REVIEW ARTICLE

Glucometric Guardianship

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ABSTRACT

It is a well-known fact that the knowledge of their current glucose readings empowered people with diabetes to evaluate and monitor the trends in glucose fluctuations and take informed decisions on adjusting their medicines, food intake, and physical activity. Glucose monitoring technology has undergone a technological evolution and has improved diabetes care in patients living with type 2 diabetes. This has also made the need to efficiently and effectively utilize blood glucose monitoring tools. Given the above, the article has reviewed the significance of glucometric guardianship. Glucometric checklists offer a standardized approach to glucometric guardianship which is necessary to improve the process of drug choice and dose titration. The stepwise factors included in the glucometric guardianship checklist include procurement, distribution, pre-testing hygiene, testing, recording, action, disposal, quality control, and procedure safety.

Keywords: Type 2 diabetes, glucometric guardianship, checklist, glucose meters, glycemic triad.

Introduction

Introduced in the late 1970s and received regulatory clearance for the first time in 1980, blood glucose monitoring (BGM) revolutionized the self-care of people with diabetes. A knowledge of their current glucose readings empowered people with diabetes to assess and better understand their glucose patterns to adjust their food intake, activity and medications to achieve their glycemic goals.[1]

BGM is an essential part of case management in clients with diabetes. Having very high or very low blood glucose levels may affect cellular function and could be life-threatening, including direct health care costs and reduced productivity; if not managed appropriately. It serves as a critical measure in individuals with ongoing diabetes management.[2]

The American Diabetes Association (ADA) 2017 reported that the total estimated cost of diagnosed diabetes in 2017 was $327 billion;[3] however, the direct cost of treating complications, including hospitalizations, emergency room visits and nondiabetes prescriptions, along with indirect costs related to lost/reduced productivity and human costs accounts for almost 73% of the total diabetes cost.[4]

The need to effectively and efficiently utilize BGM tools and resources to improve diabetes outcomes is indisputable. Continuous glucose monitoring is set to bring a fundamental change in the treatment of diabetes and patient engagement of those affected with this disease.[5] Over the years, diabetes practice has become more and more algorithm-based and statistic oriented, which facilitates the patient-centric treatment approach.

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Glucocentric screening and monitoring, added to this, have led to the neglect of a holistic medicine approach.[6] Hence, in this review, we have reviewed the significance and value of glucometric guardianship. We have also attempted to design checklists to facilitate routine clinical practice and impact decision-making.

Glycemic Guardianship

Kalra et al propose d the concept of glycemic guardianship, which was defined as "*activities carried out by the health care team and health care system to ensure optimal care of the person, or group of peoples, living with diabetes.*" Glycemic guardianship is a novel concept that can be functional at the national/regional level as well as the individual level and is ideally considered in partnership with individuals living with diabetes. The World Health Organization's Global Diabetes Compact (GDC) targets provide an umbrella for all activities related to glycemic guardianship.[7]

GDC emphasizes five targets comprising diagnosis of diabetes in 80% of individuals living with diabetes, achieving glucometric optimization in 80% of individuals diagnosed with diabetes, blood pressure control in 80% of individuals diagnosed with diabetes, ensuring statin prescription in 60% of individuals with diabetes who are 40 years or more in age, availability of affordable insulin, and blood glucose self-monitoring for all the people with type 1 diabetes. With the second-largest population of diabetes individuals living in India, the country's healthcare system and providers must strive to screen, diagnose, manage, and prevent diabetes and related complications. While the prevalence of diabetes has increased, so has the proportion of those living with undiagnosed diabetes, thereby diminishing or counterbalancing the advances in diabetes care and delivery.[7]

With the Indian pharmaceutical industry being the world leader in manufacturing good quality drugs and devices, the easy availability of good quality and reasonably priced glucose monitoring devices and ancillaries has also been facilitated. With this, glucovigilance and personalized diabetes management have become integral to diabetes management and care.[8]

The Domains of Glucometric Guardianship

The benefits of glucometric guardianship are that it encompasses the physical and electronic infrastructure and further delineates the roles and responsibilities of various healthcare team members. The infrastructural requirements of glucometric guardianship include hardware (glucose measuring devices and ancillary supplies) and software (data recording and analysis). Table 1 shows the domains of glucometric guardianship.

Glucometric Guardianship Checklist

"You can't improve what you can't measure accurately" is an adage illustrating the dilemma facing attempts to optimize glycemic control. Glucometric guardianship

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PROCUREMENT
- Meter
- Ancillaries, i.e., lancets, strips, swabs
- Indented by; at time of admission/later

DISTRIBUTION
- Individual
- Shared/number of beds

PRE-TESTING HYGIENE
- Glucometer battery
- Sanitization; finger-tip sanitization

TESTING
- Glucometer check
- Procedure of pricking
- Trouble shooting (e.g., poor circulation, lack of hygiene)
- Frequency

RECORDING
- On paper
- E-Enabled (Integrated personalized diabetes management)

ACTION
- Frequency of measurement
- Change of insulin dose
- Change in IV fluids
- Escalation to sensor medical staff

DISPOSAL
- Plastics
- Sharps
- Blood-stained swabs

QUALITY CONTROL
- Calibration
- Audit

PROCEDURE SAFETY
- What to do if there is needle stick injury/exposure to blood
- How to check BG of HIV/HBsAg+ve patient

Box 1. Stepwise factors for glucometric guardianship checklist.

Table 1. Infrastructure of Glucometric Guardianship

	Infrastructural requirement
Equipment	• Choice of the glucose monitoring device, e.g., Glucose meters vs. flash glucose monitoring device; glucose meters/FGMS model
	• Individual device or common device: e.g., prefer individual glucose meters if expected hospital stay of >2-3 days or if the expected number of glucometer pricks is >20
	• Glucose sticks: available at bedside/central station
	• Lancets: available at bedside/central station
	• Alcohol swabs: available at bedside or central station
	• Meter calibration: needed/not needed: at what frequency
Roles and responsibilities	• Glucose monitoring: by-
	• Data entry: by-
	• Analysis: by-
	• Disposal of used ancillary supplies: by-, at-
	• Red flag range: e.g., call duty doctor if plasma glucose <70 mg/dL and >400 mg/dL; check urine/blood ketones if BG >400 mg%
	• Treatment/titration: by-
	• Meter calibration: by-
Patient-specific glucometric guardianship	• Frequency of monitoring
	• Site of prick; rotation of fingers
	• De-escalation of frequency of monitoring: e.g., if BG 100-200 mg/dL; <20% change in consecutive glucose values at the current frequency
	• Escalation of frequency of monitoring: e.g., if BG <100 or >200 mg/dL; >20% change in consecutive glucose values

Table 2. Advantages of Glucometric Guardianship

• Accurate determination of glucose control
• Avoidance of hypo-/hyperglycemia
• Prevention of complications
• Facilitation of audit
• Comparison and research

ensures appropriate measurement, monitoring, and assessing glucose levels to ensure alertness in glycemic management and agility in anticipating and identifying suboptimal glycemic parameters and responding to them.[9] (Box 1)

In diabetes care, several well-developed algorithms are available for glycemic management in the inpatient and outpatient settings; however, they do not integrate the nuances of glucose monitoring. Thus, glucometric measurements act as a challenge as well as a facilitator to achieving optimal glucose control. Hence, a standardization of glucometrics and adopting a practice-based approach to glucometric guardianship is essential to improve the process of drug choice and dose titration.[9]

The objective of developing these checklists are: (i) to emphasize the need for accurate measurement, monitoring, and assessment of glucose levels to improve the management of diabetes; (ii) to facilitate the process of glucometric guardianship by outlining the steps and factors to consider when monitoring and analyzing blood glucose patterns in individuals with diabetes; (iii) standardize the process of glucose monitoring and ensure that health care providers have a systematic approach to managing blood glucose levels in different care settings.

Outpatient Glucose Monitoring

Glucose control is an imperative and essential component of outpatient deviations in blood glucose level care in diabetes. Clinical scenarios with better glucose control have been shown to improve patient outcomes. Glycated hemoglobin (HbA1c) can be used to assess the quality of outpatient glycemic control. Glucometrics has been shown to allow comparison of inpatient glycemic control among hospitals and patient care units and will allow institutions to evaluate the success of their quality improvement initiatives.[10]

The availability of point-of-care meters capable of storing glucose measurements from many patients eases, to some degree, the burden of data collection.[11]

Inpatient Glucose Monitoring

Inpatient hyperglycemia and hypoglycemia are related to worse patient outcomes, such as additional wound infections, prolonged hospital stays, and higher mortality rates, especially in ICU. In most cases, an inpatient target glucose range of 140-180 mg/dL may represent the optimal balance for avoiding complications associated with extraordinarily high- and low-glucose levels.[12]

Emergency/Casualty

Many patients reporting to emergency care could have hyperglycemia who may be undiagnosed. Uncontrolled hyperglycemia and iatrogenic hypoglycemia commonly occur with a broad range of adverse outcomes, with insulin commonly attributing to adverse drug events if the patient is a known case of diabetes on treatment. While insulin and hypoglycemia management protocols allow for managing patients in emergency care, there is a lack of glucometric standardization and limited resources acting as challenges in diabetes management.[13]

Checklist

As shown in the challenges in managing outpatient, inpatient, and emergency patients, we have attempted to devise CHECKLISTS to test, monitor and analyze the blood glucose pattern in individuals with diabetes presenting to the health care systems at different levels of point-of-care. Tables 3-6 and the Appendix 1-5 give the checklist and logs for outpatients, Ward patients, Emergency/Casualty, and ICU Checklists.

Table 3. Outpatient Checklist		
Patient ID	**Visit 1**	**Visit 2**
Procurement: • if the patient using a glucometer (which brand) • of a meter (which brand if patient not using glucometer) • of ancillaries, i.e., lancets, strips, swabs (which brand)	Procurement • Which brand of glucometer • Recommended brand of glucometer • Recommended brand of ancillaries • Comments, if any	Cross check availability of • Glucometer • Ancillaries
Usage pattern and training: • Individual/shared/family Training of • how to use the glucometer • Testing: change of lancet after how many pricks • How to share readings with the HCP	Individual ☐ Shared ☐ Family ☐ Done – Y☐ N☐ Done – Y☐ N☐ Done – Y☐ N☐ Comments, if any	Cross-check usage pattern and technique

Pre-testing hygiene:
• Time/Date of calibration
• Glucometer battery
• Sanitization
  a) Fingertip sanitization
  b) Glucometer Disinfection
• Needle
	• Time/Date
	• Glucometer
	• battery working Y☐ N☐
	• Sanitization Y☐ N☐
	  Done Y☐ N☐
	  Done Y☐ N☐
	• Needle Checked Y☐ N☐
	Comments, if any
		• Time/Date
		• Glucometer
		  battery working Y☐ N☐
		• Sanitization Y☐ N☐
		  Done Y☐ N☐
		  Done Y☐ N☐
		• Needle Checked Y☐ N☐
		Comments, if any

Testing: • Glucometer check • Confirm glucose units (mg or mmol) • Procedure of pricking/intensity of lancet prick	• Done – Y☐ N☐ • Done – Y☐ N☐ • Checked – Y☐ N☐	• Done – Y☐ N☐ • Done – Y☐ N☐ • Checked – Y☐ N☐

• Troubleshooting Frequency	• Done – Y☐ N☐ If Y, specify the reason Comments if any	• Done – Y☐ N☐ If Y, specify the reason Comments, if any
Frequency (Appendix 1,2)		
Recording: • Cross-checking glucometer data with the CBG log • E-enabled [Integrated personalized diabetes management (IPDM)] • On paper	• Done – Y☐ N☐ • Y☐ N☐ • Y☐ N☐	• Done – Y☐ N☐ • Y☐ N☐ • Y☐ N☐
Action: • Change in diet/physical activity. • Change in OAD • Change in insulin dose	• Done – Y☐ N☐ If Y, Specify. • Done – Y☐ N☐ If Y, Which OAD? • Done – Y☐ N☐ If Y Specify	• Done – Y☐ N☐ • If Y, Specify. • Done – Y☐ N☐ If Y, which OAD? • Done – Y☐ N☐ If Y Specify
Storage of strips Disposal: (home/hospital) • Plastics • Sharps • Blood-stained swabs	**Storage Done as per instruction Y☐ N☐** Disposal: Home (Y) or Hospital (Y) • Done – Y☐ N☐ • Done – Y☐ N☐ • Done – Y☐ N☐	• Crosscheck storage and disposal

Appendix 1: Glucose Monitoring Log [Outpatient]							
Date/Time	**BB**	**AB**	**BL**	**AL**	**BD**	**AD**	**3 am**	**Comments**

Week: ….Date Onwards

Date/Time	**BB**	**AB**	**BL**	**AL**	**BD**	**AD**	**3 am**	**Comments**

BB, BL, BD: Before Breakfast, Lunch, Dinner   AB, AL, AD: After Breakfast, Lunch, Dinner

Appendix 2: Diet log (Outpatient)	
Day/Time	**Diet log / changes in diet/ activity / illness next to the blood glucose levels**
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	

BB, BL, BD: Before Breakfast, Lunch, Dinner   AB, AL, AD: After Breakfast, Lunch, Dinner

Table 4. Ward Patients Checklist		
Ward ID	**Audit No. 1**	**Audit No. 2 onwards**
Procurement: • of meter (which brand?) • of ancillaries, i.e., lancets, strips, swabs (e.g., which brand)	• Recommended brand of glucometer • Recommended brand of ancillaries • Comments, if any	CMEs and CNEs should be conducted regularly (monthly or quarterly). This should be accompanied/ followed by audits at frequent intervals. These audits are targeted at ward nurses/diabetes educators. It is expected that these healthcare providers will disseminate the right knowledge to all patients admitted to their ward as well as their caregivers.
Usage pattern: • Individual • shared/beds	• Individual ☐ • Shared ☐	

Pre-testing practices:
• Glucometer battery
• Sanitization
  a) Fingertip sanitization
  b) Glucometer Disinfection
• Setting intensity of lancet prick
	• Glucometer battery working – Y☐ N☐
	• Sanitization
	• Done Y☐ N☐
	• Done Y☐ N☐
	• Done as per skin thickness over the fingertip Comments, if any	

Testing: • Glucometer check • Confirm glucose units (mg or mmol) Procedure of pricking • Loading the lancet • Rotating site of finger prick • Troubleshooting [poor circulation, lack of hygiene] • Check from the hand where the IV line is going on. • Check from the limb in which no dextrose infusion going on • Care of finger prick site after checking glucose	• Done – Y☐ N☐ • Done – Y☐ N☐ • Checked- Y☐ N☐ • Checked– Y☐ N☐ • Checked– Y☐ N☐ • Y☐ N☐ Comments, if any • Checked– Y☐ N☐ • Checked– Y☐ N☐	
Log (Appendix 3)		
Recording and analysis: • On paper	• Y ☐ N☐	

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Table 4. Ward Patients Checklist		
Ward ID	**Audit No. 1**	**Audit No. 2 onwards**
• E-enabled [Integrated personalized diabetes management (IPDM)] • Escalation matrix in place	•　　　　　　Y☐　N☐ •　　　　　　Y☐　N☐	
Action: • Change in diet • Change in frequency and timing of glucose testing. • Change in OAD/ insulin type. • Change in insulin dose. • Use of dextrose or any other IV fluids	• Done –　　Y☐　N☐ If Y, Specify • Done –　　Y☐　N☐ if Y, Specify • Done –　　Y☐　N☐ If Y, Which OAD? • Done –　　Y☐　N☐ If Y Specify	
Storage (e.g., strips) Disposal: hospital • Plastics • Sharps • Blood-stained swabs	• Storage Done as per instruction　Y☐　N☐ • Done –　　Y☐　N☐ • Done –　　Y☐　N☐ • Done –　　Y☐　N☐	

Appendix 3: Glucose Monitoring and Insulin and or OAD Log [Ward patients]									
Day/Time		**Fasting**	**AB**	**BL**	**AL**	**BD**	**AD**	**3 am**	**Comments (eg any change in diet, physical activity, illness, antibiotics)**
Date	Blood Glucose								
	Insulin Dose								
Date	Blood Glucose								
	Insulin Dose								
Date	Blood Glucose								
	Insulin Dose								
Date	Blood Glucose								
	Insulin Dose								
Date	Blood Glucose								
	Insulin Dose								
Date	Blood Glucose								
	Insulin Dose								
Date	Blood Glucose								
	Insulin Dose								

BB, BL, BD: Before Breakfast, Lunch, Dinner　**AB, AL, AD:** After Breakfast, Lunch, Dinner

Table 5. Checklist for Emergency/Casualty checklist		
	Audit 1	**Audit 2**
Procurement: • Type of glucometer- glucose oxidase or glucose dehydrogenase (which brand) of ancillaries i.e., lancets, strips, (which brand)	Procurement • Recommended brand of glucometer • Recommended brand of ancillaries Comments, if any	CMEs and CNEs should be conducted regularly (monthly or quarterly). This should be accompanied/followed by audits at frequent intervals. These audits are targeted at emergency nurses. It is expected that they will follow good glucometric practices. They should be able to refer the patient as well as their caregivers to the right healthcare provider upon discharge.
Usage pattern: • Individual bed • Shared beds	• Individual ☐ • Shared ☐	

Pre-testing practices Pre-testing practices:
• Glucometer battery
 	
• Sanitization.
  a) Fingertip sanitization
  b) Glucometer Disinfection
• Check from the hand where the IV line is going on
• Check from the limb in which no dextrose infusion going on
	• Glucometer battery working – Y☐ N☐
	• Sanitizatiion Y☐ N☐
	  Done Y☐ N☐
	  Done Y☐ N☐
	• Needle Checked Y☐ N☐
	Comments, if any	

Testing: • Glucometer check • Confirm glucose units (mg or mmol) **Procedure of pricking** • Care of finger prick site after checking glucose • Rotating site of finger prick • Troubleshooting [poor circulation, lack of hygiene]	• Done – Y☐ N☐ • Done – Y☐ N☐ • Checked – Y☐ N☐ • Checked – Y☐ N☐ • Checked – Y☐ N☐ Comments, if any	
Log (Appendix 4)		
Recording: • E-enabled matrix /hospital information system	• Done – Y☐ N☐	

Action:
• Change in insulin dose/insulin type.
 	
• Last Insulin dose and time before discharge.
 	
• Escalation/Descalation matrix.
	• Done – Y☐ N☐
	  If, Y Specify dose & type,
	• Last Insulin dose…………........
	  time before discharge……….
	• Specify	

Storage of strips Disposal: hospital • Plastics • Sharps • Blood-stained swabs	• Storage Done as per instruction – Y☐ N☐ • Done – Y☐ N☐ • Done – Y☐ N☐ • Done – Y☐ N☐	

Appendix 4: Frequency of monitoring and insulin log [Emergency/Casualty patients]

Date: …………………

Type of Insulin……………….

Day/Time	8 am	8:15 am	8:30 am	8:45 am	9:45 am	11:00 am	
GCS							
Plasma Glucose							
IV Infusion							
Oral Intake							
Insulin							

Date:

Table 6. CHECKLIST for ICU patients

Patient - Name	Audit 1	Audit 2
Procurement:	Procurement	CMEs and CNEs should be conducted regularly (monthly or quarterly). This should be accompanied/followed by audits at frequent intervals.
• Type of glucometer- glucose oxidase or glucose dehydrogenase (which brand) of ancillaries, i.e., lancets, strips, (which brand)	• Recommended brand of glucometer • Recommended brand of ancillaries • Comments, if any	This audit is targeted at ICU nurses. It is expected that they will follow good glucometric practices. They should be able to refer the patient as well as their caregivers to the right healthcare provider upon discharge.
Usage pattern of glucometer: (tick any)		
• Individual or	• Individual ☐	
• Shared	• Shared ☐	
Pre-testing practices:		
• Glucometer battery (check after how much time)	• Glucometer battery working – Y☐ N☐	
• Sanitization;	• Sanitization	
a) Fingertip sanitization	• Done Y☐ N☐	
b) Glucometer Disinfection	• Done Y☐ N☐	
• Check from the hand where the IV line is going on	• Checked Y☐ N☐	
• Check from the limb in which no dextrose infusion going on	Comments, if any	
Testing:		
• Glucometer check	• Done – Y☐ N☐	
• Confirm glucose units (mg or mmol)	• Done – Y☐ N☐	
Procedure of pricking		
• Care of finger prick site after checking glucose	• Checked – Y☐ N☐	
• Rotating site of finger prick	• Checked – Y☐ N☐	
• Troubleshooting [poor circulation, lack of hygiene]	• Y☐ N☐	
	Comments if any	
Log (Appendix 5)		
Recording:		
• E-enabled system (Hospital information system)	• Done – Y☐ N☐	
• On paper (Structured Reports)	• Done – Y☐ N☐	

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Table 6. CHECKLIST for ICU patients		
Patient - Name	**Audit 1**	**Audit 2**
Action:		
• Change in insulin dose/type • Escalation/ Descalation rules /	• Done – Y☐ N☐ If Y Specify dose & type, • Y☐ N☐ Comments, if any	
Storage (e.g., of strips) Disposal: hospital • Plastics • Sharps • Blood-stained swabs	• Storage Done as per instruction Y☐ N☐ Done – Y☐ N☐ Done – Y☐ N☐ Done – Y☐ N☐	

Appendix 5: Frequency of Monitoring and Insulin and or OAD Log [ICU Patients]									
Day/Time	**Fasting**	**2 hours After Breakfast**	**BL**	**2 hours after lunch**	**BD**	**2 hours after dinner**	**3 am**	**Random**	
		BG/Insulin Rate						Time	Glucose value
Monday									
Tuesday									
Wednesday									

Week:….Date Onwards

Day/Time	**8 am**	**10 am**	**Noon**	**2 pm**	**4 pm**	**6 pm**	**8 pm**	**Random**
		BG/Insulin Rate						
Monday								
Tuesday								
Wednesday								

Week:….Date Onwards

Conclusion

Glucometric guardianship aims to ensure optimal glycemic management. It is a process of allowing appropriate assessment, monitoring, and analysis of glucose levels regularly. The aim of glucometric guardianship is to (i) enable alertness in glycemic management; (ii) agility in anticipating and detecting suboptimal glycemic parameters, and (iii) response to glycemic variability. The checklists developed in the article will enable healthcare providers to enhance glycemic management, anticipate and identify suboptimal glycemic parameters, and respond effectively to glycemic variability.

Acknowledgment

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