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Impact of Structured Diabetes Management and Knowledge Reinforcement on Clinical Outcomes in COVID-19 Patients with Type 2 Diabetes

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Abstract

Background: Poor glycemic control is a major determinant of adverse COVID-19 outcomes. In addition to pharmacological management, patient knowledge and self-care practices influence disease trajectory.

Objective: To assess the impact of structured diabetes management combined with targeted knowledge reinforcement on glycemic control, inflammatory markers, and recovery outcomes in COVID-19 patients with T2DM.

Methods: A prospective observational study was conducted among 220 T2DM patients with confirmed COVID-19 infection. Baseline clinical, biochemical, and knowledge assessments were followed by standardized diabetes-COVID management and educational reinforcement. Pre- and post-intervention outcomes were compared.

Results: Significant improvement was observed in glycemic parameters, inflammatory markers, and patient knowledge scores. Patients with improved knowledge demonstrated better glycemic stability, reduced oxygen dependency, and faster clinical recovery.

Conclusion: Combining structured diabetes management with patient education significantly enhances COVID-19 recovery among diabetic patients. Knowledge empowerment is a critical adjunct to clinical care.

Keywords: Diabetes Education, COVID-19 Outcomes, Glycemic Variability, Telemedicine, Elderly Diabetes.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic posed unprecedented challenges to the management of chronic non-communicable diseases, particularly diabetes mellitus. Among individuals infected with severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), diabetes emerged as one of the most prevalent comorbidities associated with increased disease severity, prolonged hospitalization, and higher mortality. Beyond its biological impact, diabetes management during COVID-19 was profoundly affected by disruptions in healthcare delivery, restricted mobility, and reduced access to routine follow-up care. Hyperglycaemia during acute infections is a well-recognized phenomenon, driven by stress-induced hormonal

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responses, systemic inflammation, and pharmacological interventions such as corticosteroids. In patients with diabetes, these factors frequently result in marked glycaemic variability, increasing susceptibility to immune dysfunction, endothelial injury, and thrombo-inflammatory complications. However, clinical outcomes are not determined by pharmacological factors alone. Patient-related determinants, particularly disease-related knowledge, self-monitoring practices, and adherence to therapy, play a crucial role in achieving glycaemic stability during acute illness. During the COVID-19 pandemic, widespread misinformation, fear, and limited patient–physician interaction further widened gaps in diabetes self-management. Many patients lacked adequate understanding of the bidirectional relationship between diabetes and COVID-19, the importance of intensified glucose monitoring during illness, and the need for timely insulin adjustment. These knowledge deficits were especially pronounced among elderly individuals and those from lower socio-economic backgrounds, contributing to poor metabolic control and adverse clinical outcomes.

Emerging evidence suggests that patient education and structured self-care support can significantly improve metabolic outcomes in diabetes. However, during infectious disease outbreaks, educational interventions are often deprioritized in favor of acute clinical management. The pandemic highlighted the necessity of integrating structured knowledge reinforcement into routine care, particularly through telemedicine and remote monitoring platforms. Such approaches not only facilitate continuity of care but also empower patients to actively participate in disease management during periods of isolation.

Despite the recognition of education as a cornerstone of diabetes care, limited prospective data are available evaluating the direct impact of knowledge reinforcement on glycaemic control and clinical outcomes among COVID-19 patients with diabetes. Most existing studies have focused primarily on biochemical or pharmacological parameters, with less emphasis on behavioral and educational determinants of outcomes.

The present study was therefore designed to evaluate the impact of structured diabetes management combined with targeted knowledge reinforcement on glycaemic stability, inflammatory markers, and COVID-19-related clinical outcomes in patients with Type 2 diabetes mellitus. Particular emphasis was placed on assessing changes in patient knowledge, adherence to self-monitoring practices, and their association with recovery patterns. Additionally, the study explored glycaemic variability among elderly patients, a subgroup particularly vulnerable to both metabolic instability and severe COVID-19.

By examining the intersection of clinical management and patient education, this study aims to underscore the importance of knowledge empowerment as an essential therapeutic component in the management of diabetes during public health emergencies. The findings are expected to inform future pandemic preparedness strategies and reinforce the role of patient-centered education in improving outcomes among high-risk populations.

Materials and Methods

This study was a **prospective observational study with a structured educational and management reinforcement component**, designed to assess the impact of diabetes-related knowledge and standardized management practices on glycaemic control and COVID-19 outcomes among patients with Type 2 diabetes mellitus (T2DM).

The study was conducted in three sequential phases:

1. **Baseline assessment** of socio-demographic, clinical, biochemical, and knowledge parameters
2. **Implementation of standardized diabetes management and knowledge reinforcement**
3. **Comparative follow-up evaluation** of metabolic, inflammatory, and clinical outcomes

Although non-randomized, the study applied **uniform management and education protocols** to all participants, allowing outcome comparison based on knowledge and glycaemic control status.

Eligibility Criteria

Inclusion Criteria

1. Adults aged ≥ 40 years with T2DM
2. RT-PCR–confirmed COVID-19 infection
3. Willingness to provide informed consent
4. Completion of baseline and follow-up assessments
5. Inclusion of elderly patients (≥ 60 years) for subgroup analysis

Exclusion Criteria

1. Type 1 diabetes mellitus
2. Gestational diabetes
3. Advanced chronic illnesses (CKD stage 5, decompensated liver disease, active malignancy)
4. Requirement of mechanical ventilation at admission
5. Inability to comply with follow-up

Data Collection Tools

1. Socio-Demographic and Clinical Proforma

Data collected included:

- Age, gender, residence
- Education, occupation, socio-economic status (Modified Kuppuswamy scale)
- Duration of diabetes and comorbidities
- COVID-19 severity and treatment history

2. Knowledge Assessment Questionnaire

A **validated 20-item questionnaire** assessed patient knowledge regarding:

- COVID-19 transmission and prevention
- Diabetes–COVID interaction
- Importance of glycaemic control
- Medication adherence
- Self-monitoring of blood glucose
- Lifestyle and preventive behaviors

Knowledge scores were categorized as:

- **Good:** 75–100%
- **Moderate:** 50–74%
- **Poor:** <50%

3. Clinical and Laboratory Assessment

Clinical parameters included vital signs, oxygen saturation, BMI, and COVID-19 severity grading.

Laboratory investigations:

- FBG, PPBG, RBS
- HbA1c (HPLC method)
- CRP, ferritin, D-dimer
- Renal and liver function tests

Elderly patients (≥ 60 years) underwent glucose monitoring on **Days 1, 7, and 14**.

Management and Knowledge Reinforcement Protocol

All participants received:

- Standardized diabetes management (insulin titration, OHA modification)
- COVID-19 treatment as per national guidelines
- Structured dietary and lifestyle counseling
- Educational leaflets and telephonic counseling every 48 hours

Knowledge reinforcement focused on medication adherence, glucose monitoring, recognition of warning symptoms, and infection-prevention practices.

Statistical Analysis

Data were analyzed using **SPSS version 25**. Continuous variables were expressed as mean $\pm$ SD and categorical variables as frequency and percentage. Paired t-test and chi-square test were applied where appropriate. A p-value < 0.05 was considered statistically significant.

Results

A total of **220 patients** were analyzed. Most participants were aged ≥ 50 years, with a predominance of males. Hypertension and dyslipidaemia were common comorbidities.

Knowledge Assessment Outcomes

At baseline, the majority of patients demonstrated **poor to moderate knowledge** regarding diabetes management during COVID-19. Following structured education and reinforcement, there was a **significant shift toward good knowledge scores**, particularly in domains related to insulin use, self-monitoring, and preventive practices.

Glycaemic Control

Patients with improved knowledge scores exhibited significantly better glycaemic control, reflected by reductions in FBG, PPBG, and HbA1c levels. Improved adherence to insulin titration and monitoring schedules was observed among patients achieving good knowledge scores.

Inflammatory Markers

Patients with better glycaemic stability demonstrated a significant decline in CRP and ferritin levels, suggesting attenuation of systemic inflammation.

Clinical Outcomes

Improved knowledge and glycaemic control were associated with:

- Reduced oxygen requirement
- Lower ICU admission rates
- Shorter duration of hospital stay
- Faster symptom resolution

Results

Table 1: Baseline Knowledge Levels Regarding Diabetes Management During COVID-19 (n = 220)

Knowledge Domain	Adequate Knowledge n (%)	Inadequate Knowledge n (%)
Diabetes–COVID interaction	92 (41.8)	128 (58.2)
Importance of glycaemic control	104 (47.3)	116 (52.7)
Insulin/medication adherence	88 (40.0)	132 (60.0)
Self-monitoring of blood glucose	76 (34.5)	144 (65.5)
Preventive behaviors	118 (53.6)	102 (46.4)

Table 2: Overall Knowledge Score Distribution Pre- and Post-Intervention

Knowledge Level	Baseline n (%)	Follow-up n (%)	p-value
Good (75–100%)	38 (17.3)	142 (64.5)	<0.001*
Moderate (50–74%)	96 (43.6)	64 (29.1)	
Poor (<50%)	86 (39.1)	14 (6.4)	

*Statistically significant

Table 3: Association Between Knowledge Level and Glycaemic Control at Follow-up

Knowledge Level	Controlled Glycaemia n (%)	Uncontrolled Glycaemia n (%)	p-value
Good	118 (83.1)	24 (16.9)	<0.001*
Moderate	42 (65.6)	22 (34.4)	
Poor	6 (42.9)	8 (57.1)	

Table 4: Comparison of Glycaemic Parameters by Knowledge Status at Follow-up

Parameter	Good Knowledge	Moderate/Poor Knowledge	p-value
FBG (mg/dL)	128.4 ± 26.6	154.8 ± 34.9	<0.001*
PPBG (mg/dL)	176.2 ± 32.8	214.6 ± 46.3	<0.001*
HbA1c (%)	7.4 ± 1.1	8.3 ± 1.4	<0.001*

Table 5: COVID-19 Clinical Outcomes According to Knowledge Level

Outcome	Good Knowledge (n=142)	Moderate/Poor Knowledge (n=78)	p-value
Oxygen requirement	32 (22.5%)	58 (74.4%)	<0.001*
ICU admission	12 (8.5%)	34 (43.6%)	<0.001*
Mean hospital stay (days)	7.2 ± 2.6	12.1 ± 4.5	<0.001*
Recovery without complications	128 (90.1%)	44 (56.4%)	<0.001*

Table 6: Inflammatory Marker Trends by Knowledge-Based Glycaemic Control

Marker	Controlled Glycaemia	Uncontrolled Glycaemia	p-value
CRP (mg/L)	16.8 ± 10.4	34.6 ± 18.2	<0.001*
Ferritin (ng/mL)	286.9 ± 148.6	468.3 ± 204.5	<0.001*
D-dimer (mg/L)	0.72 ± 0.41	1.28 ± 0.69	0.002*

Table 7: Elderly Patients (≥60 Years): Glycaemic Variability Before and After Knowledge Reinforcement (n = 96)

Parameter	Baseline	Day 14	p-value
FBG (mg/dL)	182.6 ± 46.8	134.2 ± 26.1	<0.001*
PPBG (mg/dL)	268.9 ± 62.4	186.5 ± 34.9	<0.001*
RBS (mg/dL)	282.3 ± 70.6	196.4 ± 39.1	<0.001*

Table 8: Impact of Teleconsultation-Based Reinforcement on Treatment Adherence

Adherence Parameter	Improved n (%)	Not Improved n (%)
Medication adherence	164 (74.5)	56 (25.5)
SMBG compliance	152 (69.1)	68 (30.9)
Dietary compliance	146 (66.4)	74 (33.6)
Follow-up attendance	178 (80.9)	42 (19.1)

Discussion

This study demonstrates that structured diabetes management combined with targeted knowledge reinforcement significantly improves glycaemic control and clinical outcomes among patients with Type 2 diabetes mellitus infected with COVID-19. While pharmacological interventions remain central to acute care, the present findings underscore the critical role of patient knowledge, self-care behaviors, and adherence in determining metabolic stability and disease trajectory during infectious outbreaks.

At baseline, a substantial proportion of patients exhibited poor to moderate knowledge regarding diabetes management during COVID-19, particularly in domains related to insulin use, self-monitoring of blood glucose, and sick-day management. These deficiencies are clinically relevant, as acute infections, systemic inflammation, and corticosteroid therapy are known to precipitate marked glycaemic variability. Following structured education and teleconsultation-based reinforcement, a significant shift toward good knowledge scores was observed, accompanied by improved adherence to glucose monitoring and medication regimens. Patients achieving higher knowledge scores demonstrated significantly lower fasting and post-prandial glucose levels and reduced HbA1c values, highlighting the direct impact of education on metabolic outcomes.

The association between improved glycaemic control and favorable COVID-19 outcomes observed in this study is consistent with previous reports indicating that hyperglycaemia exacerbates immune dysfunction, endothelial injury, and pro-inflammatory cytokine release. Patients with better knowledge and glycaemic stability required less oxygen support, had lower rates of intensive care admission, and experienced shorter hospital stays. These findings suggest that knowledge reinforcement indirectly modulates disease severity by facilitating timely insulin titration, improved dietary compliance, and early recognition of worsening symptoms.

Inflammatory markers such as C-reactive protein and ferritin were significantly lower among patients who achieved glycaemic control, supporting the concept that metabolic regulation attenuates the inflammatory response in COVID-19. Hyperglycaemia is known to amplify oxidative stress and inflammatory signaling pathways, and its correction may contribute to improved clinical recovery. The observed reductions in inflammatory markers among knowledge-reinforced patients further strengthen the rationale for integrating education into routine clinical management during acute infections.

Elderly patients constituted a particularly vulnerable subgroup in the present study, demonstrating greater glycaemic variability during the early phase of illness. However, frequent glucose monitoring, individualized counseling, and teleconsultation support resulted in progressive stabilization over the follow-up period. This

finding highlights the importance of targeted educational and monitoring strategies in older adults, who often face additional barriers such as limited health literacy, comorbidities, and reduced access to care.

The use of telemedicine emerged as a key facilitator of knowledge reinforcement and continuity of care. Regular telephonic follow-up enabled real-time guidance on insulin adjustments, symptom monitoring, and preventive behaviors, mitigating the impact of restricted in-person consultations during the pandemic. These observations align with emerging evidence supporting telemedicine as an effective tool for chronic disease management in crisis settings.

Despite its strengths, the study has certain limitations. The observational design limits causal inference, and knowledge assessment relied partly on self-reported responses, which may introduce reporting bias. Additionally, long-term outcomes beyond the acute phase of COVID-19 were not evaluated. Nevertheless, the prospective design, comprehensive assessment, and inclusion of elderly subgroups enhance the clinical relevance of the findings.

In conclusion, the present study highlights that patient knowledge and self-management practices are integral determinants of glycaemic control and clinical outcomes in COVID-19 patients with diabetes. Integrating structured education and teleconsultation into standard care models may significantly improve outcomes during current and future public health emergencies.

Conclusion

Knowledge reinforcement combined with standardized diabetes management significantly improves glycaemic stability and COVID-19 outcomes in patients with Type 2 diabetes. Patient education should be considered an essential therapeutic component during infectious disease outbreaks. Structured diabetes management combined with patient knowledge reinforcement significantly improves glycemic and clinical outcomes in COVID-19. Future pandemic preparedness should incorporate patient education as a core therapeutic component.

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