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Gestational Diabetes Management System

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Abstract:

Gestational diabetes mellitus (GDM) is a condition in which women without previously diagnosed diabetes exhibit high blood glucose levels during pregnancy, especially during their third trimester. Gestational diabetes results from the body which makes some insulin but cannot use it properly. This in turn causes inappropriately elevated blood sugar levels. Diagnostic tests detect inappropriately high levels of glucose in blood samples. So, there is a need to manage this disease in order to reduce its risks through providing healthcare technologies.

The aim of this research is to design and implement the Gestational Diabetes Management System (GDMS).This proposed system is centralized database which contains the patients' records of gestational diabetes during Pregnancy. The system enables the patient to access the system and enter their medicinal readings like: blood glucose and blood pressure. These data will be held on a database and the system will process these medical data to statistical data for progressing of the patients and their physician. It allows the physician to make a suitable decision based on the collected data. Lastly advices of treatments are sent to the patients. The system will meet the needs of pregnancy and should be consistent with the maternal blood glucose goals that have been established. It will help to manage a gestational diabetes in a correct an easy way and to increase patient program compliance.

Key words: Gestational Diabetes, GDM, Agile approach, DSDM Atern, System scope.

1. INTRODUCTION

Diabetes is the name given to a group of conditions where there is a high rate of glucose in the blood. It develops when the body doesn't make enough insulin, or the insulin doesn't working properly [1]. Gestational diabetes affects the pregnant women who have never had diabetes before but who have high blood glucose levels during pregnancy; and it is usually resolves after the childbirth. Women with gestational diabetes have an increased risk of developing type 2 diabetes. GDM is increasing as a result of higher rates of obesity in the general population and more pregnancies in older women [2]. Gestational diabetes affects the mother in late pregnancy, after the baby's body has been formed, but while the baby is busy growing, it can hurt her baby.

Several research state that the self-management is inevitable as patients could make decisions every time relating to existence factors such as exercise and diet [3].

Fortunately recent advances in technology have opened up the doors to enable scientists to tackle the issue. Optimization of health care is probable to have a good effect on progress of this disease, quality of life, and functional outcome. The importance of early diagnosis and secondary intervention programs for prevention and early detection of gestational diabetes complications are emphasized. This proposed system will apply to increase patient program compliance and to manage their disease better. It will gather medicinal data (blood glucose, and blood pressure) from the pregnant patient and these data will be held on a database and the system will process these data to the progress of the patients. Lastly, the system will enable the physician to send the advices of treatments to the patients like: the information about the levels

of blood sugar and blood pressure, physical activity, insulin dosage, monitoring food consumption, etc. GDMS is efficient to both patients and physicians.

1.1 Overview of Gestational Diabetes

Gestational diabetes, defined as "carbohydrate intolerance of variable severity with onset or first recognition during pregnancy"[4]. GDM accuses the pregnant women who have never had diabetes before but who have high blood glucose levels during pregnancy. In the US, diabetes affects an estimated 320,000 pregnancies approximately every year. However, there are several risk factors of developing gestational diabetes like: Increasing maternal age-over 30 years, marked obesity, family history of type 2 diabetes, history of poor obstetric outcome, and when the pregnant women who have had Polycystic Ovarian Syndrome. GDM generally has few symptoms and it is most commonly diagnosed by screening during pregnancy [5]. It should undergo glucose testing as soon as feasible. GDM may be associated with an increase in the risk of intrauterine fetal death during the last 4-8 weeks of gestation.

The placenta produces hormones which supports the baby to grow during pregnancy period. These hormones also block the action of the mother's insulin which is called insulin resistance. The need for insulin in pregnancy is higher than normal because of this insulin resistance. This disease develops if the mother's body is unable to produce the extra insulin. The gestational diabetes diagnoses by performing a pathology blood glucose test at 24-28 weeks of pregnancy. The glucose test is very significant for pregnant mother, because high blood sugar can cause problems for both pregnant woman and her baby [6].

1.2 Proposed system target and functionalities

The aim of this proposed system is to design and implement a generic framework of a real time decision support in healthcare for Gestational Diabetes Management System as shown in

Figure 1. The system will reflect the ongoing challenges of providing patients with better access to, and involvement in their own care, and communication between patient and clinician. The system will be representing the medical data statistically. It will provide patients with accurate and reliable ways of caring for themselves, outside a hospital or doctor's office. Also it supports for enhanced patient and clinician communication. Lastly it is efficient by reducing healthcare costs and providing time.

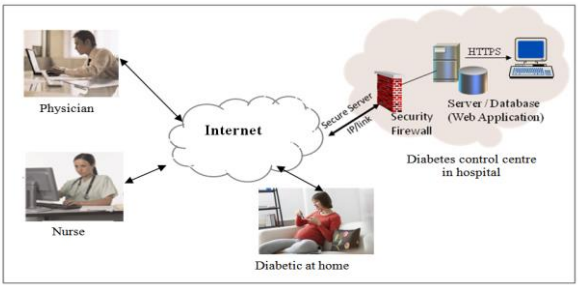

Figure 1: System architecture for Gestational Diabetes Management

1.3 Project Scope

The scope of GDMS is to design a reliable and fully functional web-based gestational diabetes management system. This system is used to illustrate store patients information electronically rather working as a complete workflow. However requirements for implementing a public health approach to gestational diabetes care include long-term planning, targeting patients for improved care, and goal setting for outcomes of care. GDMS has five users which were identified as: patient, physician, nurse , technician and administrator and each one has collection of functions in side system. The patient has the ability to register, login in and login out, enter their medical readings and update their information while the nurse is able to register, login in login out, search and send recommendation and advice to patient's email. The technician has the ability to register, login in and login out, delete and edit sensor device on the system and search the system for sensor device. While the

Physician is able to register, login in and login out, search, send recommendation to nurse and patient. Lastly the administrator is able to register, log in and log out, add user physician/ nurse, edit user physician / nurse, maintains, make system pack up, and manage database. Figure 2: shows the scope of GDMS.

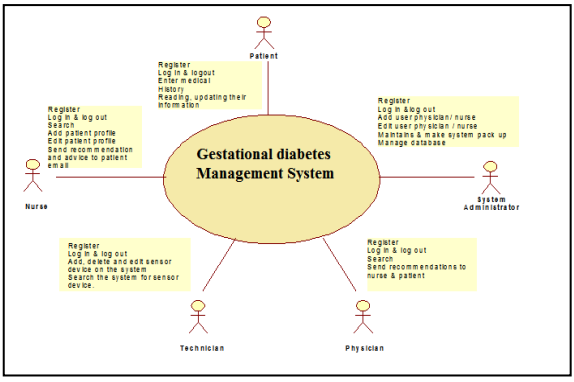

Figure 2: Scope of GDMS

1.4 System Development Lifecycle

The Agile approach was chosen as the lifecycle in the development of GDMS. We will use DSDM (Dynamic Systems Development Method) Atern to develop and fulfill the system objectives. DSDM is an agile framework for management and delivery of systems at the right time without any delay. It is an iterative and incremental approach that emphasizes continuous user involvement and delivery of projects at the right time without any delay [7]. DSDM Atern has eight guiding principles which must be applied in a system that will ensure the system successful [8]. According to Agile approach, GDMS will across within seven phases during its lifecycle as shown in Figure 3.

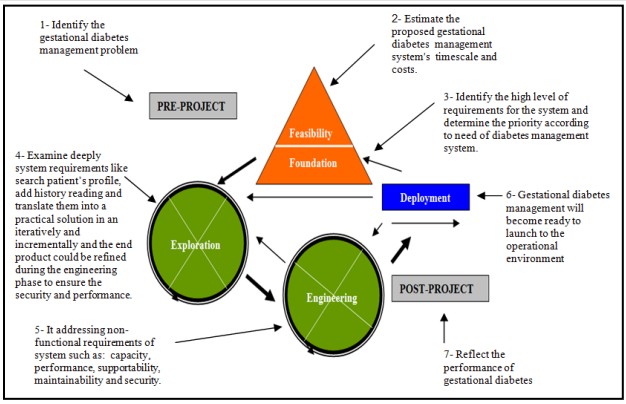

Figure 3: Lifecycle of GDMS

2. SYSTEM ANALYSIS AND METHOD

The methodology which will be used during the design of the GDMS and the analysis of its requirements will be discussed in details through this section. GDMS development lifecycle was divided into phases [9]:

2.1 Data Flow Diagram

One of the most widely used system analysis process models is the data flow diagram. A data flow diagram (DFD) is a tool that illustrates how data is processed by a system in terms of inputs and outputs. It is used to help understand the existing system and to represent the required system. The diagrams represent the external bodies sending and receiving information [10], [11]. Figure 4 shows Data flow diagram of (GDMS).

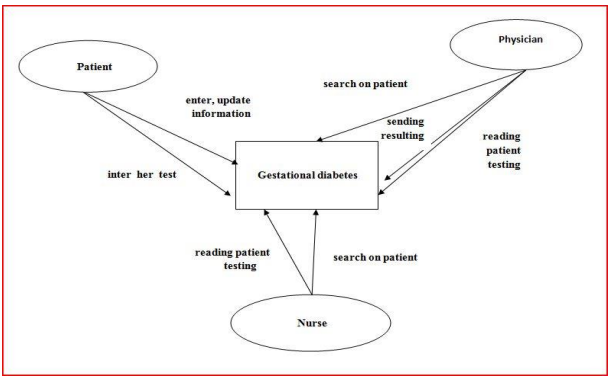

Figure 4: Data flow diagram of GDMS

2.2 Unstructured Interview

It is essential to success any system is to understand its requirements. For having a lot of information may be able to be useful to apply system of gestational diabetes management, we had an interview with the health care providers such as physician, nurse and patient for gathering rich information about system requirements to design and build this system.

2.3 Requirements Phase Elicitation

Requirement is a service that the user desires the solution to perform or display. These requirements should be flexible according to the business needs. According to the Atern DSDM technique which it will be used in lifecycle of GDMS; two types of requirements were identified, functional and non-functional requirements. And it is essential to understand both through the lifecycle of this system [12].

2.3.1 Functional requirement

Functional requirement describes the ability of the system. They are described as set of GDMS inputs, the behaviour, and outputs of the system. The system requirements of GDMS are described as the following [13]:

1. Add new user (physician, nurse, patient) account.
2. Add new patient information.
4. Update patient details.

5. Search about specify patient.
6. Enter the medical readings like: blood pressure and blood glucose.
6. View patient readings.
7. Send recommendations and advices to the patient email.

2.3.2 Non Functional requirements

Non Functional requirements describe what level, with what security, usability, Performance, reliability, capacity, maintainability and compatibility [14]. For instance the system interactive with database immediately as under a second, database searches, updates and retrieval the change to patient information must be fast.

2.4 User analysis

During the development this system, it is essential to gather information about users who related to the system. In GDMS Five users were identified like: patient, physician, nurse, technical and admin. Table 1 shows the role of one actors in the system [15].

Table 1: Role of Patient user

Actor:	**Patient**
Role:	✓ The patient can access the system. ✓ The patient can enter their information. ✓ The patient can enter their medical readings.
Characteristics:	✓ The patient will have a basic conceptual understanding of the system.
Activities:	✓ Input medical readings. ✓ Comment on any symptoms. ✓ Update Personal information.

3. SYSTEM DESIGN

At the design stage being the decision-making on how to build and operate the system. On the other words, its purpose is to create a technical solution which satisfies the

system functional requirements. Use Case Model, and Use Case specification were used to design the GDMS. Each use case describes functionality that will be built in the proposed system. Whereas Use Case Specification provides a way to capture the functional requirements of a system counting event trigger and expected outputs.

In GDMS, there are five users in the Use Case Diagram and each one has many functions in the system [16]. Figure 5 shows the functions of two actors of this system.

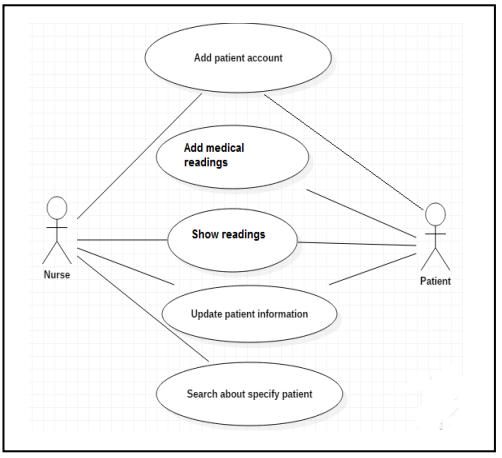

Figure 5: User's functions

4. IMPLEMENTATION TOOLS

In GDMS, Visual Studio and Web Browser Applications are used to Create Stand Alone Desktop Applications. C# language Also is used in this system .While SQl Server was used to create the database of the system. The SQL Server is Microsoft's relational database management system (RDBMS). It is a full-featured database primarily designed to compete against to its competitors [17].

5. SYSTEM INTERFACES AND RESULTS

The system interfaces that have been obtained through the implementing of gestational diabetes management system as the following:

1. To login in to patient interface as shown in Figure 6, it should follow the two steps below:
a. Entering the user name and password. b. Click login.

Figure 6: Login Page

2- If the patient entered wrong user name or wrong password, the screen will appear asking for re-entering the correct user name and password, as shown in Figure 7.

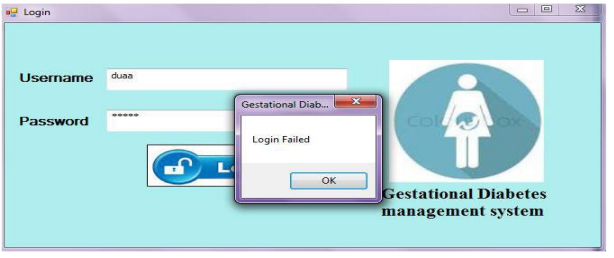

Figure 7: Failure in login

3. Figure 8 shows the main page of the system which includes four options related to the main page of Gestational Diabetes Management System.

Figure 8: Main page of Gestational Diabetes Management System

4. To add patient details, choose the option (Add patient) in the main page, the page in Figure 9 will appear, it has several options like: save, update, delete, and search. Figure 10 shows the entered patient details was added successfully, while Figure 11 shows the update process was also successfully.

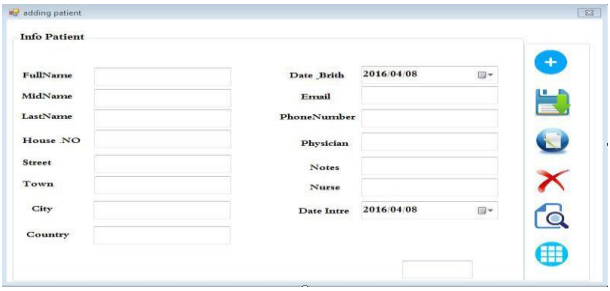

Figure 9: Add patient details

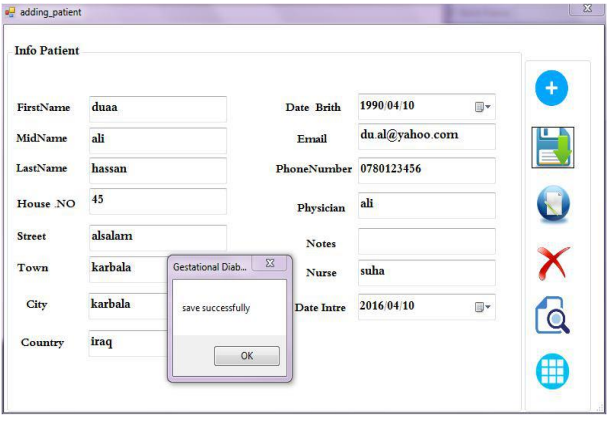

Figure 10: Patient details was added successfully

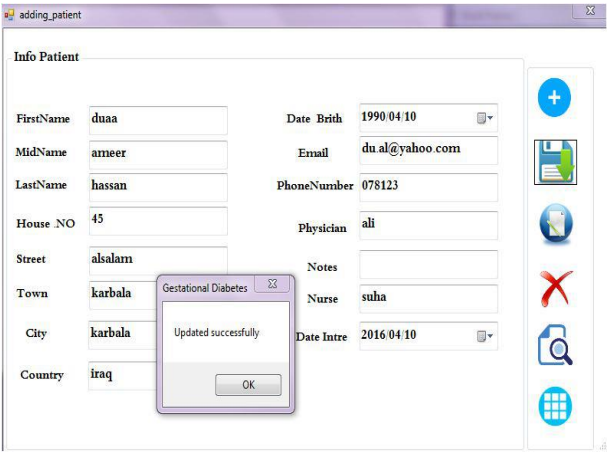

Figure 11: Patient details was updated successfully

5. Figure 12 shows the page for searching about specify patient.

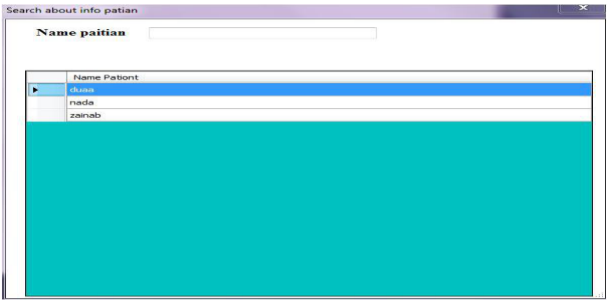

Figure 12: Searching page for specify patient

6. The patient can add their medical readings like: glucose, and blood pressure from page of new reading as shown in Figures (13, 14, 51). Then the system saves these readings in the system database.

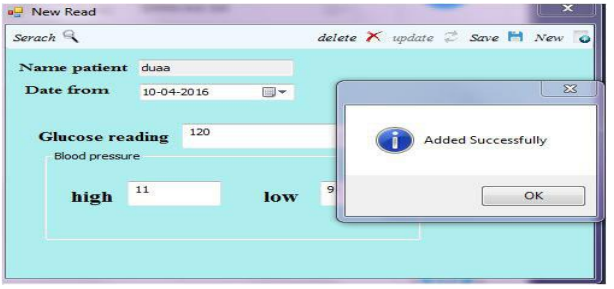

Figure 13: Readings was added successfully

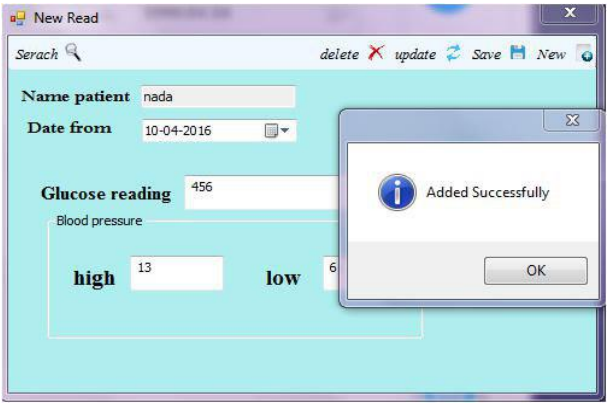

Figure 14: Readings was added successfully for the second patient

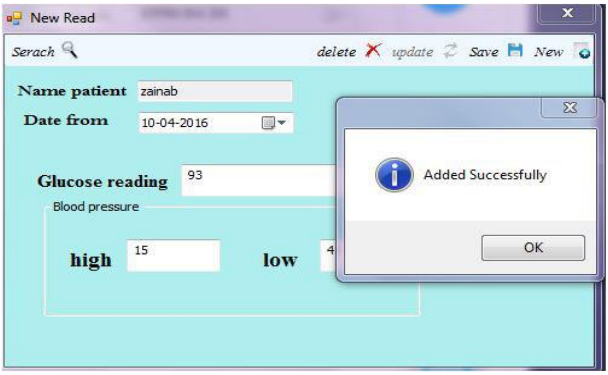

Figure 15: Readings was added successfully for the third patient

7. View medical readings interface: the patients and the physician can view the medical readings of patients from the search interface as shown in Figure 16, while Figures (17, 18, 19) show these readings graphically. If the result of glucose is more than120 mg/dl when a person is fasting, the system will warn that there will be a risk of diabetes. In this case, the physician will send recommendation to the patient about this risk.

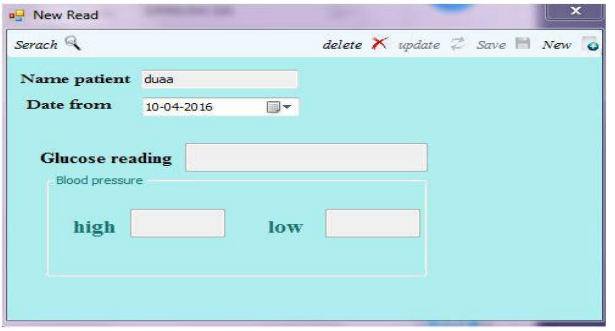

Figure 16: Searching page

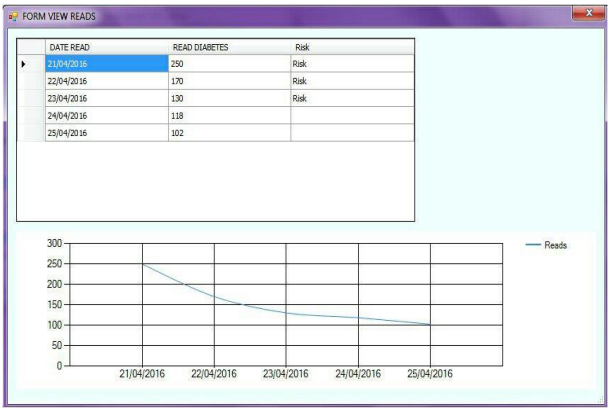

Figure 17: Medical readings for patient

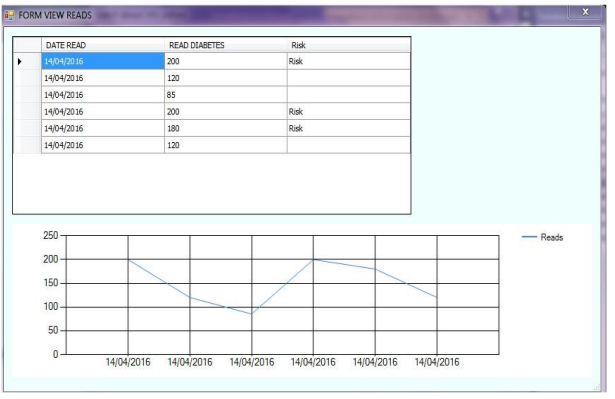

Figure 18: Medical readings for second patient

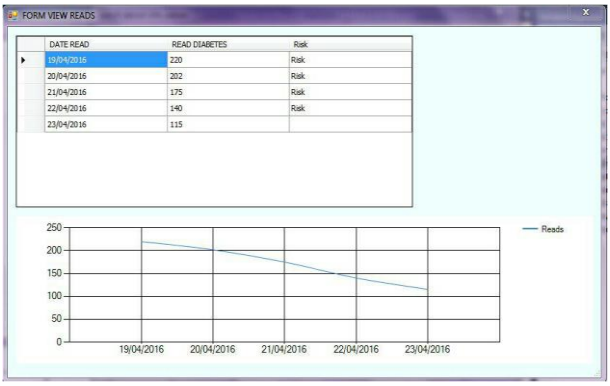

Figure 19: Medical readings for third patient

5. CONCLUSIONS

This paper has presented a design and built a system for gestational diabetes care. The system has provided the patients with reliable way to manage their disease by themselves even outside clinic doctor. It allowed the nurse (physician) to make a suitable decision based on the collected data from patients. GDMS is free for non-commercial use for all gestational diabetes patients and caretakers. It uses patient personal computer, and the patients are able to access their records whenever needed and without any conditions or costs.

After implementing the system of Gestational Diabetes Management, it will be capable of achieving the following:

1. It will serve physicians and patients by reducing healthcare costs and enable patients to manage their disease better;
2. It ensures the security and privacy via safe access;
3. It supports and increases health awareness, and enhances decision making;
4. It has dependability and consistency execute the required functions of software;
5. It helps to promote the communication between patient and clinician;
6. It has dependability and consistency execute the required functions of software.

However, to improve this system, there are several additional functionalities will be added as the following:

- ✓ Improve the web page interactivity to be more interactive;
- ✓ Using some explanations with graph to aid understand/digest information;
- ✓ Send the recommendations of treatment to the patient mobile.

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