Abstract
The aim of healthcare is to achieve the best health outcomes in the most efficient manner, and the challenge for today’s health delivery systems is to increase productivity and quality of care without increasing the economic costs. Information and communication technologies are poised to support healthcare transformation, preventing the onset of diseases, improving diagnoses and treatments, enhancing the quality of healthcare delivery, and empowering us to participate in our own health and well-being. This paper presents a developed web-based self-management advisory software for gestational diabetic patients to facilitate quality and healthy pregnancy health outcomes. Overall care and metabolic control of GDM pregnancies in Nigerian population remain sub-optimal with attendant poor feto-maternal outcomes. We reviewed literature on DM and GDM, interviewed General Practitioners on Reproductive Health to confirm the possible combinations of conditions responsible for DM and GDM. Ninety-seven (97) of such possible diabetes application rules in detecting and advising patients on GDM were contingently combined and programmed using software engineering tools including Unified Modeling Language, Hypertext Mark-up Language, Hypertext Preprocessor, MySQL database Server, JavaScript, and Editor on Microsoft Windows operating system, and Apache Web server version 2.2.8 platform. The software provides an evidence-based platform that enables a patient to work better with her healthcare provider in developing a treatment plan that addresses her specific needs and situation thereby ensuring that the patient and her baby are healthy. This improves personal efficiency of pregnant women in keeping them healthy and promoting the best outcomes for their babies if gestational diabetes is diagnosed.

Keywords: chronic diseases, gestational diabetes mellitus, healthcare, impaired glucose tolerance, lifestyle-related diseases, mortality, pregnancy

1. INTRODUCTION
The aim of healthcare is to achieve the best health outcomes in the most efficient manner, and the challenge for today’s health delivery systems is to increase productivity and quality of care without increasing the economic costs. Information and Communication Technology (ICT) has become the transformative tool for a new style of global development while playing an increasingly important role in addressing the global challenges of healthcare. With the development of ubiquitous and pervasive computing, increased and expanded adaptability to changing needs, preferences, and environments will emerge to further enhance the use of technology amongst global cultures and populations. ICTs are poised to support healthcare transformation…. preventing the onset of diseases, improving diagnoses and treatments, enhancing the quality of healthcare delivery, and empowering us to participate in our own health and well-being [1]. Chronic diseases accounted for 60% of all deaths – corresponding to a projected 36.65 million deaths worldwide in 2007. While prevalence of lifestyle-related diseases increases [2], Diabetes Mellitus (DM) is a disorder of carbohydrate metabolism that requires immediate changes in lifestyle [3]. Complex and chronic illnesses, such as cancer, diabetes mellitus, demand the use of specialist treatment protocols.

DM is a hereditary, chronic, potentially debilitating and often fatal endocrine disorder disease, characterized by hyperglycaemia and eventual glycosuria. It is caused by the inability of tissues to carry out normal metabolism of carbohydrate, lipid and protein. The long-term durable hyperglycaemia usually leads to serious damage to many of the body's systems, especially the nerves, blood vessels, heart, eyes, and kidneys, and thus concurs serious macrovascular and microangiopathy complications, including retinopathy, nephropathy, and peripheral neuropathy. Due to population growth, aging, urbanization, lifestyle alterations, and increasing prevalence of obesity and physical inactivity, the past two decades have seen an explosive worldwide increase in the number of people that are diagnosed with DM. An estimated 30 million people worldwide had DM in 1985. The latest data from International Diabetes Federation (IDF) and World Health Organization (WHO) indicate that DM now affects a staggering 246 million people worldwide, with 46% of all those affected in the 40-59 age group during their economically most productive years, and this is
likely to increase to at least 380 million by 2025 [4]. The 2.8% of the world population suffering from diabetes mellitus may cross 5.4% by the year 2025. For high quality care to be achieved, healthcare systems must have safety, effectiveness, patient-centered emphasis, timeliness, efficiency, and equitability attributes [2].

Pregnancy is a diabetogenic condition characterized by insulin resistance with a compensatory increase in β-cell response and hyperinsulinemia. The placental secretion of hormones (progesterone, cortisol, placental lactogen, prolactin, and growth hormone) is a major contributor to the insulin resistance, which likely plays a role in ensuring that the fetus has an adequate supply of glucose. Pregnancy in patients with diabetes is associated with an increased incidence of congenital anomalies for the fetus and spontaneous abortions in women with poor glycemic control [5]. DM is one of the most common medical complications of pregnancy [6, 7].

Gestational Diabetes Mellitus (GDM), hyperglycemia due to the pregnancy itself, is characterized by carbohydrate intolerance of variable severity, with onset or first recognition during pregnancy [6, 8]. Of all types of diabetes, GDM accounts for approximately 90–95% of all cases of diabetes in pregnancy. The definition is applicable regardless of whether insulin is used for treatment or the condition persists after pregnancy. It does not exclude the possibility that unrecognized glucose intolerance may have antedated the pregnancy. Diabetes in pregnancy is associated with risks to the woman and to the developing fetus. Miscarriage, pre-eclampsia and preterm labour are more common in women with pre-existing diabetes. In addition, diabetic retinopathy and preterm labour are more common in women with pre-existing diabetes. In addition, diabetic retinopathy can worsen rapidly during pregnancy. Stillbirth, congenital malformations, macrosomia, birth injury, perinatal mortality and postnatal adaptation problems (such as hypoglycaemia) are more common in babies born to women with pre-existing diabetes [3]. Diabetes is the most common pre-existing medical disorder complicating pregnancy in the UK. Approximately one pregnant women in 250 has pre-existing diabetes. This is associated with increased risks for both mother and baby. 2–5% of pregnancies involve women with diabetes [9, 10].

In a cohort study of Nigeria, the GDM prevalence was 2.98 per 1000 pregnancies. Maternal age and gestational age at diagnosis (mean ± SD) were 31.0 ± 2.4 years and 23.88 ± 8.2 weeks respectively. Fasting venous blood glucose level at diagnosis was 7.76 ± 1.6 mmol/L while the cumulative mean FVBG throughout pregnancy was 6.56 ± 0.79 mmol/L. Pre-eclampsia 26.7%, mid-trimester abortion 6.7%, intrauterine fetal death (IUFD) 6.7% were the major antenatal complications. Caesarian section rate was 10%, gestational age at delivery - 37.55 ± 1.94 weeks and birthweight - 3.75 ± 0.55 kg. Overall care and metabolic control of GDM pregnancies in our population remain sub-optimal with attendant poor feto-maternal outcomes [11].

Approximately 4% of pregnant women in the United States have diabetes. Eighty-eight percent of these women have gestational diabetes mellitus (GDM; 450,000 women per year), and the remaining 12% have either type 1 (12,000) or type 2 diabetes (50,000). Normalizing blood glucose concentrations before and early in pregnancy can reduce these risks to levels of the general population [5]. All GDM severity levels will result in adverse neonatal outcome [6]. Global fetal and infant loss, perinatal mortality, neonatal mortality, and malformations rates are significantly greater if the mother is affected by diabetes than in the nondiabetic population [12].

The incidence of GDM is 0.15–15%, and it corresponds to the prevalence of Type 2 diabetes and Impaired Glucose Tolerance (IGT) within a given population. The predominant pathogenic factor in GDM could be inadequate insulin secretion. It has been convincingly demonstrated that GDM occurs as a result of a combination of insulin resistance and decreased insulin secretion. The cumulative incidence of Type 2 diabetes is 50% at 5 years. GDM is also a predictor, or even an early manifestation, of the metabolic (insulin resistance) syndrome. GDM is a cardiovascular risk factor and affected patients should be screened to prevent late complications [4].

2. LITERATURE REVIEW

Health care delivery is moving towards disease management, focused on a patient-oriented approach, illness prevention promoting good health and managing long-term care, all of which require integrated activities from generalists, specialists and other health care professionals. This type of care requires effective coordination and an interrelated, multidisciplinary approach [13]. Risk factors for GDM are well known and their presence allows the identification of three risk categories: (1) high risk, which is characterized by marked obesity, diabetes in first-degree relatives, history of glucose intolerance, previous infants with macrosomia, current glycosuria; (2) average risk, which includes women that fit neither in the low- nor highrisk categories; and (3) low risk, which includes women of the age <25 years, normal weight before pregnancy, member of an ethnic group with a low prevalence of GDM, with no known diabetes in first-degree relatives, and no history of abnormal glucose tolerance, nor of poor obstetric outcome [12]. Risk factors for gestational diabetes include body mass index above 30 kg/m2, previous macrosomic baby weighing 4.5 kg or above, previous gestational diabetes, family history of diabetes (first-degree relative with diabetes), family origin with a high prevalence of diabetes [3].

Pregnant women with type I or type II diabetes are at a greater risk of adverse outcomes in pregnancy such as high blood pressure (gestational hypertension) and preterm births. Pregnancy can also accelerate the development of diabetic complications (retinopathy,
nephropathy, neuropathy, ischaemic heart disease, cerebrovascular disease, peripheral vascular disease). Babies born to mothers with type I or type II diabetes diagnosed before pregnancy may be larger and are at greater risk of infant death and congenital abnormality (such as neural tube defects including anencephaly and spina bifida). These infants are also at risk of developing type II diabetes in the long term. Because of the strong association between good control of a woman’s blood sugars (glycaemic control), as measured by haemoglobin A1c, and reduced congenital anomalies, glycaemic targets are central to preconception care [14].

2.1 Risks and Effects of Diabetes on Pregnancy

Common risks and effects of GDM are Miscarriages, Large Babies, Polyhydramnios (Polyhydramnios is the presence of amniotic fluid in excess throughout pregnancy, it is not so common and it rarely has harmful effects), Toxemia (the presence of toxins in the blood), and Macrosomia (symmetric macrosomia and asymmetric macrosomia) [13]; Birth Injury, Perinatal Mortality, and Asphyxia, Hyperbilirubinaemia [15].

Diabetic Nephropathy is a kidney dysfunction or disease which occurs as a result of diabetes. Pregnancy may increase the rate of progress of end-stage renal disease in women with moderate to advance diabetic nephropathy [16, 17]. Pre-eclampsia and preterm birth are associated with incipient nephropathy (microalbuminuria) as well as overt nephropathy [13]. Additional abnormalities are evident in Diabetic ketoacidosis (DKA), Diabetic Retinopathy, Hypertension, Hyperglycemia, Hypoglycemia, Stillbirth, Congenital malformations, Cardiac (Transposition of the great arteries, Ventricular septal defect, Coarctation of the aorta, Atrial septal defect and Asymmetric septal hypertrophy), Caudal regression syndrome, Central nervous system (Neural tube defects (including anencephaly)), Microcephaly, Isolated hydrocephalus, Gastrointestinal (Duodenal atresia, Anorectal atresia, Hypoplastic left colon), Musculoskeletal system (Talipes Arthrogyrosis), Orofacial cleft and Urinary tract (Urethral duplication, Cystic kidney Renal digenesis Hydronephrosis) [17]; and Abortion [13; 14].

Self-monitoring of blood glucose is mandatory during pregnancy, especially for patients with type 1 diabetes. Poor glycemic control leads to increased maternal-fetal transfer of glucose and amino acids as well as fetal hyperinsulinemia. To improve outcomes, pregnant women with type 2 diabetes should plan their pregnancies, maintain good metabolic control of their diabetes, exercise, and take folate daily. Ideally, an interdisciplinary team approach with centralized care offers the best outcomes [5].

Diabetic retinopathy rapidly progresses during pregnancy. Women with pre-existing diabetes who engaged in preconception care and advice involving glycaemic control and retinopathy have better pregnancy outcomes than does that did not have such care and advice. Babies of women with diabetes should be fed as soon as possible after birth (within 30 minutes) and then frequently during intervals (every 2–3 hours) so as to maintain pre-feed blood glucose levels at a minimum of 2.0mmol/litre. Also such babies that are born to women with diabetes who show clinical signs of hypoglycemia (postnatal adaptation problem) should have their blood tested and they should be treated with intravenous dextrose as soon as possible [17].

2.2 Review of Existing Systems

National Health Services (NHS) has a data entry form for diabetic patients during pregnancy that allows the patient to various actions that can affect her and the unborn infant, open the patient to be conscious of some symptoms that need to be checked and to recognize patterns from her previous conception and what could have caused complications in those conceptions. The data entry form is divided into Demographic and pre-pregnancy details, Pregnancy, and Delivery sections for this purpose [17], as featured in Figs. 1 to 3 respectively.
Fig 1 NHS Data Entry Form Demographic details and pre-pregnancy detail section [17]

Fig. 2 NHS Data Entry Form Pregnancy section [17]
The form provided by NHS offers the following advantages: the form is detailed therefore making patient aware of what can affect both her health, the infant’s health and her children’s health; the patient gets interested in taking necessary tests so as to know what can affect her and the infant; and the patient can print the form and take it to a doctor or specialist who can help her with diagnosis and advice her on steps to take to take care of her health. Nevertheless, the data entry for by NHS for GDM is very detailed and has cumbersome submission procedure.

California Diabetes Program, a diabetic risk assessment, is a quick and easy online tool used to help a patient know if he/she is at risk of pre-diabetes or proper diabetes. It requires the patient to fill some general personal details and health details as shown in Fig. 4. It shows the bio-data and reveals the diagnosis to the patient (that is whether he/she knows whether he/she is at risk of pre-existing diagnosis or diagnosis or he/she is not at risk) [18].

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**Fig. 3** NHS Data Entry Form Delivery section [17]

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<tr>
<td>Spontaneous vertex navel</td>
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**Fig. 4** Diabetics risk assessment form interface [18]
Fig. 5 Diabetes risk assessment result interface [18].

Registering or logging in to have demographic data of the user that could be stored and forwarded to the user’s physician with the user’s consent is not provided. The items provided on the form are not detailed enough to assist the user’s physician. Another pitfall of the California Diabetes Program is the fact that it is only concentrated on diabetes and the form is not detailed enough to know the type of diabetes affecting the patient.

2.3 Healthcare Professionals’ Awareness

Healthcare professionals should be aware that the rapid-acting insulin analogues (aspart and lispro) have advantages over soluble human insulin during pregnancy and should consider their use. Women with insulin-treated diabetes should be advised of the risks of hypoglycaemia and hypoglycaemia unawareness in pregnancy, particularly in the first trimester. During pregnancy, women with insulin-treated diabetes should be provided with a concentrated glucose solution and women with type 1 diabetes should also be given glucagon; women and their partners or other family members should be instructed in their use. During pregnancy, women with insulin-treated diabetes should be offered continuous subcutaneous insulin infusion (CSII or insulin pump therapy) if adequate glycaemic control is not obtained by multiple daily injections of insulin without significant disabling hypoglycaemia. During pregnancy, women with type 1 diabetes who become unwell should have diabetic ketoacidosis excluded as a matter of urgency. During pregnancy, women who are suspected of having diabetic ketoacidosis should be admitted immediately for level 2 critical care, where they can receive both medical and obstetric care [3].

If not treated, gestational diabetes can cause health problems for mother and fetus. There are some things that women with gestational diabetes can do to keep themselves well and their pregnancies healthy. Controlling gestational diabetes is the key to a healthy pregnancy. A general treatment plan to control gestational diabetes may include these items: knowing your blood sugar (also called glucose) level and keeping it under control; eating a healthy diet, as outlined by your healthcare provider; getting regular, moderate physical activity; maintaining a healthy weight gain; keeping daily records of your diet, physical activity, and glucose levels; test your urine for ketones, if needed; taking insulin and/or other medications as prescribed; and have your blood pressure checked as indicated [19].

Women with diabetes who are planning to become pregnant should be offered a structured education programme as soon as possible if they have not already attended one as presented in Fig. 6. Fig. 6 represents Preconception Care and Advice (PCA) versus no preconception care and advice (NPCA) decision tree showing major congenital malformation (CM) rates resulting from pregnancies in women with diabetes. The potential benefits of recognising and treating gestational diabetes include reductions in ill health in the woman and/or the baby during or immediately after pregnancy, as well as the benefits of reducing the risk of progression to type 2 diabetes in the longer term and/or future pregnancies being complicated by pre-existing or gestational diabetes [3].
Nutritionists offer a range of nutritional solutions to help patients more effectively manage diabetes and minimise common side effects. This means keeping blood glucose levels in the target range, controlling blood lipids and monitoring blood pressure to reduce the risk of complications. At the same time, people with diabetes are strongly advised to adopt a healthier lifestyle incorporating regular exercise, a balanced diet, reduced stress and no smoking.

Keeping to the various management guidelines provided by USDHHS might be difficult to remember or adhere to strictly in the present technology-driven society. A technology-based alternative that provides instant evaluation results is inexcusable to know which of the management guidelines to follow towards saving lives within nanoseconds by taking informed decisions.

3. STATEMENT OF THE PROBLEM
   i. The fact that the percentage of the world population suffering from DM (2.8%) that may exceed 5.4% by the year 2025 following prevalence of lifestyle-related diseases [2] is worrisome.
   ii. GDM accounts for approximately 90–95% of all cases of diabetes in pregnancy [3].
   iii. The difficulty encountered by GDM patients to strictly adhere to volumes of printed management guidelines requires a technology-based alternative that provides instant evaluation results.

4. AIM
   This paper presents a developed web-based self-management advisory and prescription system for gestational diabetic patients to facilitate quality and healthy pregnancy healthcare outcomes.

5. OBJECTIVES
   The objectives of the software are to:
   i. make an advisory and prescription system application available on the web platform so that it can be accessible anywhere and at anytime,
   ii. provide a platform (evidence-based) to enable patient work better with her healthcare provider in developing a treatment plan that addresses her specific needs and situation thereby ensuring that the patient and her baby are healthy.
   iii. expose gestational diabetes, its causes, and its features with a general treatment plan that helps control the condition
   iv. improve personal efficiency of pregnant women in keeping them healthy and promoting the best outcomes for their babies if gestational diabetes is diagnosed,
   v. facilitate making informed decisions about patient’s care the patient and her family.

6. METHODOLOGY
   We reviewed literature on DM and GDM, interviewed healthcare services providers in Reproductive Health (especially Specialists in Obstetrics & Gynecology) selected from Public and Private Healthcare facilities in Nigeria to confirm the possible combinations of conditions responsible for DM and GDM.
   Software engineering tools used included Unified Modeling Language (UML), HTML (Hypertext Mark-
up Language), PHP (Hypertext Preprocessor), MySQL database Server, JavaScript, and Editor (Notepad++ / Adobe Dreamweaver / Adobe CS5 package) on Microsoft Windows 32-bits operating system, and Apache Web server version 2.2.8 platform. Ninety-seven (97) possible diabetes application rules in detecting and advising patients on GDM were contingently combined and programmed.

The developed software, using UML use case and sequence diagrams shown in Figs. 7 and 8 and respectively, provides an interface to Register, Login, Validate patient, Fill form, Retrieve patient data, Display patient Bio-data and Diagnosis, View Bio-data and Diagnosis, and Print Bio-data and Diagnosis.

Fig. 7 Gestational Diabetes Mellitus Use Case Diagram
Fig. 8  GDM Management Sequence Diagram

The class diagram, a static structure diagram, displaying what interacts but not what happens when they interact, shows the system’s classes, attributes, and the relationships between the classes in Fig. 9.
Fig. 9 GDM Management Class Diagram

Some out of the 97 combinations / rules to guide the user with the outcome of the evaluation are:

echo '<h2> Your Diagnosis and prescription include (Ensure diagnosis/Prescription is confirmed by a practitioner ): <br />';</n}

if ( $date_of_birth >= $date_of_diagnosis &&
$date_of_first_visit_to_the_specialist &&
$date_of_record &&
$date_of_referral_for_index_pregnancy &&
$last_menstruation
{ echo " invalid dates, ensure your dates are entered correctly and not mixed up" ;}

else if ($prepregnancy_counselling == "yes" &&
$prepercentage < 5 && $microalbumgram > 300 &&
$proteinugram <= 5 && $sketoacidotic_episodes > 1 &&
$retinopathy == "yes" && $nephropathy == "yes"
&& $new_classification =="iddm"
)

else if ($prepregnancy_counselling == "no" &&
$prepercentage > 5 && $microalbumgram > 300 &&
$proteinugram <= 5 && $sketoacidotic_episodes > 1 &&
$retinopathy == "yes" && $nephropathy == "yes"
&& $new_classification =="iddm"
)

else if ($prepregnancy_counselling == "yes" &&
$prepercentage >= 5 && $microalbumgram > 300 &&
$proteinugram <= 5 && $sketoacidotic_episodes > 1 &&
$retinopathy == "yes" && $nephropathy == "yes"
&& $new_classification =="iddm"
)

else if ($prepregnancy_counselling == "no" &&
$prepercentage > 5 && $microalbumgram <= 30 &&
$proteinugram <= 5 && $sketoacidotic_episodes > 1 &&
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$prepercentage <= 5 && $microalbumgram <= 30 &&
$proteinugram <= 5 && $sketoacidotic_episodes > 1 &&
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else if ($prepregnancy_counselling == "no" &&
$prepercentage <= 5 && $microalbumgram <= 30 &&
$proteinugram <= 5 && $sketoacidotic_episodes > 1 &&
$retinopathy == "yes" && $nephropathy == "yes"
&& $new_classification =="iddm"
)
else if ($pregnancy_counselling == "yes" && $prepercentage < 5 && $microalbumin > 30 && $protein > 5 && $ketoacidotic_episodes >= 1 && $retinopathy == "yes" && $nephropathy == "yes" && $new_classification == "iddm")

else if ($pregnancy_counselling == "no" && $prepercentage >= 5 && $microalbumin <= 30 && $protein < 5 && $ketoacidotic_episodes < 1 && $retinopathy == "no" && $nephropathy == "no" && $new_classification == "igt")

else if ($pregnancy_counselling == "no" && $prepercentage < 5 && $microalbumin > 30 && $protein > 5 && $ketoacidotic_episodes >= 1 && $retinopathy == "yes" && $nephropathy == "yes" && $new_classification == "iddm")

else if ($pregnancy_counselling == "yes" && $prepercentage > 5 && $microalbumin > 30 && $protein > 5 && $ketoacidotic_episodes > 1 && $retinopathy == "yes" && $nephropathy == "yes" && $new_classification == "iddm")

else if ($pregnancy_counselling == "no" && $prepercentage > 5 && $microalbumin >= 30 && $protein < 5 && $ketoacidotic_episodes < 1 && $retinopathy == "no" && $nephropathy == "no" && $new_classification == "igt")

else if ($pregnancy_counselling == "yes" && $prepercentage > 5 && $microalbumin < 30 && $protein < 5 && $ketoacidotic_episodes < 1 && $retinopathy == "no" && $nephropathy == "no" && $new_classification == "igt")

else {echo "Do a new test to confirm your diagnosis and in case your glucose tolerance is unknown, you need urgent attention;";}

7. RESULTS

Registration / Login: This module allows already existing users to login into the diabetes management system interface. It also enables new users to register so
that they can access the diabetes quality management form by logging in as shown in Fig. 10.

**Fig. 10 GDM Management System Home Page**

**Diabetes Management Form:** Already existing users or registered users who have successfully logged into the diabetes management form get to fill the form in Figs 11 and 12 which request some personal health parameters relating to pregnancy and diabetes and this allows the patients to view their bio-data that has been filled and the diagnosis if any and advice where necessary but they are always advised to confirm from their doctors.

**Fig. 11 GDM Self-Assessment Interface**
7.1 Possible Outcomes of Questions Responded

Possible advice generated by the software arising from the evaluation of the answers to the self-assessment questions included:

“Please go for prepregnancy counselling because you need special advice and ensure you understand what is being advised.

Poor glycaemic level, continue making use of insulin to reduce blood sugar but balance it so as to prevent low blood sugar, you have normal urinary albumin excretion meaning no microalbuminuria and diabetic nephropathy.

Due to your experience of diabetic ketoacidosis, you should be admitted immediately for level 2 critical care where you can receive both medical and obstetric care.

Your proteinuria level requires you to consider heparin as diagnosed by your doctor and planned early birth may need to be considered because of the risk of developing pre-eclampsia.

Perform another retinal assessment test (retinopathy test) at 16-20 weeks to confirm the presence of retinopathy, then have an ophthalmological follow-up for at least 6 months following the birth of the baby because treatment for diabetic retinopathy is available and could prevent short- or long-term deterioration of visual acuity.

Good glycaemic level but balance it so as to prevent low blood sugar, you definitely have microalbuminuria but you do not have diabetic nephropathy, make use of methyldopa to treat microalbuminuria to reduce the risk of preterm birth (before 34 weeks of gestation)."

8. DISCUSSION

The software advises pregnant women who are suspected of having diabetic ketoacidosis to be admitted immediately for level 2 critical care, where they can receive both medical and obstetric care. Where tests show microalbuminuria, users are advised to make use of methyldopa to treat microalbuminuria to reduce the risk of preterm birth (before 34 weeks of gestation). In most of the conditions assessed, it was advised that diabetic retinopathy should not be considered a contraindication to vaginal birth.

The software has undergone some tests with healthcare services providers and some pregnant women to ascertain the expected situations have been properly captured. It is awaiting deployment to the web for the international community.

9. FUTURE WORK

Mobile technology is being explored as smartphones are becoming affordable by many Nigerians, including the pregnant women. Development work has already commenced on a mobile version of this application using smart phones. These would facilitate seamless and secured connection with patients’ physicians and vice versa for faster assessment and medical advice.
10. CONCLUSION

The increasing comorbid epidemics of diabetes mellitus and obesity conditions mandates a thorough examination of best therapies, adherence issues, access, and prevention strategies. Various symptoms and complications that can be related to pregnancy due to diabetes which can affect the mother and the unborn infant even after birth have been identified. Comprehensive education guidelines are provided by the software to would-be diabetic pregnant women. Taking a print-out of this precautionary measures goes a long way at assisting the physician in addressing critical cases before crisis sets in. At any stage of pregnancy for the diabetic, a self-assessment using this software is desirable until full term and even extended to postpartum period. Self-management programmes for women with diabetes who are planning a pregnancy are highly imperative. Diabetic patients of all types will be able to take quality care and directions easily to manage their pregnancy. Reduction in complications for diabetic pregnant patients and the infants both during the pregnancy and after the child delivery is achievable.

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REFERENCES

[4] Qi, Lian-Wen; Liu, E-Hu; Cha, Chu; Peng, Yong-Bo; Cai, Hai-Xia; and Li, Ping (2010), Anti-Diabetic Agents from Natural Products—An Update from 2004 to 2009, Current Topics in Medicinal Chemistry, 2010, 10 (4), 434-457
women for improving maternal and infant health, John Wiley & Sons, Ltd.


