Roche

Frontiers in DIABETES

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Regular self-monitoring of blood glucose reduces diabetes mellitus-related comorbidities

InTouch

Tools for quality improvement to handle emergency ambulance callbacks from diabetic patients

Reference: Farhat H et al. Quality improvement tools to manage emergency callbacks from patients with diabetes in a prehospital setting. BMJ Open Quality 2023;12:e002007.

- One in ten adults around the world are currently living with diabetes.
- The incidence of diabetes and the number of emergencies connected to it, like hypoglycemia and diabetic coma, are gradually rising.
- Once patients are medically stabilized in an emergency, paramedics must transport them to the proper healthcare facility.
- Some patients, though, decline hospital transportation after getting on-site emergency care.
- However, they often return with similar complaints within a short span of time. This causes delays in providing final medical care.

Study Objective

To test the hypothesis: Providing appropriate diabetes education to patients by Medical Ambulance Service, it would reduce the occurrence of diabetes-related emergencies and consequently reduce their callback rates within 72 hours

Results:

- In 37.58% of cases, callbacks took place within 72 hours.
- Hospital transport refusal calls accounted for 87.7% (52.27% females) of hyperglycemic emergencies and 12.3% of hyperglycemic cases.
- Patients with diabetes who declined to be sent to the hospital, had an average age of 61.89 years.
- The number of patients with random blood sugar (RBS) levels between 12 mmol/L and 16.65 mmol/L was higher than those with RBS levels >16.65 mmol/L.
- Providing adequate health education could reduce transport refusals, ambulance callbacks, and save resources. Thereby increasing the number of ambulances available to respond to other emergency calls.

“By providing proper health education, emergency callbacks could be decreased, freeing up resources for other emergency calls.”

Diabetic retinopathy: Future perspective

Reference: Tan TE et al. Diabetic retinopathy: Looking forward to 2030. Front Endocrinol (Lausanne). 2023 Jan 9;13:1077669.

- About 30 to 40 percent of people with diabetes develop diabetic retinopathy (DR), the main visual consequence of diabetes mellitus.
- More than 100 million people worldwide have DR, and it is a major contributor to blindness and visual impairment, particularly in working-age adults.
- The rates of vision loss from diabetes and DR have steadily decreased over the past few decades as a result of improved systemic risk factor control as well as recent advancements in the assessment, screening, imaging, and treatment of ocular diseases.

Study Objective To review the recent progress that has been made, and suggest how these developments may continue to shape the field in 2030 and beyond.

Results:

- A 25% increase in the global prevalence of diabetic macular edema (DME), to about 24 million individuals by 2030.
- As a result, the costs of healthcare are projected to increase.
- The rates of increase in DR prevalence for historically high-income regions like North America and Europe appear to be relatively low, ranging from 10.8 to 18.0%, according to epidemiologic predictions through 2030.
- The growth rates in middle- and low-income regions, such as the Western Pacific (WP), South and Central America, Asia, Africa, the Middle East, and North Africa (MENA), are significantly greater, ranging from 20.6% to as high as 47.2%.
- Global health measures to combat DR will need to adapt to the changing disease population as a result of the geographic shift in disease burden towards Asia, Africa, and WP.
- In these regions, there is an urgent need for healthcare resources for DR screening, diagnosis, follow-up, and treatment.

New imaging modalities and biomarkers

Ultra-widefield (UWF) retinal imaging

- Provides a field of view of about 110° to 220°, and allows for visualization up to at least the anterior edge of the ampullae of the vortex veins
- Noncontact and often do not require pupillary mydriasis
- Provide assessment of the retinal peripheries, and overall a much larger retinal surface area than standard color fundus photography (CFP)

Optical coherence tomography angiography (OCTA)

- Non-invasive, non-contact system that can provide angiographic information without the need for invasive dye administration like fluorescein
- Better visualization of the capillary microvasculature, and depth-resolved segmentation of the superficial, middle and deep capillaries plexuses, which are differentially affected in diabetes and DR
- Provide quantitative metrics relating to the retinal microvasculature, and many of these, such as lower vessel density, lower fractal dimension, greater tortuosity, and greater foveal avascular zone area

Artificial intelligence

- Over the coming decade, deep learning (DL) and artificial intelligence (AI) algorithms will become more and more crucial in the domains of medical diagnostics, screening, prognostication, and aiding in management or treatment decisions.
- An AI algorithm as an assistive tool in a large-scale DR screening program will be associated with significant cost savings.
- AI-based detection of DME from CFP images is promising and could help to improve and reduce false positive referral rates from DR screening programs.
- An attractive area to look forward to is the application of AI to analyze multimodal clinical and imaging data in DR to provide more precise prognostication of long-term results, including visual outcomes, risk of developing incident DME, and anti-Vascular endothelial growth factor (VEGF) therapy burden in DME.

New treatment strategies

Anti-VEGF therapy	● First-line treatment for DME ● A valid treatment option for proliferative DR (PDR) ● Significant improvements in DR severity for patients with non-proliferative DR
Intravitreal aflibercept	● FDA-approved for treatment of non-proliferative DR, as well as PDR and DME
Bi-specific monoclonal antibody	● Dual inhibition of both the VEGF and the angiopoietin (Ang) and tyrosine kinase with immunoglobulin-like and epidermal growth factor homology domains (Tie) pathways ● Provides substantial visual gains ● Had a durable treatment effect, with more than 70% and 50% of eyes reaching dosing intervals of every 12 to 16 weeks, and 16 weeks respectively at 1 year

“Many of these novel imaging, diagnostic, and therapy techniques could greatly enhance clinical results in DR.
If we want to continue seeing declines in the rates of visual loss and blindness from DR in 2030 and beyond, advances in DR management must be accessible to patient populations in low-resource settings, according to epidemiologic projections.”

DR, diabetic retinopathy; DME, diabetic macular edema; WP, Western Pacific; MENA, Middle East, and North Africa; UWF, Ultra-widefield; CFP, color fundus photography;
OCTA, Optical coherence tomography angiography; DL, deep learning; AI, artificial intelligence; Anti-VEGF, anti-vascular endothelial growth factor; PDR, proliferative DR ; AGN, angiopoietin; Tie, tyrosine kinase;

Self-monitoring of blood glucose for patients with insulin-dependent diabetes

Reference: Ruderman T et al. Implementation of self-monitoring of blood glucose for patients with insulin-dependent diabetes at a rural non-communicable disease clinic in Neno, Malawi. S Afr Med J. 2023 Feb 1;113(2):84-90.

- Self-monitoring of blood glucose (SMBG) affects glycaemic control in two ways: first, by making patients more aware of their blood glucose levels, and second, by giving healthcare professionals information that permits more precise titration of insulin dosages.
- Home blood glucose monitoring is possible and acceptable in high-resource environments, and more frequent SMBG is associated with lower glycated hemoglobin (HbA1C) levels.
- The importance of SMBG is emphasized in international guidelines for assuring patient safety, reducing complications, and fostering individualized self-management in people with diabetes, particularly those using insulin.

Study Objective	To evaluate adherence and change in clinical outcomes with SMBG implementation at two rural hospitals in Neno, Malawi
Study Design	A prospective 6-months cohort study
Study Population	N= 48 patients with type 1 and insulin-dependent type 2 diabetes
Study Outcomes	Adherence: Primary outcome Glycaemic variability: Secondary outcome

Results:

- About 94% and 100% of patients brought their glucometers and logbooks to the clinic, with an overall average of 98%.
- The mean (standard deviation) percentages of participants for monthly compliance with planned glucose checks, the correctness of logbooks, and both were 69.4% (15.7), 69.0% (16.6), and 66.4% (17.0), respectively.
- Participants with primary or no education and those with type 2 diabetes had improved over time in adherence to scheduled checks and accuracy of logbooks, according to trends highlighted by stratification by education and diabetes type.
- At enrollment, the cohort's mean HbA1C was 9.0% (75 mmol/mol), and at six months, it was 7.8% (62 mmol/mol) (mean difference 1.2%; p=0.0005).
- Patients with type 1 diabetes had a mean difference between baseline and end-line that was higher (p=0.0031) than those with type 2 illness (p=0.0630, Figure 1).

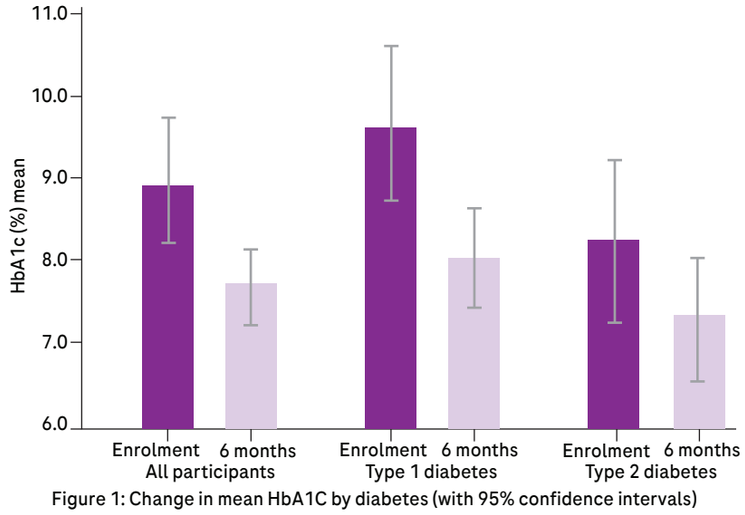

Figure 1: Change in mean HbA1C by diabetes (with 95% confidence intervals)

Adapted from: Ruderman T et al.

"In a rural sub-Saharan African population, SMBG is practical for individuals with insulin-dependent diabetes and may lead to lower HbA1C levels. Implementing SMBG is linked to a reduction in the average HbA1C level."

Bridge to Excellence

Reference: Cardiovascular Disease and Risk Management: Standards of Care in Diabetes-2023. Diabetes Care 2023;46(Supplement_1):S158–S190

Q.1. ADA recommends a comprehensive approach to the reduction in risk of diabetes-related complications with a combination of:

A. Management of glycemia, blood pressure, and lipids and the incorporation of specific therapies with cardiovascular and kidney outcomes benefit
B. Management of glycemia, blood pressure, and lipids
C. Management of glycemia, blood pressure and incorporation of specific therapies with cardiovascular and kidney outcomes benefit

Q2. ADA recommends: All people with hypertension and diabetes should monitor their blood pressure at home

A. True
B. Falls

Q3. People with diabetes and hypertension qualify for antihypertensive drug therapy when the blood pressure is persistently elevated

A. ≥150/80 mmHg
B. ≥120/80 mmHg
C. ≥130/90 mmHg
D. ≥130/80 mmHg

Q4. People with type 2 diabetes with or at high risk for ASCVD, heart failure, or CKD should be treated with

A. SGLT2 inhibitor and/or GLP-1 receptor agonist
B. SGLT2 inhibitor
C. GLP-1 receptor agonist

(Please check answers on the last page)

Diabetes Connect

Cost and complications of diabetes: Indian view

Reference: Kansra P et al. Cost of diabetes and its complications: results from a STEPS survey in Punjab, India. Glob Health Res Policy. 2023; 8: 11.

Introduction:

The expense of treating and controlling diabetes is increasing as epidemiological problems are becoming more prevalent at an exponential rate.

Study Objective	To estimate the cost of diabetes and identify the determinants of the total cost among diabetic patients
Study Design	A cross-sectional study
Study Population	N= 720

Results:

- When compared to the costs experienced by rural respondents, the average direct and indirect costs are higher among urban respondents ($p < 0.05$), which is a significant difference.
- In terms of outpatient care, female respondents' mean direct and indirect costs were greater than those of male respondents.
- Age manifests eccentric results; respondents under the age of 20 paid the greatest mean direct outpatient care cost of Indian Rupee (₹) 52,104; whereas, respondents between the ages of 21 and 40 paid the highest mean indirect cost.
- Respondents 60 years of age and above incurred significant direct (₹ 41,482) and indirect (₹ 4818) costs related to inpatient treatment.
- Both direct and indirect expenditures for outpatient care increased steadily with the amount of education, demonstrating a statistically significant difference.
- The expense of diabetes is significantly influenced by the family history of the disease.
- When compared to respondents without a history of diabetes, respondents with a history of diabetes spent more money directly on an outpatient (₹ 36,936) and inpatient (₹ 37,104) care ($p = 0.013$; $p = 0.024$).
- Respondents with complications spent statistically significant amounts more on outpatient (₹ 41,940, $p = 0.000$; ₹ 10,728, $p = 0.004$) and inpatient (₹ 41,875, $p = 0.000$; ₹ 4819, $p = 0.001$) care per year (p 0.05).
- The mean total cost of diabetes was ₹ 49,037 of which the total direct cost was 93% and the total indirect cost was 7%.
- Expenditure on medicine was the highest cost component of diabetes and accounts for 64% of the direct cost and 60% of the total cost of diabetes.
- Gender, complications, income, history of diabetes and work status were statistically significant determinants of the total cost.
- The economic haunting of diabetes could be restrained by early identification and prevention of diabetes complications.

“A rapid increase in the median annual direct and indirect cost from ₹15,460 and ₹3572 in 1999 to ₹34,100 and ₹4200 reported in India (Punjab), which is approximately 2.5 times for direct cost and 1.2 times for indirect costs.
Outpatient care should be reimbursed under the "Ayushman Bharat-Sarbat Sehat Bima scheme" to cut expenses, and the use of generic medications should be encouraged.”

"AYUSHMAN BHARAT-MUKH MANTRI SEHAT BIMA YOJANA" is a flagship State Health Insurance Program of the Government of Punjab. A health insurance cover of 5 lakh rupees per family per year for secondary and tertiary care hospitalization (in-patient services) for treatment of listed diseases and medical conditions.. The Scheme covers 1579 treatment packages that include hospitalization expenses, daycare surgeries, 3 days pre and 15 days post-hospitalization expenses.
Available Online at:https://sha.punjab.gov.in/shapunjab/index.php

Diabetes in Control

A Case Study of Self-Monitoring of Blood Glucose

Case history:

A 69-year-old woman was diagnosed with type 2 diabetes in June 2011. Before diagnosis the patient had not used any oral or parenteral steroids nor had she experienced any traumatic physical or emotional event or illness that could have abruptly increased her blood glucose. Metformin 500 mg twice daily was initiated at diagnosis, but was discontinued 9 days later to avoid risk of lactic acidosis, as her serum creatinine was 1.5 mg/dL.

Physical examination:

- Weight: 72.7 kg
- Height: 149.86 cm
- BMI: 32.3 kg/m^2

Laboratory tests

- A1C: 17.6%
- Fasting blood glucose (FBG): 452 mg/dL (25.1 mmol/L)
- Fasting self-monitoring of blood glucose (SMBG): 185 - 337 mg/dL (10.3- 18.7 mmol/L)

Treatment recommendations:

Treatment with 25 units of insulin detemir daily (0.34 units/kg/day) was initiated in place of metformin. The patient was counseled on diet modifications, encouraged to exercise, and use SMBG. (recording readings for 1–3 times/day)

Follow-up:

1st Follow-up

- One month later, the patient's fasting SMBG values had improved to a range of 71–212 mg/dL with a single hypoglycemic episode (58 mg/dL); her weight and BMI increased slightly to 74.1 kg and 32.9 kg/m^2, and insulin therapy was switched from 25 units to 28 units (0.38 units/kg/day) of insulin glargine.

2nd Follow-up

- Two weeks later, the patient reported continued improvements in fasting SMBG (70–175 mg/dL) with one hypoglyce mic episode (67 mg/dL).
- In response to the hypoglycemic episode, her insulin glargine dose was decreased to 25 units daily.

3rd Follow-up

- In September, the patient reported fasting SMBG values ranging between 71 and 149 mg/dL, and her A1C was 7.9%.
- On days when the patient skipped lunch, her midday blood glucose level would drop to <70 mg/dL (54–60 mg/dL).
- She was counseled not to skip meals, and her insulin glargine dose was maintained.

4th Follow-up

- In October, the patient's weight was 71.4 kg, and her BMI was 31.7 kg/m^2.

- She reported recently initiating a cinnamon supplement and switching her beverage intake from sugar-sweetened products to water.

5th Follow-up

- In December (5th visit), her SMBG values ranged between 70 and 106 mg/dL pre-prandial and 111 and 207 mg/dL postprandially, and she had had six additional hypoglycemic episodes (42–66 mg/dL).

- The patient's weight remained stable at 71.4 kg (BMI 31.7 kg/m^2).

- At this follow-up visit, her daily insulin glargine dose was decreased (15 units subsequently).

6th Follow-up

- The patient self-discontinued daily insulin glargine in March 2012 but continued using the cinnamon supplements.

- She continued to perform SMBG 1–3 times/day, anticipating loss of glycemic control.

- During the next 2 years, her A1C remained stable (from 6.3% in January 2012 to 6.9% in May 2014).

Discussion:

An essential part of contemporary treatment for diabetes mellitus is self-monitoring of blood glucose (SMBG). To reach a certain level of glycemic control and avoid hypoglycemia, SMBG has been suggested for patients with diabetes and their medical experts. People with diabetes should check their blood glucose levels more frequently at different intervals. Many medical professionals concur that individuals on insulin should check their blood sugar at least four times a day, most frequently before meals, before night, and when fasting. Additionally, postprandial blood glucose levels can help patients who use insulin more precisely adapt their insulin regimen.[1]

In this case, even though weight changes did not appear to be associated with disease remission, the mild weight loss (6.5%) attained during the drug-free time and continuing SMBG may have both helped to keep the remission phase going. According to the Diabetes Prevention Program lifestyle changes targeted at a 7% weight loss effectively postpone the onset of diabetes compared to placebo and metformin. Finally, by presenting the patient with the objective standards required to validate the advantages of lifestyle changes, doing SMBG throughout the drug-free period may have empowered the patient.[2]

SMBG can play an important role in improving metabolic control in patients with diabetes. Judicious use of SMBG data can help to improve glycemic control and provide powerful feedback to patients wishing to improve metabolic control.

References: 1. Benjamin EM et al. Self-Monitoring of Blood Glucose: The Basics. Clinical diabetes. 2002;20(1):45-47. 2. Schmidt SC et al. Case Study: Remission of Type 2 Diabetes After Outpatient Basal Insulin Therapy. Diabetes Spectr. 2016 Feb; 29(1): 50–53.

Spotlight

Regular self-monitoring of blood glucose reduces diabetes mellitus-related comorbidities

Reference: Mohan V et al. Reduced Diabetes Mellitus-related Comorbidities by Regular Self-monitoring of Blood Glucose: Economic and Quality of Life Implications. Indian J Endocrinol Metab. 2018 Jul-Aug; 22(4): 461–465.

Introduction:

The International Diabetes Federation (IDF) and American Diabetes Association (ADA)

To estimate the cost of diabetes and identify the determinants of the total cost among diabetic patients

Barriers to compliance with self-monitoring of blood glucose (SMBG)

Cost of the equipment
Recurrent cost of disposables
Lack of awareness
Literacy levels
Perception that SMBG is painful

Study Objective

To understand the role of SMBG for better management of glycemic fluctuations, reducing the risk of complications, and the associated cost benefits for diabetes patients in India

Results:

- Table 1 shows expected cost of monitoring diabetes and treating complications associated with diabetes.

Table 1: Costs of monitoring type 2 diabetes mellitus and disease related complications

Component	Cost in INR	Cost in USD	Source
Cost of monitoring with SMBG			
SMBG per test	26	0.31	JnJ India
SMBG (m)	1540	18.52	JnJ India
Cost of complications			
Severe hypoglycaemic event(event cost)	5070	60.98	Expert opinion (Indian physicians)
Cardiovascular complications (annual cost)	214,236	2576.94	Kumpatla *etal.* 2013
Foot complications(annual cost)	160,677	1932.71	Kumpatla *etal.* 2013
Eye complications(annual cost)	107,118	1288.47	Kumpatla *etal.* 2013
Renal complications(annual cost)	107,118	1288.47	Kumpatla *etal.* 2013

INR: Indian rupee, SMBG: Self-monitoring of blood glucose

- In type 2 diabetes mellitus patients, risk of complications has been directly related to HbA1C level, i.e., the risk of complications decreases with a decrease in HbA1C level (Table 2, The prevalence rates of diabetes-related complications were taken from the DiabCare India 2011 Study).

Table 2: Risk of Complications

	Risk of complication(%)	Reduction in risk due to 1% drop in HbA1C (%)	Reduction in risk due to 0.7% drop in HbA1C (%)	Risk for no SBMG patients (%)	Risk for patients conducting 1 SMBG per day (%)	Source
Cardiovascular complications	6.80	14.00	10.02	6.80	6.12	DiabCare India 2011 study for baseline risk and UKPDS 35 study for risk reduction
Foot complications	32.70	43.00	32.53	32.70	22.06	
Eye complications	19.70	19.00	13.71	19.70	17.00	
Renal complications	6.20	37.00	27.63	6.20	4.49	
Hypoglycemia	11.50	NA	NA	11.50	11.50	Lipska *etal.* 2013

NA: Not available, SMBG: Self-monitoring of blood glucose, HbA1c: Hemoglobin A1C, UKPDS: UK Prospective Diabetes Study

- A type 2 diabetes patient is at high risk of complications with a baseline HbA1c of 8.9% and no SMBG monitoring, putting him at a financial risk of INR 838,513 over a 10-year time horizon.
- In contrast, a patient who underwent SMBG once every day for 10 years at an additional cost of INR 26 per day would experience fewer problems and a lower financial risk of INR 718,340 (Table 3).

Table 3: Cost burden reduction with single self-monitoring of blood glucose over 10 years

Complication cost factor	Risk adjusted cost for no SMBG cohort (INR)	Risk adjusted cost for single SMBG per day cohort (INR)
Cost of complications		
Cardiovascular	127,997	115,172
Foot	461,635	311,466
Ocular	185,407	159,980
Renal	58,351	42,227
Hypoglycemia	5,123	5123
Cost of monitoring with SMBG		
Cost of 7 SMBG tests/week	0	82,832
Cost of SMBG meter	0	1540
Total costs over 10 years, discounted to present value	838,513	718,340

SMBG: Self -monitoring of blood glucose, INR: Indian rupee

- In comparison to patients who do not frequently undergo SMBG testing, those who do so would have a reduction in the financial risk of about INR 120,173 over ten years.
- This cost savings is the result of patients undergoing SMBG testing having less expensive diabetes-related problems.
- The potential cost of complications can be significantly decreased by implementing a once-daily SMBG program for 10 years.
- Along with lifestyle adjustments, more regular SMBG and HbA1C testing can significantly lessen the patient's lifetime financial burden.
- To guarantee the best adherence to suggested regimens, diabetes patients need thorough training in SMBG.
- The affordability of the necessary tools and the accessibility of test strips are essential components of compliance.

"Diabetes can be actively managed with SMBG to enhance treatment results and lower the morbidity and mortality that come with the condition.
By reducing long-term consequences and avoiding recurring hospitalizations for the management of such complications, near-normal blood glucose levels can cut costs while also improving quality of life."

Answers

1. **A.** Management of glycemia, blood pressure, and lipids and the incorporation of specific therapies with cardiovascular and kidney outcomes benefit
2. **A.** True
3. **D.** ≥130/80 mmHg
4. **A.** SGLT2 inhibitor and/or GLP-1 receptor agonist

Abbreviations: RBS, random blood sugar; DR, diabetic retinopathy; DME, diabetic macular edema; WP, Western Pacific; MENA, Middle East, and North Africa; UWF, Ultra-widefield; CFP, color fundus photography; OCTA, Optical coherence tomography angiography; DL, deep learning; AI, artificial intelligence; Anti-VEGF, anti-vascular endothelial growth factor; PDR, proliferative DR ; AGN, angiopoietin; Tie, tyrosine kinase; SMBG, Self-monitoring of blood glucose; HbA1C, glycated hemoglobin; ADA, American diabetes association; IDF, International Diabetes Federation; NA; Not available, UKPDS;UK Prospective Diabetes Study; SGLT2 inhibitors, Sodium-glucose Cotransporter-2 inhibitors; GLP-1, Glucagon-like peptide 1

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