Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Diabetes & Metabolic Syndrome: Clinical Research & Reviews 14 (2020) 1213–1216

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Impact of lockdown in COVID 19 on glycemic control in patients with type 1 Diabetes Mellitus

Anjali Verma [a,*], Rajesh Rajput [b], Surender Verma [c], Vikas K.B. Balania [b], Babita Jangra [d]

[a] Department of Pediatrics, PGIMS, Rohtak, India
[b] Department of Endocrinology, PGIMS, Rohtak, India
[c] Department of General Surgery, PGIMS, Rohtak, India
[d] Department of Community Medicine, BPS, Khanpur, India

ARTICLE INFO

Article history:
Received 1 July 2020
Received in revised form
9 July 2020
Accepted 10 July 2020

Keywords:
Lockdown
COVID 19
Diabetes mellitus

ABSTRACT

Background and aims: COVID 19 is a novel pandemic affecting globally. Although no reliable data suggests that patients of well controlled Type 1 Diabetes Mellitus (T1DM) being at increased risk of becoming severely ill with SARS-CoV2, but lockdown may impact patients with T1DM requiring regular medications and follow up. Hence this study was planned to see the impact of lockdown on glycemic control in patients with T1DM.

Methods: A cross sectional study was done in T1DM patients in whom a structured questionnaire was administered on follow up within 15 days after lockdown. Data regarding hypoglycemic and hyperglycemic episodes, Diabetic ketoacidosis (DKA), insulin dose missed, regular glucose monitoring, dietary compliance, physical activity, hospitalization during the phase of lockdown was taken. Average blood glucose and HbA1C of lockdown phase was compared with the readings of prelockdown phase.

Results: Out of 52 patients, 36.5% had hyperglycemic and 15.3% had hypoglycemic episodes. Insulin dose was missed in 26.9%, glucose monitoring not done routinely in 36.5% and 17.4% were not diet compliant during lockdown. Average blood glucose during lockdown phase was 276.9 ± 64.7 mg/dl as compared to 212.3 ± 57.9 mg/dl during prelockdown phase. Mean HbA1c value of lockdown (10 ± 1.5%) which was much higher that of pre lockdown (8.8 ± 1.3%) and the difference was statistically significant ($p < 0.05$).

Conclusion: Glycemic control of T1DM patients has worsened mainly due to non availability of insulin/glucostrips during lockdown period. There is a need for preparedness in future so that complications can be minimised.

1. Introduction

Coronavirus disease 2019 (COVID-19) has aroused public health concerns in recent days and has progressively spread globally [1]. Although there are reports suggesting high mortality in adults with diabetes [2,3], however none suggested that children and adults with Type 1 Diabetes Mellitus (T1DM) are more severely affected than those who don't have diabetes. Nevertheless, the International Society for Pediatric and Adolescent Diabetes (ISPAD) has emphasized the continued attentiveness to standard diabetes care during this period to avoid the need for urgent care visits or hospitalization [4].

So as to hinder and limit the possible spread of COVID-19, Indian government has ordered a series of phased lockdowns in which medical services were limited to emergencies only. During lockdown people were forced to stay in their homes which has resulted in change in physical activity, dietary pattern and psychological status of the individuals. All of these can impact the glucose control in patients of diabetes especially T1DM who are on insulin therapy. Also the lockdown has impacted the availability of treatment facilities for patients of chronic disease like diabetes. Past studies have showed that during disasters individuals with diabetes had short-term and long-term impact on glycemic parameters owing to the lack of medical care, appropriate food and medications [5–7]. Some studies in past have shown increase in complications of diabetes [8–10] whereas others have shown increase in elevation of HbA1c post disasters [11,12].

Although impact of COVID 19 on general health has been

* Corresponding author. 117- A, Sector 14, Rohtak, India.
E-mail address: dranjali604@gmail.com (A. Verma).

https://doi.org/10.1016/j.dsx.2020.07.016
1871-4021/

reported in various studies [1–3], there is paucity of literature on the impact of lockdown on management of patients of chronic illness like diabetes and no study has been reported from India till date. Hence this study was planned to see its impact on glycemic control of Type 1 Diabetes which will help us to be prepared about future disasters or pandemics.

2. Material and methods

This observational study was planned in a tertiary care teaching hospital and patients with T1DM who were on regular follow up in Endocrinology Outpatient department (OPD) were enrolled in the study. The first case of COVID-19 pandemic in India was reported on 30 January 2020 possibly originating from China. So as to prevent its spread, India has imposed lockdown in phased manner starting from 25th March till 30th May and thereafter started unlocking [13]. Local transport and interdistrict/interstate communication was strictly prohibited during the entire period. Hence we planned this study from 25th March till 31st May 2020 in which no diabetes specific specialty clinic was functional and only emergency services were going on in the state. However, primary care was available at a variety of community clinics with fragmented health care services.

52 consecutive patients who visited after lockdown and had given the consent were included in the study. The demographic details as well as their contact numbers of enrolled patients were taken from their databases in the endocrine OPD. Demographic details in form of age, sex, residence, source of family income, socioeconomic status using Modified Kuppuswamy scale updated for year 2020 were taken [14]. Details about type of insulin, its administration and associated diseases were also noted. They were telephonically called at the end of lockdown period and asked to report within 15 days after end of lockdown i.e. 30 May 2020. A structured questionnaire was administered to all the enrolled patients. Frequency of blood glucose readings falling in hypo and hyperglycemic range were noted from their daily blood glucose monitoring charts. Blood glucose levels $\leq$70 mg/dl and $\geq$180 mg/dl were considered as hypoglycemic and hyperglycemic episodes respectively. Data regarding episodes of DKA, insulin dose missed, regular blood glucose monitoring and any hospitalization during the period was recorded. Details regarding dietary compliance, physical activity, any psychological issues during the period were taken by recall method. Details regarding unavailability of insulin/glucostrips in their region or other reasons for impaired glucose control were also noted. Average of 3 glucose measurements per day was recorded in patients who were doing regular self monitoring of blood glucose levels and their mean was calculated over the entire period of lockdown. Whereas, mean of all the available readings was taken in patients who were not regularly monitored. Data of average blood glucose levels during both prelockdown and lockdown and HbA1C of both pre and lockdown phase was collected and analysed with paired sample t tests.

3. Results

Out of 52 patients, 27 (51.9%) patients were in the age group of 1–10 years followed by 19 (36.6%) in 11–20 years and only 6 (11.5%) were more than 20 years of age. Mean age was 11.9 years and male to female ratio was 0.7:1. Maximum and minimum age of enrolled patients were twenty three years and one and half year respectively. Associated celiac disease was present in 5 patients and hypothyroidism in 2 patients. Among 5 celiac patients, 2 children were not compliant with gluten free diet during lockdown due to non availability of gluten free food. More patients were from rural background [39 (75%)] and mainly belonging to lower socioeconomic status [34 (65.4%)] (Table 1). Only 13 (25%) had family income from government jobs who were regularly getting salaries during whole lockdown.

Table 1
Showing demographic characteristics of patients with T1DM (n = 52).

Characteristics	n (%)
Age	
1–10 years	27 (51.9)
11–20 years	19 (36.6)
21–30 years	6 (11.5)
Sex	
Male	22 (42.3)
Female	30 (57.6)
Background	
Rural	39 (75)
Urban	13 (25)
Source of income in family	
Government job	13 (25)
Private job	28 (53.8)
Self employed	11 (21.2)
Socio economic status	
Upper middle	4 (7.6)
Lower middle	14 (27)
Upper lower	25 (48.1)
Lower	9 (17.3)
Insulin administered by	
Parents	19 (37)
Self	24 (44)
Both	10 (19)
Insulin used	
Long acting + short acting analogue	32 (62)
Intermediate acting + Short acting insulin	17 (32)
Premix insulin (30:70)	3 (6)
Associated illness	
Celiac disease	5 (9.6)
Hypothyroidism	2 (3.8)

Insulin doses were missed in 14 (26.9%) and blood glucose monitoring was not done in 20 (38.5%) and 9 (17.4%) were not compliant with the diet during lockdown. Some (36.5%) have decreased physical activity out of which mainly were adolescents and adults (Table 2).

19 (36.5%) had hyperglycemic episodes, 4 (7.7%) out of them landed into DKA and were ultimately hospitalised (Table 3). Out of 19 patients having hyperglycemia, 8 patients were not getting insulin injections due to non availability during lockdown and 3 patients because of financial issues as their family income was from

Table 2
Showing impact of lockdown period on various parameters (n = 52).

Parameters	n (%)
Insulin doses missed	
Yes	14 (26.9)
No	38 (73.1)
Blood glucose record maintained	
Yes	32 (61.5)
No	20 (38.5)
Dietary compliance	
Yes	43 (82.6)
No	9 (17.4)
Physical activity	
Increased [a]	3 (5.7)
Decreased [a]	19 (36.5)
Same as before	30 (57.8)
Psychological issue	
Normal	25 (48.1)
Irritable	5 (9.6)
Happy	16 (30.8)
Depressed	6 (11.5)

[a] As compared to pre lockdown period.

Table 3
Showing impact of lockdown period on parameters related to glycemic control (n = 52).

Parameters	n (%)
No of patients having hyperglycemic episodes	19 (36.5)
No of patients having hypoglycemic episodes	8 (15.3)
No of patients with hospitalization	6 (11.5)
(a) DKA	4 (7.7)
(b) Hypoglycemia	1 (1.9)
(c) Non COVID febrile illness	1 (1.9)

DKA: Diabetic ketoacidosis.

private jobs. Non COVID febrile illness has lead to hyperglycemia in 3 patients whereas in rest 5 cases cause couldn't be ascertained. Out of 4 patients with DKA, 3 patients had missed insulin doses due to non availability whereas one patient has started homeopathic medication. Reasons of not monitoring blood glucose were non availability of glucostrips (13 out of 20), financial issues (3 out of 20) and in 4 patients cause was not known.

8 (15.3%) patients had hypoglycemic episodes and 1 of them was hospitalised (Table 3). Out of 8 patients with hypoglycemic episodes, 3 patients were in honeymoon phase, 2 children had decreased intake in a febrile illness and in 3 patients cause could not be found.

Average blood glucose during lockdown phase was 276.9 ± 64.7 mg/dl and during prelockdown phase was 212.3 ± 57.9 mg/dl. Although average blood glucose in lockdown was higher than that of prelockdown but the difference was not statistically significant ($p = 0.15$).

Mean HbA1c of prelockdown and lockdown phase was 8.8 ± 1.3% (73 mmol/mol) and10 ± 1.5% (86 mmol/mol) respectively and the difference was statistically significant ($p < 0.001$).

4. Discussion

This study was done to identify challenges of complete lockdown during COVID19 in T1DM patients considering the importance of continuity of care.

A lot of patients had impaired glucose control during this period and the main reason was non availability of insulin/glucostrips. This was probably due to limited stock in rural and semi urban areas and restrictions in transportation during the lockdown period. Furthermore, disparities in health, related to socioeconomic status that existed before the disaster have been exacerbated as there are many parents with private jobs who are not earning during lockdown. Our study was in concordance with previous few studies carried out on the effect of natural calamities on diabetes in which similar problems were encountered [7,15].

Moreover, authors in a study after Hurricane in Florida also suggested that by knowing the prevalence of major chronic conditions, assessment of need of medications should be made earlier so that replacement medications may be obtained well in time [15,16].

Other reasons were poor dietary compliance and lack of physical activity noticed in few patients. During lockdown children were at home with their non diabetic peers and all family members leading to poor compliance to their dietary habits. In addition children particularly adolescents are having much longer screen time, irregular sleep patterns thus limiting their routine physical activity which is usually recommended to improve glycemic control. It is already known that breaks from school (e.g. holidays) or periods when there is increase of sedentary behaviour lead to harmful influence on the glycemic control [17]. Similar results were seen in a recent study which showed that there was increase in carbohydrate intake, decrease in exercise, decreased monitoring of blood glucose and widespread mental stress in patients with Type 2 Diabetes Mellitus during the lockdown [18].

A few children recently diagnosed with T1DM also had episodes of hypoglycemia as a result of honeymoon phase during which they were not able to visit hospitals to show their sugar monitoring charts. Others had febrile illness leading to decreased intake ultimately leading to hypoglycemia.

Some of the patients had serious emergencies like DKA and hypoglycemia requiring hospitalisations. That may be because many first responders in form of primary health care workers have limited knowledge about the management of diabetes emergencies. Some previous studies have also recommended development of more educational resources for patients and health care providers about the specific needs of people with diabetes pre, during and post disaster [5,9,10].

Most of our patients remained playful and happy. Most of our patients were children and adolescents who were enjoying holidays due to lockdown and concept of joint families won't lead to stress in our country. This was contrary to studies in Japan after major earthquakes which had demonstrated an increase in stress associated with poor glycemic control [19,20].

Our study has showed negative impact of lockdown on glycemic control. Average blood glucose was higher during the lockdown phase however this was not statistically significant as our study was involving mainly pediatric patients and some of them (15.3%) had multiple episodes of hypoglycemia whereas some patients were not able to do regular glucose monitoring. Difference of HbA1c in prelockdown and lockdown phase was highly significant as it indicates average glucose levels over a prolonged period of 3 months.

Our results were in concordance with a recent systematic review of health effects of storms and floods which reported an increase in HbA1c levels and the number of evaluations for diabetic complications post events [21]. Another recent study by Ghosal et al. has also concluded that duration of lockdown in COVID 19 is directly proportional to the worsening of glycaemic control and diabetes-related complications [22].

However, a similar study in Italy in this COVID pandemic showed that glycemic control of T1DM in adolescents did not worsen during the restrictions due to close monitoring of children by parents, more regular timetable of meals and reduced stress levels caused by school and all after-school activities. It rather improved in those who continued physical activity during the quarantine. Another reason found was the continuation of the health care professional assistance through telemedicine and CGMS which was not there in our set up [23].

Few more studies in which data was collected by remote monitoring of glucose sensors showed no deleterious effect of lockdown on glycemic control [24,25]. In addition, the knowledge that diabetes worsens the outcomes of COVID-19 may have improved patients' awareness and compliance to diabetes management [26] but maximum of these patients were adults whereas in our study maximum were children and adolescents.

No of patients in previous reports were small. This is one of largest study on T1DM from developing countries with limited resources, different sociodemographic culture as compared to the western world. Telehealth or telephonic consultations for sick day management and routine diabetes care should be encouraged to prevent complications and to partly mitigate the problem of uncontrolled diabetes during such pandemics in future. Advances in technology such as downloading records from insulin pumps/CGMS and remote monitoring should be used whenever possible to optimize glucose control. A module on preparedness should be included in diabetes self-management education. Proper

assessment of community requirement of insulin as well as glucostrips should be made in advance as a part of preparedness.

The limitation of this study was that it is a single-centre study. However, we believe that this information is valuable for health care professionals caring for children and adolescents during the COVID-19 pandemics and offers real-life data for further research. Hence results of our study should be used to establish innovative management strategies for patients with T1DM by collect maintaining data registry in order to learn for future pandemics.

5. Conclusion

Our study has clearly demonstrated negative impact of a pandemic on glycemic control in T1DM, a chronic condition which needs regular attention. The factors responsible such as non availability of insulin/glucostrips, poor dietary compliance and decreased physical activity need to be taken into consideration in planning and addressing chronic health conditions in the future pandemics because if appropriate action is not taken, the increase in health care costs could be considerable.

Funding

None.

Compliance with ethical standards

Yes.

Authors contribution

AV: implemented the study, collected data and wrote manuscript; RR: generated idea, supervised data collection, contributed to writing of manuscript; SV, BJ: data compilation, analysis and provided inputs in manuscript; VB: helped in data collection.

Declaration of competing interest

None.

References

[1] Lai C, Shih T, Ko W, Tang H, Hsueh P. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019(COVID-19): the epidemic and the challenges. Int J Antimicrob Agents 2020:105924.
[2] Huang C, Wang Y, Li X. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497–506.
[3] Zhou J, Tan J. Diabetes patients with COVID-19 need better blood glucose management in Wuhan, China. Metabolism 2020;107:154216.
[4] Coronavirus infection (COVID-19)—II ISPAD summary 2020. https://www.ispad.org/page/CoronavirusinfectionCOVID-19-IIISPADSummary.
[5] Cefalu WT, Smith SR, Blonde L, Fonseca V. The Hurricane Katrina aftermath and its impact on diabetes care: observations from “ground zero”: lessons in disaster preparedness of people with diabetes. Diabetes Care 2006;29:158–60.
[6] International Diabetes Federation. https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html. Accessed June 2020.
[7] Carameli KA, Eisenman DP, Blevins J, Angona B, Glik DC. Planning for chronic disease medications in disaster: perspectives from patients, physicians, pharmacists, and insurers. Disaster Med Public Health Prep 2013;7(3):257–65. https://doi.org/10.1001/dmp.2010.46.
[8] Miller A, Arquilla B. Chronic diseases and natural hazards: impact of disasters on diabetic, renal and cardiac patients. Prehospital Disaster Med 2008;23(2):185–94.
[9] ArrietaM ForemanR, CrookE IcenogleM. Insuring continuity of care for chronic disease patients after a disaster: key preparedness elements. Am J Med Sci 2008;336(2):128–33.
[10] Mokdad AH, Mensah GA, Posner SF, Reed E, Simoes EJ. Engelgau MM, and the Chronic Diseases and Vulnerable Populations in Natural Disasters Working Group. When chronic conditions become acute: prevention and control of chronic diseases and adverse health outcomes during natural disasters. Prev Chronic Dis 2005;2:A04.
[11] Arrieta M, Foreman R, Crook E, Icenogle M. Providing continuity of care for chronic diseases in the aftermath of Katrina: from field experience to policy recommendations. Disaster Med Public Health Prep 2009;3:174–82.
[12] Fonseca VA, Smith H, Kuhadiya N, Leger SM, Yau CL, Reynolds K, et al. Impact of a natural disaster on diabetes: exacerbation of disparities and long-term consequences. Diabetes Care 2009;32(9):1632–8.
[13] 2020 Coronavirus pandemic in India. Accessed June 2020, https://en.wikipedia.org/wiki/2020.
[14] Saleem SM. Modified Kuppuswamy socioeconomic scale updated for the year 2020. Indian J Forensic Community Med 2020;7:1–3.
[15] Centers for Disease Control and Prevention (CDC). Rapid assessment of the needs and health status of older adults after Hurricane charley–charlotte, DeSoto, and hardee counties, Florida, August 27-31, 2004. MMWR Morb Mortal Wkly Rep 2004;53(36):837–40.
[16] Brown DW, Young SL, Engelgau MM, Mensah GA. Evidence based approach for disaster preparedness authorities to inform the contents of repositories for prescription medications for chronic disease management and control. Prehospital Disaster Med 2008;23(5):447–57.
[17] MacMillan F, Kirk A, Mutrie N. A systematic review of physical activity and sedentary behavior intervention studies in youth with type 1 diabetes: study characteristics, intervention design, and efficacy. Pediatr Diabetes 2014;15:175–89.
[18] Ghosh A, Arora B, Gupta R, Anoop S, Misra A. Effects of nationwide lockdown during COVID-19 epidemic on lifestyle and other medical issues of patients with type 2 diabetes in north India [published online ahead of print, 2020 Jun 2]. Diabetes Metab Syndr 2020;14(5):917–20. https://doi.org/10.1016/j.dsx.2020.05.044.
[19] InuiA KitaokaH, MajimaM TakamiyaS, Uemoto M, Yonenaga C, et al. Effect of the Kobe earthquake on stress and glycemic control in patients with diabetes mellitus. Arch Intern Med 1998;158:274–8.
[20] Pibernik-Okanovic M, Roglic G, Prasek M, Metelko Z. War-induced prolonged stress and metabolic control in type 2 diabetic patients. Psychol Med 1993;23:645–51.
[21] Saulnier DD, Brolin Ribacke K, Von Schreeb J. No calm after the storm: a systematic review of human health following flood and storm disasters. Prehospital Disaster Med 2017;32(5):568–79.
[22] Ghosal S, Sinha B, Majumder M, Misra A. Estimation of effects of nationwide lockdown for containing coronavirus infection on worsening of glycosylated haemoglobin and increase in diabetes-related complications: a simulation model using multivariate regression analysis [published online ahead of print, 2020 Apr 10]. Diabetes Metab Syndr 2020;14(4):319–23. https://doi.org/10.1016/j.dsx.2020.03.014.
[23] Tornese G, Ceconi V, Monasta L, Carletti C, Faleschini E, Barbi E. Glycemic control in type 1 diabetes mellitus during COVID-19 quarantine and the role of in-home physical activity. Diabetes Technol Therapeut 2020;22:6.
[24] Beato-Víbora PI. No deleterious effect of lockdown due to COVID-19 pandemic on glycaemic control, measured by glucose monitoring, in adults with type 1 diabetes. Diabetes Technol Therapeut 2020 May 12. https://doi.org/10.1089/dia.2020.0184. Epub ahead of print. PMID: 32396400.
[25] Maddaloni E, Coraggio L, Pieralice S, Carlone A, Pozzilli P, BuzzettiR. Effects of COVID-19 lockdown on glucose control: continuous glucose monitoring data from people with diabetes on intensive insulin therapy. Diabetes Care 2020;6:dc200954. https://doi.org/10.2337/dc20-0954.
[26] Bonora BM, Boscari F, Avogaro A, Bruttomesso D, Fadini GP. Glycaemic control among people with type 1 diabetes during lockdown for the SARS-CoV-2 outbreak in Italy. Diabetes Ther 2020;11:1369–79. https://doi.org/10.1007/s13300-020-00829-7.