# Clinical Decision Support System (CDSS) for Demand Management in the Healthcare Supply: A Case Study of Impacts Status (Risks) During Pregnancy

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***Abstract*—** *In recent years, the medical industry has shown interest in reorganizing its operations to accommodate technological advancements and incorporating decision support systems into normal clinical procedures. Clinical Decision Support Systems (CDSS) combine observations and knowledge of health to encourage physicians to make health-related decisions in order to improve health care. The goal of this study is to examine the problems with Clinical Decision Support Systems (CDSS) and concentrate on their utility in improving clinical practice. This article contained a case study of CDSS implementation for high-risk pregnancy (HRPCDSS) and a description of the conditions for a successful CDSS implementation. A Clinical Decision Support System (HRPCDSS) was provided to assist doctors in estimating the probability of an illness, thereby enhancing their ability to provide therapeutic advice and eliminates the risk factors that community midwives'/lady health visitors encounter in providing standardized/effective healthcare services to mothers and children. Finally, using the C4.5 algorithm decision trees to identify these diseases and compare their effectiveness and correction rates.*

**Keywords—Clinical Decision Support Systems; C4.5 Algorithm Decision Trees; Digital Healthcare; Electronic Health Records; High-Risk Pregnancy.**

## I. INTRODUCTION

A Clinical decision support system (CDSS) aims to improve delivery of healthcare by incorporating targeted clinical knowledge, patient information, and other health data into medical decisions [1]. A conventional CDSS is consisted of software built to be a straightforward aid to medical decision making, in which a person patient's features are matched to a computerized clinical existing expertise, as well as patient-specific information assessments or suggestions are then presented to the doctor for a decision [2].

Today, Clinical decision support systems are most typically used at the point of care, permitting doctors to integrate their knowledge with the CDSS's knowledge or recommendations. Furthermore, Clinical decision support systems are increasingly being implemented with the possibility to use data and observations that would also be inaccessible another or unclear to humans. Computer-assisted clinical decision support systems have been around since the 1970s. They had inadequate information systems at the time, took a very long time, and were frequently limited to academic subjects [3].

The use of Clinical decision support systems has been recommended as a feasible approach for improving medical service overall proficiency and features. They've been credited with encouraging better adherence to evidence-based rules, increasing the use of preventive measures, recognizing potential risks associated with the use of various medications,

increasing the accessibility of more precise clinical records, and improving persistent doctor correspondence [4].

The range of clinical challenges that lend themselves to decision analysis is vast. Such concerns are centered on a certain decision, where there is a compromise, implying that one of the options evaluated isn't obviously dominating. The purpose of decision investigations is to:

- Assist in clinical decision-making for a specific patient.
- Determine the best tactics for different types of infections based on their clinical characteristics in a given situation.
- Why Provide assessments of predicted outcomes in situations where traditional methods, such as randomized preliminary, are either impossible or impractical. Choice research may clearly combine concerns relating to personal happiness and how specific patient characteristics affect outcomes [5].
- The technique to characterize the breadth and boundaries of the specific clinical situation to be explored is to frame the inquiry.
- Set the stage for the clinical problem — Structuring the problem entails creating a decision model that addresses the most important aspects of the problem.
- Determine the most important probabilities — After a decision tree has been created, the quantitative estimates of various probabilities should be resolved. There are a variety of sources of data that can be used to get these results [6].
- Evaluate the results estimations - Different solutions to a problem have different outcomes. The specific result measure to be used is defined by the issue's framework. One of the advantages of choice examination is that a given model can be evaluated using a variety of outcome measures.
- Analyse the tree - The most popular approach of investigating a problem is to apply a methodology that improves the normal estimation of the outcome.
- Validate the design's assumptions - The accuracy of the data used to assess the probability and outcomes is critical to the conclusion of a choice inquiry. One of the most important features of choice examination models is their ability to swiftly test and input data – allowing the decision model to be approved by conducting a thusly inquiry [7].

Data collection, provision of health information, and communications have all been found to benefit from the use of digital technology in healthcare. Despite the fact that doctors and patients are increasingly using medical applications (apps), there appears to be a dearth of peer-reviewed articles evaluating their usage, particularly in pregnancy. The utility of apps for clinical decision support in pregnancy was investigated in this scoping review. The study's specific goals were to:

- Evaluate the present application use for clinical decision assistance in pregnancy.
- Identify perceived benefits and potential risks of use.
- Identify facilitators and barriers to app adoption in clinical practice [8].

The well-being of women during pregnancy, childbirth, and the postpartum period is referred to as maternal health. It also incorporates other aspects of healthcare, such as preconception and postnatal care, in order to reduce mortality. The goal of prenatal care is to identify potential issues early on so that they can be treated correctly by any medical practitioner. Postnatal care, on the other hand, includes postpartum recovery, newborn care, nursing, family planning, and nutrition [9]. Maternal health is an important issue in global development. Maternal health and mortality have an impact on society, communities, and families. On socioeconomic levels, it has unsociable realization effects. Although the most recent statistics show that maternal life is improving, 342,900 pregnant women die each year during their pregnancy [10].

Personnel in the health-care sector, such as administrators, clinicians, nurses, and pharmacist depend largely on patient medical data. They regard it as a treasure to enhance patient care and have quickly adjusted to the most up-to-date technology solutions for patient data storage and handling. Healthcare information systems assist the healthcare system in addressing quality and cost of care challenges [11]. However, CDSS are increasingly being developed with the potential to use data and observations that would otherwise be unavailable or unintelligible to humans. types and categories, including intervention timing and active vs passive delivery [12].

Although no knowledge based Clinical decision support systems are a rapidly developing use case for artificial intelligence in medicine, they are riddled with obstacles, such as a lack of comprehension of the reasoning used by artificial intelligence to create suggestions and problems with availability of data [13].

The organization of this manuscript is as the following. Section 2 discussed relevant related works referred to the exploitation of classification technology in the medical CDSS field are surveyed. Section 3 explained the types of CDSS. Section 4 discussed the integration considerations for accomplishment of Clinical decision support systems. Section 5 depicts all the information that related with High-Risk Pregnancy (symptoms, treatment, and prevention), the design of HRPCDSS framework and implementation. Section 6 discussed the signs of high-risk pregnancy. Section 7 discussed the comparative related work. Section 8 illustrates conclusions and future work.

## II. RELATED WORK

The platform and diagnostic methods warn practitioners about potentially harmful drug interactions. These programs have helped physicians diagnose more accurately by reducing difficulties and mistakes, and lowering the risk. The quality of care and the cost of treatment may be affected if damage is detected early [14]. As shown in a study conducted in the UK, using computer-based recommendations can result in a shift in health outcomes and the unsolved questions that the 24 participants face. CDSS Implementation: A Real-World example in KSA physicians will have the opportunity to use the CDSS throughout the clinical interaction [15].

advocated using classification of a decision tree-based system as an automatic tool for estimating risk, with parameters put in individually via a dashboard, or autonomously via equipment like pregnancy screening and ultrasonography [16]. Created a network-based clinical decision support system that includes a clinical centralized database as well as web-based apps for image and signal analysis methods and techniques. The leading methodologies in the system are those for eye fundus image examination and ECG P-wave morphology appraisal, which encompass two clinical domains: ophthalmology and cardiology [17].

The CDSS emphasizes the obstacles and needs of integration, yet they are commonplace to it. They claimed that various healthcare systems and instruments could help with related strategies. According to their findings, the CDSS aids clinicians in identifying a patient's initial prevention time from an automatic ventilator. They propose an ontologically based CDSS for ventilation avoidance by mapping the clinical domain with CDSS functionalities [18].

There are many regulations on risk assessment and suggested care plans for labor and pregnancy in prenatal care. These recommendations could, though, alter when new information becomes available. These two problems with the SAFER (Safe Assessment Form to ;8Evaluate Risk) maternity system take a lot of time for clinicians to resolve. This CDS system generates care plans at different stages of gestation based on patient data and comprises rules taken from recent recommendations for maternity services. The technology has both a web - based interface and a mobile phone app. The mobile application can be used to edit patient information and monitor care plans. The web interface contains an authoring tool that enables physicians to update the rules by editing the logic used to produce the care plans [19].

Women who are expecting for the first time are more likely than women who have already had infants to obtain answers on drugs and wellbeing issues during pregnancy. Despite their extensive use of the internet, pregnant women rarely talk to their doctors about the advice they have found online. Pregnant women may be empowered and make better-informed decisions if specific and reliable data is offered using a decision support tool [20].

Patient participation in judgment differs across patient populations, but it is more common in young women, who are also more likely than other patient populations towards becoming pregnant and, for many of them, encounter entirely new wellbeing decisions at this stage of their lives. Making decisions regarding medicine use during pregnancy, in specific, can be difficult because it entails addressing the particular challenge of evaluating the advantages and disadvantages of the medication in conjunction with the advantages and disadvantages for the unborn child. These circumstances are typical; in fact, more than 60% of pregnant women utilize drugs at least once [21].

An overview of studies examining the impact of physician tools for decision-making for pregnant women is given in this comprehensive study. From their start through December 1, 2019, they evaluated five online databases: MEDLINE, EMBASE, Web of Science, PsycINFO, and Scopus. Titles, abstracts, and complete texts were examined by two separate researchers in relation to the inclusion criteria. Included were all research examining the impact of patient-centered decision support tools for pregnant women's health-related issues. Prenatal screening (n=10), gestational diabetes and weight gain (n=7), lifestyle (n=3), blood pressure and preeclampsia (n=2), depression (n=1), asthma (n=1), and psychological well-being (n=1) were some of the health issues covered by the 25 qualifying research. Using decision support tools generally improved women's understanding, and keeping track of indicators life satisfaction with prenatal care [22].

In order to pinpoint the pregnancy's placement and assess the graphics performance, this research will evaluate a unique Cognitive Scan Assistance System for early pregnancy ultrasound. With and without the technology, two trainers performed simulated vaginal ultrasound exams of gestational instances. Two specialists performed a blind evaluation of the ultrasonic findings and photos using scoring techniques. The accuracy of a pregnancy diagnosis and the quality of the ultrasound images were evaluated between examinations conducted using and without the technique [23].

To detect at-risk women that require focused maternity treatment, a machine learning-based clinical decision-making system (CDSS) has been designed. The PEARS study's initial pregnant features and blood indicators were employed. Five algorithms for machine learning were used using a five-fold cross checked grid search to optimize the equilibrium precision after the proper data preparation, synthetic minority oversampling methodology, and extraction of features [24].

The utility of smartphone applications for support with clinical decisions in pregnancy was investigated in this need's assessment. The focusing on specific goals were set: 1. to assess the existing state of mobile app use for clinical decision support in pregnancy; 2. to determine produces benefits and possible risks of use; and 3. to assess enablers and impediments to their integration into primary care [25].

Pregnancy-associated cancer (PAC), which includes cancer discovered throughout pregnant either within one year of delivery, is becoming more common. They looked into the prenatal treatment and results for women with PAC and their unborn children. large inhabitants longitudinal research of all women in New South Wales, Australia, who gave birth between 1994 and 2013. Women were divided into three groups: those with prenatal cancer (the gestational cancer group), those with postpartum cancer (the postnatal cancer group), and a group without PAC. The relationship between PAC and unfavorable maternal and newborn mortality was investigated using generalized additive formulas [26].

Enhanced compliance to the Dietary pattern in the beginning stages of pregnancy and if this improvement is supported by modifications in nutrition and psychological parameters were the focus of a decision support system (CDSS). They created a three-month randomized controlled clinical experiment, and 40 healthy pregnant women participated in it (20 in the CDSS and 20 in the control group). Before and after the therapy, a health records, biochemical analysis, physical assessment, food analysis, and a subjective stress assessment were performed. Throughout the first trimester of their pregnancies, pregnant women in the CDSS group reported a larger increase in adherence to the Mediterranean diet, as measured by MedDietScore (p 0.01) [27].

The challenges surrounding maternity and maternity care for individuals with breast cancer are discussed in this systematic study of the literature. It includes descriptions of six examples of pregnant women (aged 29 to 39) who received their first diagnosis of breast cancer in order to highlight various factors that must be taken into account at various months of pregnancy [28].

## III. TYPES OF CDSS

Depending on the organization framework, the period of choice throughout therapy, and who it is designed for, there are several forms of Clinical decision support system (clinicians, nurses, pharmacists or staff). Clinical decision support system, in essence, generates warnings based on the patient's status or responds to physician input. Clinical decision support system is technically a stand-alone system or a component of a computer-based patient information system. Knowledge-based systems (which rely on mathematical foundations) and non-knowledge-based systems (which use machine learning methodologies and mathematical foundations) are the two most common classifications of Clinical decision support system [29].

### *A. Knowledge-Based System*

The majority of knowledge-based systems arose based on previous expert system research, which aimed to create computer algorithms that could mimic human reasoning in data processing. Healthcare and patient safety are usually regarded as two of the most important domains in which knowledge-based solutions can be implemented to increase healthcare quality. A database containing clinical data is at the heart of a knowledge-based system. Knowledge-based systems are made up of three components: a knowledge base, an inference system, and a way of interacting.

1) ***Knowledge-base***: This is a dataset that is used to determine the likelihood of diseases, signs, symptoms, diagnosis, and treatment options using if-then rules.
2) ***Inference engine***: It combines the evidence from the knowledge base and the patient's available data to draw appropriate conclusions about the patient's condition.
3) ***Communication mechanism***: This is a method of delivering the result to the user by introducing the patient's data into the system and assisting the user in making a decision. The user enters patient data into a stand-alone system that is combined with an electronic medical record. The result is either an alarm or a set of recommendations for making a decision. The user, for example, enters the specific symptoms into the system or obtains them from an electronic medical record. The inference engine then combines this data with that stored in the knowledge base. The communication system then presents the output to the user as a list of symptoms, which the user picks [27].

### *B. Non-Knowledge-Based System*

Machine-learning techniques are used in this kind of Clinical decision support system as a type of artificial intelligence that gains knowledge from its experiences by detecting patterns. Genetic algorithms and data mining algorithms are the two basic types of non-knowledge-based systems [28]. To replicate human reasoning, data mining algorithms (decision tree C4.5) learns from experiment [29]. It can process incomplete data and export the results; thus, it doesn't require a large database.

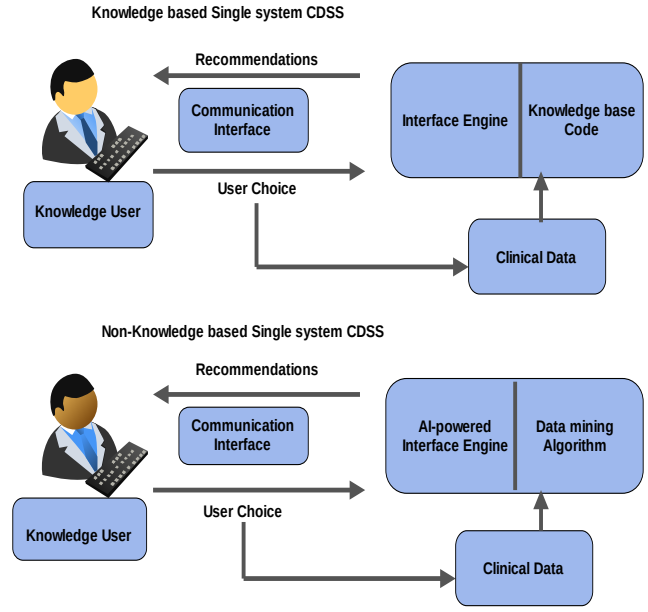



Fig.1. Shows the diagram tyes of Clinical Decision Support System of essential relationships CDSS that are both knowledge-based and non-knowledge-based They are made up of three parts: (1) the instructions that are encoded into the system (knowledge-based), the technique that is used to determine the choice (non-knowledge-based), and the data provided. (2)

inference engine: applies programmed or Intelligence rules and data structures to the client's health data to produce a result or activity, which is presented to the end user (e.g. doctor) via the (3) communication mechanism: the application, or electronic hospital record interface, through which the end user communicates [30].

## IV. THE REQUIREMENTS FOR SUCCESSFUL IMPLEMENTATION OF CDSS

As indicated in figure 2, the recommendations and requirements can be divided into three groups. The first criterion relates to the clinical criteria for the Clinical decision support system content and expertise involved. The second set of requirements focuses on merging Clinical decision support system and Hospital Information Systems, as well as implementing a passive and active alert system that relates to clinical process experience. Finally, the other criterion concerned the quality of CDSS's output recommendations.

### *A. The Contents of CDSS*

- **The content of clinical has to be accurate.**
  Clinical procedures, rules, and recommendations at the hospital must be transformed into digital formats so that they may be integrated with a hospital information system that can support physical evidence. In fact, this is extremely complicated because clinical processes, regulations, and guidelines are typically broad rather than patient-specific, making this a very challenging issue [31]. To address this issue, the hospital should enlist the help of interdisciplinary experts to produce accurate clinical guidelines.
- **The content of clinical must be reliable.**
  The key factors that reduce or impair the utility of such a system include imprecise information content, low warning specificity, generalization, and the system's response is very high [32]. To ensure the correctness of warnings and messages, as well as the validity of clinical rules/guidelines, the contents should be evaluated when the clinical rules/guidelines are being automated.

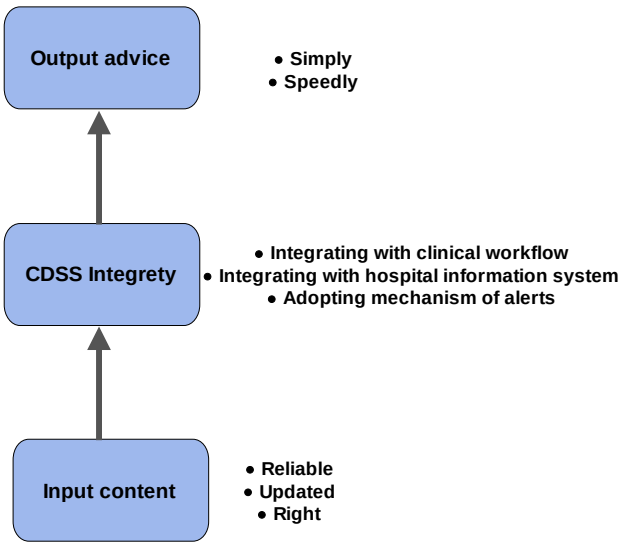



Fig.2. Qualifications of CDSS Success [32].

- **The clinical is necessary to update material.**
  In the situation of continual change, Clinical decision support system rely on clinical knowledge [33]. In order to maintain the successful use of Clinical decision support system, a framework for reviewing and improving clinical knowledge relating to guidelines and rules must be established.

### *B. Integrity of CDSS*

- **The clinical decision-making system must be linked into the clinical process.**
  Making Clinical decision support system appropriate for incorporation in conventional and normal medical system is one of the elements for success [34]. Clinical decision support system success will be aided by a thorough grasp of clinical process and user expectations/needs.
- **A clinical decision support system must be connected with health information systems.**
  Doctors find it challenging to carve out time from their daily routines to enter each patient's data into a clinical decision support system on a regular basis. Clinical decision support systems integrated with Hospital Information System, particularly electronic health records, will give essential information to physicians at the appropriate moment [35]. This integration can ensure doctors' adoption of CDSS.
- **Clinical decision support system alert systems, both active and passive**
  There are three levels of alert: critical, somewhat significant, and smallest essential [36]. An active alert is an urgent warning in which a clinical decision support system informs doctors to make a decision and take immediate action. While a passive notice is issued to doctors for the least and moderately important, they must enquire about the necessary suggestions to follow [36].

In a word, the following are the major requirements for a successful clinical decision support system implementation:

1) Expert doctors should be included from the beginning of the process of developing clinical procedures, principles, and guidelines.

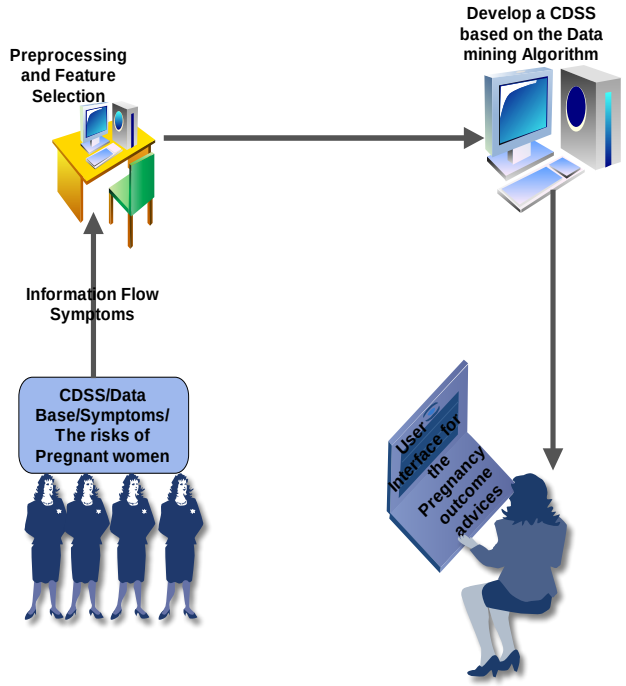
2) To increase user commitment and acceptance of these standards where these expert doctors are the system's end users.

The system's implementation in clinical practices will inspire other users to use and adopt it. Clinicians find it difficult to devote time and effort to understanding and using computer systems [37]. Clinical decision support systems can assist physicians by presenting associations and links between distinct data fields, allowing clinicians to traverse between them using these methodologies.

## V. HIGH-RISK PREGNANCY CLINICAL DECISION SUPPORT SYSTEM (HRPCDSS) IMPLEMENTATION

The clinical decision support system has evolved into a critical Evidence-Based Medicine tool for enhancing patient safety. It does, however, necessitate adherence to treatment

and preventative standards, as well as the avoidance of pharmaceutical errors. High-Risk Pregnancy Clinical Decision Support System (HRPCDSS) gives clinicians the information they need about a given condition or patient. IT researchers investigated the most effective strategies and elements for efficiently managing clinical decision support system knowledge [38]. In an emergency room, it is vital to make a choice swiftly and precisely in order to save a life in real time. Urgent doctors deal with a variety of urgent and delicate disease scenarios. They lack the necessary expertise to deal with all elements of sickness. Moreover, by adopting computerized clinical practices guidelines, the urgent section requires certain criteria to describe the standard treatment and services provided help to the physician in making a decision. This system is evidence-based, includes changes to the guidelines, and prioritizes decisions based on medical resources (table 1). The computerized clinical practice guidelines are assessed by comparing the system's recommendations to physicians' decisions [39]. This framework allows urgent doctors to better their practices while also assisting them in dealing with life-threatening conditions and making accurate real-time decisions to save patients' lives (pregnancy woman). Finally, the HRPCDSS was created using the most accurate network. The




HRPCDSS was created using the MATLAB 2013b program.

Fig. 3. System Architecture of High-Risk Pregnancy Clinical Decision Support System (HRPCDSS).

Every pregnancy has some level of danger. A "high-risk" pregnancy is defined as one in which the pregnant woman, the fetus (unborn infant), or both are exposed to greater health hazards. High-risk pregnancies may necessitate special attention before, during, and after delivery. This helps to minimize the risk of problems.

*A. Factors That Make a Pregnancy High Risk Include:*

- Pre-existing health issues.
- Health problems associated with pregnancy.
- Personality traits (including smoking, drug addiction, alcohol abuse and exposure to certain toxins).
- Age (being over 35 or under 17 when pregnant).

*B. Algorithm (C4.5 Algorithm) And System Flow of (HRPCDSS).*

Selects one data characteristic at each node of the tree, that most efficiently divides its dataset into subgroups enhanced in one of two classes. The normalized information gain (difference in entropy) that results from selecting a property for data splitting is its criterion. To make the decision, the attribute with the highest normalized information gain is picked [39]. C4.5 [40], The main problem of CDSS is that they are not truly separated in their execution from the platform. The design of the High-Risk Pregnancy (HRPCDSS) platform architecture can define the object of clarifying something which exists in the real world, such as (user) and in the present development which belongs to the system architecture model. The tasks of the HRPCDSS flow are presented in the algorithm below.

**Algorithm C4.5**

**Input**:an attribute-value dataset(parameter value ,Age ,current health status (Anemia, Gestational diabetes, Pre-eclampsia or Toxemia)), primary symptoms (High blood pressure, Eclampsia and Placenta Previa)) D, C ;2

**Where D=** parameter value , Age , current health status (Anemia, Gestational diabetes, Pre-eclampsia or Toxemia).

**Where C=** primary symptoms ( High blood pressure, Eclampsia and Placenta Previa)**.**

**Where a = status of infections**

1: Tree = {}
2: **if** D is larger than 17 / less than 35 and C parameters are normal **then**
3: terminate
4: **end if**
5: **for all** parameters a ∈ D,C **do**
6: High-Risk Pregnancy calculation of a
7: **end for**
8: a over 35 and have diabetes ,High blood pressure, Eclampsia and Placenta Previa = high degree risk according to above calculation
9: a less than 17 and have diabetes, High blood pressure, Eclampsia and Placenta Previa = high degree risk according to above calculation
10: a over 17 and have not diabetes, High blood pressure, Eclampsia and Placenta Previa = small degree risk according to above calculation
11: a less than 35 and have not diabetes, High blood pressure, Eclampsia and Placenta Previa = normal degree risk according to above calculation
12: Tree = Create a decision node that tests a infection status in the root

13: $D_v$ = Induced sub-datasets from D based on a infection status
14: **for all** $D_v$ **do**
15: $Tree_v$ = C4.5 ($D_v$)
16: Attach $Tree_v$ to the corresponding branch of Tree
17: **end for**
18: **return** Tree

*C. Signs of High-Risk Pregnancy*

A pregnant woman is more susceptible to hazards throughout pregnancy, labor, and birth. A high-risk pregnancy is any unanticipated or unorganized healthcare or intrapartum issue related to pregnancy that poses a probable or actual threat to the mother's or fetus' health or well-being. Of the 20 million high-risk pregnancies around the world, more than 800 women die every day due to perinatal illnesses. In the world, between 5% and 10% of births are affected by hypertension [40].

Gestational hypertension, hemorrhage, and heart disease are the three main causes of maternal death. These three main research factors, such as pregnancy problems, labor issues, and disease history, may have an impact on maternal mortality. For women to maximize preventive efforts, early detection of risk factors and likely maternal issues, especially after birth, is advised [41].

*D. Prevention of Signs High-Risk Pregnancy*

Just about 6 to 8 percent of pregnancies are regarded as high-risk. Although most pregnancies are healthy, understanding common pregnancy concerns can help you make better choices for your health and the well of your unborn child. Every pregnancy is different. Some pregnancies begin low-risk, but as the pregnancy goes on, problems like gestational diabetes or hypertension surface, demanding special medical care for both the mother and the unborn child. In some circumstances, women can be carrying a high-risk pregnancy right away.

*E. Sample of The Study*

100 pregnant patients at the Baghdad Maternity and Children hospital in Baghdad City make up a non-probability “purposive sample". The sample is selected based on the following standards:
1. A pregnant woman only experiences high-risk pregnancies.
2. Healthy expectant mothers.

*F. Data Collecting*

This section covers the process of gathering demographic information from patients during face-to-face interviews. It contains 20 items pertaining to the living circumstances of a pregnant lady (table 1). Also, the information on pregnant women includes a questionnaire with 20 questions that asks about the mother's symptoms of a high-risk pregnancy (table 2).

TABLE I. SIGNS OF HIGH-RISK PREGNANCY

| | |
|---|---|
| 1 | Do you have high blood pressure now that you are pregnant? |
| 2 | Do you have high blood sugar now that you are pregnant? |
| 3 | Have you been diagnosed with anemia recently? |
| 4 | Have you ever given birth prematurely? |
| 5 | Have you ever had an artificial abortion? |
| 6 | Have you previously experienced a pregnancy? |
| 7 | Did you hemorrhage vaginally while you were pregnant? |
| 8 | Are you HELLP syndrome-affected? |
| 9 | Do you experience a fetus with insufficient fluid? |
| 10 | Have you been diagnosed with a restriction on intrauterine growth? (intrauterine growth retardation) |
| 11 | Do you have early rupture of the amniotic cavity? |
| 12 | Have you ever experienced placenta abdominal incision? |
| 13 | Are you a placental early form patient? |
| 14 | Have you recently experienced acute urinary tract infections? |
| 15 | Have you recently experienced gynecologic diseases? |
| 16 | Do you have a cervix that isn't working properly? |
| 17 | Do you have an Rh discrepancy? |
| 18 | Do you experience irregular vaginal fluid release? |
| 19 | Do you have insufficient fetal growth or insufficient fetal action? |
| 20 | Do y;2ou have excruciating lower abdominal pain? (painful cramps) |
| 21 | Is the mother is exhausted? (critical situation). |

The implementation of (HRPCDSS) is based on the information that available in Tables 2, for the High-Risk Pregnancy disease action when infected people cases are happened, and the appropriate action is taken, when asses the status of High-Risk Pregnancy symptoms as described above. The results are available for the program user is shown in Fgure3. There are distinctive 6 cases to diagnose the symptoms to determine the degree of High-Risk Pregnancy to take a suitable action and to give the patient a suitable treatment as the degree of infection, for each individual situation, standard characteristics and attributes have been established. (see tables 2). With regard to them, you may determine the kind of High-Risk Pregnancy treatment and therefore, we should decide on an option providing appropriate guidelines for the specific type of an action for High-Risk Pregnancy. Consequently, the application sends an email to an authorized person / gathering of individuals with data in relation to the responsible of medical center occasion (provider service). Data is included in the email message to the emergency diseases, the source of this dangerous situation, and also the suggested treatment. All these data are put in a method as a meta-database.

TABLE II. THE CLASSIFICATION OF DIAGNOSIS AND SYMPTOMS OF HRPCDSS [42]

| NO. | Risk factor | Symptoms and Causes | Diagnosis and Tests | Management and Treatment | Prevention |
|---|---|---|---|---|---|
| 1- | COVID-19. | Abdominal pain that doesn't go away. | Blood and urine analysis to see if your baby has any genetic problems or certain birth abnormalities. | Follow-up with your obstetrician will be more regular. | Drugs and alcohol are to be completely removed. |
| 2- | Diabetes. | Chest pain. | Ultrasounds is a method of screening for birth abnormalities that employs sound waves to make images of your baby in the womb. | Discussion with a professional in mother's medicine (high-risk pregnancy). | Detecting possible health risks prior to pregnancy. Tell your doctor about your medical history, both family and personal. |
| 3- | Fibroids. | Dizziness or fainting. | A biophysical profile, which uses ultrasound to monitor your unborn baby's breathing, movements, and amniotic fluid, and a non-stress test, which monitors their heartrate, are two examples of monitoring to ensure your unborn kid is getting enough oxygen. | Contacted with another medical doctors. | Even before to pregnancy, maintain a healthy body weight. |
| 4- | High blood pressure. | Extreme fatigue. | Blood and urine testing | More ultrasounds and a more thorough examination of the fetus are needed. | Taking care of any pre-existing medical problems you might have. |
| 5- | HIV/AIDS. | Your unborn baby's movement stopping or slowing. | Blood and urine testing | Blood pressure monitoring can be done at home. | Ensure any long-term treatments you're taking are safe to use while you're pregnant. |
| 6- | Kidney disease. | Fever over 100.4°F. | biophysical profile | Careful monitoring of medications used to manage preexisting conditions. | Smoking stopping. |
| 7- | Low body weight (BMI of less than 18.5). | Heart palpitations. | biophysical profile | Closer follow-up with your obstetrician. | Pregnancies between the ages of 18 and 34 are planned. |
| 8- | Depression and other mental health issues are examples. | Signs and symptoms that is more terrible than morning sickness | biophysical profile | Consultation with other medical specialists. | Prenatal care should be sought on a frequent basis. Prenatal visits can help your doctor keep track of your health and that of your baby. |
| 9- | Obesity. | A sinus headache that refuses to go away or grows. | biophysical profile | Discussion with a professional in mother's medicine (high-risk pregnancy). | Taking care of any pre-existing medical problems you might have. |
| 10- | Polycystic ovary syndrome (PCOS). | In your face or limbs, you may experience swelling, redness, or pain. | Ultrasonography | More ultrasounds and a more thorough examination of the fetus are needed. | Ensure any long-term treatments you're taking are safe to use while you're pregnant. |
| 11- | Thyroid disease. | Suspicion of injuring yourself or your unborn child. | Blood and urine testing | Medication used to treat pre-existing conditions must be closely monitored. | Drugs and alcohol are to be completely removed. |
| 12- | Blood clotting disorders. | Trouble breathing. | Blood and urine testing | Medication used to treat pre-existing conditions must be closely monitored. | Taking care of any existing medical conditions you may have. |
| 13- | Low birth weight | • respiratory infections<br>• learning disabilities<br>• heart infections<br>• blindness | Ultrasonography | The baby may need to stay in the hospital for a few months after birth. | Prevent the use of cigarettes, alcohol, or drugs during pregnancy |

| | | | | | |
|---|---|---|---|---|---|
| 14- | Several pregnancies (pregnancy with more than one baby, such as twins or triplets). | | Ultrasonography | More ultrasounds and closer fetal evaluation. | Make an appointment for a prenatal consultation. If you're thinking about getting pregnant, talk to your doctor first. |
| 15- | Anemia | You may have pale skin and a lower-than-normal quantity of red blood cells in your body, and you may feel more weary and weak than usual. | Blood and urine testing | Taking iron and folic acid medications during pregnancy | Medication used to treat pre-existing conditions must be closely monitored. |
| 16- | Preterm labor | When you go into labor before week 37 of your pregnancy, it's called early labor. | Ultrasonography , This occurs before your baby's organs, such as the lungs and brain, have completed their development. | Doctors usually recommend bed rest to keep the baby from being born too early. | Consultation with other medical specialists. |
| 17- | Preeclampsia | high blood pressure and the possibility of kidney problems | Ultrasonography , If you're 37 to 40 weeks pregnant, your doctor may decide to induce labor. | To prevent the condition from worsening, the baby and placenta must be delivered. | If it's too soon to deliver your baby, your doctor will need to keep a close watch on both you and your baby. |
| 18- | Infection | A variety of bacterial, viral, and parasitic infections may complicate a pregnancy | • a urinary tract infection<br>• bacterial vaginosis<br>• cytomegalovirus<br>• group B *Streptococcus* | Closer follow-up with your obstetrician. | Handwashing frequently can help avoid some infections. Others, such as the hepatitis B virus and influenza, can be prevented with immunization. |
| 19- | Cancer | | Ultrasonography | More ultrasounds and closer fetal evaluation. | Discussion with a professional in mother's medicine (high-risk pregnancy). |
| 20- | Miscarriage | loss of pregnancy during the first 20 weeks | • maternal difficulties<br>• mother's severe health problems<br>• infections | Closer follow-up with your obstetrician. | miscarriage isn't preventable |


Fig. 4. Primary Window of the Application (HRPCDSS).

The main window of an application (HRPCDSS) is shown in figure 4. Various fields as buttons make up the HRPCDSS method. High-risk pregnancy disease application: provides information on how to treat high-risk pregnancy diseases in order to protect the health of the pregnant woman. Sign in: includes the authority of application access. Send an email to: The urgent case causes, the source of this problem, the dangers associated with this sort of case, as well as the prescribed therapy, are all included in the email message. Exit signifies the end of the application.


Fig. 5. Authentication window to entre to the HRPCDSS application.

The login page for entering urgent clinical information is shown in figure 5. The user can change the default value of password vault and user name (username: user1 and password:admin).


Fig. 6. The Dialog of Primary Test of HRPCDSS To Detect The Risks Factor Of Pregnant Women.

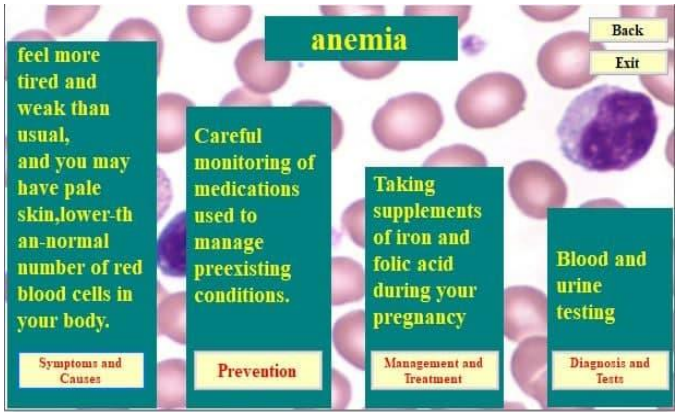



Fig. 7. An Example of High Risk Pregnancy in HRPCDSS (Anemia).

The urgent situation (Anemia) in the HRPCDSS application is shown in figure 7. From then, the user can learn more about anemia instances, starting with symptoms (see figure 7), then making decisions, and lastly acquiring suggestions (treatment and prevention, as shown in figure 7) as given in table 1.


Fig. 8. Main Window of Data Report For High Risk Pregnancy in HRPCDSS.

Figure 8 provides a report of all details relating any emergency case that should receive an impact risk factor of pregnancy action (see table2), containing all of the parameters used to assess high-risk pregnancy. Lastly, the application automatically sends an e - mail with the instance report data to the control center (medical professional).

## VI. DISCUSSION SIGNS OF HIGH-RISK PREGNANCY

The study's findings indicated that, with the exception of acute gynecologic infections, acute infections of the urinary tract, atypical vaginal fluid discharges, and fetal inactivity, which exhibited high levels, teenage pregnant women displayed mild symptoms of high-risk pregnancy. According to the study, urinary tract infections, which are prevalent and account for 92% of cases, may be brought on by poor water quality in Baghdad or by the excessive salt of the city's tap water. The findings of this study are consistent with those of a study done in Iraq on 170 pregnant women at five primary healthcare facilities in al-Amin City, which discovered a rise in the incidence of urinary tract infections in pregnant women, especially in 3 rd. trimester (93%) [43].

The study found that a large percentage of acute gynecologic illnesses (86%), which may be related to the environment's economic, social, and cultural circumstances. The findings of this study are in agreement with those of a study on 300 pregnant teenagers performed in Henrietta, New York, titled Prevalence and Risk Factors for Infections in a Pregnant Adolescent Population. It's well known that adolescent and young women have a higher prevalence of STDs like chlamydia and gonorrhea. Where it was shown that young pregnant women had an elevated prevalence of STDs (80%) [44].

The study found that a significant majority of pregnant women (85%) experienced abnormal vaginal fluid flow. The findings of this study corroborate those of a study conducted in Jeddah, Saudi Arabia, with 1407 pregnant participants. The study's goal was to discover whether there were more aberrant vaginal discharges throughout pregnancy, and the results revealed that this was the case in 73.9% of cases. Another investigation on pregnant women in various parts of Saudi Arabia revealed that 72.2% of the pregnant women under investigation had elevated vaginal bleeding [45].

The study discovered a high proportion of fetal low intensity (72%), which may be caused by an amniotic fluid deficiency, hemorrhage, anemia, or other disorders. The findings of this study are consistent with those of a study done on 729 pregnant women who visited the maternal emergency room to evaluate the links between mother impression of decreased fetal movements and nutrition during pregnancy (ER) High levels of low fetal movement were perceived by mothers. A prominent reason for medical admission is maternal perception of decreased fetal movement, which affects (50–65%) of pregnancies. In addition to major medical assessment such placenta previa, intrauterine fetal mortality, intrauterine FGR, oligohydramnios, and fetal and maternal bleeding, there were other situations related with DFM [46].

## VII. COMPARATIVE RELATED WORK

The Sustainable and Healthy Communities (SHC) Research Program's main instrument for improving sustainable decision-making is known as HRPCDSS (High-Risk Pregnancy Clinical Decision Support System). The HRPCDSS's planned application focuses on urgent instances and has as its desired target the enhancement of decision making. The customer service, which is part of the decision-making process system, uses services to display and monitor its performance as well as the other layers to evaluate data from the information integrator layer and develop solutions. It seems important to develop a decision support system (DSS) for extracting knowledge and evaluation of health care suspense on the inhabitants through in-depth analysis of both endogenous and exogenous illnesses because all of these works have shown novel and good potential both theoretical and practical outcomes. Table (3) lists a few CDSS examples together with the relevant surroundings, type, and outcome.

TABLE III. THE CHARACTERISTICS OF STUDIES

| No. | Author, year, | Purpose | Type | Number | Data collection tool | Results |
|---|---|---|---|---|---|---|
| **1.** | M. Sinclair et al. (2018) [47] | to assess how pregnant women use the web for information seeking | Descriptive Study | 284 women who were pregnant or mother | Online questionnaire | The goal of using the Internet for pregnant women who use medications, the topics they inquired for the most, the prevalence of purchasing products illegally, and their trustworthiness were identified. |
| **2.** | E. J. Jacobs et al. (2019) [48] | to determine how Dutch women who are trying to get pregnant and those who are already pregnant behave online. | Descriptive cross--sectional study | 365 women attempting pregnancy and pregnant women | Online questionnaire | Before or during their pregnancy, they used the Internet as a source of knowledge (95.6%). Pregnancy, lifestyle, fetal development, and birth difficulties were the most popular search terms. 90% of women said that they base their choices about getting pregnant on the validity of the data they see online. A trustworthy website, according to 75% of women. |
| **3.** | F. Dhombres Et al. (2019) [46] | to find pregnant women who need specific pregnancy treatment and are at risk. | Descriptive study | 313 women who were pregnant or mother | Online questionnaire | The comprehensible CDSS indicates the possibility of helping clinicians identify at-risk individuals who might benefit from GDM preventive actions in the early stages of pregnancy. |
| **4.** | Y. Du Et al. (2022) [49] | To create and assess applications that can be utilized by doctors as decision-support tools during pregnancy | Descriptive study | 598 women who were pregnant or mother | Online questionnaire. mobile app. | 1. approval and contentment; 2. portability and simplicity of use; 3. flexibility; and 4. the significance of user input in development and assessment. |
| **5.** | N. Safi Et al. (2023) [50] | to describe how prenatal decision-making is impacted by the Internet | Descriptive study | 1143 women who were pregnant or mother | Online questionnaire. | utilize the internet to research pregnancy-related topics. The Internet influences choices about method of delivery, pregnant medication use, and regular exercise. |
| **6.** | A. Taştekin Ouyaba Et al. (2021) [51] | to determine whether a Clinical Decision Support System (CDSS) can enhance Healthy eating compliance in the beginning stages of pregnancy. | Descriptive study | 40 women who were pregnant or mother | questionnaire. | The good health of the woman may be improved by receiving support from a CDSS during the first period of pregnancy. |
| **7.** | P. Papandreou Et al. (2023) [52] | to look at the maternal results and care of pregnant mothers with PAC. | Descriptive study | 601 women who were pregnant or mother | questionnaire. | Potential failures problems are more likely to occur in women with PAC. They are more likely to experience less favorable birth outcomes even though their newborns do not have an elevated risk of neonatal mortality. |
| 8. | K. Paydar Et al. (2017) [53] | to create a clinical decision support system (CDSS) that can forecast maternal health in pregnant people with SLE | Descriptive study | 149 women who were pregnant or mother | Online questionnaire. | Clinicians can forecast the results of pregnancies in SLE-affected women using the newly created CDSS based on the MLP network. |

| | | | | | | |
|---|---|---|---|---|---|---|
| **9.** | K. Song Et al. (2021) [54] | to put out a decipherable experience and understanding decision support system (IKBDSS) that will help doctors gauge the likelihood that a condition would manifest during pregnancy. | Descriptive study | women who were pregnant or mother | Online questionnaire. | (1) The creation of a health care decision-support system that combines clinical data and subject-matter expertise to forecast diagnoses. (2) Feature representation is guaranteed by the decision-making procedure. (3) The technical expertise supplied in MLTS form is used to determine the requirement weights. |

## VIII. CONCLUSION

The High-Risk Pregnancy Clinical Decision Support System (HRPCDSS) was proposed to assist individuals and professionals in the field of clinical administration in implementing a comprehensive "one-bundle" strategy to manage basic crisis cases and to take proactive measures in the event of risky instances of high-risk pregnancy. The CDSS is suitable for handling issues that lack a clearly defined structure, as applying a standard PC program synthesis for high-risk pregnancy conditions can be challenging. A logical model organizes and monitors a variety of causes. The application takes into account the actual evaluation of standard symptoms associated with high-risk pregnancy, aiming to accurately identify high-risk pregnancy factors and provide a suitable treatment plan. An easy-to-use interface gathers a variety of programming tools, such as models, records, databases, and information organization programs, to form a CDSS. The clinical DSS is suitable for dealing with kinds of issues that don't have a clearly portrayed structure. The HRPCDSS provides significant enhancements to a standard decision-making procedure, utilizing a decision tree C4.5 algorithm. We presented the system plan's levels and their practical and logical connections. Real-time effort with the client gives an extent of possible results in choosing one activity from some decisions, which are made by the system through guided data mining and PC simulation. The (HRPCDSS) is an assortment of programming tools, (e.g., models, reports, data bases, and information the management programming) which incorporated combined with a simple-to-use (GUI/graphical user interface). It is important to deal with kinds of problems that do not have a plainly characterized structure. In data mining, a decision tree serves as a visible and explicit tool for decision examination and decision-making. The decision tree presents information instead of options, and the subsequent categorization tree aids in decision-making. HRPCDSS helps doctors make decisions and contributes to patient safety. It also improves the quality of healthcare services. In our research, we also discussed the prerequisites for a successful deployment of the CDSS. This paper proposed a functional decision support system to classify infected individuals, manage requests, and track high-risk pregnancy factors in the medical care supply. The Decision Tree C4.5 Inference System (DTCIS) then categorizes these users. Finally, we estimated the suggested application by attaching data to the four individuals, offering the appropriate treatment for each status and providing guidance on preventing high-risk pregnancy factors. The findings indicated that adolescents who were pregnant exhibited mild symptoms of a high-risk pregnancy. We recommend writing them in plain language, preferably with eye-catching images, and delivering them to women and families in various areas of the governorate. Further research is required to determine the causes of the rising trend of teenage pregnancies in the Iraqi governorates. Nutrition-focused health and nutrition promotion programs can prepare teenage females for a healthy marriage and pregnancy.

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