

Diabetes management by either telemedicine or clinic visit improved glycemic control during the coronavirus disease 2019 pandemic state of emergency in Japan

Yukiko Onishi*¹, Yoko Yoshida, Toshiko Takao¹, Tazu Tahara, Takako Kikuchi, Toshiko Kobori, Tetsuya Kubota, Asuka Shimmei, Masahiko Iwamoto, Masato Kasuga

The Institute of Medical Science, Asahi Life Foundation, Tokyo, Japan

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*Correspondence

Yukiko Onishi
 Tel.: +81-3-3639-5501
 Fax: +81-3-3639-5520
 E-mail address:
 y-ohnishi@asahi-life.or.jp

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ABSTRACT

The purpose of this retrospective cohort study at a Tokyo diabetes clinic was to evaluate the effect of telemedicine and clinic visit on glycated hemoglobin (HbA1c) during the coronavirus disease 2019 state of emergency. The effect of telemedicine and clinic visit during the emergency period on the post-emergency measured HbA1c was evaluated by multiple regression models and logistic regression models adjusted for age, sex, type of diabetes, pre-emergency HbA1c and body mass index, and body mass index change during the emergency period. Among 2,727 patients who visited the clinic before and after the emergency period, the interval between clinic visits during the emergency period was significantly associated with HbA1c improvement. Telemedicine and clinic visit were independently associated with HbA1c improvement when pre-emergency HbA1c was $\geq 7\%$. In conclusion, clinic visit and telemedicine during the coronavirus disease 2019 emergency period were both independently effective in HbA1c improvement in Japanese diabetes patients who had insufficient HbA1c control.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has forced lifestyle changes throughout the world, with lockdowns and interruption of standard diabetes care. Telemedicine became a patient care option¹.

In Japan, the virus spread rapidly from February to May, 2020, especially in Tokyo. In response to the COVID-19 pandemic, the Japanese government declared a state of emergency on 7 April lasting until May 25th 2020^{2,3}. During this emergency period, people living in and around Tokyo were asked to refrain from non-essential outings. Although hospital visits were excluded from this restraint, many patients were, nevertheless, reluctant to visit clinics for their regular checkups. The Ministry of Health, Labor and Welfare allowed clinics and hospitals to fax or mail prescriptions after consulting patients remotely by phone or video calls from 1 March 2020. This was a new strategy in diabetes care in Japan, so there had been no prior evidence of its effect on glucose control.

At our diabetes clinic in Tokyo, 1,163 diabetes patients visited during the emergency period, less than half of the 2,574 in 2019 over the same dates, while doctors informed the patients about telemedicine and 1,393 utilized it. The purpose of the present study was to determine the effect of telemedicine and clinic visit on glycated hemoglobin (HbA1c) during the emergency period, independent of bodyweight change and other factors.

MATERIALS AND METHODS

This was a retrospective cohort study at the Institute of Medical Science, Asahi Life Foundation, Tokyo, Japan.

The emergency period (7 April to 25 May) followed a declaration by the government of a state of emergency. The 8 weeks before the emergency period (11 February to 6 April) were designated as the pre-emergency period. The 8 weeks after the emergency (26 May to 20 July) were the post-emergency period. The last visit during the pre-emergency period and the first visit during the post-emergency period were defined as pre-visit and post-visit, respectively. HbA1c and body mass index (BMI) at the pre-/post-visit were the pre-/post-HbA1c and pre-/post-

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BMI. The change of BMI, from pre-visit to post-visit, was ΔBMI. A phone consultation between the pre-visit and the post-visit was considered a telemedicine event.

Before the pandemic, diabetes patients usually visited our clinic every 1–2 months to check their HbA1c, blood glucose, BMI and so on. Depending on these measurements, patients consulted their doctors for 5–20 min and medications were changed when necessary. When patients visited the clinic during the emergency period, this practice was continued. Telemedicine was also provided and patients were advised to check their bodyweight, not to overeat, to exercise and not gain weight while they stayed home. Some had no contact during the emergency period. HbA1c change from pre-HbA1c ≥7% to post-HbA1c <7% was defined as improvement.

Among 3,150 diabetes patients who checked HbA1c and BMI during the pre-emergency period, 2,727 also checked HbA1c and BMI during the post-emergency period, and they comprised the analysis population (Figure 1). This research was approved by the Human Subjects Review Committee at the Institute for Medical Science (approval number 12205). Informed consent was obtained by opt-out online.

Characteristics of the population are presented as median (interquartile range) or the number (proportion) for categorical data. Multiple regression or multiple logistic regression analysis was used to evaluate the factors associated with post-HbA1c or its improvement adjusted for age, sex, pre-HbA1c, pre-BMI, ΔBMI and diabetes type. Linear trends were evaluated, and model fit was compared by the Akaike information criterion.

The threshold of statistical significance was two-tailed $P < 0.05$. Statistical analyses were carried out using Stata MP, version 16.0 (StataCorp, College Station, TX, USA).

RESULTS

The characteristics of the 2,727 study participants are shown in Table 1. Multiple regression models assessed the association between clinic visit, telemedicine and HbA1c measured in the post-emergency period (Table 2). Average days between clinic visits were associated with post-HbA1c adjusted for age, sex, pre-HbA1c, pre-BMI, ΔBMI and type of diabetes (Table 2, model 1). Model 2 was identical to Model 1, but average days were between clinic visits and/or telemedicine. The association of average days and post-HbA1c remained. We then evaluated in model 3 the effect of clinic visit and/or telemedicine on those patients with inadequate diabetes control in the pre-emergency period (pre-HbA1c ≥7%). The variables in model 3 were the same as in model 2. The association of average days between clinic visits and/or telemedicine and post-HbA1c was stronger than in model 2. In model 4, visiting the clinic and telemedicine were both independently associated with lower post-HbA1c adjusted for age, sex, pre-HbA1c, pre-BMI, ΔBMI and diabetes type. Pre-HbA1c, pre-BMI, ΔBMI and age were also significantly and positively associated with post-HbA1c in all four models of Table 2.

In addition, among the same population with pre-HbA1c ≥7%, we evaluated the effect of clinic visit and telemedicine on improving the post-HbA1c to <7%. Multiple adjusted odds

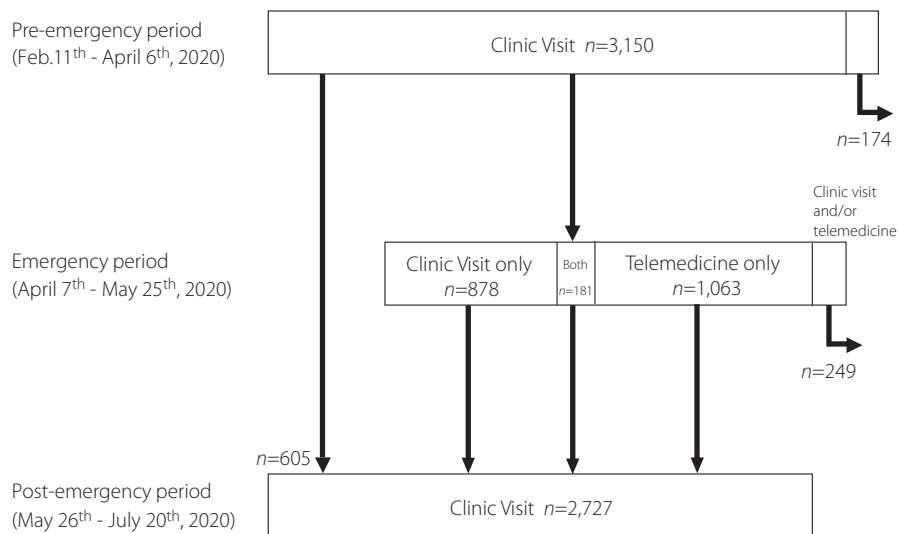


Figure 1 | Clinic follow-up status of diabetes patients 8 weeks before the coronavirus disease 2019 pandemic emergency period (pre-emergency period, from 11 February to 6 April 2020), during the state of emergency period (from 7 April to 25 May 2020) and 8 weeks after the emergency period (post-emergency period, from 26 May to 20 July 2020). There were 3,150 patients who visited our clinic during the pre-emergency period. Among those 3,150, 605 did not visit during the emergency period, 878 visited the clinic during the emergency period, 1,063 utilized telemedicine between the pre- and post-emergency period visits, and 181 had both clinic visit and telemedicine, and all of these patients visited the clinic again during the post-emergency period. There were 174 patients who had no contact during the emergency period or post-emergency period, and 249 patients who had clinic visit and/or telemedicine during the emergency period, but did not visit during the post-emergency period. A total of 2,727 patients comprised the analytic cohort.

Table 1 | Characteristics of study participants according to HbA1c level at pre-period (pre-HbA1c)

Characteristics	Total (n = 2,727)	Pre-HbA1c $\geq 7.0\%$ (n = 1,741)	Pre-HbA1c $< 7.0\%$ (n = 986)
Age (years)	68.6 (59.0, 75.5)	68.7 (58.9, 75.8)	68.3 (59.5, 75.2)
Male sex	2157 (79.1)	1348 (77.4)	809 (82.0)
Type 2 diabetes	2556 (93.7)	1594 (91.6)	962 (97.6)
No clinic visit nor telemedicine	605 (22.2)	335 (19.2)	270 (27.4)
Only clinic visit during emergency period	878 (32.2)	610 (35.0)	268 (27.2)
Only telemedicine between pre- and post-visits	1063 (40.0)	668 (38.4)	395 (40.1)
Both clinic visit and telemedicine	181 (6.6)	128 (7.4)	53 (5.3)
Pre-BMI (kg/m ²)	24.2 (22.0, 26.6)	24.3 (22.1, 26.8)	23.9 (21.8, 26.4)
Pre-HbA1c (%)	7.2 (6.7, 7.7)	7.6 (7.2, 8.1)	6.6 (6.3, 6.8)
Post-BMI (kg/m ²)	24.2 (22.0, 26.7)	24.4 (22.1, 26.8)	23.8 (21.8, 26.6)
Post-HbA1c (%)	7.1 (6.6, 7.6)	7.4 (7.0, 8.0)	6.5 (6.2, 6.8)
Δ BMI (kg/m ²)	0.04 (-0.27, 0.33)	0.04 (-0.28, 0.32)	0.06 (-0.26, 0.35)
Δ HbA1c (%)	-0.1 (-0.4, 0.1)	-0.2 (-0.5, 0.1)	0 (-0.2, 0.1)
Days between pre- and post-visit (days)	97 (84, 112)	96 (84, 112)	98 (84, 119)
Average days between clinic visits during emergency period (days)	70 (54.5, 98)	66.5 (49, 97)	84 (59.5, 98)
Average days between clinic visits and/or telemedicine (days)	52.5 (41, 63)	49 (37.3, 63)	56 (45.5, 66.5)

Data are the median (interquartile range) or number (%). BMI, body mass index; HbA1c, glycated hemoglobin.

Table 2 | Multiple linear regression analysis of HbA1c at post-period (post-HbA1c)

Independent variables in the model	β	β'	P	Model R ²
Model 1 (all participants, n = 2727)				
Average days between clinic visits	0.00069	0.022	0.038	0.698
Pre-HbA1c	0.79610	0.820	<0.001	
Pre-BMI	0.01678	0.073	<0.001	
Δ BMI	0.13517	0.083	<0.001	
Age	0.00363	0.046	<0.001	
Model 2 (all participants, n = 2727)				
Average days between clinic visits and/or telemedicine	0.00148	0.031	0.004	0.698
Pre-HbA1c	0.79675	0.821	<0.001	
Pre-BMI	0.01704	0.074	<0.001	
Δ BMI	0.13458	0.083	<0.001	
Age	0.00388	0.049	<0.001	
Model 3 (participants with pre-HbA1c $\geq 7.0\%$, n = 1741)				
Average days between clinic visits and/or telemedicine	0.00351	0.077	<0.001	0.554
Pre-HbA1c	0.73916	0.712	<0.001	
Pre-BMI	0.02494	0.118	<0.001	
Δ BMI	0.13944	0.091	<0.001	
Age	0.00541	0.074	<0.001	
Model 4 (participants with pre-HbA1c $\geq 7.0\%$, n = 1741)				
Visiting the clinic	-0.13969	-0.080	<0.001	0.553
Telemedicine	-0.09261	-0.054	0.004	
Pre-HbA1c	0.74115	0.714	<0.001	
Pre-BMI	0.02477	0.117	<0.001	
Age	0.00530	0.072	<0.001	

All models are adjusted for sex and type of diabetes. β and β' denotes regression coefficient and standardized regression coefficient, respectively. BMI, body mass index; HbA1c, glycated hemoglobin.

Table 3 | Multiple logistic regression analysis of whether HbA1c at post-period (post-HbA1c) reached <7.0%

Independent variables in the model	Multiple-adjusted odds ratios (95% CI)	P-value
Model 1 (participants with pre-HbA1c $\geq 7.0\%$, $n = 1741$)		
Average weeks between clinic visits and/or telemedicine	0.92 (0.87–0.97)	0.003
Pre-HbA1c per 0.1% increase	0.80 (0.77–0.83)	<0.001
Pre-BMI per 1 kg/m ² increase	0.95 (0.92–0.99)	0.007
Δ BMI per 1 kg/m ² increase	0.45 (0.35–0.57)	<0.001
Age per 5 years	0.89 (0.83–0.94)	<0.001
Model 2 (participants with pre-HbA1c $\geq 7.0\%$, $n = 1741$)		
Visiting the clinic	1.53 (1.12–2.08)	0.007
Telemedicine	1.56 (1.15–2.11)	0.004
Pre-HbA1c per 0.1% increase	0.80 (0.77–0.83)	<0.001
Pre-BMI per 1 kg/m ² increase	0.95 (0.91–0.99)	0.006
Δ BMI per 1 kg/m ² increase	0.45 (0.35–0.58)	<0.001
Age per 5 years	0.88 (0.83–0.94)	<0.001

The multiple adjusted odds ratios are adjusted for sex and type of diabetes. BMI, body mass index; CI, confidence interval; HbA1c, glycated hemoglobin.

ratios of shorter intervals of clinic visits and/or telemedicine (Table 3, model 1), as well as visiting the clinic during the emergency period and telemedicine (Table 3, model 2) were both independently associated with improvement of pre-HbA1c $\geq 7\%$ to post-HbA1c $< 7\%$. Lower pre-HbA1c, lower pre-BMI, lower Δ BMI and younger age were also associated with improvement of post-HbA1c adjusted for sex and type of diabetes in both models of Table 3. No evidence of multicollinearity was seen in any model evaluated by variance inflation factor of < 4 .

These retrospective data showed that during the state of emergency due to the COVID-19 pandemic, both telemedicine and clinic visit improved glucose control among Japanese diabetes patients. Among those who had HbA1c $\geq 7\%$ before the state of emergency, telemedicine and clinic visit during the state of emergency were both independently associated with improvement to HbA1c $< 7\%$ after the emergency period.

Although there are several reports on the use of telemedicine in diabetes patient care, reports of the use of this method during the COVID-19 pandemic are limited. There have been reports about the efficacy of telemedicine^{4–9}, and some recent reports about the necessity and possibility of telemedicine during the COVID-19 lockdown^{1,10–16}, but we were unable to find any study evaluating the effect of clinic visit or telemedicine on glucose control among diabetes patients during a lockdown or state of emergency.

There are studies reporting greater COVID-19 mortality at higher HbA1c^{17,18}, suggesting the necessity for diabetes patients to maintain good glycemic control during this pandemic. Other studies reported that HbA1c levels were not associated with

COVID-19 mortality^{19,20}. Nevertheless, diabetes patients must still keep their blood glucose levels under good control to minimize diabetes-related complications.

There were limitations to the present study. First, this was a single-site retrospective study from Japan, so generalizability is limited, as the medical insurance system, clinic style, telemedicine facility and the pandemic situation might not apply to other countries. Second, the present study design is subject to selection bias, as the contact during the emergency period was dependent on patients' and/or doctors' decision. Third, we could not evaluate the risk of COVID-19 infection due to clinic visit during the emergency period. Finally, clinic visit or telemedicine was not effective for those with pre-HbA1c $< 7\%$ to keep post-HbA1c $< 7\%$ (data not shown). Further investigation is necessary to clarify this limitation.

In conclusion, although the results should be interpreted with caution, the present study provides possible evidence that telemedicine and clinic visit were both associated with improving HbA1c in our diabetes patients. Our findings suggest that diabetes care should be provided to patients through either clinic visits or telemedicine, whichever is more feasible, during future emergencies.

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DISCLOSURE

The authors declare no conflict of interest.

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