

Peri-operative management of diabetes mellitus - A survey of current practices among Indian anesthesiologists

Vansh Priya, Prateek S. Bais, Amit Rastogi, Rafat Shamim, Anil Aggarwal, Abinash Patro¹

Department of Anaesthesiology, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, ¹Departemnt of Anaesthesia, Nizam Institute of Medical Sciences, Hyderabad, Telangana, India

Abstract

Background and Aims: Increased burden of diabetes in India has resulted in a spurt in the number of patients with diabetes posted for surgeries. The paucity of national guidelines can lead to marked practice variations in the peri-operative management of diabetes. This survey intends to discern current peri-operative practices among anesthesiologists working in medical colleges, tertiary care government, and private health care institutes of the country.

Material and Methods: An anonymous online survey comprising of 25 closed-ended questions was conducted using Google Forms® and disseminated through social media, emails, and messaging platforms. The questionnaire dealt primarily with the peri-operative management of diabetes in patients scheduled for elective surgery. The survey was conducted over a period of 1 month and targeted anesthesia resident trainees with more than 1-year experience, senior residents, and consultants working in India.

Results: Statistically significant difference was observed between the three types of health facilities with respect to prior evaluation for diabetes ($P = 0.007$), prioritizing operative list ($P = 0.006$), hospital encouragement of day care surgery ($P < 0.001$), glycated hemoglobin level (HbA1c) level >8.5 for postponement of surgery ($P < 0.05$), insulin infusion preference ($P < 0.001$), hourly intra-operatively capillary blood glucose (CBG) assessment ($P = 0.021$), and avoiding peri-operative use of Ringer's lactate (RL) ($P = 0.025$).

Conclusion: This survey primarily highlights the lack of prioritizing the operative list, early discontinuation of metformin, and reduced tendency to consider diabetics for day care surgeries.

Keywords: Diabetes mellitus, questionnaire, survey

Introduction

The burden of diabetes has steadily increased over the past quarter-century in India which means an increasing number of patients listed for surgery will have diabetes.^[1]

A clear association between peri-operative hyperglycemia and adverse outcomes exists^[2-4] thereby making it peremptory for all members of the surgical and anesthesia

teams to be accustomed to contemporary management of diabetes.

Despite the availability of a plethora of guidelines, National Confidential Enquiry into Patient Outcome and Death (NCEPOD) in their review of the peri-operative quality of care provided to patients with diabetes over the age of 16, observed a lack of multidisciplinary team approach and joint ownership in peri-operative management of diabetes.

Address for correspondence: Dr. Rafat Shamim, Department of Anaesthesia, SGPGIMS, Rae Bareilly Road, Lucknow, Uttar Pradesh - 226 014, India.
E-mail: shamim.shamim15@gmail.com

Access this article online	
Quick Response Code:	Website: https://journals.lww.com/joacp
	DOI: 10.4103/joacp.joacp_463_21

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Priya V, Bais PS, Rastogi A, Shamim R, Aggarwal A, Patro A. Peri-operative management of diabetes mellitus - A survey of current practices among Indian anesthesiologists. J Anaesthesiol Clin Pharmacol 2023;39:411-21.

Submitted: 05-Nov-2021

Revised: 06-Jan-2022

Accepted: 25-Mar-2022

Published: 29-May-2023

It further remarked that the presence of multiple guidelines targeted at specific specialties has further added to the lack of uniformity in peri-operative management.^[5-10]

Jackson *et al.* conducted a prospective region-wide audit of the peri-operative management of patients with diabetes undergoing elective surgery in the North West of England, over a 2-week period and they concluded that national peri-operative guidelines were not adhered to in a substantial proportion of patients with diabetes undergoing elective surgery.^[10]

In India, a lack of national guidelines can potentially lead to marked variations in practices and may result in suboptimal peri-operative management of patients with diabetes.

This survey intends to discern current practices related to peri-operative management of diabetes among anesthesiologists working in medical colleges, tertiary care government, and private health care institutes of the country.

Material and Methods

Assuming knowledge among anesthesiologists pertaining to peri-operative management of diabetes at 50% and a 10% relative error in the given percentage of knowledge, a minimum two-sided 95% confidence interval, estimated sample size was 385 (Power analysis and sample size version-16, NCSS, LLC, USA).

A survey comprising of 25 closed-ended questions (appendix 1) was conducted as an anonymous online survey using Google Forms® and distributed through social media, email, and messaging platforms. A total of 544 responses were received.

The questionnaire dealt primarily with the peri-operative management of patients with diabetes scheduled for elective surgery. The survey was conducted over a period of 1 month and targeted anesthesia resident trainees with more than 1-year experience, senior residents, and consultants working in India.

After the first draft of the questionnaire was prepared, its content was validated by a panel of five experts. All the items were considered, and the content validity ratio (CVR) was calculated with the direct advice of five panelists. The content was validated through a panel of five experts from anesthesia and biostatistics backgrounds. Each expert was requested to rate the questions (content) on a score of 1 to 5 with a score of 5 being best. A good score was observed for each of the measurements a) simplicity - 88%, b) clarity - 92%, c) free of ambiguity - 88%, and d) relevance - 100%.

Each question had a binary outcome. Cronbach's alpha was used to assess the internal consistency in the

questionnaire. Average consistency was observed between the questionnaires (Cronbach's alpha 0.62).

Confidentiality of responses in this survey was maintained. A prior written informed consent was not taken. Successfully completing the questionnaire was considered as consent for participation in the survey.

Statistical analysis: Categorical variables are presented in frequency (%) and compared between three types of institutions by Pearson's Chi-square test. *P* value < 0.05 was considered as statistically significant. Adjacent and cumulative bar diagrams are used to present the finding among three types of health care facilities. Statistical analyses were performed using Statistical Package for Social Sciences, version 23.0 (SPSS Inc., Chicago, IL, USA).

Results

In this survey, a total of 544 anesthesiologists (study participants) responded. Twenty-two respondents did not respond to all the questions and were excluded from the study. Table 1 depicts the state-wise distribution of respondents. The distribution of 522 respondents with respect to their place of work and qualification is as shown in Figure 1. Majority of respondents are <35 years of age ($n = 344, 65.9%$) and are working in medical colleges ($n = 249, 47.7%$) and have Doctor of Medicine (MD) as the highest educational qualification ($n = 299, 57.3%$).

Responses to the questionnaire have been subdivided according to the place of work of respondents [Tables 2-4].

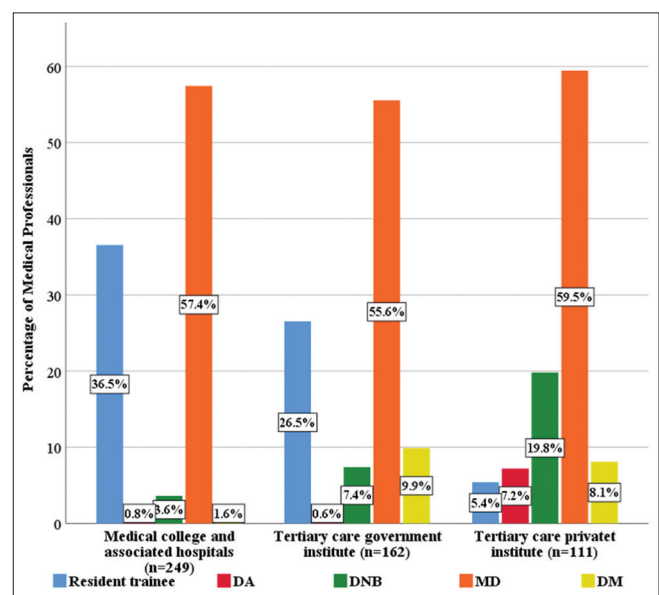


Figure 1: Distribution of respondents with respect to their place of work and qualification

Table 1: State-wise distribution of respondents (n=522)

State	Total
Uttar Pradesh	192
New Delhi	57
Uttarakhand	35
Tamil Nadu	22
Telangana	21
Gujarat	17
Karnataka	17
Maharashtra	17
Bihar	15
Himachal Pradesh	15
West Bengal	15
Kerala	13
Haryana	12
Puducherry	11
Rajasthan	11
Chattisgarh	8
Odisha	8
Assam	7
Punjab	6
Andhra Pradesh	5
Jammu and Kashmir	5
Jharkhand	5
Manipur	5
Goa	4
Madhya Pradesh	4
Chandigarh	3
Tripura	2

A total of 342/522 (65.5%) study participants had a protocol for peri-operative management of diabetes in their department. A substantial number of the study participants (56.9%, $n = 297$) affirmed that diabetic patients presenting for pre-anesthetic evaluation had a prior diabetes evaluation; however, patients in tertiary care private institutes are an exception (45%, $n = 50$). Majority of respondents (88.5%, $n = 462$) advice glycated hemoglobin level (HbA1c) for pre-anesthetic evaluation and postpone elective case when HbA1c >8.5 for further optimization of glycemic control ($n = 308$, 59%). The overwhelming majority of respondents (91.2%, $n = 476$) requested the operating surgeon to schedule patients with diabetes as the first case of the day but only half felt that surgery colleagues prioritize the operative list accordingly (49.4%, $n = 258$). The majority of participants agreed that the pre-operative period of fasting of diabetic patients is usually between 6 and 8 h (87.9%, $n = 458$).

Respondents were observed to be almost equally divided in their choice of intravenous (IV) insulin infusion {variable rate intravenous insulin infusion (VRIII) (56.4%) versus glucose-insulin-potassium (GIK) (46.4%)}. However,

respondents from tertiary care private institutes preferred VRIII (71.2%; $n = 79$) while those from medical colleges preferred GIK (56.2%). Majority of respondents ($n = 409$, 78.4%) observed that subcutaneous sliding scale insulin regimen was the preferred modality for inpatient glycemic management followed by neutral protamine Hagedorn (NPH)-regular insulin ($n = 54$, 10.3%) while basal-bolus-correctional insulin regime ($n = 35$, 6.7%) and 30/70 mixed formulations ($n = 24$, 4.6%) have yet to find favor for inpatient glycemic management.

A significant majority (65.9%, $n = 344$) stated that they advise pre-operative reduction of insulin dosage (the night before and on the day of surgery), 80.5% ($n = 420$) measure capillary blood glucose (CBG) before induction of anesthesia, 98.7% ($n = 515$) affirmed that their intra-operative glycemic goal is between 100 mg/dl and 180 mg/dl. A notable majority of respondents (84.7%, $n = 442$) agreed that they conduct an hourly intra-operative CBG assessment, 70.3% ($n = 367$) acknowledged discussing with the surgeon about the patient's potential post-operative resumption of oral diet. Almost all respondents (99.2%, $n = 518$) agreed that adequate post-operative analgesia would result in optimum post-operative glycemic control and early resumption of oral diet.

The majority of respondents (69.7%; $n = 364$) avoided using Ringer's lactate (RL) for peri-operative fluid management with respondents from medical colleges predominantly avoiding its peri-operative use (75.5%, $n = 188$). Surprisingly and on a worrisome note, only 37.9% ($n = 198$) prescribed insulin with the brand name and units written in full in pre-anesthesia and post-anesthesia advice. Only as much as 44% of the respondents ($n = 231$) acknowledged that they advise continuation of metformin up to the day of surgery in American Society of Anesthesiologists (ASA) II diabetic patients undergoing minimally invasive elective surgery. Only 55.4% ($n = 289$) respondents stated that their hospital encourages day care surgery admission of ASA II diabetic patients listed for elective low-risk surgery. Tertiary care private hospitals seem to be more receptive to the idea of considering diabetics for day care surgery (74.8%; $n = 83$).

Significant variance was observed between the three types of health facilities with respect to prior evaluation for diabetes before referring for pre-anesthetic evaluation ($P = 0.007$), request to schedule diabetics as first case ($P = 0.006$), hospital encouragement of day care surgery ($P < 0.001$), insulin infusion preference ($P < 0.001$), hourly intra-operative CBG measurement ($P = 0.021$), and avoiding use of RL for peri-operative fluid management ($P = 0.025$) [Tables 2-4].

Table 2: Peri-operative management of patients with diabetes listed for elective surgery (n=522)

Variables	Total (n=522)	Medical college and associated hospitals (n=249, 47.7%)	Tertiary care government institute (n=162, 31%)	Tertiary care private institute (n=111, 21.3%)	P
Age <35 years	344 (65.9)	180 (72.3)	111 (68.5)	53 (47.7)	<0.001
Does your department have a protocol for peri-operative management of diabetes?					
Yes	342 (65.5)	167 (67.1%)	97 (59.9)	78 (70.3)	0.161
Diabetic patients referred by surgical team for pre-anesthetic evaluation for an elective surgery always have a prior diabetes evaluation done by a specialist?					
Yes	297 (56.9)	157 (63.1)	90 (55.6)	50 (45)	0.007
Do you advise HbA1c in pre-anesthetic evaluation of a diabetic patient?					
Yes	462 (88.5)	225 (90.4)	145 (89.5)	92 (82.9)	0.108
When do you postpone an elective case for inadequate preoperative blood sugar control?					
HbA1c >7	53	21	20	12	
HbA1c >7.5	78	33	17	28	0.005
HbA1c >8	83	46	19	18	
HbA1c >8.5	308	149	106	53	
Do you request that a diabetic patient be scheduled as first case of the day?					
Yes	476 (91.2)	230 (92.4)	153 (94.4)	93 (83.8)	0.006
Do your surgery colleagues prioritize elective O.T. list to list a diabetic patient as first case of the day?					
Yes	258 (49.4)	116 (46.6)	84 (51.9)	58 (52.3)	0.463
Period of fasting of diabetic patients listed for surgery in your hospital is usually between 6 and 8 h?					
Yes	458 (87.9)	218 (87.6)	141 (87.6)	99 (89.2)	0.897

Data presented in frequency (column %). Chi-square test is used. $P < 0.05$ significant

Discussion

Joint British Diabetes Societies (JBDS) has suggested the concept of a multidisciplinary comprehensive care pathway by stressing on close co-ordination between anesthesiologists, surgeons, and diabetologists for optimum peri-operative management.^[5,11]

Pre-operative glycemic management of a diabetic patient listed for elective surgery should be initiated before pre-anesthetic evaluation so as to avoid unnecessary delay in optimization and listing of the case. A substantial majority (56.9%) of the participants agree that patients usually have undergone diabetes evaluation before presenting for pre-anesthetic evaluation while only 45% of the respondents working in the tertiary care private institutions agreed to former.

The majority of the respondents (91%, $n = 476$) request for prioritizing operative list but only half (49.4%, $n = 258$) feel that their surgical speciality colleagues prioritize the operative list, an area that needs more sensitization and co-ordination.

Long-term glycemic control is assessed by HbA1c. The overwhelming majority of respondents request HbA1c as part of the pre-anesthetic evaluation. An increased risk of peri-operative adverse outcomes has been associated with elevated HbA1c levels in several surgical specialties.^[12-15]

However, there is a paucity of data to suggest that pre-operative glycemic optimization would result in reduced morbidity or mortality. Moreover, recent studies suggest that elevated HbA1c is predictive of peri-operative hyperglycemia which is now considered to be more predictive of adverse events rather than mortality in surgical patients.^[16]

Guidelines and consensus statements from different societies have advocated different HbA1c values as a marker of the adequacy of long-term glycemic control which is in accordance with surgical subspecialty.^[5-9] JBDS guidelines are most liberal in this regard setting an HbA1c value of 8.5% which is in accordance with recommendation by NCEPOD subsequent to an audit conducted in 2019 which emphasizes on treating an elevated pre-operative HbA1c level as a trigger for aggressive

Table 3: Peri-operative management of patients with diabetes listed for elective surgery (n=522)

Variables	Total (n=522)	Medical college and associated hospitals (n=249, 47.7%)	Tertiary care government institute (n=162, 31%)	Tertiary care private institute (n=111, 21.3%)	P
Which insulin infusion you usually prefer?					
VRIII	280 (53.6)	109 (43.8)	92 (56.8)	79 (71.2)	<0.001
Do you advice continuation of metformin up to the day of surgery in ASA II diabetic patients undergoing minimally invasive surgery?					
Yes	231 (44.3)	120 (48.2)	70 (43.2)	41 (36.9)	0.132
Do you advice pre-operative reduction of insulin dosage (the night before and on the day of surgery) for patients on insulin listed for elective surgery?					
Yes	344 (65.9)	165 (66.3)	111 (68.5)	68 (61.3)	0.456
Do you measure capillary blood glucose (CBG) prior to induction of anesthesia?					
Yes	420 (80.5)	208 (83.5)	125 (77.2)	87 (78.4)	0.232
Intra-operatively your glycemic management goals involve keeping blood sugar between 100 mg/dl and 180 mg/dl?					
Yes	515 (98.7)	247 (99.2)	160 (98.8)	108 (97.3)	0.283
Intra-operatively do you measure CBG hourly in a diabetic patient undergoing an elective surgery?					
Yes	442 (84.7)	219 (88)	138 (85.2)	85 (76.6)	0.021
Intra-operatively do you avoid using Ringer's lactate for IV fluid management in a diabetic patient?					
Yes	364 (69.7)	188 (75.5)	106 (65.4)	70 (63.1)	0.025
Do you discuss with surgeon about patient's potential post-operative resumption of oral diet?					
Yes	367 (70.3)	174 (69.9)	113 (69.8)	80 (72.1)	0.900
Do you prescribe insulin with the brand name and units written in full in pre-anesthesia and post-anesthesia advice?					
Yes	198 (37.9)	90 (36.1)	61 (37.7)	47 (42.3)	0.533

Data presented in frequency (column %). Chi-square test is used. P<0.05 significant

peri-operative glucose control, for peri-operative risk stratification as opposed to deferral of surgery, a marked shift from earlier practice.^[9,17] Majority of our respondents treat HbA1c <8.5 as a marker of the adequacy of blood sugar control.

Subcutaneous sliding scale insulin regimen has been widely popular for inpatient glycemic optimization as evident from our survey findings. Lee Y-Y *et al.* in their meta-analysis concluded that a sliding scale is less effective and more prone to adverse effects like an infection.^[18,19] Basal-bolus and basal-bolus-correctional insulin therapy although found to be more effective than sliding scale with reduced complications (RABBIT 2 trial) has yet to find more widespread use suggesting an important role diabetologists can play in this regard.^[20,21]

Despite lack of scrutiny, the mainstay of peri-operative metabolic control in diabetics has been the administration of

IV glucose with potassium chloride and an insulin infusion. Two modalities most commonly used are GIK infusion and VRIII as evident from our survey with respondents equally divided between the two.^[22]

GIK regimen although labor- and resource-intensive is still in use in developing countries.^[21] However, in developed countries, the GIK regimen has largely been replaced by VRIII. GIK and VRIII, although theoretically have the potential for achieving safe glycemic control, have in fact been found to be associated with hyponatremia and hyperglycemia.^[23-25]

Alberti and Thomas cautioned against the use of RL in GIK infusion citing theoretical hepatic conversion of lactate into glucose.^[26] A paucity of data has resulted in avoidance of RL in diabetics as is evident from our survey, more so among those

Table 4: Peri-operative management of patients with diabetes listed for elective surgery (n=522)

Variables	Total (n=522)	Medical college and associated hospitals (n=249, 47.7%)	Tertiary care government institute (n=162, 31%)	Tertiary care private institute (n=111, 21.3%)	P
Do you agree that adequate post-operative analgesia would result in optimum post-operative glycemic control and early resumption of oral diet?					
Yes	518 (99.2)	246 (98.8)	161 (99.4)	111 (100)	0.818
Does your hospital encourage "day case surgery" admission of ASA II diabetic patients listed for elective low-risk surgery?					
Yes	289 (55.4)	134 (53.8)	72 (44.4)	83 (74.8)	<0.001
Do you advice BG monitoring in pre-operative area?					
Yes	507 (97.1)	242 (97.2)	157 (96.9)	108 (97.3)	0.980
Do you advice continuing basal insulin at 80% of usual dose in fasting patients who are on insulin for glycemic control?					
Yes	204 (39.1)	101 (40.6)	67 (41.4)	36 (32.4)	0.267
Do you advice BG monitoring in pre-operative area?					
Yes	507 (97.1)	242 (97.2)	157 (96.9)	108 (97.3)	0.980

Data presented in frequency (column %). Chi-square test is used. P<0.05 significant

respondents working in medical college than those working in tertiary care facilities.

Billiodeaux *et al.*^[27] observed that RL does not appear to cause a significant change in the mean blood glucose (BG) levels in diabetic patients undergoing carotid endarterectomy compared to patients receiving normal saline. Simpson *et al.*^[28] in an editorial gave a theoretical explanation that 1 l of RL would result in a rise of BG by 18 mg/dl only. However further randomized controlled trials are required to assess the safety of peri-operative use of RL in diabetics.

Metformin, a commonly used oral hypoglycemic agent has been linked with acute kidney injury (AKI) and lactic acidosis. The routine practice involves stopping metformin 48 h before surgery, which may adversely affect glycemic control. Recommendations by JBDS, Association of Anaesthetists of Great Britain and Ireland (AAGBI), and Society for Ambulatory Anesthesia (SAMBA) suggest that metformin can be safely continued up to the day of surgery provided the patient has a minimum period of starvation (one missed meal) and has no risk of AKI, a practice which only 43.3% (n = 231) of the respondents seem to favor.^[6,7]

For patients on domiciliary insulin for glycemic control, it has been suggested that the patient's basal insulin (glargine or detemir) dose be reduced to approximately 80% of the normal dose the evening before or morning of surgery if on twice-daily dosing.^[7,8]

NPH insulin/premixed formulations are reduced by 20% the evening before surgery and by 50% the morning of surgery while short-acting insulin requires the only omission of morning dose.^[29]

While the majority of respondents (65.9%) believe in a pre-operative reduction in insulin dosages, only 39.1% agree to continue basal insulin at 80% of the usual dose.

Controversy still exists about the intra-operative frequency of CBG measurements. Duggan *et al.*^[30] recommend that hourly intra-operative CBG measurement should be done in a patient undergoing surgery of prolonged duration (>4 h) and every 2 h in those with less duration (4 h).

The majority of respondents agree to pre-operative (97.1%) and hourly intra-operative (84.7%) measurement of CBG.

The target peri-operative CBG level depends upon factors like duration of surgery, invasiveness of the surgical procedure, type of anesthetic technique, expected time to resumption of oral intake, and routine antidiabetic therapy.^[31,32] The Endocrine Society, SAMBA, JBDS, and AAGBI recommend that intra-operative BG levels be maintained at less than 180 mg/dl which the majority of respondents agree to (98.7%).^[8,9,29] JBDS and the AAGBI in a recent advisory have recommended lower acceptable peri-operative CBG levels at 108 mg/dl in the surgical patient.^[6,7,29]

Existing data demonstrate diabetics being inappropriately denied day care surgery as is also evident from our survey

findings ($n = 289,55.4\%$) with a notable exception being tertiary health care private facilities which seem to encourage day care surgery in diabetics ($n = 83,74.8\%$).^[25,26,33]

Day care surgery can be promoted in patients with diabetes provided they satisfy certain criteria. A low pre-operative HbA1c, as advocated by SAMBA, usually indicates that peri-operative glycemic control will be easier to achieve, and thus it can be used to predict the suitability of patients for day care surgery and those patients who will not necessarily require a VRIII to achieve optimal glycemic control.

Insulin is frequently mal-prescribed and mal-administered, which is associated with patient morbidity and mortality.^[34] A notable percentage of respondents ($n = 198,37.9\%$) do not prescribe insulin in pre-anesthetic advice as recommended (brand name and units in full) which is a cause of concern.

The survey brings to light the practices that are commensurate with established guidelines, namely, HbA1c levels of 8.5% as a marker of adequate glycemic control, intra-operative glycemic target <180 mg/dl, minimizing fasting period to 6–8 h, frequency of CBG measurement, and reduction of insulin dosage night before. Survey lay bare certain practices, namely, lack of prioritizing of the operative list and considering diabetics ineligible for day care surgery.^[9,10] Our survey further reveals that practices like discontinuation of basal insulin, early discontinuation of metformin, and not prescribing insulin in recommended manner are in marked difference from established guidelines.

Our survey did not cover anesthesiologists working as private practitioners or those working in smaller health care facilities which stand as a limitation of our survey. The questionnaire comprised of closed-ended questions resulting in limited interaction with participants with respect to certain practices notable being the extent to which insulin dosages are reduced pre-operatively.

Conclusion

A simple logistic step like prioritizing operative list to schedule diabetics as the first case can go a long way in minimizing the period of starvation, minimizing disruption of domiciliary regimen, avoiding IV insulin infusion, and accompanying complications.

Optimum peri-operative management of diabetes requires protocol-driven multidisciplinary patient care along the entire peri-operative pathway by a dedicated team of health care professionals led by a designated head.

In the absence of national guidelines and national or regional audit system along the lines of NCEPOD, ASA closed claims analysis, and National Diabetes Inpatient Safety Audit (NADIA), it would be difficult to ascertain adherence to guidelines and quality of current peri-operative practices in the management of diabetes.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE. Hyperglycemia: An independent marker of in-hospital mortality in patients with undiagnosed diabetes. *J Clin Endocrinol Metab* 2002;87:978-82.
2. Frisch A, Chandra P, Smiley D, Peng L, Rizzo M, Gattcliffe C, et al. Prevalence and clinical outcome of hyperglycemia in the perioperative period in noncardiac surgery. *Diabetes Care* 2010;33:1783-8.
3. Kotagal M, Symons RG, Hirsch IB, Umpierrez GE, Farrokhi ET, Flum DR, et al. Perioperative hyperglycemia and risk of adverse events among patients with and without diabetes. *Ann Surg* 2015;261:97-103.
4. Dhatariya K, Levy N, Kilvert A, Watson B, Cousins D, Flanagan D, et al. NHS Diabetes guideline for the perioperative management of the adult patient with diabetes. *Diabet Med* 2012;29:420-33.
5. Association of Surgeons of Great Britain and Ireland. Issues in professional practice: Guidelines for implementation of enhanced recovery protocols. 2009.
6. Membership of the Working Party; Barker P, Creasey PE, Dhatariya K, Levy N, Lipp A, Nathanson MH, et al. Peri-operative management of the surgical patient with diabetes 2015: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia* 2015;70:1427-40.
7. Joint British Diabetes Society (JBDS). Available from: <https://abcd.care/joint-british-diabetes-societies-jbds-inpatient-care-group>. [Last accessed on 2020 Nov 18].
8. British Association of Day Surgery (BADS). Available from: <https://daysurgeryuk.net/en/home/>. [Last accessed on 2020 Nov 29].
9. The National Confidential Enquiry into Patient Outcome and Death. Highs and Lows. 2018. London. [Last accessed on 2020 Nov 29].
10. Jackson MJ, Patvardhan C, Wallace F, Martin A, Yusuff H, Briggs G, et al. Perioperative management of diabetes in elective patients: A region-wide audit. *Br J Anaesth* 2016;116:501-6.
11. Modi A, Lipp A, Dhatariya K. An audit of a new diabetic management regime suitable for day and short stay surgery. *J One Day Surg* 2009;19(Suppl):A2.
12. Gustafsson UO, Thorell A, Soop M, Ljungqvist O, Nygren J. Haemo-globin A1c as a predictor of postoperative hyperglycaemia and complications after major colorectal surgery. *Br J Surg* 2009;96:1358-64.
13. Walid MS, Newman BF, Yelverton JC, Nutter JP, Ajjan M, Robinson JS. Prevalence of previously unknown elevation of glycosylated haemoglobin in spine surgery patients and impact on length of stay and total cost. *J Hosp Med* 2010;5:E10-4.
14. O'Sullivan CJ, Hynes N, Mahendran B, Andrews EJ, Avalos G, Tawfik S, et al. Haemoglobin A1c (HbA1C) in non-diabetic and

- diabetic vascular patients. Is HbA1C an independent risk factor and predictor of adverse outcome? *Eur J Vasc Endovasc Surg* 2006;32:188-97.
15. Halkos ME, Lattouf OM, Puskas JD, Kilgo P, Cooper WA, Morris CD, *et al.* Elevated preoperative hemoglobin A1c level is associated with reduced long-term survival after coronary artery bypass surgery. *Ann Thorac Surg* 2008;86:1431-7.
 16. van den Boom W, Schroeder RA, Manning MW, Setji TL, Fiestan GO, Dunson DB. Effect of A1C and glucose on postoperative mortality in noncardiac and cardiac surgeries. *Diabetes Care* 2018;41:782-8.
 17. Dhatriya K, Levy N. Perioperative diabetes care. *Clin Med* 2019;19:437-40.
 18. Lee YY, Lin YM, Leu WJ, Wu MY, Tseng JH, Hsu MT, *et al.* Sliding-scale insulin used for blood glucose control: A meta-analysis of randomized controlled trials. *Metabolism* 2015;64:1183-92.
 19. Miller DB. Why won't the sliding scale go away? *Can J Diabetes* 2011;35:340-4.
 20. Umpierrez GE, Smiley D, Zisman A, Prieto LM, Palacio A, Ceron M, *et al.* Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes (RABBIT 2 trial). *Diabetes Care* 2007;30:2181-6.
 21. Umpierrez GE, Smiley D, Jacobs S, Peng L, Temponi A, Mulligan P, *et al.* Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery (RABBIT 2 surgery). *Diabetes Care* 2011;34:256-61.
 22. Alberti KGMM, Thomas DJB. The management of diabetes during surgery. *Br J Anaesth* 1979;51:693-710.
 23. Achinger SG, Ayus JC, Moritz ML. Dysnatremias: Why are patients still dying? *South Med J* 2006;99:353-62.
 24. NHS Digital National Diabetes Inpatient Audit (NaDIA), open data—2013. Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-inpatient-audit/national-diabetes-inpatient-audit-nadia-open-data-2013>. [Last accessed on 2020 Nov 29].
 25. NHS Digital National Diabetes Inpatient Audit (NaDIA), open data-2011. Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-inpatient-audit/national-diabetes-inpatient-audit-nadia-open-data-2011>. [Last accessed on 2020 Nov 29].
 26. Thomas DJ, Alberti KG. Hyperglycaemic effects of Hartmann's solution during surgery in patients with maturity onset diabetes. *Br J Anaesth* 1978;50:185-8.
 27. Billioudaux ST, Samuelson CG, Willett O, Arulkumar S, Thomas D, Hamilton CS, *et al.* Intraoperative and postoperative blood glucose concentrations in diabetic surgical patients receiving lactated Ringer's versus normal saline: A retrospective review of medical records. *Ochsner J* 2014;14:175-8.
 28. Simpson AK, Levy N, Hall GM. Peri-operative i.v. fluids in diabetic patients-don't forget the salt. *Anaesthesia* 2008;63:1043-5.
 29. Joshi GP, Chung F, Vann MA, Ahmad S, Gan TJ, Goulson DT, *et al.* Society for Ambulatory Anesthesia consensus statement on peri-operative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesth Analg* 2010;111:1378-87.
 30. Duggan EW, Carlson K, Umpierrez GE. Perioperative hyperglycemia management: An update. *Anesthesiology* 2017;126:547-60.
 31. Likavec A, Moitra V, Greenberg J, Drum M, Sweitzer BJ. Comparison of preoperative blood glucose levels in patients receiving different insulin regimens. *Anesthesiology* 2006;105:A567.
 32. Mendez CE, Umpierrez G. Management of the hospitalized patient with type 1 diabetes mellitus. *Hosp Pract* (1995) 2013;41:89-100.
 33. NHS Digital National Diabetes Inpatient Audit (NaDIA), open data-2019. Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-inpatient-audit/national-diabetes-inpatient-audit-nadia-open-data-2019>. [Last accessed on 2020 Nov 29].
 34. National Patient Safety Agency. The fourth report of the Patient Safety Observatory. Safety in doses: Medication safety incidents in the NHS, January 2007. Available from: www.nrls.npsa.nhs.uk/resources/patient-safety-topics/medication-safety/. [Last accessed on 2020 Nov 11].

APPENDIX

Peri-operative management of diabetes mellitus - A survey of current practices among Indian anesthesiologists.

This is a short survey being conducted by a team of anesthesia consultants of SGPGIMS, Lucknow, a tertiary care institute. The survey consists of 25 questions dealing primarily with peri-operative management of patients with diabetes scheduled for elective surgery. The survey will target anesthesia resident trainees with more than 1-year experience, senior residents, and consultants. Confidentiality of your responses in this survey will be maintained. Responses submitted by respondents can be used for a possible study in the future. Thanks for giving your valuable time.

1. What is your age?
 - A. <25 years
 - B. 25–35 years
 - C. 35–45 years
 - D. 45–55 years
 - E. >55 years
2. What is your qualification?
 - A. Resident trainee
 - B. DA
 - C. MD
 - D. DNB
3. Where are you currently working at?
 - A. Medical college and associated hospitals
 - B. Tertiary care government institute
 - C. Tertiary care private hospital
4. Please mention the state you are currently working in?
5. Does your department have a protocol for peri-operative management of diabetes?

Yes No
6. Does your hospital encourage “day care surgery” admission of ASA II diabetic patients listed for elective low-risk surgery?

Yes No
7. Diabetic patients referred by the surgical team for pre-anesthetic evaluation for an elective surgery always have a prior diabetes evaluation done by a specialist?

Yes No
8. Do you advice HbA1c in pre-anesthetic evaluation of a diabetic patient? *Mark only one oval.*

Yes No
9. When do you postpone an elective case for inadequate preoperative blood sugar control?

HbA1c>7 HbA1c>7.5 HbA1c>8.0 HbA1c>8.5
10. Do you request that a diabetic patient be scheduled as the first case of the day? *Mark.*

Yes No
11. Do your surgery colleagues prioritize elective O.T. list so as to list a diabetic patient as the first case of the day?

Yes No

12. Period of fasting of diabetic patients listed for surgery in your hospital is usually between 6–8 h?
Yes No
13. Which insulin infusion do you usually prefer? *Mark only one oval.*
Glucose-insulin-potassium infusion (GIK)
Variable-rate intravenous insulin infusion (VRIII)
14. For pre-operative BG optimization, surgical in-hospital diabetic patients are prescribed which subcutaneous insulin regimen in your hospital?
Mark only one oval.
Sliding scale (regular insulin)
Basal-bolus correctional regime (glargine/determir - regular/lispro)
NPH-Regular insulin
30/70 mixed formulations
15. Do you advice continuation of metformin up to the day of surgery in ASA II diabetic patients undergoing minimally invasive surgery?
Mark only one oval.
Yes No
16. Do you advice continuing basal insulin at 80% of usual dose in fasting patients who are on insulin for glycemic control?
Mark only one oval.
Yes No
17. Do you advice pre-operative reduction of insulin dosage (the night before and on the day of surgery) for patients on insulin listed for elective surgery?
Mark only one oval.
Yes No
18. Do you measure capillary blood glucose (CBG) in the pre-operative area? *Mark only one oval.*
Yes No
19. Do you measure CBG before induction of anesthesia? *Mark only one oval.*
Yes No
20. Intra-operatively your glycemic management goals involve keeping blood sugar between 100 mg/dl and 180 mg/dl?
Mark only one oval.
Yes No
21. Intra-operatively do you measure CBG hourly in a diabetic patient undergoing an elective surgery?
Mark only one oval.
Yes No
22. Intra-operatively do you avoid using Ringer's lactate for IV fluid management in a diabetic patient?
Mark only one oval.
Yes No
23. Do you discuss with the surgeon about the patient's potential post-operative resumption of oral diet?
Mark only one oval.
Yes No

24. Do you prescribe insulin with the brand name and units written in full in pre- anesthesia and post-anesthesia advice?

Mark only one oval.

Yes No

25. Do you agree that adequate post-operative analgesia would result in optimum post-operative glyceimic control and early resumption of oral diet?

Mark only one oval.

Yes No