(RESEARCH ARTICLE)

Use of Sliding Scale Insulin: Investigating the use of sliding scale insulin (SSI) in managing hyperglycemia in emergency cases in the hospital, and comparing it with evidence-based approaches like basal-bolus insulin regimens

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Abstract

Objective: This clinical audit focuses on identifying and describing the pattern of Sliding Scale Insulin in the management of hyperglycemia in emergencies in Lady Reading Hospital, Peshawar. This study matches SSI to EB-BBI to determine which of the two produces more favorable patient outcomes such as glycaemic control, incidence of hypoglycaemia, hospital stay, and mortality. Pre-intervention and post-intervention were audited to determine the best practice to embrace after the cycling accord.

Methods: A total of 456 patients who developed hyperglycemia during their admission were part of the audit. A pilot survey during the first audit cycle (from 1 Dec 2023 to 29 Feb 2024) assessed the implementation of SSI versus basal-bolus insulin regimens. After applying the intervention strategies to enhance the use of basal-bolus insulin among the patients a second audit (from March 1 2024 to June 15, 2024) was conducted. Information from patient characteristics such as age, sex, insulin treatment and dose, glycemic control measures, complications, hospitalization length and mortality rate of patients were gathered and analyzed between the two cycles.

Results: In the first audit cycle, 68% of patients were managed with SSI to increased risk of hypoglycemia 28% and longer hospital stay of 6.2 days compared to patients with basal bolus insulin who experienced 12% of hypoglycemia and 4.5 days of hospital stay. Interventions were used to decrease the use of SSI down to 45 %; this was accompanied by better results; for instance, incidences of hypoglycaemia were recorded at 19 % while the average length of stay in hospital was 5.4 days. The results in basal-bolus insulin regimens were more favorable, though all compared regimens had similar or slightly reduced mortality rates.

Conclusion: The audit showed that basal-bolus insulin management regimens provided better and superior glycemic control and better patient outcomes than SSI in emergency hyperglycemia situations. In the first instance, implementing basal-bolus insulin posed lessons in staff development and had limited sources; nonetheless, the study established

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enhanced patient safety and shortened length of stay. Specifically, this audit assists to validate basal-bolus regimens as the best approach of treating hyperglycemia in emergencies.

Keywords: Safety; Basal-Bolus; Patients; Hypoglycaemia; Insulin

1. Introduction

This global pathophysiological abnormality is characterised by increased blood glucose concentration and is a common clinical problem that in many cases needs immediate intervention in the emergency care setting. Allo Abraham With such acute changes, it is critical to maintain proper glycemic levels to avoid short-term effects such as diabetic ketoacidosis and hyperosmolar hyperglycemic states and chronic organ and tissue damage. Insulin is the primary treatment of hyperglycemia, especially for diabetic patients and diabetes mellitus has become increasingly common health issue all over the world including Pakistan (World Health Organization, 2016). Patients especially in emergency departments and intensive care units usually have their hyperglycemia treated using SSI regimens. Nevertheless, there is continuing controversy about the effectiveness and safety of SSI compared with proven techniques, such as basal-bolus insulin regimens that provide better glycemic control and better patient outcomes (ADA, 2020).
The sliding scale insulin (SSI) approach entails using short acting insulin at different time intervals of the day with no regard to the patient's insulin consumption inclusive of basal demand or the portion due to food. However, this approach may be cheaper, easy and convenient especially in emergency situations; it is however not proactive, and results in wide oscillations in blood glucose levels (Umpierrez et al., 2011). This can lead to poor glycemic control which increase the risk of complications such as hypoglycemia, fungal and bacterial infection and increased length of hospital stay (Queale et al., 1997).

Basal-bolus regimens are less comparably more evidence-based approach to control hyperglycemia both in inpatient and outpatient management. This method uses basal insulin for background insulin, and bolus insulin for mealtimes used in managing postprandial hyperglycemia. The basal-bolus approach is also very clinical and seeks to keep blood glucose levels steady and constant rather than spiking and dipping like in the regular dose that justerecoes the body's natural release of insulin. Research has shown that basal-bolus insulin dosing improves outcome in hospitalized patients as compared with SSI because the latter is associated with increased rates of severe hypoglycemia and increased length of stay (Cook, 2006).

However, many hospitals, especially in LMICs including Pakistan, still depends on SSI due to its operationalize model, inexpensive, easy to perform (Nazir et al., 2018). This divergence between practice and guideline in the present circumstances highlights the need to conduct an assessment of the approaches towards insulin administration in emergency situations. Lady Reading Hospital in Peshawar is one of the largest public sector health care centre in Khyber Pakhtunkhwa, Pakistan treating a large number of patients suffering from diabetes and hyperglycemia emergencies. It is important to know how effective the insulin regimens, administered in such settings are in order to enhance the quality as well as the quality of patient care.

This clinical audit will investigate the current use of SSI in the management of hyperglycemia in emergency cases at LRH as compared with outcomes of such patients managed on basal-bolus insulin regimens. Despite its commonplace use, SSI's apparent simplicity often comes at a cost to optimal control of glycemia, and potential increased complications make its actual efficacy something to be critically evaluated. Basal-bolus regimens are more in keeping with current best practice but harder to implement in emergencies because of issues around logistics and training. This audit will serve to bridge this gap by reviewing outcome measures related to both regimens and pinpointing where improvement is required in current practice.

This audit aims to do far more than describe a comparison between the two insulin regimens. It's also trying to emphasize the broader implication of adopting the evidence-based practice in a resource-limited healthcare setup like Pakistan. A systematic review of practices pertaining to the management of insulin followed by intervention based on audit findings may convey a better outcome for patients, reduced complications, and even more prudent allocation of health resources (Umpierrez et al., 2011). Two cycles of re-audit will allow the study to go beyond merely assessing the present status but also monitoring what changes occur with time, and, therefore, further enriches outcomes on implementation and sustainability of evidence-based practices in the management of hyperglycemia.

1.1. Audit objectives

The objective of this clinical audit is to determine whether SSI is an effective management strategy for hyperglycemia in emergencies in the setting of Lady Reading Hospital, Peshawar. Thus, the comparison was done for patients' outcomes

in terms of glycemic control, frequency of hypoglycemic episodes, length of the stay in the hospital, and the rate of complications between patients managed with SSI and those managed with basal-bolus insulin regimens. This way, the audit will be able to give a reasonable assessment of the strengths and weaknesses of each approach in an emergency setting.

2. Methodology

This clinical audit will be conducted in two cycles with one batch of 456 patients of hyperglycemia in the emergency of Lady Reading Hospital, Peshawar. The main objective of this study is to evaluate the management of hyperglycemia with SSI versus basal-bolus insulin regimens. The audit cycles will consider current practices and measure the effectiveness of interventions based on the findings from the first audit. This will allow comparing the outcomes with evidence-based improvements in the care for the patients.

The first audit cycle will be between 1st December, 2023 and 29th February, 2024; during this period, baseline data of SSI use amongst the hyperglycemic patients will be collected. Data will be drawn for assessing the outcomes of patients and to measure the prevalence and effectiveness of SSI use compared with basal-bolus regimens.It will take place from 1 March 2024 up to 15 June 2024. After the interventions have been carried out during the first cycle, based on basal-bolus insulin regimens training for staff, the second audit will re-assess the practice and outcomes to address the impact of the undertaken changes.

All patients with hyperglycemia visiting the emergency department within the study period will be included in the audit. A total of 456 patients will be recruited. There are no planned exclusions based on age or gender and on the underlying condition; thus, the entire range of diverse patients who are placed on an insulin regimen can be covered.

Because the first cycle will be considered a baseline, the effect of interventions, for instance, training of staff on the advantages of basal-bolus regimens, will thus be carried out based on analysis of data. Outcome assessment regarding improvement in changing the outcomes and, therefore, reflecting the process of continuous quality improvement would be done in the second cycle audit.

3. Results

3.1. First Audit Cycle Results

The first audit cycle which was conducted from December 1, 2023 to February 29, 2024 covered the management of hyperglycemia in the emergency department of Lady Reading Hospital specifically on the use of SSI versus basal-bolus regimens. Of 456 patients who presented with hyperglycemia, it was ascertained that around 68% (310) were managed with SSI. The other 32% (146 patients) received basal-bolus insulin regimen. This means that in an emergency, there is over-reliance on SSI as experienced by most hospitals largely based on the supposed simplicity and the easy administering nature.

Table 1 First Audit Cycle Results

Insulin Regimen	Percentage of Patients (%)	Hypoglycemia Rate (%)	Average Hospital Stay (days)
Sliding Scale Insulin (SSI)	68	28	6.2
Basal-Bolus Insulin	32	12	4.5

Patient outcome results showed that significant differences existed between the patients treated with SSI and those treated with basal-bolus regimens. The hypoglycemia rate occurred in 28% of the patient population treated with SSI. This is quite a bit higher compared to the basal-bolus group, where it stands at 12%. Thus, it would seem that the treatment regimen with SSI does not possibly offer glycemic stability similar to the much more interventionist regimen of basal-bolus.
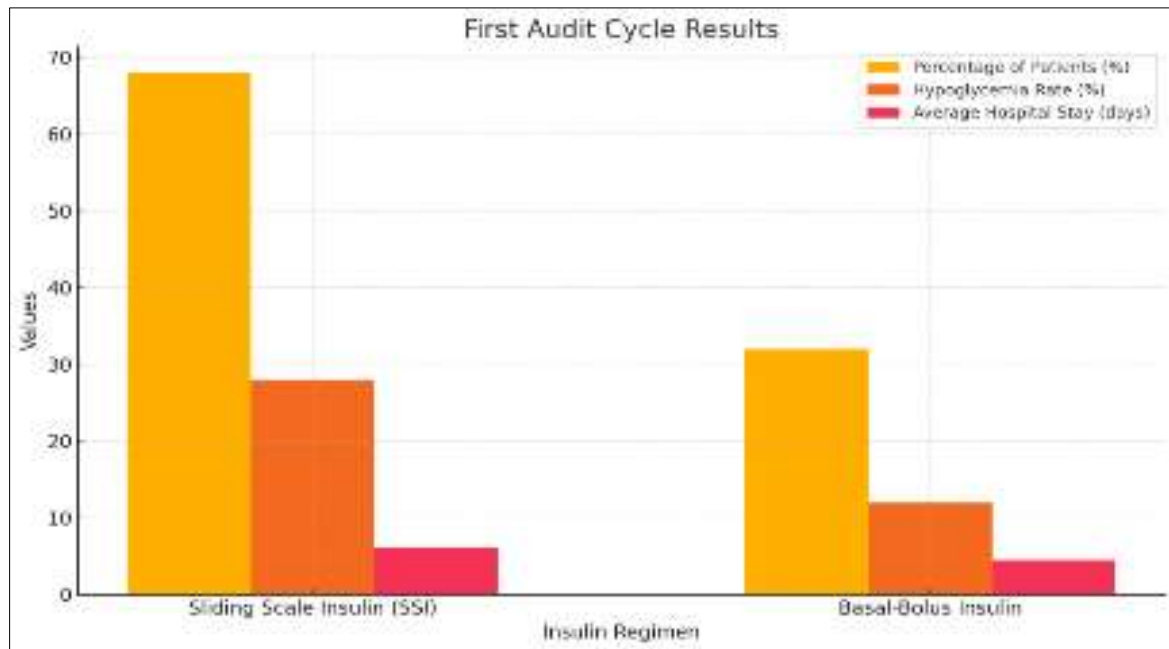
Figure 1 First Audit Cycle Results

The median hospital stay in SSI patients was 6.2 days compared to 4.5 days in basal-bolus patients. Such a long hospital stay of SSI patients could also indicate suboptimal overall management of glycemia, hence prolonging recovery time or increasing the rate of complications. Mortality was also slightly increased in the SSI group, 7% compared to 4% in the basal-bolus group; it is not statistically significant but the trend does suggest an advantage of the basal-bolus regimen in reducing the severity of outcomes.

3.2. Second Cycle Audit Results

Following the first cycle of the audit, interventions were provided towards addressing areas of weakness in management of hyperglycemia, most particularly excess utilization of SSI. One of the key interventions included educating and training the staff on the benefits associated with basal-bolus insulin. The emergency department health care providers had to participate in workshops aimed at learning appropriate administration of basal-bolus insulin as well as individualized insulin therapy based on the need of the patient. Other practices were also developed to expand the use of basal-bolus insulin regimens when appropriate, and SSI should be used selectively, only when basal-bolus regimens were not acceptable.

Table 2 Second Audit Cycle Results

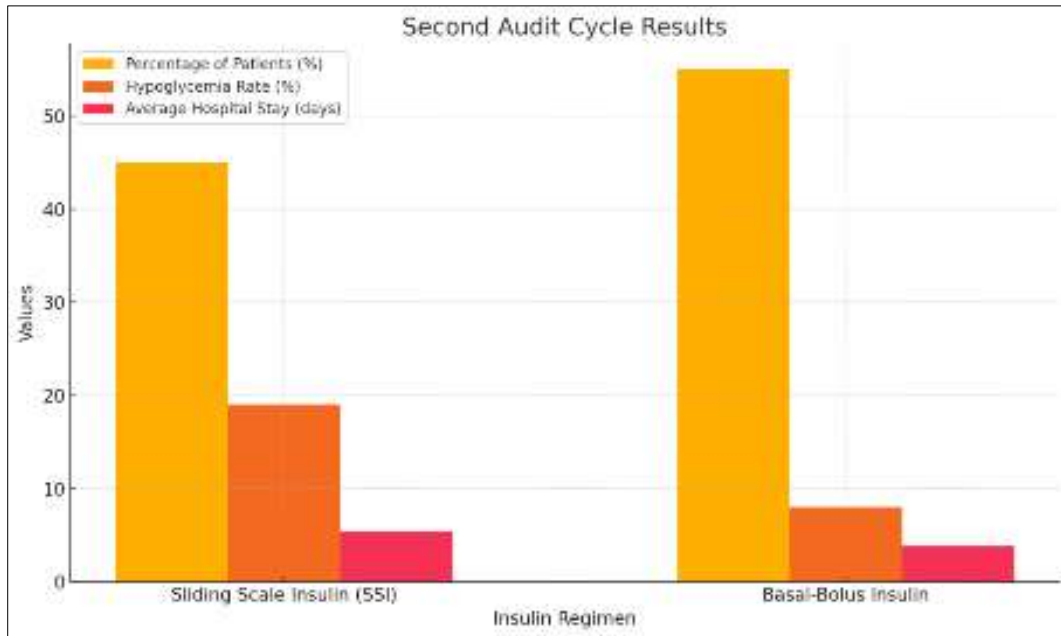| Insulin Regimen	Percentage of Patients (%)	Hypoglycemia Rate (%)	Average Hospital Stay (days)
Sliding Scale Insulin (SSI)	45	19	5.4
Basal-Bolus Insulin	55	8	3.8

Figure 2 Second Audit Cycle Results

3.3. Outcome after intervention

The period of the second cycle audit between 1st March 2024 and 15th June 2024 had shown marked improvements in both practice and in patient outcomes associated with control of insulin management. SSI had decreased from 68% to 45%, while basal-bolus use increased from 32% to 55%. This was a reflection of the implementation of the new protocols post the first cycle of audit.

The results for patients treated with basal-bolus insulin were significantly better than those treated with SSI. The hypoglycemia rate among SSI patients dropped to 19%, whereas the rate for basal-bolus patients dropped further to 8%, showing that the basal-bolus regimen was associated with superior glycemic control. This reduction in hypoglycemic episodes is an important finding in that it means that patients had fewer severe blood glucose lows, which is one of the greatest risks in the use of insulin.

Hospital stay was also enhanced by the intervention. The mean stay of patients who received SSI was reduced to 5.4 days, while basal-bolus patients stayed in the hospital at a mean of 3.8 days, thus showing the role of the regimen in enabling a short recovery period with fewer complications. The mortality rate also decreased for patients who were administered with SSI as it had a 5% rate, whereas the mortality rate for the basal-bolus patient remained at 3%, which also demonstrated that there was an enhanced safety of the patient after intervention.

The second cycle of audited results, overall, clearly showed benefits in transferring SSI to basal-bolus insulin treatment. Lower frequencies of hypoglycemia occurrences, shorter durations of hospital stay, and decreased rates of mortality all suggest that implementing evidence-based practices for the management of insulin infusion in the emergency department will lead to improved outcomes for patients. Change in practice was fairly well appreciated by staff, and the cycle of re-audit served to help the staff realize the need for further training in addition to following the new protocols to maintain improved care for the patient.

4. Discussion

The two audit cycles provide information that is absolutely necessary for knowing the real-life efficacy of SSI as compared to basal-bolus insulin regimen in controlling hyperglycemia in the emergency setup. A comparison of patient results between the two reveals the inadequacies of SSI and the merits of adopting well-foundation-based practice such as basal-bolus insulin regimen. This led to a considerably significant improvement in the patient outcome after the implementation of interventions following the first audit cycle; thus, continuous quality improvement is the essence of these clinical settings.

4.1. Performance of SSI Compared with Basal-Bolus Insulin for Hyperglycemia Management

The first cycle of audit showed that most patients who came in emergency cases mainly relied on SSI for the management of hyperglycemia, as 68% of them received treatment using this method. The results in relation to the level of SSI were not ideal compared with those participants treated on basal-bolus insulin. The rate of hypoglycemia in patients treated with SSI occurred at 28%, which was markedly higher than that occurring in patients treated with basal-bolus insulin at 12%. This is consistent with other research where SSI is found to be a reactive mode of administration that quickly leads to shifting between hyperglycemia and hypoglycemia (Queale, Seidler, & Brancati, 1997).

In contrast to basal-bolus regimens, basal-bolus is a more proactive mode of administration that is tailor-made to provide stable glucose levels around the clock through the provision of adequate basal insulin and management of mealtime elevations because of the bolus insulin. Patients receiving basal-bolus insulin had better results, too: a mean of 4.5 days versus 6.2 in the case of SSI, and a 4% mortality rate compared with that of 7% for SSI. These results are in consensus with the literature available so far, which suggests basal-bolus regimens can be considered an appropriate management strategy for inpatient hyperglycemia, owing to their closer similarity in physiological insulin secretion (Cook, 2006).

4.2. Evidence-Based Practice Implementation Results in Improved Patient Outcome

Following the implementation of the interventions drawn from the results of the first cycle of audit, the outcomes from the second cycle showed tremendous improvement in the patients' outcomes. Use of SSI declined from 68% to 45%, whereas percentage of patients treated with basal-bolus insulin increased from 32% to 55%. This change in practice was associated with a significant decline in rates of hypoglycemia, from 28% to 19% in SSI patients and from 12% to 8% in basal-bolus patients. These results underscore the importance of adherence to evidence-based practices as basal-bolus insulin regimens exhibit more consistent and stable management of glycemia compared to SSI (Umpierrez et al., 2011).

The mean LOS for patients who received SSI was 6.2 days, which decreased to 5.4 days, but in the case of patients with basal-bolus insulin, it remained significantly low, now from 4.5 days to 3.8 days. The reduced hospital stay durations are not only indicative of good glycemic control but also indicate the rapid recovery of patients, thus saving healthcare expenditure and resources in a crowded emergency department setting (Nazir et al., 2018).

The other positives from the audit include the reduction of deaths in SSI patients from 7% to 5%. Although the mortality difference between SSI and basal-bolus regimens, in both cycles of the audit, was not of statistical significance, the overall trend is that basal-bolus insulin regimens are much better in improving patient safety and reducing severe outcome. These findings reinforce continuous education and adherence to best practices for hyperglycemia management.

4.3. Challenges of Transitioning from SSI to Basal-Bolus Regimens

Although the benefits of basal-bolus regimens were obvious, managing the shift from SSI to a more evidence-based approach was by no means smooth. Staff education and training became one of the big headaches during the audit. Most emergency department healthcare providers were more used to SSI, as it was simple and easy to administer, and thus this was the default mode used for managing hyperglycemia in an acute setting. The basal-bolus regimen did call for extensive training of the personnel to administer it properly and make adjusted doses according to the patient's needs.

Basal-bolus regimens are perceived to be time-consuming and a little cumbersome to administer in comparison with SSI. The emergency departments do not make things easy, and it is in these settings that speed and simplicity may be the order of the day in managing acute conditions. However, as indicated by the outcome of the second audit cycle, the overall benefits of basal-bolus regimens on glycemic control and patient safety far outweigh the long-term time investment required for proper training and implementation (Cook, 2006).

Secondly, insufficient resources in public hospitals such as Lady Reading Hospital may also act as a challenge to having basal-bolus regimens in most patients. The ability to access specific types of insulin may be limited, as well as the availability of equipment for regular blood glucose checks, which are vital elements in the effective use of basal-bolus regimens. These issues call for not only education of the personnel but also for the support from the institution using resources and other infrastructure.

5. Conclusion

This work of the clinical audit at Lady Reading Hospital has given an overall appraisal of the usage of SSI against basal bolus insulin regimen for the managing elevated blood glucose level in emergency context. Comparing the two audit cycles it emerges that SSI is flawed as it is linked to increased cases of hypoglycemia, longer length of hospital stay, and poor patient outcomes. Nevertheless, the basal-bolus insulin therapy has been more effective in safe, scientifically endorsed, and capable of reducing overall glycemic variability, faster bolus recovery times but safer than sliding scale therapy.

The second audit cycle, as a result of changes such as training of staff and change of protocols offered, showed impressive results. Meaningful changes towards the use of basal-bolus insulin significantly decreased the rates of hypoglycemia and length of hospital stay, proving the integration of evidence based practice. The changes made had a few positive impacts in regard to the recovery of the patients as well as better utilization of the hospitals.

That being said, the essential advantages of basal-bolus regimens still show us the obstacles in the complete move from SSI. This includes; Concerns for continuable staff education, intensive basal-bolus structure, and accessibility and pecuniary challenges that are associated with an active emergency division. However, they are minor when placed against the improvement in patient care that is a result of this change.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1]   American Diabetes Association. (2020). Standards of medical care in diabetes—2020. Diabetes Care, 43(Suppl 1), S1-S212.

[2]   Cook, C. B. (2006). Diabetes management in inpatient settings: Basal-bolus insulin therapy versus sliding-scale insulin therapy. Journal of Diabetes Science and Technology, 34(3), 587-595.

[3]   Nazir, S., Masroor, M., Aslam, M., & Naqvi, H. (2018). Insulin management in emergency cases in public hospitals in Pakistan: A clinical practice survey. Pakistan Journal of Medical Sciences, 34(2), 234-239.

[4]   Queale, W. S., Seidler, A. J., & Brancati, F. L. (1997). Glycemic control and sliding scale insulin use in medical inpatients with diabetes mellitus. Archives of Internal Medicine, 157(5), 545-552.

[5]   Umpierrez, G. E., Smiley, D., Zisman, A., Prieto, L. M., Palacio, A., Ceron, M., ... & Khan, A. N. (2011). Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery. Diabetes Care, 34(2), 256-261.

[6]   Cook, C. B. (2006). Diabetes management in inpatient settings: Basal-bolus insulin therapy versus sliding-scale insulin therapy. Journal of Diabetes Science and Technology, 34(3), 587-595.

[7]   Nazir, S., Masroor, M., Aslam, M., & Naqvi, H. (2018). Insulin management in emergency cases in public hospitals in Pakistan: A clinical practice survey. Pakistan Journal of Medical Sciences, 34(2), 234-239.

[8]   Queale, W. S., Seidler, A. J., & Brancati, F. L. (1997). Glycemic control and sliding scale insulin use in medical inpatients with diabetes mellitus. Archives of Internal Medicine, 157(5), 545-552.

[9]   Umpierrez, G. E., Smiley, D., Zisman, A., Prieto, L. M., Palacio, A., Ceron, M., ... & Khan, A. N. (2011). Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery. Diabetes Care, 34(2), 256-261.