (65)
5-10	6 (11)	53 (43)	59 (33)	9 (24)
11-20	3 (5)	19 (15)	22 (12)	3 (8)
≥21	0 (0)	1 (1)	1 (1)	1 (3)

*Not every respondent answered this question. ICUs: Intensive Care Units.

Supplementary Table 2: Hyperglycemia and hypoglycemia management

Items	First survey, *n* (%)			Second survey, *n* (%)
	Guizhou	Hangzhou	Total	
When do you start to use insulin in non-diabetic patients?*				
BGL >6.1 mmol/L	0	2 (2)	2 (1)	0
BGL >8.3 mmol/L	4 (6)	5 (4)	9 (5)	0
BGL >10.0 mmol/L	7 (11)	32 (26)	39 (21)	1 (3)
BGL >11.1 mmol/L	16 (25)	30 (24)	46 (24)	11 (30)
BGL >12.0-15.0 mmol/L	24 (37)	29 (23)	53 (28)	8 (22)
BGL >15.0 mmol/L	12 (18)	24 (19)	36 (19)	15 (41)
BGL > Others	2 (3)	2 (2)	4 (2)	2 (5)
What method do you routinely use to treat hyperglycemia with insulin?*,†				
Subcutaneous injection	26 (39)	46 (37)	72 (38)	12 (32)
Continuous sc pumping	1 (1)	3 (2)	4 (2)	0
Intravenous injection	2 (3)	6 (5)	8 (4)	0
Continuous iv pumping	46 (69)	89 (72)	135 (71)	31 (84)
Other methods	2 (3)	0	2 (1)	0
Do you use tight blood glucose control strategies in critically ill patients?*				
No	18 (27)	25 (20)	43 (23)	3 (8)
Yes, 4.4-6.1 mmol/L	1 (2)	10 (8)	11 (6)	1 (3)
Yes, 8.0-10.0 mmol/L	30 (45)	79 (64)	109 (57)	28 (76)
Yes, other ranges	17 (26)	10 (8)	27 (14)	5 (14)
When do you think hypoglycemia occurs?*				
BGL <2.2 mmol/L	3 (5)	16 (13)	19 (10)	0
BGL <2.8 mmol/L	29 (44)	65 (52)	94 (49)	7 (19)
BGL <3.9 mmol/L	30 (45)	22 (18)	52 (27)	14 (38)
BGL <4.4 mmol/L	4 (6)	21 (17)	25 (13)	8 (22)
BGL <6.1 mmol/L	0	1 (1)	1 (1)	8 (22)
BGL < Others	0	0	0	0
How many 50% glucose solution do you generally use to correct hypoglycemia?*				
60 ml	9 (14)	11 (9)	20 (11)	10 (28)
40 ml	40 (62)	61 (50)	101 (54)	13 (36)
20 ml	12 (18)	17 (14)	29 (15)	6 (17)
Other	4 (6)	34 (28)	38 (20)	7 (19)
How soon do you remeasure BGL after glucose infusion to correct hypoglycemia?*				
<15 min	14 (25)	27 (22)	41 (23)	2 (6)
15-30 min	32 (57)	74 (60)	106 (59)	25 (69)
1 h	10 (18)	22 (18)	32 (18)	9 (25)
Longer than 1 h	0 (0)	0 (0)	0 (0)	0 (0)

The data was presented by *n* (%). *Not every respondent answered this question. †Some respondents chose two or more answers to this question. BGL: Blood glucose level; sc: Subcutaneous; IV: Intravenous.

Supplementary Table 3: Attitudes and practices regarding blood glucose variability

Items	First survey, *n* (%)			Second survey, *n* (%)
	Guizhou	Hangzhou	Total	
Do you use glucose solution for fluid resuscitation?				
No	13 (19)	86 (69)	99 (52)	15 (41)
Yes, routinely	11 (16)	3 (2)	14 (7)	5 (14)
Yes, occasionly	43 (64)	36 (29)	79 (41)	17 (46)
How do you routinely mixed glucose insulin when infusion of glucose solution?*				
<2g:1u	0	0	0	1 (3)
2–3g:1u	1 (2)	4 (3)	5 (3)	1 (3)
4–6g:1u	56 (86)	103 (83)	159 (84)	27 (73)
6–10g:1u	6 (9)	15 (12)	21 (11)	6 (16)
>10g:1u	2 (3)	2 (2)	4 (2)	2 (5)
How long is the regular interval to monitor blood glucose level?*				
6–12 h	5 (7)	24 (19)	29 (15)	3 (8)
4 h	26 (39)	78 (62)	104 (54)	27 (73)
2 h	17 (25)	13 (10)	30 (16)	5 (14)
1 h	6 (9)	7 (6)	13 (7)	2 (5)
Others	13 (19)	3 (2)	16 (8)	0
How do you determine the dose of regular insulin to be given for hyperglycemia?*				
Based on experiences	23 (35)	30 (24)	53 (28)	13 (35)
Guidelines or books	34 (52)	80 (65)	114 (60)	21 (57)
Local strategies	4 (6)	14 (11)	18 (9)	3 (8)
Others	5 (8)	0	5 (3)	0
Do you pay attention to control the blood glucose variability?*				
No	1 (2)	4 (3)	5 (3)	0
Yes, pay a little attention	13 (20)	28 (23)	41 (22)	3 (8)
Yes, pay much attention	51 (78)	91 (74)	142 (76)	34 (92)

*Not every respondent answered this question.