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Another simple regimen for perioperative management of diabetes mellitus

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Abstract

Persons with diabetes who require surgical procedures are increasing day by day. Many of the regimens available to manage patients with diabetes perioperatively are complex. Hence, the junior doctors and the paramedics (Primary care providers on a 24/7 basis) find it difficult to execute them. We need a simple regimen that can be executed in a primary care setting/general floor as it is becoming difficult to accommodate the patients in a sophisticated setting because of the increasing burden of the disease. We suggest a simple regimen in this article (Ram's regimen) which we believe safer, economical and more effective than few simple regimens available to date. Moreover, this regimen does not require any additional equipment such as syringe pumps, measured-volume set, etc. Hence, this regimen can be implemented in a primary care setting/general floor easily and we hope that it will be useful for doctors of various specialties and their patients.

Key words: Diabetes mellitus; Insulin therapy; Perioperative management; Simple regimen

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Core tip: Peri-operative management of diabetes is like walking a tightrope. Complexity of the regimens adds fuel to the fire. We propose a simple regimen, which we believe safer, economical and more effective. "User-friendly" for the primary care providers on 24/7. Executable in a primary care set-up/general floor too, which is becoming inevitable because of the increasing burden of the disease.

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INTRODUCTION

Patients with diabetes who require surgical procedures are increasing day by day. The frequency of surgical procedures as well as the duration of stay in the hospital is more in them when compared to those who do not have diabetes^[1]. The two major types of regimens^[2] available for managing patients with diabetes peri-operatively are (1) subcutaneous insulin; and (2) variable-rate intravenous insulin infusion (VRIII) administered continuously. In our opinion, the latter one, which is commonly followed currently in many parts of the world, is cumbersome for the patients as well as the junior doctors/paramedics (Primary care providers on 24/7) as they require hourly checking of glucose. Also, there is a potential possibility of equipment failure resulting in unintended dose or total stopping of insulin being delivered to the patient in this method, leading to extremes of blood glucose levels. Concerning the subcutaneous regimens, there is a possibility of “peaks and valleys” in the blood glucose levels because of mismatching between the duration of action of insulin and intravenous dextrose/uncertainty of oral intake (as the case may be). Also, the absorption of subcutaneous insulin is unpredictable particularly in the perioperative period^[3].

“No Glucose-No Insulin” method adopted by some anesthesiologists (probably due to the complexity of the regimens and/or fear of hypoglycemia) is not acceptable on many occasions or dangerous sometimes as there is a potential chance of starvation ketosis and electrolyte imbalances^[4]. Although the peri-operative team (anesthesiologists, surgeons, and paramedics) is overburdened with many tasks, the management of diabetes cannot be put on the backburner. Nevertheless, it is unfortunate that it (ignoring the management of diabetes) happens commonly. One of the important causes for this could be the complexity of the regimens, which cannot be brushed aside as a “lame excuse”.

WHAT SHOULD BE THE OBJECTIVES OF THE REGIMEN?

It is disheartening to note that the level of confidence in managing patients with diabetes among junior doctors in the United Kingdom was poor, according to an article published in 2011^[5]. We are afraid that the scenario would be “no different” anywhere, even now. As we are aware of the fact that the peri-operative period consists of inherent problems such as starvation, anxiety, pain, unstable hemodynamics, *etc.* which would have a major impact on patients with diabetes, the complexity of the regimens of perioperative management would add only fuel to the fire. Furthermore, a recent review article about the update of peri-operative hyperglycemia has stated that many studies have established the fact that hyperglycemia is an important cause for increased mortality and morbidity in general surgery patients^[2]. On the other hand, it is mentioned in the same review article that there is a potential chance of hypoglycemia causing death in intensive insulin regimen compared to the moderate one^[2]. Hence, a simple regimen having features such as a moderate target, which can be followed by the trainee doctors and the paramedics round the clock easily thereby improving their confidence, which would also provide a stable blood glucose level, is the need of the hour. Besides, it should be executable in any variety of the places of a hospital (operating room, recovery area and general floors)^[3].

Mode of the regimen

Ram’s regimen (Table 1) suggested in this article is based on an old concept concerning the dose of insulin only (Incidentally, we found that it was originally suggested for continuous insulin infusion)^[6] and modified in all other aspects by the first author who has been adopting this regimen for over two decades. Indeed, the dose of insulin is also modified slightly to remember it easily in the increments of numerical five (5, 10, 15, 20 Units at the rate of 25 drops per minute). After preparing the solution with calculated insulin (Table 1), it can be administered through a separate small-bore intravenous line (Metabolic line) in addition to a large-bore intravenous line (Hemodynamic line) or as a piggyback through a three-way connector to only one line according to individual preference at the rate of 100 mL per hour (*i.e.*, 25 drops per minute or by drop-infusion pump if available). In emergencies where we might encounter a case with very high levels of glucose too, it can be initially stabilized with short-acting insulin (one unit of insulin for every 30 mg/dL rise above 180 mg/dL) administered in 100 mL of isotonic saline over 30 min to one hour. Once the target glucose level (140-180 mg/dL) is achieved, we can switch over to the regimen. Similarly, if a slightly more strict control (120-150 mg/dL) is needed (for instance, joint replacement surgeries) 2.5 U of insulin (0.5 U/h) can be added in

the 500 mL solution in addition to the calculated insulin.

WHY ANOTHER SIMPLE REGIMEN?

To our knowledge, there are only a few simple regimens available to date. The Alberti and Thomas regimen^[7], a simple algorithm for the VRIII^[3], and the Vellore regimen^[8] to name a few. We believe that our regimen is simpler, safer and economical than those few simple regimens, on the following grounds:

(1) Despite its great features such as safety, simplicity and classical concepts, there is a chance of hyponatremia in Alberti regimen^[4] (we believe that it is quite possible in Vellore regimen too), which is unlikely in our regimen as we recommend dextrose in isotonic saline instead of plain dextrose. Moreover, a majority of the VRIII regimens do not recommend routine administration of the required dextrose on an hourly basis (which is mandatory), yet Marks JB recommends 5 g of dextrose per hour as a separate infusion which would prevent protein breakdown, ketosis or hypoglycemia^[3]. Nonetheless, hyponatremia is more likely to happen in any regimen that advocates plain dextrose for prolonged duration^[9]. We recommend 10% dextrose for patients who are susceptible to water load. The dose of insulin needs to be doubled and the rate of administration has to be halved in that case. Despite this, if any patient develops hyponatremia, it should be corrected judiciously by administering hypertonic saline through a central line and/or diuretics according to the case.

(2) Vellore regimen suggests potassium supplementation only when the level reaches 3.5 mEq/L or below, whereas Alberti regimen recommends 10 mmol for every bottle. We suggest it for selected patients (Table 1).

(3) This regimen doesn't require even the 100 mL measured-volume-set as well as hourly checking of glucose, unlike the Vellore regimen. Hence, it is simpler and economical.

(4) We suggest the target glucose of 140-180 mg/dL, which is moderate, aimed to prevent both extremes of glucose levels.

(5) Technically analyzing, Vellore regimen is similar to VRIII regimens with only a change of administering the calculated insulin in 100 mL of 5 % dextrose together instead of insulin as a separate infusion. All the VRIII regimens, as well as the Vellore regimen, require hourly checking of glucose level. In addition to being cumbersome to patients as well as care providers, we believe that there is a possibility of fluctuations in the blood glucose values in these regimens which could be due to the fact that the controlling of diabetes happens retrospectively *i.e.*, the dose of insulin is calculated on the glucose level which probably reflects the metabolic trend of the previous hour, but administered for the subsequent hour. In this context, it is worth to note that it is a usual practice to adjust the night dose of insulin for any deviations of fasting blood glucose and the morning dose of insulin concerning post-lunch values, hence considered a prospective approach. Although the scenario is different (longer-acting subcutaneous versus short-acting intravenous insulin, oral feeds versus intravenous glucose *etc.*) concerning the perioperative period, we believe that the retrospective element would probably play a lesser role in our regimen when compared to VRIII or Vellore regimen. This is because we recommend administration of required dextrose (5 g/h) and the calculated insulin (based on clinical conditions and other factors) together from the beginning to achieve a moderate glucose level (140-180 mg/dL). Hence, our regimen requires only two-hourly checking of glucose until four hours and fourth hourly once stabilized, as it is expected to provide a reasonably stable glucose level. Furthermore, it is easier for the junior doctors/paramedics to follow-up, as the crucial period of control would be usually over within the first few hours under the supervision of a senior physician. Once stabilized, the patient can be managed on the general floor also.

(6) Marks JB mentions that glucose-insulin-potassium (GIK) regimen has easier maintenance following initial stabilization despite its drawback of inability to adjust the dose of insulin and the dextrose administration independently, warranting preparation of new solution^[3]. Nonetheless, our regimen (having a similar concept) requires preparation of a new solution only for a rare occasion (glucose value of less than 100 mg/dL). We can add the extra units of insulin in the remaining solution taking sterile precautions, for any value of above 180 mg/dL.

And (7) Alberti regimen is safe because of its salient feature of administering the combination of insulin with dextrose^[4]. Although our regimen is based on a similar concept, the following variations are worth noting: (1) 5% dextrose with isotonic saline versus plain 10 % dextrose; (2) The dose of insulin is based on clinical conditions and other factors thus tailoring to individual needs. Alberti *et al* had stated this point in 1979 itself, that the starting therapy of their GIK regimen should not be

Table 1 Ram's regimen (dose of insulin)* Target glucose level 140-180 mg/dL.

Condition of the patient	Dose of insulin, i.e., units of insulin per gram of dextrose per hour (U/g per hour) ^[6]	Total insulin in 500 mL of 5% dextrose isotonic saline solution
General guideline	0.2-0.4	5 to 10 U
Obese/hepatic dysfunction	0.6	15 U
Severe infections/sepsis/steroid therapy	0.6-0.8	15 to 20 U

* The dose of insulin can be chosen based on the clinical condition mentioned above as well as other factors such as preoperative requirement of insulin/other anti-diabetic drugs, the preoperative blood glucose level. The solution can be administered at 100 mL/hour. Check capillary glucose two hourly for the first four hours. Add 1 U of insulin per hour for every 50 mg of rising of glucose level above 180 mg (e.g., If it is 280 mg after two hours, it would become 2 U/h, i.e., 6 U for the remaining 300 mL of solution). If the glucose level is between 100 and 140 mg, start 10% dextrose at 50 mL per hour simultaneously, and reduce the insulin dose by 0.5 U per hour in the subsequent preparations. If <100mg, give only 10% dextrose until it reaches 140mg, and reduce the insulin dose by 1 U per hour (minus five of total dose calculated previously) in the subsequent preparations. Once stabilized, the capillary glucose can be checked every four hours. Potassium can be added if required as in cases of (1) hypokalemia; (2) gastrointestinal procedures; and (3) requirement of infusion for more than five hours.

adhered blindly to each and everybody ("Patients will always vary") rather it must be flexible with an application of common sense too^[7]; and (3) Addition of potassium in selected patients.

CONCLUSION

As the perioperative management of diabetes is inherently complex, simpler and safer the regimen better for all persons involved in the care. We hope that the regimen suggested here will be useful for all care providers, educators as well as the patients regardless of the care setting. We certainly agree that our regimen needs to be studied in the future to prove the advantages we have claimed here.

REFERENCES

1. Frisch A, Chandra P, Smiley D, Peng L, Rizzo M, Gatliffe C, Hudson M, Mendoza J, Johnson R, Lin E, Umpierrez GE. Prevalence and clinical outcome of hyperglycemia in the perioperative period in noncardiac surgery. *Diabetes Care* 2010; **33**: 1783-1788 [PMID: 20435798 DOI: 10.2337/dc10-0304]
2. Duggan EW, Carlson K, Umpierrez GE. Perioperative Hyperglycemia Management: An Update. *Anesthesiology* 2017; **126**: 547-560 [PMID: 28121636 DOI: 10.1097/ALN.0000000000001515]
3. Marks JB. Perioperative management of diabetes. *Am Fam Physician* 2003; **67**: 93-100 [PMID: 12537172]
4. Hall GM. Management of diabetes during surgery: 30 yr of the Alberti regimen. *Br J Anaesth* 2009; **103**: 789-791 [PMID: 19918021 DOI: 10.1093/bja/aep315]
5. George JT, Warriner D, McGrane DJ, Rozario KS, Price HC, Wilmot EG, Kar P, Stratton IM, Jude EB, McKay GA, TOPDOC Diabetes Study Team. Lack of confidence among trainee doctors in the management of diabetes: the Trainees Own Perception of Delivery of Care (TOPDOC) Diabetes Study. *QJM* 2011; **104**: 761-766 [PMID: 21511736 DOI: 10.1093/qjmed/hcr046]
6. Hirsch IB, McGill JB, Cryer PE, White PF. Perioperative management of surgical patients with diabetes mellitus. *Anesthesiology* 1991; **74**: 346-359 [PMID: 1990909 DOI: 10.1097/0000542-199102000-00023]
7. Alberti KG, Thomas DJ. The management of diabetes during surgery. *Br J Anaesth* 1979; **51**: 693-710 [PMID: 399195 DOI: 10.1093/bja/51.7.693]
8. Miriam A, Korula G. A simple glucose insulin regimen for perioperative blood glucose control: the Vellore regimen. *Anesth Analg* 2004; **99**: 598-602, table of contents [PMID: 15271748 DOI: 10.1213/01.ANE.0000122824.21065.CA]
9. Simpson AK, Levy N, Hall GM. Peri-operative i.v. fluids in diabetic patients--don't forget the salt. *Anaesthesia* 2008; **63**: 1043-1045 [PMID: 18821885 DOI: 10.1111/j.1365-2044.2008.05641.x]



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