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# Alphabetical approach to managing Type 1 diabetes in a limited resource setting: implications and solutions- a perspective from India

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## Abstract

Type 1 diabetes (T1D) is characterized by the progressive loss of pancreatic beta cells, resulting in insulin deficiency. This condition requires exogenous insulin therapy to prevent fatal complications caused by hyperglycemia. Effective management of T1D also includes structured diabetes education, proper nutrition, addressing psychosocial issues, and managing comorbidities. Additionally, various challenges must be addressed at different stages of life. Managing T1D in a limited resource setting presents numerous challenges for healthcare professionals. However, an alphabetical approach can help to deliver comprehensive management of T1D and achieve the best possible outcome in a limited resource setting.

***Keywords:*** *type 1 diabetes management, resource-limited settings, insulin administration, diabetes education, blood glucose monitoring, accessible healthcare solutions*

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## Evidence in Context

- Introduces an alphabetical diabetes management strategy for resource-limited settings.
- Emphasizes symptom-based diagnosis and tailored insulin protocols.
- Highlights the importance of standardized education and empowerment.
- Stresses regular glucose monitoring and insulin adjustments.
- Advocates for holistic care and accessible treatment options.

To view Article

## Introduction

Limited-resource settings (LRS) are frequently utilized as an umbrella term in the context of global health due to their ease of operationalization. In the realm of diabetes care, LRS is often defined by the lack of access to medications, insulin, equipment and quality diabetes care. This can be due to insufficient funds to cover healthcare expenses, limited facilities to introduce the latest medical technologies, and inadequate availability of healthcare education, infrastructure, and workforce [1]. LRS often coexists with socio-demographics such as poverty, low literacy rates, stigma, myths, cultural beliefs, and discrimination. Multiple studies describe the multitude of problems encountered in diabetes management in a resource-poor setting[2-4]. Some of the barriers to effective treatment are practical, but there are also political, cultural, and social issues that must be attended.

India is one such nation that has LRS existing within its often complex, fragmented health system that is grappling with a growing burden of non-communicable diseases such as diabetes. Sadly, it has not yet achieved the best-known standards of care, leaving millions of people living with diabetes facing the negative consequences of high healthcare expenditure, out-of-pocket costs, and high rates of diabetes-associated complications. Despite significant progress, disparities in healthcare access still need to be critically addressed. To achieve the best possible outcomes in diabetes management, it's important to make the most of the resources available to us, even when those resources may be limited.

India faces a multitude of challenges on different levels- social, economic and healthcare systems. In the context of the healthcare system, there are inadequately trained staff involved in the management of T1D, a lack of a structured diabetes education program, lack of free supplies of insulin and glucose meters and strips. In such a scenario, this approach can act as a helpful resource in managing T1D, to optimize therapeutic outcomes and provide the best care possible [5]. The approach (Figure 1) has been prepared considering the consensus of the International Society of Adolescent and Pediatric Diabetes (ISPAD) Clinical Practice Consensus Guidelines 2022: Management of the Child, adolescent, and young adult with Diabetes in limited resource settings [6] and the recommendation by the American Diabetes Association (ADA) [7].

**Alphabetical approach**

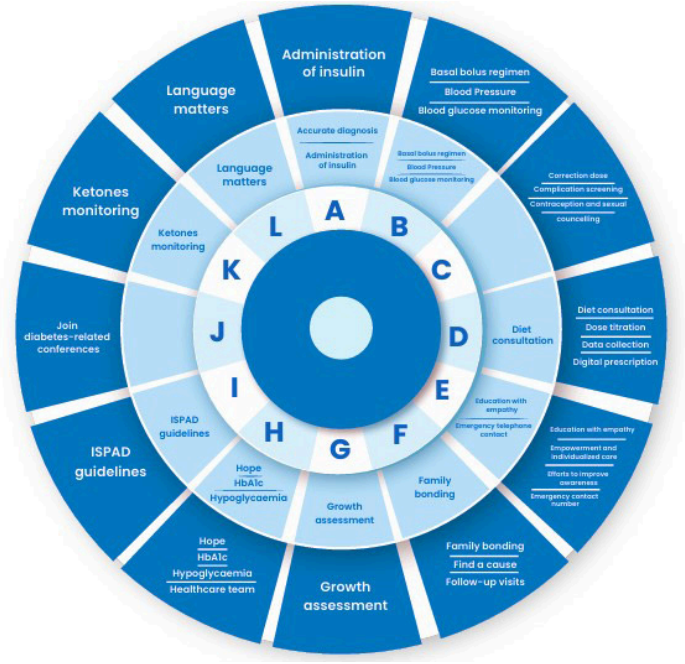


**Figure 1: Management of type 1 diabetes presented alphabetically. The inner circle represents the minimum that needs to be undertaken for PwD. The outer circle represents the comprehensive care required in restricted settings.**

- **Accurate diagnosis**

The diagnosis of T1D is based on elevated plasma glucose levels and HbA1c. One must pay attention to the history given by the family/caregiver. Symptoms include glycosuria, which causes polyuria and nocturia, and uninhibited gluconeogenesis due to lack of insulin, which causes protein and fat breakdown, resulting in dramatic weight loss, emaciation and failure to thrive may be the first noticeable symptoms in children. In addition, persistent hyperglycemia can lead to diabetic ketoacidosis, which requires hospitalization. Measurement of islet autoantibodies, C-peptide, or genetic testing is not routinely recommended for the diagnosis of T1D in LRS, and can be done if the type of diabetes is unclear [6]. The American Diabetes Association (ADA) 2024 Standard of Care recommends testing for antibodies, mainly glutamic acid decarboxylase (GAD), for further confirmation. If negative, islet tyrosine phosphatase 2 (IA-2) and/or zinc transporter 8 (ZnT8) should be followed. C-peptide values should be checked when hyperglycemic crises resolve. C-peptide values of 0.6-1.8 ng/mL are generally consistent with a confirmatory diagnosis of T1D [7].

At certain constraints settings, there is no facility to perform genetic tests. Moreover, the cost of the tests is higher and affordability is the major issue. In such scenarios, diagnosis can be confirmed from elevated plasma glucose levels, higher HbA1c and a history of DKA at diagnosis.

**Administration of insulin, storage, and disposal**

Insulin should be injected into the subcutaneous tissue at the abdomen, lateral aspect of the arm, front of thighs/lateral thighs, or lateral upper quadrant of the buttocks. In the same sequence, the rate of absorption is quick, intermediate, and slow.

Several other aspects should be considered,

- Rotation of insulin injection sites within the same injection region and needle must be changed daily. In the case of children and adolescents, 4 mm needles are the safest.
- A two-finger pinch-up technique is conventionally recommended to ensure proper insertion of a subcutaneous injection.
- A delay of 10-15 seconds after pushing in the plunger helps to ensure complete administration of insulin.
- The insulin pen can be kept at room temperature. Extra cartridges should be stored in the door of the refrigerator (2-8 degrees Celsius).
- Check insulin before use, and discard it if it is frozen. Keep an eye on the expiration date of the insulin and plan beforehand to avoid a shortage of insulin. In case of lack of a refrigerator, double-layered clay pots can be used. (Figure 2)
- Sharps should be collected in a thick plastic container with a fitted cap and carried to a healthcare centre for safe disposal. (Figure 3)
- Check for lipodystrophy and if present it is advisable to leave that insulin site. Change the needle and injection site to prevent lipodystrophy. SELFIE- Self Insulin Site Examination should be encouraged. Examination and palpation of injection sites should be performed at each visit. Appropriate insulin administration will help to optimize glucose levels and prevent lipodystrophy [8].

**Figure 2: A water-filled clay pot used to store insulin vials [9]**

**Figure 3: Insulin storage technique (Shared with permission from a patient at Diacare, Ahmedabad)**

- **Basal Bolus therapy**

Analog insulin has to be the first choice of treatment as it mimics physiologic insulin secretion and offers benefits as compared to conventional insulin regimens. The starting dose is decided based on body weight, ranging from 0.4 to 1 unit per kilogram body weight [7].

Life for A Child supplies basal insulin in India, reducing families' out-of-pocket expenses and overall healthcare burden. In some states, the government provides basal insulin in vials, further alleviating the financial burden on families. Pre-mixed insulins have drawbacks including increased acute and chronic complications. This makes them unsuitable for managing T1D, despite any potential financial advantages [10].

**Blood Pressure (BP)**

BP should be measured at every clinical visit and recorded [6]. Use an appropriate-sized cuff and take measurements while seated and relaxed. Elevated blood pressure readings should be confirmed on at least three separate days [6]. Hypertension is linked to the risk of developing retinopathy and nephropathy [11] and treatment involves lifestyle changes such as healthy eating, physical activity, weight management, and sufficient sleep. If the child is over 13 years old and their blood pressure is above 130/80 mm Hg, ACE inhibitors or angiotensin receptor blockers should be chosen for treatment. However, these medications should be avoided in females of childbearing age [7].

**Blood glucose (BG) monitoring**

This practice is the only way to effectively manage blood glucose and achieve glycemic targets. Setting glycaemic targets is recognized as a standard practice by ISPAD, and ADA [6] [7] BG should be performed at each clinical visit and the normal range is between 80-180 mg/dl [12]. The BG targets depend on factors like the age of a child, literacy rate, family circumstances, and hypoglycaemia awareness [13].

Self-monitoring should be taught during the first and subsequent visits as necessary. Ideally, multiple daily BG tests should be performed. However, it is recommended to check BG at least before meals and bedtime to determine the appropriate insulin dose and prevent nocturnal hypoglycaemia. Bluetooth glucose meters are currently available that are convenient to capture real-time BG values [14]. The associated application offers features like alerts, real-time BG graphs, and personalised advice. (Figure 4) These advancements help alleviate diabetes distress in both parents and children.

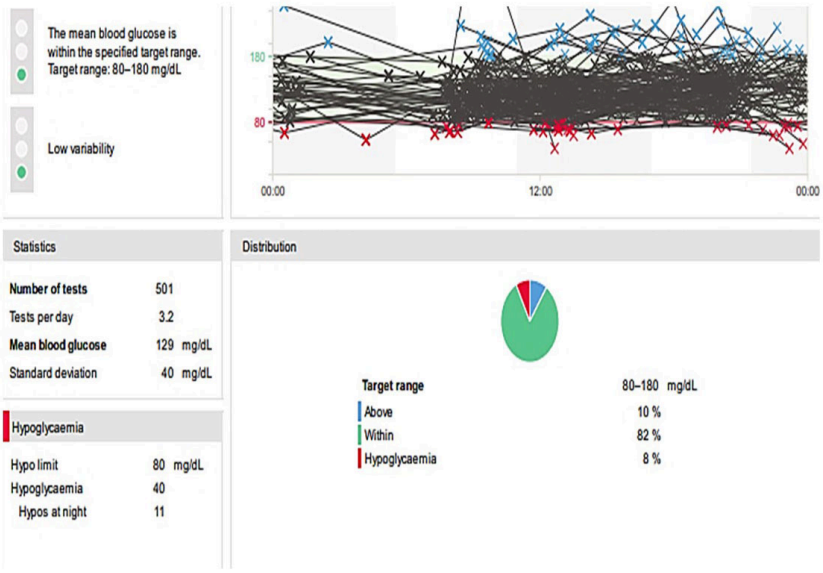


**Figure 4: Graphical presentation of blood glucose level through Bluetooth glucose meters (shared with permission from a patient at Diacare, Ahmedabad)**

**Pie chart:** The targeted BG range is 80-180 mg/dl, 85% the BG has been in the targeted range. 10% of BG has exceeded 180 mg/dl and 8% of the BG has dropped below 80 mg/dl.

**Extreme left shows the incidence of overall hypoglycaemia, number of finger pricks performed by patients, mean average glucose and standard deviation.**

- **Correction dose**

If BG goes above 180 mg/dl, a correction dose is recommended. This dose should be taken separately from the pre-bolus dose. If pre-meal glucose levels are high, the correction dose can be added to the meal dose. However, if one frequently needs insulin to correct high blood glucose before meals, the insulin dose may need to be adjusted for each meal [6].

**Complication screening**

Screening for retinopathy, neuropathy, and nephropathy needs to be initiated once the child reaches 10 years of age or at puberty, whichever comes first, and if the child has had diabetes for 5 years or more. Dyslipidemia should be assessed in newly diagnosed cases soon after glycemic status improves. ADA also recommends screening for thyroid and celiac disease shortly after diagnosis. If the initial screening is negative, it should be repeated annually, and the child should be screened for celiac disease again after 5 years [7].

**Contraception and sexual Counselling**

Condoms are a suitable contraceptive choice as they do not affect blood glucose levels. Norgestimate is the recommended drug and emergency morning pills can cause hyperglycaemia in T1D [15]. Intra-uterine devices are better contraceptive options for individuals with T1D complications. Adults with T1D should be made aware of the risks of foetal abnormalities linked to elevated HbA1C levels, use effective contraception to prevent unintended pregnancy and preconception counselling at clinical visits [7].

- **Diet consultation**

Counting carbohydrate consumption is crucial since the dosage of insulin relies on it. The alternative to carbohydrate counting is the plate method to prioritize a balanced diet with sufficient protein, fat, and micronutrients, while avoiding excessive carbohydrate intake. Limiting carbohydrate intake to 25% of the plate can help control post-meal BG spikes [16].

**Dose titration**

Bolus doses of insulin need to be adjusted based on the type and amount of food consumed. A dynamic scale is used to vary the insulin dose according to the BG level. This method is more accurate than fixed-dose insulin because it considers the fact that BG levels can vary before meals [17]. It is a helpful approach for adjusting insulin doses when parents or individuals face challenges due to limited understanding.

**Data collection**

Systematic data collection supports informed decision-making, aids in reaching out to individuals for follow-ups, and can be utilized for research.

- **Education with empathy**

"*Diabetes education is an interactive process that facilitates and supports the individual and/or families, and caregivers to acquire and apply the knowledge, confidence, practical, problem-solving and coping skills, needed to manage their life with diabetes to achieve the best possible outcomes within their unique circumstances*" [18].

Qualified diabetes educators must deliver it within the multidisciplinary team. In situations where staff is limited, a mother who has a child with T1D can serve as a mentor for another mother. The MyT1 Moms mentorship program, launched at a centre in Aurangabad, has successfully created such connections [19]. The mothers are trained to become D-coaches, serving as a valuable addition to the care ecosystem. The training involves workshops, basic training, experience sharing, and support.

Empathy involves understanding and respecting a patient's perspective, considering their limitations, and making collaborative decisions to improve their BG. People

With diabetes can empathize well with others who have the same condition, as they have experienced similar situations. In LRS, individuals with diabetes can be motivated to become diabetes educators, which can provide them with a career path and an opportunity to contribute to society.

**Empowerment and individualised care**

The aim is to assist parents and children who may struggle with administering insulin due to fear of needles. Educators are essential in empowering and building the confidence of families to effectively manage diabetes. Each child's conditions, abilities, needs, routines, and goals are unique, requiring an individualized road map for care.

**Efforts to improve awareness**

To combat the high prevalence of stigma, myths, and discrimination surrounding T1D, [20] it is crucial to promptly spread awareness among communities, schools, and the general public. In some cases, families feel the need to hide the condition from society, teachers, family members, and even life partners. Engaging in educational events, distributing information pamphlets, and conducting social media awareness campaigns can be effective in bringing about positive societal change.

**Emergency telephone contact**

Provide caregivers with emergency contact details of a healthcare professional and the nearest hospital. This is helpful during episodes of severe hypoglycaemia, diabetic ketoacidosis, or other illnesses when caregivers cannot manage diabetes or make informed decisions [6].

- **Find a cause**

When dealing with persistent hyperglycaemia or hypoglycaemia, it is important to investigate the factors causing these effects. For example, if a child has elevated HbA1c levels that correspond with random glucose readings. Before increasing insulin doses, it is wise to obtain a proper medical history to know if any insulin doses were missed or if the child was sick. In addition, checking for lipodystrophy and verifying the expiry date of the insulin. All of these interfere in achieving glycaemic control.

**Follow-up visits**

Implementation of guidelines in LRS can be difficult, particularly for those in remote and rural areas. Factors such as travel expenses, consultation fees, and laboratory tests can pose challenges. Families have to bear the burden of medical and travel costs, along with the loss of daily wages. Therefore, it is recommended that families be encouraged to have regular visits, ideally once every 6 months, and stay in contact with the diabetes care team [6].

**Family bonding**

Family-centred intervention has been shown to improve diabetes outcomes by reducing psychological distress and depression and assisting them to ask for social support [21] [22].

Healthy behaviour should be exercised for both children equally, where a T1D should be considered no different from a non-T1D sibling/s. Little gestures to remind insulin injections, BG check, correction dose if needed, and assistance during hypoglycaemia show concern towards T1D and provide strong emotional support.

- **Growth assessment**

Use a stadiometer and digital weighing scale to measure height and weight during each visit. Plot a growth chart to check if height and weight are appropriate for the age [6]. In cases of growth retardation, conduct a thyroid test after improving glycemic status. Subclinical hypothyroidism may increase the risk of symptomatic hypoglycaemia and reduce the linear growth rate.

**H- Hope**

T1D encounters age-specific challenges. It is crucial to provide hope for a normal life with insulin, determination to conquer obstacles, and motivation to achieve glycemic goals. Certain boosters can have a transformative impact.

**Hypoglycaemia**

The most common adverse event caused by excessive insulin is hypoglycaemia. Treatment is initiated when glucose levels drop to 70 mg/dl, confirmed by glucose monitoring. Severe hypoglycaemia (<54 mg/dl) requires the administration of rapid-acting glucose, orally at a dose of 0.3 grams/kg. This will increase blood glucose by 54 to 72 mg/dl. If the patient is unconscious, rubbing glucose on the gums can help raise BG levels [23]. The "rule of 15" is also used to treat hypoglycaemia, which is easier to follow for those with low understanding and more widely accepted in low-resource settings.

**HbA1c**

Performed every 3 months, if possible and affordable [6]. An HbA1c level below 7% is suitable for most children and teenagers with diabetes. Individuals with hypoglycaemia unawareness, limited access to analog insulins, infrequent BG monitoring, or non-glycemic factors that raise HbA1c should aim for an HbA1c level below 7.5% [7].

**Healthcare Professionals team**

Diabetes management involves a team of healthcare professionals, such as Endocrinologists/diabetologists, dieticians, educators, nurses, psychologists, and social workers. In certain situations, a doctor, dietician, educator, or nurse may take on multiple roles to provide comprehensive care. When complications or other co-existing conditions arise, it is recommended to promptly refer the patient to a specialist for accurate diagnosis and improved prognosis [6] [24].

**I- ISPAD guidelines**

The guidelines put forward by ISPAD for clinical practice in limited resource settings provide the best possible guidance on the management of T1D and type 2 diabetes in LRS [6].

**J-Join conferences, education workshops, and diabetes-related events**

The professional gathering provides us with research updates, treatment updates, and collaborative opportunities which further can help to improve our knowledge.

**K-Ketones monitoring**

Common incidences of diabetic ketoacidosis (DKA) in LRS stem from inadequate awareness and misconceptions. Families/caregivers should be educated about DKA symptoms, monitoring, management during sick days, and the necessity of hospitalization. Additionally, healthcare providers must investigate the underlying causes of DKA, including missed insulin doses, lipohypertrophy, hospitalization due to other illnesses, or insufficient insulin dosage [6].

**L-Language matters**

The use of certain words like patients, diabetic children, suffering from diabetes, poor control, and never well since childhood should be avoided. This should be replaced by people with diabetes or children living with diabetes, not desirable control. Using positive language leaves a positive impact on PwD and families as well [6].

In summary, detailed discussion and dialogue are required in each Indian language and dialect to optimize conversation. Continuously seek the solution to the challenges and find the simplest possible way to achieve it. Living with diabetes may be tough and unique for each person. Still, by coming together and learning from others' experiences who share our struggles - even in low-resource settings - we can rise above the obstacles and make progress every day. Sustaining ongoing efforts can lead to meaningful improvements in diabetes care and help achieve health equity while also optimizing the utilization of existing resources.

## Supporting information

None

## Ethical Considerations

None

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## Author contribution statement

**Mahira Saiyed**: Conceptualise and visualisation, writing and editing, figures; **Apoorva Gomber:** Writing and editing; **Rutul Gokalani:** Conceptualise, visualisation, figures; **Archna Sarda:** Supervision and review; **Banshi Saboo:** Supervision and review; **Sanjay Karla:** Supervision and review

All authors attest they meet the ICMJE criteria for authorship and gave final approvalforsubmission.

## Data availability statement

Data included in article/supp. material/referenced in article.

## Additional information

No additional information is available for this paper.

## Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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