Original Article

Impact of Telemedicine System Automatic Reminder on Outcomes in Women with Gestational Glycosuria

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Abstract

Background: Telemedicine is part of the health care information system that helps collect and share data efficiently. Healthcare information processing includes data storage, analysis, retrieval, data sharing for knowledge and communication purposes, and decision-making through the obtained data. Health information technology characterizes computer and communication features that can be webbed to build a system for dynamic health data. In this study, we are trying to determine the effect of the telemedicine system on gestational diabetic patients.

Objective: The objective of this research is to identify the telemedicine system effect on gestational diabetic patients.

Method: An internet-based telemedicine and interactive voice response telephone-communication system was used to contact patients and doctors. At the same time, a total of eighty patients with gestational diabetes mellitus were randomly divided among the two groups, which amounted to forty patients each. One group was given a telemedicine system while another group was treated with the general medical treatment (control group) and requested to monitor their blood glucose level four times per day. Women in the telemedicine group have transited the information with the help of the internet while the other group submitted their report manually using the paper logbook entry method. Data collection includes maternal glucose control, new-born birth weight, and the data transmission of the intervention group.

Result: There was no substantial variation between the telemedicine and control group patients regarding the maternal blood glucose value and the new-born birth weight. Telephone access and the reminder system enhance the transmission rate in the telemedicine group than the control group ($p<0.001$).

Discussion: Though the telemedicine group had no significant impact on the gestational patients' blood glucose levels, telemedicine has been shown to improve healthcare efficiency. For example, by controlling the site, insurance, pre-pregnancy BMI, and group assignments, the site difference effects are reduced, allowing patients to receive better care.

Conclusion: Newly developed telemedicine is a breakthrough for the medical field. It helps doctors keep updated by efficiently collecting data and allows patients to perform routine self-management for their data submission, which also helps them get better treatment. [*Ethiop. J. Health Dev.* 2021; 35(3): 276-280]

Keywords: Telemedicine; Gestational Diabetes mellitus; Diabetes; IVR; Computer; Glycosuria

Introduction

Gestational glycosuria is a common symptom in gestational diabetes mellitus; this condition happens in more than 2 thousand pregnant cases each year in the USA. Globally, this affects about 84% of pregnant women, who have gestational diabetes (1). According to the epidemiological report, this case is rising daily. Gestational glycosuria is not caused by insulin deficiency like other diabetes types, rather this occurs due to not utilizing the insulin hormone. This condition occurs due to a hormone called human placental lactogen (HPL). Human chorionic somatomammotropin (HCS) raises blood glucose levels and makes the mother's body less sensitive to insulin, i.e., the body cannot utilize the insulin properly. If the body cannot use the insulin, then blood glucose levels will rise, which will cause diabetes for the mother. The IADPSG (International Association of Diabetes and Pregnancy Study Group) recommends dropping the threshold level, i.e.,>130mg/dl, for tolerance test of oral glucose for diagnosing the gestational Glycosuria (GG). These recommendations have been accepted by the ADA (American Diabetes Association) due to increasing pregnancy complications for glycosuria. Information technology helps in providing good health care for diabetic complications in pregnant women. According to some studies, a telemedicine monitoring system allows blood glucose control and keeps haemoglobin A1c level down.

Three studies have been conducted with type 1 diabetic pregnant women, and study results show maternal blood glucose improvement (2). To date, another three studies have performed using the information technology with gestational diabetic women. Kruger et al. randomise patients using telephone reporting data or modem transmission data; while there are no differences in blood glucose levels, modem transmission improves clinical effectiveness (3).

While in Spain a group of researcher uses a technology that connects a mobile phone with a glucose meter (4), which transmits central database and have access to SMS (Short Message Service). This results from a 62% reduction in the non-scheduled visits. There is a previous report of using a web-based telemedicine system for Gestational diabetic women. We conducted this observation to understand the utility of the telemedicine system to connect the Gestational diabetic woman of the inner-city area and healthcare personnel (5). In that observation, participants without internet

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access, were trained to use the internet. About 22% of females never use the computer. So, Later an IVR (Interactive Voice Response) system was introduced to remove this barrier. The Internet-integrated IVR system is accessible from any phone by a charge-free number and does not need any training.

Additionally, the system functionality was developed using phone messaging between doctors and patients and consisted of a reminder for patients to send data. The reason for the study was to test the effect of this telemedicine system on Gestational women related to usual treatment. It has been hypothesized that a telemedicine system with modern features, and ease of access, will enhance the transmission rate within the intervening women. It results in better glucose control and reduced pregnancy problems.

Telemedicine and its uses

Our secured encoded health record (e-health Insurance Portability and Accountability Act or HIPAA) web-dependent communication structure contains a secure server, an Interactive Voice response phone, and data source. The system transfers data like messages, healthcare information between patient and doctor simultaneously. Women send their blood glucose data and clinical information using this system through the internet. The patient can send the information by dialling a particular number or through the web by logging into a secured account. These systems allow a patient to send or ask a question to the doctor after providing them with the clinical data. The message, which contains the data collected, may then be accessible by doctors and clinicians when they enter the portal, allowing the question to be addressed. While the information is sent as a .wav file, the nurse can hear the message through the portal. Through the systems, the nurse can send a response in the form of a text message or voice message, which is accessed by the patient anytime using IVR. If the patient accesses the internet, the news is accessible in the text format that appears first after entering the account. The system also planned to remind the patient to record and send the necessary data if it was not done at a designated time. If the patient forgot to transmit data, then the IVR system makes three calls on the phone in a day, at a selected time, to remind the patient. Despite these efforts, some patients did not submit the clinical data. Then the respective nurse would provide a reminder again or make a direct call to the individual patient.

Materials and Methods

Gestational diabetic patients were recruited from two different places. The Temple University of Philadelphia and Tallahassee memorial of Florida. Patients were between the ages of 18 to 45 years, and they were experiencing their 33-week gestational period. An Oral glucose tolerance test (3 hr.) was conducted for Gestational Diabetes Mellitus, as confirmation, when using the Carpenter and Coustan criteria (6). Patients were randomized into two groups telemedicine and Usual care group (Control group). After randomization, the patients were trained to use the computer, internet and elaborately on how to use the internet program. They were introduced to the clinic website and provided with a telephone for communication and instruction to benefit IVR in the telephone system. The system provided the group with a specific login ID and password for secure access to the website, and those who use the IVR system were offered a Toll-Free number for updating their data. While using the IVR system, patients were prompted to input clinical information like blood glucose data, hypoglycemia episodes, medication changes and to recognize the daytime utilizing the phone keypad. For this observation, patients were provided with a response, supported emotionally, and diabetes self-management reinforcement was done.

Additionally, patients received a brief informative tip through messages every time the system was accessed on both the internet and phone. Patients in both groups were requested to monitor their blood glucose level, fetal movement performance, and insulin level recording, and hypoglycemia episode daily. Patients in the treatment group were asked to submit their data via a phone or the internet weekly. While in the control group, patients were requested to maintain a logbook record. The medical team reviewed this during a prenatal visit. Both patient groups have undergone the standard medical care in the two programs (7,8). Up until the 36 weeks gestation period, all the patients were observed by medical practitioners every two weeks. Clinical care was provided by fetal medicine specialists, residents, and certified diabetes educators and nutritionists. All patients provided individual diet charts and diabetes awareness. Participants were instructed for glucose self-controlling and requested to observe their glucose levels four times a day. All patients were treated to achieve metabolic goals of the blood glucose level of about 95 mg/dL and post-prandial blood glucose up to 120 mg/dL. Those patients who failed to achieve the target minimum of 90% at the initial time, were treated using glyburide or insulin treatment. The main aim for this observation was glucose regulation in the mother's body and new-born birth weight.

In contrast, the minor aim was pregnancy result (mode of delivery, gestational period at delivery, Apgar value) and the efficiency of the telemedicine system. New-born birth weight above the 90th percentile was considered as significant. Transient tachypnoea, hyaline membrane disease, and respiratory support needed was included in the respiratory outcome. A Glucose level of less than 40mg/dL was treated as Hypoglycaemia, and a plasma value of more than 12 mg/dL was regarded as Hyperbilirubinemia. Student's T-tests were analysed to compare the continuous variable means. Chi-squared statistics analysed comparison between the categorical variable. To assess the gender impact, parity, pre-pregnancy BMI, and mean blood glucose level, multivariate analyses were done.

Results

A total of 80 patients with gestational diabetes were selected from the two hospitals. Thirty patients from the Temple University hospital, and fifty were derived from the Tallahassee hospital. Data collection was

done from 2018 September to November 2020. Among the 80 patients, 40 women were randomized to the intervention group, and the other 40 women were the randomizing dot control group, two patients in the usual care and three patients in the telemedicine group had no follow-up.

Additionally, patients in the telemedicine group had a fetal loss in the 19th week of gestation. Only 38 participants and 36 intervention patients' outcomes are available. There was no difference in the intervention group (Table 1).

Table 1. **Presenting the general characters of the participants.**

Character	Control	Telemedicine
	n=40	n=40
Age	31.0 ± 6.0	31 ± 6.5
Body mass index	33.1 ± 7.5	33.1 ± 9.8
Weight gain (pound)	20.5 ± 17.1	20.7 ± 18.7
Gravidity	3.9 ± 2.9	2.4 ± 2.0
Parity	1.8 ± 2.0	1.0 ± 1.1
Gestational Age at entry(weeks)	27.4 ± 3.5	29.5 ± 4.1
Race		
African-American	16	14
White	15	19
Latino	7	5
Asian and others	2	2
Schooling		
< high school	7	1
high school graduated	13	14
> high school	19	25
Missing	1	0
Family Income		
<15000	7	10
15001-24999	5	8
25001-34999	10	6
35001-44999	6	6
45001-54999	0	3
>55000	6	6
Missing	6	1
Glucose (mg/dL)	185.5 ± 28.7	175.3 ± 26.2
3-h OGTT (mg/dL)		
FBS	94.5 ± 19.7	98.7 ± 22.1
One h	194.1 ± 23.5	202.4 ± 38.8
Two h	179.3 ± 24.5	181 ± 53.7
Three h	129.8 ± 37.5	148 ± 46.7

Maternal outcomes

Both patients' groups attained the same glycaemic control level (Table 2). As per the assessment of blood glucose data obtained from logbook record (control) or telemedicine data (intervention). Patients having nutrition treatment reached a lower blood glucose level than the patients with insulin or glyburide treatment.

Post controlling the site, insurance, pre-pregnancy BMI, and group assignments, the site difference effects are reduced while only mode of treatment was significantly (p-value<0.05) persistent. About 40% of the patients (shown in table 3) in each group need medical treatment.

Table 2: **Maternal glucose control**

	Control	Telemedicine	P-Value
FBS (mg/dL)	92.2 ± 10.4	90.8 ± 9.04	0.27
Blood glucose level (mg/dL)			
Breakfast	111.8 ± 19.4	109.2 ± 16.0	0.48
Lunch	112.3 ± 17.8	109.5± 16.1	0.89
Dinner	116.7 ± 21.0	118.9 ± 16.3	0.59

Table 3. **Representing the diabetes treatment result**

Diabetes therapy	Control	Telemedicine
Diet	26	22
Oral agent	9	5
Insulin	5	13

While 7% of the patients have pre-eclampsia counting two control group patients and three telemedicine group patients (Table 4), though the cesarean delivery in the control group is highest, this difference is less significant (P value= 0.52).

Table 4. **Maternal Outcomes by Treatment Group**

	Control	Telemedicine	P-value
Cesarean delivery	20	14	0.29
Pre-eclampsia/gestational hypertension	4	4	0.69
Premature rupture of membranes	1	3	0.19
Chorioamnionitis	1	1	1.0

New-born Result

Analysis for new-borns is shown in table 5. There was no significant variation found in the two groups regarding birthweight on univariate or multivariate analysis. There were eleven babies who needed admission to the neonatal care unit, but there was no mortality. One new-born had an inherent chromosomal problem and several hereditary abnormalities from a control group mother. While fewer babies were admitted to the ICU in the intervention group (8 in the control group and five in the telemedicine care group), these differences were statistically insignificant.

Table 5. **presenting Neonatal Outcomes**

	Control	Telemedicine	P
Birth weight(g)	3350 ± 511	3400 ± 430	0.28
GA at delivery(weeks)	38.0 ± 2.1	39.0 ± 1.2	0.07
Apgar score			
1min	7.9±0.9	8.1±1.9	0.19
5min	9.0±0.2	9.0 ± 0.48	0.79
LGA	6	8	0.69
neonatal hypoglycemia	5	3	0.9
ICU admissions	8	5	0.7
preterm delivery	4	3	0.5
Jaundice/hyper-billirubenia	3	3	0.9
RDS/respiratory	6	3	0.3

Telemedicine utilization

18% of women in the telemedicine group had not accessed the internet; they used the IVR system for data transfer. Out of 40 patients, 36 patients had follow-up availability until the delivery. While two patients never utilized the system and five women had frequent utilization of the system. On average, patients sent 36 datasets, including fasting, blood glucose level, count of fetal movements, and insulin level data. Patients sent significantly more data through the internet than the IVR system (p-value is 0.007). There is a significant correlation between the family income and transmission number with patients who had higher income (correlation value is 0.5; p-value is <0.01). the self-submitted glucose dataset and the IVR or internet transmitted dataset did not significantly differ between the two study groups.

Discussion

This study was designed to observe the enhanced telemedicine with IVR facility impact on the pregnancy results of woman with gestational diabetes. The system supported patients with feedback on diabetes by reinforcing self-management. This system also facilitates contact between the patients and healthcare providers.

This system can be access via the internet and telephonically. Additionally, this system provides an automatic reminder for those who failed to submit their information within the due period. We hypothesized that diabetes self-management would be augmented by increasing contact with healthcare providers, which ultimately enhances glucose control, resulting in a better pregnancy outcome. While this is an unacceptable result, the telemedicine system did not promote maternal hyperglycemia, even though more than 66 % of patients achieved a glucose level of 110mg/dL. The experiment was able to detect 10 mg/dL variation among the two study groups. Due to the short time and small sample number, this system fails to control diabetes because it just didn't have enough time, as ultimately the ability to control lies with the parents, so the system was unable to help patients promote better glucose control during their pregnancy. Pregnancy and neonatal outcomes also did not vary significantly. Though the babies from the

telemedicine group are less prone to be admitted to the ICU.

Additionally, the telemedicine group has a reduced rate of pre-period delivery, also reduced respiratory distress syndrome. However, in the telemedicine group, childbirth time was more than 0.7 weeks larger than the control group, which explains the low premature delivery rate in the telemedicine system. It can be postulated that with the larger sample, the variation of the neonatal outcome also increases. According to Kruger et al. (3), enhanced clinical workflow efficiency with developed transmission systems is unaffected on glucose control and pregnancy results. While, according to Perez-Ferre et al. (4), there are a smaller number of impulsive visits of gestational diabetes patients in the telemedicine system, though they have no variation in the blood glucose level or maternity result. However, in the current observation, we did not emphasize patient satisfaction or workflow efficacy. From the above study, it has been inferred that telemedicine system advancement also increases patients' care quality and increases work efficiency. The real benefit of the telemedicine system is the ability to provide equal care to all patients. We observed a strong correlation between the family earning and data transmission number. Patients with a low-income family have fewer resources, making prioritizing health issues difficult, while patients from high-income families frequently transmit information.

In the original research, the entire process was web-based. Patients who did not have any internet or computer access were provided with the system for use. However, those machines were refurbished and delivered to the participant's home address. At the same time, the participant learned computer access in the college and from the graduate students. Several technical difficulties were found in the computer access, additionally lagging of the renewed system. To cope with these problems the IVR system was redesigned, which can be utilized through use of the landline or the internet. We hypothesized that this system, combined with the automatic reminder ability, will enhance system utilization. Compared to the other study, the data transmission increased from 17.4 to 35.6 (p-value <0.01). The other published data also support this observation. According to the other literature, a reminder can enhance self-monitoring (9,10).

Conclusion

The modern telemedicine system improves patient-doctor communication but did not affect the pregnancy result. The expectancy of the enhanced controlling and efficiency among the gestational diabetic patients is impractical. The significant ability for new technology to enhance the treatment quality and efficiency is noted. Future research emphasizes these problems and the health information technology's effect on the patient's satisfaction and treatment.

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