**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**COLLEGE OF ENGINEERING**

**DEPARTMENT OF COMPUTER ENGINEERING**

**BIOMEDICAL ENGINEERING**



**AUTOMATED NEONATAL EXCHANGE TRANSFUSION (ANET 4.0)**

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**BANDOMA GIDEON**

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**SUPERVISED BY: MR. PRINCE ODAME**

**APRIL, 2023**

# **DECLARATION**

We declare that this project is our own work as a requirement for the award of a Bsc. Biomedical Engineering degree, under the supervision of Mr. Prince Odame. We also declare that except where references were made and credit duly given, the project is a result of our collective effort, ingenuity, research and skills.

NAME SIGNATURE DATE

AMEYAW ARTHUR SAMUEL ……………………………..

BANDOMA GIDEON ………………………………

CANN JOSEPHINE ESI ……………………………….

SUPERVISOR

Mr. PRINCE ODAME …………………………….

# ACKNOWLEDGEMENT

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# CHAPTER ONE

## INTRODUCTION

## BACKGROUND

During pregnancy, the placenta excretes bilirubin. According to recent statistics, 80% of preterm and 60% of term neonates develop jaundice, which can be attributed to the underdevelopment of organs like the liver leading to the build-up of bilirubin in the blood, other tissues, and fluids of the body of neonates. This condition is termed hyperbilirubinemia. Hyperbilirubinemia is a leading cause of long-term neurodevelopmental impairment such as kernicterus and bilirubin-induced neurologic dysfunction (BIND). In Sub-Saharan Africa, long-term impairment following kernicterus is eight times more common than in high-income countries.

Diagnostic methods of hyperbilirubinemia include direct and indirect bilirubin levels, red blood cell (RBC) counts, blood type, and testing for Rh compatibility. Neonates whose mothers are diabetic and have Rh disease are more prone. The condition may disappear on its own after birth, usually for a period of 2 to 4 days. But for most neonates, this usually does not happen.

Treatment methods include phototherapy, fiberoptic blanket, exchange transfusion, and ceasing breastfeeding for one or two days. Globally, the most predominant modality is phototherapy especially when there is early detection of hyperbilirubinemia. However, in severe cases of hyperbilirubinemia, usually as a result of late detection, phototherapy becomes a less effective treatment method, and considering the cost of phototherapy units, exchange transfusion becomes a more preferred approach in our part of the world. Exchange transfusion is an allogenic procedure where the neonate’s blood which is contaminated with very high levels of bilirubin, is replaced with fresh blood from a donor. Exchange transfusion is a procedure that involves alternating giving and withdrawing blood in small amounts through a vein or artery. If bilirubin levels remain high, the procedure may need to be repeated.

The aim of the project is to design a cost-effective, time-saving workable device to make the procedure of exchange a smooth one with less human intervention for use in our part of the world.

## PROBLEM STATEMENT

A neonatal exchange transfusion is a critical procedure that is performed on newborn infants suffering from severe medical conditions, such as hemolytic disease (HDN), which is caused by incompatibility between the mother's and baby's blood types, jaundice, anemia, or metabolic disorders.

Although the procedure replaces a large volume of the baby's blood and is life-saving, it poses several challenges that threaten the infant's well-being and survival. Other complications can arise during or after the procedure, including bleeding, transfusion reactions, infections, and, most importantly, iron overload, which damages the infant's heart, liver, and lungs. It is crucial to control the transfusion rate carefully to prevent overloading the infant's circulatory system. The transfusion should also be performed slowly to reduce the risk of adverse reactions and complications, such as transfusion reactions, bleeding, and infections.

It is very important that the procedure be performed accurately and consistently in order to ensure the best outcomes for the newborn, but since it takes such a long time, it is tedious and prone to human error.

## OBJECTIVES

This project's main goal is to develop, build, and test the machine on lab subjects that automates the neonatal exchange transfusion procedure. The machine will then be used in clinical settings and intended for commercial purposes as well. All the information utilized in the manual procedure is included in the device's functionality. A motor will be programmed to move the syringe at a constant speed in order to draw and inject blood. Motors will also take the role of the doctor manually switching valves throughout the exchange operation. By doing this, human interference in the process will be eliminated. The automatic shut-off would turn the machine off when the process was complete using the alarm system.

### 1.3.1 SPECIFIC OBJECTIVES

The following are the project's specific goals:

1. Use programming, classical electronics, and mechanics to virtually automate the exchange transfusion procedure.

2. Include all the information from the manual procedure in our design III. Create an educational user interface

3. Produce a cost-effective effective and energy-efficient device.

4. Adding an alarm system to give a signal when the process is done.

# CHAPTER TWO

## LITERATURE REVIEW

## 2.1 HISTORY OF NEONATAL EXCHANGE TRANSFUSION