PREGNANCY COMPLICATIONS THROUGH THE LENS OF DIGITAL HEALTH

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AGENDA

01 Introduction
02 Literature Review Deliverable
03 Perinatal Deliverable
04 Next Steps
05 Q&A
INTRODUCTION
I completed my internship with the University of North Carolina at Chapel Hill’s (UNC’s) Perinatal Research Service Center (PRSC), the UNC School of Medicine, and the UNC Collaborative for Maternal and Infant Health.

**Literature Review Deliverable**
- Risk Factors
- AI Tools
- CDSS

**Perinatal Deliverable**
- EDA
- AI-based algorithms
- CDSS
- Challenges to Implementing
LITERATURE REVIEW
DELIVERABLE
LITERATURE REVIEW

Approach

1. 4 Modified literature review
2. 6 papers from PubMed
   - 1 - 2 papers: General Scope
   - 4 - 5 papers: Specific Scope
3. Screening Process
   - Publishing year $\geq$ 2017
   - Written in English
   - Grey literatures
   - Theses
   - Registry

Topics

- Pregnancy Complications Risk Factors
- Artificial Intelligence Tools Developed within Obstetrics And Gynecology
- Clinical Decision Support Systems (CDSS) Used During Peri- & Postnatal Care
- The Challenges of Developing, Implementing, & Integrating Digital Health-Related Tools In Patient Care
The maternal mortality rate in the US is a growing concern. There are a number of factors that significantly increase the risk of pregnancy-related complications.

At the population level, many risk predictors were identified. These predictors included obesity, diabetes, lack of high school education, African American race, and fewer than 10 prenatal care visits, along with the revised death certificate, implemented in the early 2000s. A paper was able to explain 91% of the increases in maternal mortality between 1997 and 2012 using these predictors.

At the neighborhood level, several risk factors were recognized. These factors included a higher percentage of minority populations, violent crimes, renter-occupied housing units, housing violations, women who did not graduate high school, and women receiving public assistance.

At the individual level, several risk variables were seen. These variables were race, cesarean birth, stillbirth, preterm birth, and preeclampsia.
Health disparities and high rates of maternal morbidity and mortality are prevalent within obstetrics care. AI is a promising tool that can not only lead to the improvement of health outcomes but will also develop new approaches for prevention, risk mitigation, and optimization of treatments and resource utilization.

Fetal Heart Monitoring
AI was used to monitor the fetal heart rate during labor by analyzing cardiotocography and predicting future outcomes.

Gestational Diabetes Management
One study developed a telemedicine platform, Sinedie, that remotely monitored gestational diabetes. Dietary recommendations were automatically prescribed to the patient and insulin therapy recommendations were relayed to the physicians. This system reduced clinician evaluation time by 27% and face-to-face visits per patient were reduced by 89%.
CLINICAL DECISION SUPPORT SYSTEMS (CDSS) USED DURING PERI- & POSTNATAL CARE

CDSSs can optimize clinicians’ time and identify high-risk patients.

CDSS & rural health in Africa
A CDSS was a java-based software that was based on the WHO’s Integrated Management of Pregnancy and Childbirth. It was developed to improve care in 6 rural health centers in Tanzania. It provided guidance and clinical decision support during routine antenatal, childbirth, and post-childbirth care. This clinical information was integrated to detect high-risk patients. It also tracked peri and post-natal activities.

CDSS & ectopic pregnancies
A clinical decision support system was developed to provide diagnosis assistance during examinations of pregnancies of an unknown locations. During the ultrasound, it assisted the operator by suggesting ultrasound views to capture and signs to look for. Thus, the operator was guided by the system through a structured acquisition process.
THE CHALLENGES OF DEVELOPING, IMPLEMENTING, & INTEGRATING DIGITAL HEALTH-RELATED TOOLS IN PATIENT CARE

While there are many benefits to the utilization of AI tools, successful deployment of these tools will require identifying, monitoring, and mitigating biases and patients' and providers' concerns.

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<th>Issues</th>
<th>Solutions</th>
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<tr>
<td>Nonrandom missing data</td>
<td>Including more individuals from underrepresented communities or adjusting the weights of the data</td>
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<td>Interpretability of AI models</td>
<td>Using similar technologies like deep Taylor decomposition which showed which risk factors were present and what contributions were made in the final decision</td>
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**Patients**
- 88% Believed that these devices would help improve health
- 50% Downloaded a pregnancy-related app
- 42% Had no privacy concerns about their data being stored

**Providers**
- 75% Believed that more devices in an already hectic workflow would be a problem
- 50% Believed more devices should be used in patient care
- 7% Used mHealth or wearable sensor technologies
PERINATAL DELIVERABLE
PERINATAL DELIVERABLE

Approach

1. Publicly available dataset
2. Multilayer perceptron algorithm
3. Clinical decision support tool to predict maternal risk

Steps

- Exploratory Data Analysis
- Developing the Algorithm
- Creating a clinical decision support tool
EXPLORATORY DATA ANALYSIS

The dataset came from the University of California–Irvine Machine Learning Repository.

1014 patients

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<th>PREDICTORS</th>
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<tr>
<td>1. Maternal Age</td>
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<tr>
<td>2. Systolic Blood Pressure</td>
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<td>3. Diastolic Blood Pressure</td>
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<td>4. Body Temperature</td>
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<td>5. Blood Sugar Level</td>
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<td>6. Heart Rate</td>
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1. Risk Level for Pregnancy Complications

- 33% High Risk
- 40% Low Risk
- 27% Mid Risk
**Diastolic Blood Pressure vs Risk Level**

a. There is a positive correlation between diastolic blood pressure and risk level.

b. The higher the diastolic blood pressure, the higher the risk of maternal complications.

c. 85, 72, and 74 mmHg was the mean for the high, low, and mid risk groups, respectively.

d. The difference in mean was significant and had a medium effect size (p-value = 9.0e-30, effect size = 0.1).

**Systolic Blood Pressure vs Risk Level**

a. There is a positive correlation between systolic blood pressure and risk level.

b. 124, 105, and 113 mmHg was the mean for the high, low, and mid risk groups, respectively.

c. The higher the systolic blood pressure, the higher the risk of maternal complications.

d. The difference in mean was significant and had a large effect size (p-value = 8.59e-37, effect size = 0.2).

**Age vs Risk Level**

a. There is a positive correlation between age and risk level.

b. 36, 26, and 28 years old was the mean for the high, low, and mid risk groups, respectively.

c. The higher the maternal age, the higher the risk of maternal complications.

d. The difference in mean was significant and had a medium effect size (p-value = 3.85e-22, effect size = 0.1).

**Blood Sugar vs Risk Levels**

a. There is a positive correlation between blood sugar and risk levels.

b. 12, 7, and 8 mmol/L was the mean for the high, low, and mid risk groups, respectively.

c. The higher the blood sugar levels, the higher the risk of maternal complications.

d. The difference in mean was significant and had a large effect size (p-value = 1.0e-66, effect size = 0.3).
HEART RATE VS RISK LEVEL

- There is a slight positive correlation between heart rate and risk levels.
- 76, 72, and 74 bpm was the mean for the high, low, and mid risk groups, respectively.
- The higher the heart rate, the higher the risk of maternal complications.
- The difference in mean was significant and had a small effect size (p-value = 7.2e-09, effect size = 0.03).

BODY TEMPERATURE VS RISK LEVEL

- There is a slight positive correlation between body temperature and risk levels.
- 98.899, 98.368, and 98.833 mmHg was the mean for the high, low, and mid risk groups, respectively.
- The higher the body temperature, the higher the risk of maternal complications.
- The difference in mean was significant and had a small effect size (p-value = 7.07e-08, effect size = 0.03).

HEATMAP

- The correlation between each predictor and the outcome is like the findings above.
- Systolic and diastolic blood pressure are strongly correlated.
- Other pairs of predictors are moderately, weakly, or negligibly correlated.
MULTILAYER PERCEPTRON (MLP) ALGORITHM

Brief summary
Why I chose to use it
Scikit-learn
RESULTS

Legend

Class 0  High risk
Class 1  Mid risk
Class 2  Low risk
1. EXPLORE OTHER DEEP LEARNING ALGORITHMS
2. CONDUCT LITERATURE REVIEW (E.G., SYSTEMATIC REVIEW)
3. EXPLORE OTHER FUNCTIONALITIES THAT COULD BE PROVIDED VIA THE CLINICAL DECISION SUPPORT TOOL
4. SUBMIT ABSTRACT
APPRECIATION

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Mariell Ruiz
Addie Griffin
Erika Takeda
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THANK YOU FOR LISTENING
ANY QUESTIONS?