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Pregnancy Postpartum Hemorrhage Detection Using Ultrasonic Sensor and Automated Blood Compensation

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ABSTRACT: Pregnancy Postpartum Hemorrhage (PPH) is characterized by excessive bleeding, exceeding 500ml after a vaginal delivery or 1000ml after a cesarean delivery. Loss of blood within 24 hours of delivery is termed as early or primary PPH, whereas loss of blood that occur after 24 hours of delivery is termed as secondary PPH. Losing lots of blood can cause a severe drop in blood pressure. It may lead to suffering and death if not treated at the appropriate time. This kind of excessive blood loss that occurs most commonly after the placenta is delivered. Currently, physician use visual estimation to calculate blood loss and provide fluid or plasma during delivery. Sometimes this method is in accurate. In this project, after delivery, blood loss measurement system is integrated with fluid delivery and vital sign monitoring method is also proposed. Heart rate sensor, Temperature sensor are used to monitor the vital parameters. We collect the blood loss of the patient in collection jar through vaccum pump which transfers the blood into the collection jar. And then the volume of the blood loss is measured by using the ultrasonic sensor placed inside the collection jar and the details are recorded. When the blood loss falls within the normal range, the fluid delivered to the patient remains at a normal level. Incase of abnormal blood loss, the automated flow rate sensor adjusts itself to provide the necessary plasma to the patients. In addition to that, when the blood loss is in the abnormal range then the buzzer will also get turned ON to alert the physician.LCD is used to display the parameters. By giving required plasma/fluid to the patients according to the blood loss, the fatal condition of the women can be reduced.

KEYWORDS: Ultrasonic sensor, collection jar, keypad, flow rate sensor

I. INTRODUCTION

Primary postpartum hemorrhage (PPH) is defined as blood loss of 500 ml after vaginal delivery and above or 1000 ml of blood loss after caesarean section within the first 24 hours [1,2]. It is the most common cause of premature mortality of women worldwide. PPH is dangerous and life-threatening and can also lead to long-lasting health effects, including severe anemia [3]. According to the 2013 World Health Statistics, the

Maternal mortality rate in low income countries were 410/100,000 live births [4]. The majority of maternal deaths occurred mainly in Asian and African countries [5]. Major causes of maternal deaths are similar across low income countries, often obstetric in origin including hemorrhage,hypertensive diseases and maternal infections [4, 6] 94% of births in Ethiopia are estimated to occur at home and 10% of maternal deaths are attributed to PPH [2] .Uterine atony , or lack of effective contraction of the uterus, is the most common cause of PPH [3] followed by infection, sub involution of the placental site, and inherited coagulation deficits [1]. The majority of these fatal obstetric complications occur during labor and immediately after birth. In the low income countries, more than three-quarters of maternal deaths due to the direct obstetric causes occur during and after birth [4,].Organized diagnosis and management of PPH, including administration of uterotonic agents, controlled cord traction, and uterine massage after delivery of the placenta, are required to avoid maternal death. The high frequency of PPH in the developing world is due to the lack of diagnosis and management methods as well as medications used in the active management of the third stage. Lack of experienced caregivers who can manage PPH and lack of blood transfusion services, anesthetic services, and operating capabilities also play a role. Uterine Atony, or the inability of the uterus to contract effectively after childbirth, is the leading causes of postpartum hemorrhage. This lack of uterine muscle tone prevents proper closure of

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blood vessels, leading to uncontrolled bleeding. Incomplete expulsion of the placenta after delivery is another common cause. If the placenta is not completely removed from the uterus, it can obstruct normal contractions, leading to hemorrhage. Conditions that affect the blood's ability to clot properly, such as coagulopathies or the use of anticoagulant medications, increase the risk of excessive bleedingThe symptoms of Postpartum Hemorrhage are Excessive Bleeding, Drop in Blood pressure, Rapid Heart Rate, Pale or Clammy Skin. The diagnosis of PPH are done by clinical evaluation, Blood Tests and Imaging. These evaluations are sometimes inaccurate which leads to the increased mortality rate of woman. So, to overcome this issue, an automated system is designed to reduce the blood flow after the child birth. In this project, after delivery, blood loss measurement system is integrated with fluid delivery and vital sign monitoring method is also proposed. Heart rate, Temperature rate sensor are used to monitor the vital parameters. We collect the blood loss of the patient in collection jar through vaccum pump. And then the volume of the blood loss is measured by using the ultrasonic sensor and the details are recorded. If the blood loss is normal value, then the fluid deliver to the patient is normal level[5]. If the blood loss is abnormal, then the flow rate sensor is automated to give required plasma to the patients. Buzzer will be turned ON during the abnormal condition.LCD is used to display the parameters. By giving required plasma/fluid to the patients according to the blood loss, the fatal condition of the women can be reduced.

II. OBSERVATION OBTAINED ABOUT PPH

Postpartum haemorrhage is the leading cause of maternal mortality. Postpartum haemorrhage is heavy bleeding after the birth of baby. Antennal practices help in identifying risk factor and modern technology is used to overcome the risk. It may lead to suffer and die if not treated well. Different medical based solutions used to predict the postpartum haemorrhage and observed the percentage levels[7]. The observation have been discussed and summarized the methods and percentage in tabular format.

S.No	Author Name	Methodology and Demerits
1.	S.V.Ruphitha & V.D. Ambeth Kumar	The patients vital parameters data are collected and it is stored in a dataset. Then, the physician give treatment to the patients according to the dataset. There is no accurate fluid delivery after the postpartum.
2.	Xin Wang	Physicians predict the risk and critical level of PPH patients. This will help in the reduction of mortality of pregnant woman. There is no solution for reducing the blood loss after the postpartum.
3.	Ruyi Wang, Yuan Liao et al.,	Here, the robot collects the mental health of the pregnant woman and helps the physician to give treatment to the patient. There is no accurate treatment for blood loss after the PPH.

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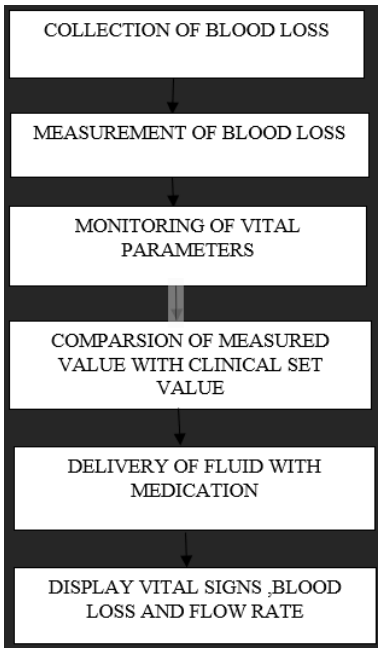
4.	Sriram Natarajan	The Physicians give treatment to the patients and boost their mental health which results in the reduction of mortality of patients.

III. PPH FEATURES

For the primary goal of PPH prediction, our clinical team maintain a large dataset consisting of 3842 patient records, with 361 PPH records which were collected during 2017 at the Beijing Obstetrics and Gynecology Hospital. The dataset, as common cases, is also characterized by the significant imbalance positive/negative samples. I.e., the true PPH occurrence ratio accounts for 9.4%, which is a moderate value for the patient class of vaginal delivery. To achieve better prediction performance, the assessment indicators of PPH and its complication DIC have been systematically reviewed, by comprehensively exploring their relationship with the blood loss [2,5]. On this basis, we have further studied and selected 23 features with high relation to the occurrence of PPH. These features are categorized into ‘‘Present Gestation’’ and ‘‘Factors related to delivery’’. The data formats and categories of such selected features are described . We use f0 to f22 to denote the 23 features in sequentially. It should be noted that, according to the ranking analysis of such features, we believe such features constitute a relatively complete description or representation of PPH, which are expected to produce the good prediction diagnosis model



The Proposed solution includes blood loss collection and measurement system, vital sign monitor (pulse rate and blood pressure), processor unit (Arduino microcontroller), low rate monitor and regulator, display and alarm system. Inputs from the blood loss measurement system, vial sign monitor as well as the number of gauze used from the key-pad are used to estimate the recommended IV fluid to be delivered. The alarm is used to notify the physicians in case of severe conditions. Under-buttock drape, which allows the blood loss to enter to the collection jar without loss, was constructed from locally available material[13]. Ultrasonic sensor is used to measure the volume of blood collected in the jar. The functional block diagram and general block diagram of our proposed design. The solenoid valve controls the amount of fluid to be delivered to the patient. Solenoid valve and flow sensor will stay on until enough fluid is delivered. [10]
The flow rate will be used to calculate the amount of fluid delivered. If the measured value is larger than the clinical set value the solenoid value will be turned off automatically to prevent excess medication.

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IV. FEATURE SELECTION

In the work, our study aims to construct a prediction model of PPH and its complications based on the method of ensemble learning. Our prediction results are expected to give the obstetricians necessary time to deal with the potential PPH, and therefore the proactive treatment can be carried out in advance, such as appropriate hemostasis, resuscitation, massive transfusion protocol, and tranexamic acid.[11] There are dozens of (or even more) associative features relevant to each patient. In practical clinic trails, collecting all the potential features for the prediction model would become rarely feasible for our large dataset involving 3842 records. Thus, the associative features shall be carefully selected, to balance the potential information loss and the complexity. The widely accepted rule in feature engineering is that more features do not necessarily leads to the improved prediction accuracy.[8]

V. POTENTIAL FOR RAPID LOSS OF A LARGE VOLUME OF BLOOD

In pregnancy, the total blood volume is ~5 to 7 L (70-80 mL/kg lean body mass). By term, the blood supply to the uterine arteries is ~500 to 600 mL per minute, increased from its normal level of 10 to 15 mL per minute outside of pregnancy[11]. After delivery of the placenta, the uterine muscles contract, effectively staunching blood flow from the utero placental bed. Uterine atony, retained placental tissue, and abnormal placental implantation impede the normal action of the uterus in completing this critical mechanical hemostatic process. Given the high blood flow to the uterine arteries, it is easy to appreciate how rapidly a large volume of blood can be lost in a short time.

VI. CLINICAL FEATURES OF POSTPARTUM HEMORRHAGE

In clinical practice, the cause of PPH are represented by the '4Ts' formula
Tone: for abnormalities of uterine contraction
Tissue: for retention of amniochorial tissue or retained placenta
Trauma: for uterine rupture, cervical tears, uterine inversion, or birth canal tears.
Thrombin: for coagulation disorder caused by thrombin dysfunction[12].

The clinical presentation of PPH can be blurred and blood loss is often underestimated, due to problem with correct quantification. Very often the first clinical and signs are late and due to frank anaemia, such as tachycardia, small and frequent pulse, hypotension, sweating, palness.

In addition a series of physiological changes occur during pregnancy, so that vital signs may show no change until blood loss reaches 2-3 litres. These changes include an increase of up to 50% in plasma volume and about 20% in red blood cells [9], especially, in young and healthy women with good cardiac reserve. Conversely, co existing factors such as maternal anaemia before delivery or a low body mass index, can lead to haemodynamic in stability even with low blood loss.

BLOOD LOSS	SYSTOLIC PRESSURE	SIGNS AND SYMPTOMS	SHOCK DEGREE
5000-1000ml	Normal	Palpitations, tremor tachycardia	compensated
1000-1500 ml	Slight decrease	Weakness, Sweating	Mild
1500-2000ml	Sharp decrease	Agitation, pallor	moderate
2000-2500ml	Deep decrease	Collapse, air hunger	severe

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VII. CONCLUSION

Globally PPH is the leading cause of maternal mortality and morbidity. Prevention plays a very important role by identifying high risk factors and active management of labour. Management is medical, mechanical, surgical and radiological. A multi disciplinary approach is essential in severe haemorrhage. Availability of blood and blood products is essential. It is very important to identify the aetiology, through uterine atony is common. Prediction and assessment of blood loss remains the cornerstone for prompt and effective management of PPH.

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