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Design of an Improved Portable Blood Detector for Post-Partum Hemorrhage for Mothers After Delivery in Uganda

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Abstract*: Postpartum hemorrhage (PPH) is a leading cause of maternal mortality worldwide, particularly in low-income countries like Uganda. Defined as blood loss exceeding 500 mL within 24 hours after childbirth, PPH poses significant risks, especially in cesarean deliveries. Major causes include uterine atony, birth canal trauma, retained placenta, and clotting disorders. Preventive strategies, such as administering uterotonics like oxytocin and managing the third stage of labor, have proven effective in reducing PPH risk. However, in resource-constrained settings, limited access to skilled healthcare, essential medications, and emergency services exacerbates the challenges of managing PPH. This project aims to design a postpartum hemorrhage alarm device to detect early signs of hemorrhage and alert healthcare providers in real-time, enabling prompt intervention. The proposed technology seeks to improve maternal health outcomes by addressing the critical need for timely and effective Postpartum hemorrhage management, particularly in resource-limited environments like Uganda.*

Keywords: Postpartum hemorrhage, childbirth, maternal death, healthcare

1. INTRODUCTION

Postpartum hemorrhage (PPH) is a significant health issue that involves excessive bleeding following childbirth. It is defined by a blood loss of 500 mL or more within the first 24 hours after delivery and is considered the leading cause of maternal death, particularly in low-income countries such as Uganda. Globally, PPH accounts for almost a quarter of all maternal deaths, making it a critical focus for improving maternal health outcomes [1]. Postpartum hemorrhage can occur after both vaginal and cesarean deliveries, though the risk is higher in cesarean sections, where blood loss is often more substantial. In some cases, PPH can be so severe that it triggers symptoms such as a significant drop in blood pressure, changes in heart rate, and signs of shock, all of which indicate life-threatening levels of blood loss.The most dangerous period for PPH is within 24 hours after delivery, which is referred to as primary PPH. However, this condition can also develop later, up to 12 weeks postpartum, in what is known as secondary PPH. The potential for delayed onset makes continuous monitoring essential, even after the initial postpartum period [2] . Given the life-threatening nature of PPH, its prevention, early detection, and prompt treatment are vital to ensuring the safety and well-being of mothers. Addressing this issue effectively can help to reduce maternal mortality rates, especially in resource-constrained settings. Uterine atony, the failure of the uterus to contract properly after childbirth, is a leading cause of postpartum hemorrhage (PPH). Normally, the uterus contracts to compress the blood vessels where the placenta was attached, but when these contractions are weak or absent, heavy bleeding occurs. Trauma to the birth canal, such as lacerations in the cervix, vagina, or perineum, especially during instrumental deliveries or the birth of a large baby, can also cause PPH [3]. Additionally, a retained placenta, where pieces of the placenta remain inside the uterus, prevents proper contraction and can lead to ongoing bleeding, often requiring manual removal. Clotting disorders, whether hereditary or related to pregnancy complications like preeclampsia or placental abruption, further increase the risk of excessive bleeding. Retained placental tissue, where small fragments remain in the uterus after delivery, can cause delayed bleeding. Uterine infections, like endometritis, may also lead to inflammation and bleeding in the weeks following childbirth [4]. Additionally, subinvolution of the uterus, which is the failure of the uterus to shrink back to its normal size after delivery, can result in excessive postpartum bleeding if the uterus remains enlarged.Most cases of postpartum hemorrhage are preventable with the use of uterotonics, medications that stimulate the uterus to contract and reduce blood loss. **Oxytocin**, a common uterotonic, is often administered during the third stage of labor, after the baby is born but before the placenta is delivered. This intervention significantly lowers the risk of PPH by promoting effective uterine contractions [5].Other preventive strategies include: Active management of the third stage of labor (AMTSL), which includes administering uterotonics, controlled cord traction, and

uterine massage, helps facilitate the placenta's expulsion and reduces the risk of hemorrhage. Additionally, avoiding routine episiotomies, which can increase the risk of trauma and bleeding, minimizes the chances of postpartum hemorrhage by preventing unnecessary birth canal injuries.When Postpartum hemorrhage occurs, rapid and effective treatment is crucial. The earlier the condition is identified and treated, the better the chances of avoiding severe complications, such as shock, organ failure, or death. The burden of postpartum hemorrhage is disproportionately high in low-income countries like Uganda, where healthcare infrastructure and access to medical care are often limited. In many rural areas, women give birth at home without the presence of a skilled healthcare provider. This increases the risk that PPH will go unrecognized and untreated, leading to fatal outcomes. Even in healthcare facilities, resource limitations such as a lack of essential medications like oxytocin or the absence of blood transfusion services can further complicate the management of PPH [6]. Delays in accessing emergency care, combined with a lack of trained healthcare professionals, contribute to Uganda's high maternal mortality rate, where PPH remains a leading cause of death. International organizations, including the World Health Organization (WHO), have made significant efforts to reduce the incidence of PPH and improve maternal health outcomes globally. WHO has established guidelines that prioritize the prevention and treatment of PPH, focusing on increasing the availability of uterotonics, training healthcare providers in safe delivery practices, and ensuring access to life-saving interventions [5]. One of the key global health objectives is to reduce maternal mortality as part of the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). Improving maternal healthcare systems and ensuring access to quality care during childbirth is essential to achieving these goals. In the context of improving maternal healthcare, technology can play a crucial role in reducing PPH-related deaths. In this project, a PPH alarm device will be designed to ensure the early detection of postpartum hemorrhage, alerting healthcare providers to the mother's condition immediately [7].

2. Methodology

When the level sensor detects that the blood has reached a certain limit (>450mls of blood) it will send the information to the timer circuit which will switch on the buzzer producing an audible sound. The RCL circuit controls the power flow in the timer circuit and protecting it also.

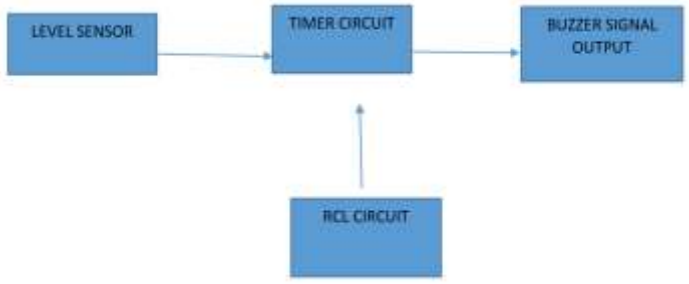

Figure 1: Block diagram for the proposed project

3. Principle of operation

The device is switched on and placed under a mother after delivery. When the collecting jar detects that blood has reached 500mls. the healthcare provider gets an audible alarm and LEDS alerting her. Then she performs the required procedures in treatment of this danger.
The buzzer will be giving an audible sound.

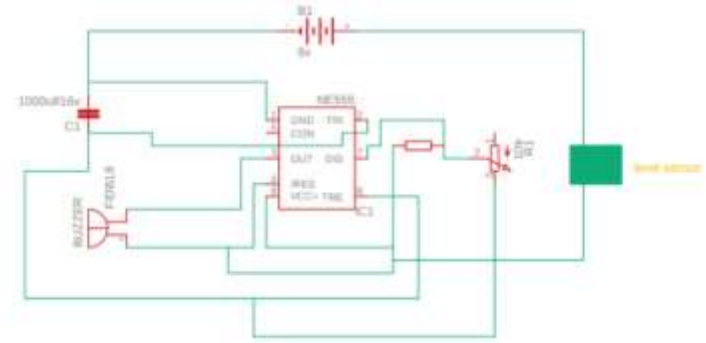

Figure 2: Circuit diagram for the proposed project

4. Conclusion

In conclusion, this project aims to address the critical issue of postpartum hemorrhage (PPH), a leading cause of maternal mortality, especially in low-income countries like Uganda. By developing an innovative PPH alarm device, the project seeks to enhance early detection and provide timely alerts to healthcare providers, ensuring prompt intervention. This solution is particularly impactful for rural and urban communities with limited healthcare resources. With the integration of this technology, alongside proper management techniques such as active management of the third stage of labor and the avoidance of unnecessary episiotomies, the project has the potential to significantly reduce PPH-related deaths. Ultimately, this initiative contributes to improving maternal healthcare outcomes, aligning with global health goals, and fostering safer childbirth experiences for women in resource-constrained settings.

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