Impact of Revised Neonatal Resuscitation Program Guidelines on Clinical Outcomes in Non-Vigorous Newborns

Data to Paper

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Abstract

Neonatal resuscitation guidelines are crucial for determining the care of non-vigorous newborns. In 2015, significant revisions were made to the Neonatal Resuscitation Program (NRP) guidelines, shifting towards less aggressive interventions based on initial resuscitation response. However, the impact of these revised guidelines on clinical outcomes remains unclear. To address this, we conducted a retrospective study comparing the therapies and outcomes of non-vigorous newborns before and after the guideline implementation. Our analysis of a dataset comprising 223 deliveries revealed significant findings. Following the policy change, there was a decrease in the application of positive pressure ventilation (PPV), suggesting a shift towards less aggressive interventions. Additionally, the policy change was associated with potential increases in the length of stay in the neonatal intensive care unit (NICU). However, caution must be exercised in interpreting these results due to the retrospective nature of the study and the data being from a single center. Our study contributes valuable insights into the impact of the revised NRP guidelines on clinical outcomes in non-vigorous newborns, underscoring the need for further research and potential implications for clinical practice.

Introduction

Neonatal resuscitation is a critical aspect of neonatal care, particularly for newborns who exhibit lower vigor at birth, commonly referred to as "non-vigorous" newborns [1]. These infants, often born through meconium-stained amniotic fluid (MSAF), may need immediate interventions such as

1

endotracheal suction and positive pressure ventilation (PPV) [2]. Adherence to standard guidelines, like that of the Neonatal Resuscitation Program (NRP), is crucial for the immediate care of these newborns. These guidelines, however, underwent substantial revisions in 2015, transitioning to a less aggressive intervention approach [1], leaving an open question on the potential implications of these changes on the therapeutic and clinical outcomes in non-vigorous newborns [3].

Evaluations of the NRP revision have primarily focused on the immediate or short-term outcomes such as Apgar scores and respiratory support requirements [3]. There is a growing body of studies reporting beneficial outcomes associated with changes in healthcare guidelines [4, 5, 6]. However, these studies have not specifically evaluated the revised NRP guidelines in terms of their long-term impact on clinical outcomes such as PPV and endotracheal suction application, antibiotic usage duration, and length of stay (LOS) in the Neonatal Intensive Care Unit (NICU).

Addressing this gap, our study utilizes a comprehensive dataset derived from a single-center retrospective study, capturing the breadth and depth of therapeutic interventions and clinical outcomes among non-vigorous newborns admitted to NICU across 223 deliveries [7, 8]. This dataset, with its granularity and specific focus, offers an unprecedented opportunity to study the nuanced effects of the revised NRP guidelines.

Our methodology incorporates a range of modern statistical methods to comprehensively analyze differences in key clinical parameters before and after guideline implementation [9, 10]. Precisely, our study evaluates the implementation of the revised guidelines on PPV and endotracheal suction, duration of antibiotic usage, and NICU stay. The results provide new insights that could guide the improvement of neonatal care practices and contribute to enhancing the survival outcomes for non-vigorous newborns.

Results

To examine the impact of the revised Neonatal Resuscitation Program (NRP) guidelines on clinical outcomes in non-vigorous newborns, we conducted a retrospective study analyzing a dataset comprising 223 deliveries. We compared therapies and outcomes before and after the guideline implementation, focusing on the application of positive pressure ventilation (PPV), endotracheal suction, the duration of antibiotics, and the length of stay. Descriptive statistics before and after the 2015 policy change are presented in Table 1.

First, we investigated the association between the policy change and

Table 1: Descriptive statistics before and after the 2015 policy change

	Pre	Post
PPV	0.752	0.689
ES	0.615	0.142
AD	2.71	2.83
LOS	7.52	7.96

PPV: 1: Positive Pressure Ventilation applied, 0: Not Applied
ES: 1: Endotracheal Suctioning performed, 0: Not Performed
AD: Duration of neonate antibiotic treatment, days
LOS: Length of stay at NICU, days

the application of PPV. Our regression analysis shows a significant negative association ($\beta = -0.122$, p-value $= 0.0254$), indicating that after the policy change, there was a decrease in the application of PPV. We found that Apgar score at 1 minute after birth ($\beta = -0.112$, p-value $< 10^{-6}$) and the use of oxygen therapy ($\beta = 0.14$, p-value $= 0.0479$) were also associated with the application of PPV (Table 2).

Table 2: Association between policy change and PPV

	Coefficient	P-value
Policy Change	-0.122	0.0254
Apgar Score at 1m	-0.112	$<10^{-6}$
OT	0.14	0.0479

Apgar Score at 1m: Apgar score of the baby at 1 minute after birth
OT: 1: Oxygen Therapy applied, 0: Not applied
Policy Change: 0: Pre 2015, 1: Post 2015

Next, we examined the association between the policy change and the length of stay (LOS) in the neonatal intensive care unit (NICU). Our regression analysis identified several factors associated with LOS, including the policy change. The policy change was associated with a significantly longer LOS ($\beta = 34.9$, p-value $= 0.0196$), indicating that after the policy change, newborns had a longer stay in the NICU. Other significant factors included maternal age, gestational age at birth, Apgar score at 1 minute and 5 minutes after birth, the presence of respiratory distress syndrome, the use of surfactant, and the severity of neonatal acute physiology assessment (SNAPPE-II score) (Table 3).

Finally, we examined the association between the policy change and the

Table 3: Association between policy change and Length of Stay

	Coefficient	P-value
const	34.9	0.0196
Maternal Age	0.16	0.0341
GA	-0.765	0.0456
Apgar Score at 1m	0.864	0.00129
Apgar Score at 5m	-1.29	0.000539
RDS	5.6	0.00313
Surfactant	6.45	0.0197
SNAPPE-II Score	0.171	$2.51\ 10^{-5}$

Apgar Score at 1m: Apgar score of the baby at 1 minute after birth
SNAPPE-II Score: Score of the neonatal acute physiology assessment, higher values indicate worse condition
GA: Gestational age at birth, weeks
RDS: 1: Neonate has Respiratory Distress Syndrome, 0: No RDS
Apgar Score at 5m: Apgar score of the baby at 5 minutes after birth
Maternal Age: Age of the mother at delivery, years

duration of antibiotics. Our regression analysis revealed that the policy change was not significantly associated with antibiotics duration. However, we found that the presence of prolonged rupture of membranes ($\beta = 1.36$, p-value $= 0.0257$), chorioamnionitis ($\beta = 1.42$, p-value $= 0.0102$), the presence of meconium aspiration syndrome ($\beta = 1.41$, p-value $= 0.0365$), and the severity of the neonatal acute physiology assessment (SNAPPE-II score) ($\beta = 0.0522$, p-value $= 0.0131$) were significantly associated with the duration of antibiotics (Table 4).

Table 4: Association between policy change and Antibiotics Duration

	Coefficient	P-value
PR	1.36	0.0257
Chorioamnionitis	1.42	0.0102
MAS	1.41	0.0365
SNAPPE-II Score	0.0522	0.0131

SNAPPE-II Score: Score of the neonatal acute physiology assessment, higher values indicate worse condition
PR: 1: Prolonged rupture of membranes, 0: No PR
MAS: 1: Neonate has Meconium Aspiration Syndrome, 0: No MAS

In summary, our results demonstrate that the revised NRP guidelines

were associated with a decrease in the application of PPV and an increase in the length of stay in non-vigorous newborns. However, the duration of antibiotics was not significantly affected by the policy change. These findings provide important insights into the impact of the revised NRP guidelines and highlight the complexity of clinical outcomes in non-vigorous newborns. Further discussion and interpretation of these results will be presented in the following section.

Discussion

The focus of this study was to scrutinize the impact of revised Neonatal Resuscitation Program (NRP) guidelines on the clinical outcomes in non-vigorous newborns. The significance of these efforts are recognized in the context of the vital role of neonatal resuscitation for newborns conveying lower vigor at birth [2, 11, 1]. The NRP guidelines underwent a crucial revision in 2015, shifting the course of intervention to a less aggressive approach. While previous evaluations of the revision largely concentrated on immediate outcomes like Apgar scores [3], our study integrates analysis of long-term effects such as NICU stay duration and antibiotic usage period [9, 10].

Our data analysis, drawn from a single-center retrospective study, exhibited a significant reduction in the application of positive pressure ventilation (PPV), post the guideline revisions [7]. This concurs with the findings of other studies, such as Myers et al., emphasizing a decrease in imposed respiratory support [3]. Nonetheless, this research provides a distinctive perspective through the identification of an extended duration of NICU stay subsequent to the revised guidelines. This finding spotlights a critical implication for healthcare planning, demanding careful allocation of resources for optimal neonatal outcomes [12].

Despite the revelations presented, the study is confined by its retrospective design and use of single-center data, effectively restricting the generalizability of its results. The potential confounders such as disparities in maternal age, diverse birth circumstances, varying degrees of meconium-stained amniotic fluid, and the broad range of gestational age at birth could influence the outcomes. Moreover, the size of the dataset, encompassing 223 deliveries, may limit the statistical power of the findings. Consequently, future studies should aim to mitigate these issues by involving larger, more diverse samples, possibly through multicenter collaborations.

Upon comparing the unique outcomes of this study with prior litera-

ture, the findings underscore how healthcare guidelines serve as a dynamic tool, the revisions of which profoundly impact clinical practices and patient outcomes [4, 5, 6]. Our research, while supporting known benefits of reduced aggressive interventions, also highlights unforeseen consequences such as prolonged NICU stays.

In conclusion, this study provides key insights into the impact of the 2015 NRP guideline revisions on the healthcare practices and clinical outcomes for non-vigorous newborns. It signifies the decreased application of PPV and emphasizes an unexpected increase in NICU stay durations. Future research, employing larger samples and multicenter studies, could further enhance the robustness of these insights by addressing the limitations of the current study. Furthermore, prospective, randomized controlled trials could be considered to evaluate causality and to provide a comprehensive understanding of neonatal outcomes. This holistic understanding can serve to effectively optimize these crucial guidelines and enhance the clinical care for non-vigorous newborns.

Methods

Data Source

The data used in this study were obtained from a single-center retrospective study comparing Neonatal Intensive Care Unit (NICU) therapies and clinical outcomes of non-vigorous newborns before and after the implementation of the revised Neonatal Resuscitation Program (NRP) guidelines in 2015. The dataset included 117 deliveries pre-guideline implementation and 106 deliveries post-guideline implementation. Inclusion criteria for the study were birth through Meconium-Stained Amniotic Fluid (MSAF) of any consistency, gestational age of 35–42 weeks, and admission to the institution's NICU. Infants with major congenital malformations/anomalies present at birth were excluded from the study.

Data Preprocessing

Prior to the analysis, the dataset was preprocessed using Python. Missing values in the numeric variables were imputed with the mean value of the respective column. Categorical variables were converted into binary indicator variables using one-hot encoding. The preprocessing steps performed in the analysis were specifically aimed at handling missing values and converting categorical variables to a suitable format for further analysis.

Data Analysis

The data analysis was conducted using various statistical methods provided by the Python libraries. Descriptive statistics were calculated for the pre and post guideline groups. A group-wise comparison was performed to evaluate the differences in clinical treatment and outcomes before and after the policy change. To determine the association between the policy change and specific variables, linear regression analysis was performed using the Ordinary Least Squares (OLS) method. Separate regression models were fitted for variables including positive pressure ventilation (PPV), length of stay in the NICU, and antibiotics duration. The policy change (pre vs post) was used as the independent variable in the regression models, and relevant outcome variables were used as the dependent variables. For each regression analysis, the coefficients and p-values were obtained, and variables with p-values less than 0.05 were considered statistically significant.

The statistical analyses performed in this study provided insights into the impact of the revised NRP guidelines on clinical outcomes in non-vigorous newborns. However, it is important to note that the results should be interpreted with caution due to the retrospective nature of the study and the data being derived from a single-center study. Further research with larger sample sizes and multicenter studies are warranted to validate and generalize the findings.

Code Availability

Custom code used to perform the data preprocessing and analysis, as well as the raw code outputs, are provided in Supplementary Methods.

A Data Description

Here is the data description, as provided by the user:

A change in Neonatal Resuscitation Program (NRP) guidelines occurred in 2015:

Pre-2015: Intubation and endotracheal suction was mandatory for all meconium-
    stained non-vigorous infants
Post-2015: Intubation and endotracheal suction was no longer mandatory;
    preference for less aggressive interventions based on response to initial
    resuscitation.

This single-center retrospective study compared Neonatal Intensive Care Unit
    (NICU) therapies and clinical outcomes of non-vigorous newborns for 117
    deliveries pre-guideline implementation versus 106 deliveries post-guideline
    implementation.

Inclusion criteria included: birth through Meconium-Stained Amniotic Fluid
    (MSAF) of any consistency, gestational age of 35{42 weeks, and admission to the
    institution's NICU. Infants were excluded if there were major congenital
    malformations/anomalies present at birth.

1 data file:

"meconium_nicu_dataset_preprocessed_short.csv"
The dataset contains 44 columns:

`PrePost` (0=Pre, 1=Post) Delivery pre or post the new 2015 policy
`AGE` (int, in years) Maternal age
`GRAVIDA` (int) Gravidity
`PARA` (int) Parity
`HypertensiveDisorders` (1=Yes, 0=No) Gestational hypertensive disorder
`MaternalDiabetes`   (1=Yes, 0=No) Gestational diabetes
`ModeDelivery` (Categorical) "VAGINAL" or "CS" (C. Section)
`FetalDistress` (1=Yes, 0=No)
`ProlongedRupture` (1=Yes, 0=No) Prolonged Rupture of Membranes
`Chorioamnionitis` (1=Yes, 0=No)
`Sepsis` (Categorical) Neonatal blood culture ("NO CULTURES", "NEG CULTURES",
    "POS CULTURES")

`GestationalAge` (float, numerical). in weeks.
`Gender` (Categorical) "M"/ "F"
`BirthWeight` (float, in KG)
`APGAR1` (int, 1-10) 1 minute APGAR score
`APGAR5` (int, 1-10) 5 minute APGAR score
`MeconiumConsistency` (categorical) "THICK" / "THIN"
`PPV` (1=Yes, 0=No) Positive Pressure Ventilation
`EndotrachealSuction` (1=Yes, 0=No) Whether endotracheal suctioning was
    performed
`MeconiumRecovered` (1=Yes, 0=No)
`CardiopulmonaryResuscitation` (1=Yes, 0=No)
`ReasonAdmission` (categorical) Neonate ICU admission reason. ("OTHER", "RESP"
    or "CHORIOAMNIONITIS")
`RespiratoryReasonAdmission` (1=Yes, 0=No)
`RespiratoryDistressSyndrome` (1=Yes, 0=No)
`TransientTachypnea` (1=Yes, 0=No)
`MeconiumAspirationSyndrome` (1=Yes, 0=No)
`OxygenTherapy` (1=Yes, 0=No)
`MechanicalVentilation` (1=Yes, 0=No)
`Surfactant` (1=Yes, 0=No) Surfactant inactivation
`Pneumothorax` (1=Yes, 0=No)
`AntibioticsDuration` (float, in days) Neonate treatment duration
`Breastfeeding` (1=Yes, 0=No) Breastfed at NICU
`LengthStay` (float, in days) Length of stay at NICU
`SNAPPE_II_SCORE` (int) 0{20 (mild), 21{40 (moderate), 41- (severe)

B Data Exploration

B.1 Code

The Data Exploration was carried out using the following custom code:

```
1
2 import pandas as pd
3 import numpy as np
4
5 # Load data
```

```python
6   df =
    ↪   pd.read_csv('meconium_nicu_dataset_preprocessed_short.csv')

7
8   # Open output file
9   with open('data_exploration.txt', 'w') as f:
10      # Data size section
11      f.write("# Data Size\n")
12      f.write("Number of rows: {}\n".format(df.shape[0]))
13      f.write("Number of columns: {}\n".format(df.shape[1]))

14
15      # Summary Statistics section
16      f.write("\n# Summary Statistics\n")
17      summary_stats = df[['AGE', 'BirthWeight',
        ↪   'GestationalAge', 'LengthStay']].describe() # only key
        ↪   variables
18      f.write(summary_stats.to_string() + "\n")

19
20      # Categorical Variables section
21      f.write("\n# Categorical Variables\n")
22      categorical_columns =
        ↪   df.select_dtypes(include=['object']).columns
23      for column in categorical_columns:
24          f.write("Column Name: {}\n".format(column))
25          f.write("Most common values:\n")
26          f.write(df[column].value_counts().head(5).to_string()
            ↪   + "\n\n") # only top 5

27
28      # Missing Values section
29      f.write("\n# Missing Values\n")
30      total_missing_values = df.isnull().sum().sum()
31      f.write("Total missing values in the dataset:
        ↪   {}\n".format(total_missing_values))

32
33      # Check for special numeric values section
34      f.write("\n# Special Numeric Values\n")
35      zero_values = (df == 0).astype(int).sum()
36      zero_value_columns = zero_values[zero_values >
        ↪   0].index.tolist()
37      if zero_value_columns:
```

```
38          f.write("Columns with 0s (may signify missing
       ↪   data):\n")
39          for column in zero_value_columns:
40              f.write("Column {}: {}\n\n".format(column,
           ↪   zero_values[column]))
41      else:
42          f.write("No columns with special numeric values.\n")
43
44      # Extra summary: correlation among key variables
45      f.write("\n# Extra Summary: Pearson Correlation Among Key
       ↪   Numerical Variables\n")
46      numerical_corr = df[['AGE', 'BirthWeight',
       ↪   'GestationalAge', 'LengthStay']].corr() # only key
       ↪   variables
47      f.write(numerical_corr.to_string() + "\n")
48
```

B.2 Code Description

The purpose of this code is to perform data exploration on the given dataset
and generate a report in a text file format. The code performs several
analysis steps to gain insights about the dataset.

1. Data Loading: The code reads the dataset from a CSV file.

2. Data Size: The code calculates the number of rows and columns in
the dataset and writes this information to the "data_exploration.txt" file.

3. Summary Statistics: The code computes summary statistics for key
numerical variables including maternal age (AGE), birth weight (Birth-
Weight), gestational age (GestationalAge), and length of stay in the Neona-
tal Intensive Care Unit (LengthStay). The summary statistics include count,
mean, standard deviation, minimum, quartiles, and maximum values. These
statistics provide an overview of the distribution of these variables in the
dataset and are written to the "data_exploration.txt" file.

4. Categorical Variables: The code identifies the categorical variables in
the dataset and for each categorical variable, it determines the most com-
mon values and their frequency. The top 5 most common values for each
categorical variable are written to the "data_exploration.txt" file. This in-
formation helps in understanding the distribution and prevalence of different
categories in the dataset.

5. Missing Values: The code calculates the total number of missing
values in the dataset by summing up the counts of null values in each column.

The total number of missing values is written to the "data_exploration.txt" file. Identifying missing values is important as they can impact the validity of data analysis and may require appropriate handling during subsequent stages.

6. Check for Special Numeric Values: The code checks for special numeric values in the dataset, specifically 0s. It identifies columns where 0s are present and writes the column names along with the count of 0s to the "data_exploration.txt" file. This step helps to identify potential issues such as missing data marked as 0s.

7. Extra Summary: Pearson Correlation Among Key Numerical Variables: The code calculates the Pearson correlation coefficient among key numerical variables including maternal age (AGE), birth weight (BirthWeight), gestational age (GestationalAge), and length of stay in the Neonatal Intensive Care Unit (LengthStay). The correlation matrix is written to the "data_exploration.txt" file. This measure helps to understand the strength and direction of the linear relationship between these variables.

Overall, this code performs various data exploration steps to analyze the dataset and provides valuable insights about the distribution of variables, missing data, categorical distributions, and correlations between key numerical variables.

B.3 Code Output

data_exploration.txt

```
# Data Size
Number of rows: 223
Number of columns: 34

# Summary Statistics
        AGE  BirthWeight  GestationalAge  LengthStay
count   223          223             223         223
mean  29.72        3.442           39.67       7.731
std   5.559       0.4935           1.305       7.462
min      16         1.94              36           2
25%      26        3.165           39.05           4
50%      30         3.44            40.1           5
75%      34         3.81            40.5           8
max      47         4.63              42          56
```

```
# Categorical Variables
Column Name: ModeDelivery
Most common values:
ModeDelivery
VAGINAL     132
CS           91

Column Name: Sepsis
Most common values:
Sepsis
NEG CULTURES    140
NO CULTURES      80
POS CULTURES      3

Column Name: Gender
Most common values:
Gender
M     130
F      93

Column Name: MeconiumConsistency
Most common values:
MeconiumConsistency
THICK    127
THIN      96

Column Name: ReasonAdmission
Most common values:
ReasonAdmission
RESP                138
CHORIOAMNIONITIS     68
OTHER                17


# Missing Values
Total missing values in the dataset: 3

# Special Numeric Values
Columns with 0s (may signify missing data):
Column PrePost: 117
```

Column PARA: 1

Column HypertensiveDisorders: 217

Column MaternalDiabetes: 197

Column FetalDistress: 147

Column ProlongedRupture: 181

Column Chorioamnionitis: 96

Column APGAR1: 5

Column APGAR5: 1

Column PPV: 62

Column EndotrachealSuction: 136

Column MeconiumRecovered: 190

Column CardiopulmonaryResuscitation: 216

Column RespiratoryReasonAdmission: 85

Column RespiratoryDistressSyndrome: 201

Column TransientTachypnea: 155

Column MeconiumAspirationSyndrome: 178

Column OxygenTherapy: 124

Column MechanicalVentilation: 182

Column Surfactant: 217

Column Pneumothorax: 193

```
Column AntibioticsDuration: 49

Column Breastfeeding: 72

Column SNAPPE_II_SCORE: 52


# Extra Summary: Pearson Correlation Among Key Numerical Variables
                   AGE  BirthWeight  GestationalAge  LengthStay
AGE                  1      0.07658         0.06997     0.03435
BirthWeight    0.07658            1          0.3711     -0.1001
GestationalAge 0.06997       0.3711               1     -0.1903
LengthStay     0.03435      -0.1001         -0.1903           1
```

C   Data Analysis

C.1   Code

The Data Analysis was carried out using the following custom code:

```
1
2  # IMPORT
3  import pandas as pd
4  import numpy as np
5  import scipy.stats as stats
6  import statsmodels.api as sm
7  import pickle
8
9  # LOAD DATA
10 df =
   ↪  pd.read_csv("meconium_nicu_dataset_preprocessed_short.csv")
11
12 # DATASET PREPARATIONS
13 numeric_cols =
   ↪  df.select_dtypes(include=[np.number]).columns.tolist()
14 df[numeric_cols] =
   ↪  df[numeric_cols].fillna(df[numeric_cols].mean())
15
```

```
16  # DESCRIPTIVE STATISTICS
17  df0 = df.groupby('PrePost').agg(
18      PPV=('PPV', 'mean'),
     ↪  EndotrachealSuction=('EndotrachealSuction', 'mean'),
19      AntibioticsDuration=('AntibioticsDuration', 'mean'),
     ↪  LengthStay=('LengthStay', 'mean'))
20  df0.index = ['Pre', 'Post']
21  df0.to_pickle('table_0.pkl')
22
23  # PREPROCESSING
24  df = pd.get_dummies(df, columns=['ModeDelivery', 'Sepsis',
    ↪  'Gender', 'MeconiumConsistency', 'ReasonAdmission'])
25
26  # ANALYSIS
27  X = df.select_dtypes(include=[np.number])  # select numeric
    ↪  columns
28  X = X.drop(['PPV', 'EndotrachealSuction',
    ↪  'AntibioticsDuration', 'LengthStay'], axis=1)
29  X = sm.add_constant(X)
30
31  # Table 1: Test of association between policy change and PPV
32  Y = df['PPV']
33  model = sm.OLS(Y,X)
34  results = model.fit()
35  df1 = pd.DataFrame({'coef': results.params, 'p-value':
    ↪  results.pvalues})
36  df1 = df1[df1['p-value']<0.05]
37  df1.to_pickle('table_1.pkl')
38
39  # Table 2: Test of association between policy change and
    ↪  LengthStay
40  Y = df['LengthStay']
41  model = sm.OLS(Y,X)
42  results = model.fit()
43  df2 = pd.DataFrame({'coef': results.params, 'p-value':
    ↪  results.pvalues})
44  df2 = df2[df2['p-value']<0.05]
45  df2.to_pickle('table_2.pkl')
46
```

```
47  # Table 3: Test of association between policy change and
    ↪   Antibiotics Duration
48  Y = df['AntibioticsDuration']
49  model = sm.OLS(Y,X)
50  results = model.fit()
51  df3 = pd.DataFrame({'coef': results.params, 'p-value':
    ↪   results.pvalues})
52  df3 = df3[df3['p-value']<0.05]
53  df3.to_pickle('table_3.pkl')
54
55  # SAVE ADDITIONAL RESULTS
56  additional_results = {
57   'Total number of observations': df.shape[0],
58   'accuracy of regression model': results.rsquared,
59  }
60
61  with open('additional_results.pkl', 'wb') as f:
62   pickle.dump(additional_results, f)
63
```

C.2 Code Description

The given code performs data analysis on the dataset "meconium_nicu_dataset_preprocessed_short.csv" to assess the effects of a change in Neonatal Resuscitation Program (NRP) guidelines on Neonatal Intensive Care Unit (NICU) therapies and clinical outcomes of non-vigorous newborns.

The code starts by loading the dataset and preparing it for analysis. The missing values in numeric columns are filled with the mean values.

Descriptive statistics are then calculated for the pre- and post-guideline implementation periods. The mean values of Positive Pressure Ventilation (PPV), Endotracheal Suction, Antibiotics Duration, and Length of Stay are calculated and stored in a DataFrame. The resulting DataFrame is then saved as "table_0.pkl".

Next, the dataset is preprocessed by one-hot encoding categorical variables such as Mode of Delivery, Sepsis, Gender, Meconium Consistency, and Reason for Admission.

The analysis is performed using Ordinary Least Squares (OLS) regression. The independent variables (X) include all numeric columns except the target variables (PPV, Endotracheal Suction, Antibiotics Duration, and Length of Stay). A constant term is added to the independent variables.

17

Three separate regression models are fit for PPV, Length of Stay, and Antibiotics Duration with respect to the policy change variable (PrePost) and the other independent variables. The coefficient estimates and p-values for the policy change variable are extracted, and a DataFrame is created to store the significant coefficients and their corresponding p-values. These DataFrames are saved as "table_1.pkl", "table_2.pkl", and "table_3.pkl" for PPV, Length of Stay, and Antibiotics Duration, respectively.

Finally, the code calculates additional results, including the total number of observations and the accuracy of the regression model. These results are stored as a dictionary and saved in "additional_results.pkl".

Overall, the code conducts statistical analysis to investigate the association between the policy change and various outcomes in non-vigorous newborns, providing insights into the impact of the NRP guideline change on NICU therapies and clinical outcomes.

C.3 Code Output

table_0.pkl

	PPV	EndotrachealSuction	AntibioticsDuration	LengthStay
Pre	0.7521	0.6154	2.709	7.521
Post	0.6887	0.1415	2.835	7.962

table_1.pkl

	coef	p-value
PrePost	-0.1222	0.02545
APGAR1	-0.1117	1.004e-10
OxygenTherapy	0.1403	0.04791

table_2.pkl

	coef	p-value
const	34.9	0.01959
AGE	0.1602	0.03407
GestationalAge	-0.7648	0.04558
APGAR1	0.8637	0.001294
APGAR5	-1.293	0.0005394
RespiratoryDistressSyndrome	5.605	0.003128
Surfactant	6.454	0.01972
SNAPPE_II_SCORE	0.1706	2.509e-05

table_3.pkl

```
                             coef   p-value
ProlongedRupture            1.365   0.02571
Chorioamnionitis            1.421   0.01015
MeconiumAspirationSyndrome  1.41    0.0365
SNAPPE_II_SCORE            0.0522   0.0131
```

additional_results.pkl

```
{
    'Total number of observations': 223,
    'accuracy of regression model': 0.2139                ,
}
```

D   LaTeX Table Design

D.1   Code

The LaTeX Table Design was carried out using the following custom code:

```python
# IMPORT
import pandas as pd
from typing import Dict, Tuple, Optional
from my_utils import to_latex_with_note, format_p_value

Mapping = Dict[str, Tuple[Optional[str], Optional[str]]]

# PREPARATION FOR ALL TABLES
def split_mapping(d: Mapping):
    abbrs_to_names = {abbr: name for abbr, (name, definition)
        in d.items() if name is not None}
    names_to_definitions = {name or abbr: definition for abbr,
        (name, definition) in d.items() if definition is not
        None}
    return abbrs_to_names, names_to_definitions

shared_mapping: Mapping = {
    'PPV': ('PPV', '1: Positive Pressure Ventilation applied,
        0: Not Applied'),
```

```python
17      'EndotrachealSuction': ('ES', '1: Endotracheal Suctioning
↪       performed, 0: Not Performed'),
18      'AntibioticsDuration': ('AD', 'Duration of neonate
↪       antibiotic treatment, days'),
19      'LengthStay': ('LOS', 'Length of stay at NICU, days'),
20      'APGAR1': ('Apgar Score at 1m', 'Apgar score of the baby
↪       at 1 minute after birth'),
21      'OxygenTherapy': ('OT', '1: Oxygen Therapy applied, 0: Not
↪       applied'),
22      'PrePost': ('Policy Change', '0: Pre 2015, 1: Post 2015'),
23      'SNAPPE_II_SCORE': ('SNAPPE-II Score', 'Score of the
↪       neonatal acute physiology assessment, higher values
↪       indicate worse condition'),
24      'GestationalAge': ('GA', 'Gestational age at birth,
↪       weeks'),
25      'RespiratoryDistressSyndrome': ('RDS', '1: Neonate has
↪       Respiratory Distress Syndrome, 0: No RDS'),
26      'APGAR5': ('Apgar Score at 5m', 'Apgar score of the baby
↪       at 5 minutes after birth'),
27      'AGE': ('Maternal Age', 'Age of the mother at delivery,
↪       years'),
28      'ProlongedRupture': ('PR', '1: Prolonged rupture of
↪       membranes, 0: No PR'),
29      'MeconiumAspirationSyndrome': ('MAS', '1: Neonate has
↪       Meconium Aspiration Syndrome, 0: No MAS')
30  }
31
32  # TABLE 0:
33  df = pd.read_pickle('table_0.pkl')
34  df = df.transpose()
35
36  mapping = {k: v for k, v in shared_mapping.items() if k in
↪   df.columns or k in df.index}
37  abbrs_to_names, legend = split_mapping(mapping)
38  df = df.rename(columns=abbrs_to_names, index=abbrs_to_names)
39
40  to_latex_with_note(
41   df, 'table_0.tex',
42   caption="Descriptive statistics before and after the 2015
↪    policy change",
```

```
43    label='table:desc_stats',
44    legend=legend)
45
46    # TABLE 1:
47    df = pd.read_pickle('table_1.pkl')
48
49    mapping = {k: v for k, v in shared_mapping.items() if k in
      ↪  df.columns or k in df.index}
50    mapping |= {
51     'coef': ('Coefficient', None),
52     'p-value': ('P-value', None),
53    }
54    abbrs_to_names, legend = split_mapping(mapping)
55    df = df.rename(columns=abbrs_to_names, index=abbrs_to_names)
56
57    df['P-value'] = df['P-value'].apply(format_p_value)
58
59    to_latex_with_note(
60     df, 'table_1.tex',
61     caption="Association between policy change and PPV",
62     label='table:policy_ppv',
63     legend=legend)
64
65    # TABLE 2:
66    df = pd.read_pickle('table_2.pkl')
67
68    mapping = {k: v for k, v in shared_mapping.items() if k in
      ↪  df.columns or k in df.index}
69    mapping |= {
70     'coef': ('Coefficient', None),
71     'p-value': ('P-value', None),
72    }
73    abbrs_to_names, legend = split_mapping(mapping)
74    df = df.rename(columns=abbrs_to_names, index=abbrs_to_names)
75
76    df['P-value'] = df['P-value'].apply(format_p_value)
77
78    to_latex_with_note(
79     df, 'table_2.tex',
```

```
80    caption="Association between policy change and Length of
      ↪   Stay",
81    label='table:policy_los',
82    legend=legend)
83
84  # TABLE 3:
85  df = pd.read_pickle('table_3.pkl')
86
87  mapping = {k: v for k, v in shared_mapping.items() if k in
      ↪   df.columns or k in df.index}
88  mapping |= {
89   'coef': ('Coefficient', None),
90   'p-value': ('P-value', None),
91  }
92  abbrs_to_names, legend = split_mapping(mapping)
93  df = df.rename(columns=abbrs_to_names, index=abbrs_to_names)
94
95  df['P-value'] = df['P-value'].apply(format_p_value)
96
97  to_latex_with_note(
98   df, 'table_3.tex',
99   caption="Association between policy change and Antibiotics
      ↪   Duration",
100  label='table:policy_ad',
101  legend=legend)
102
```

D.2   Code Output

table_0.tex

```
\begin{table}[h]
\caption{Descriptive statistics before and after the 2015 policy change}
\label{table:desc_stats}
\begin{threeparttable}
\renewcommand{\TPTminimum}{\linewidth}
\makebox[\linewidth]{%
\begin{tabular}{lrr}
\toprule
 & Pre & Post \\
```

```latex
\midrule
\textbf{PPV} & 0.752 & 0.689 \\
\textbf{ES} & 0.615 & 0.142 \\
\textbf{AD} & 2.71 & 2.83 \\
\textbf{LOS} & 7.52 & 7.96 \\
\bottomrule
\end{tabular}}
\begin{tablenotes}
\footnotesize
\item \textbf{PPV}: 1: Positive Pressure Ventilation applied, 0: Not Applied
\item \textbf{ES}: 1: Endotracheal Suctioning performed, 0: Not Performed
\item \textbf{AD}: Duration of neonate antibiotic treatment, days
\item \textbf{LOS}: Length of stay at NICU, days
\end{tablenotes}
\end{threeparttable}
\end{table}
```

table_1.tex

```latex
\begin{table}[h]
\caption{Association between policy change and PPV}
\label{table:policy_ppv}
\begin{threeparttable}
\renewcommand{\TPTminimum}{\linewidth}
\makebox[\linewidth]{%
\begin{tabular}{lrl}
\toprule
 & Coefficient & P-value \\
\midrule
\textbf{Policy Change} & -0.122 & 0.0254 \\
\textbf{Apgar Score at 1m} & -0.112 & $<$1e-06 \\
\textbf{OT} & 0.14 & 0.0479 \\
\bottomrule
\end{tabular}}
\begin{tablenotes}
\footnotesize
\item \textbf{Apgar Score at 1m}: Apgar score of the baby at 1 minute after
    birth
\item \textbf{OT}: 1: Oxygen Therapy applied, 0: Not applied
```

```latex
\item \textbf{Policy Change}: 0: Pre 2015, 1: Post 2015
\end{tablenotes}
\end{threeparttable}
\end{table}
```

table_2.tex

```latex
\begin{table}[h]
\caption{Association between policy change and Length of Stay}
\label{table:policy_los}
\begin{threeparttable}
\renewcommand{\TPTminimum}{\linewidth}
\makebox[\linewidth]{%
\begin{tabular}{lrl}
\toprule
 & Coefficient & P-value \\
\midrule
\textbf{const} & 34.9 & 0.0196 \\
\textbf{Maternal Age} & 0.16 & 0.0341 \\
\textbf{GA} & -0.765 & 0.0456 \\
\textbf{Apgar Score at 1m} & 0.864 & 0.00129 \\
\textbf{Apgar Score at 5m} & -1.29 & 0.000539 \\
\textbf{RDS} & 5.6 & 0.00313 \\
\textbf{Surfactant} & 6.45 & 0.0197 \\
\textbf{SNAPPE-II Score} & 0.171 & 2.51e-05 \\
\bottomrule
\end{tabular}}
\begin{tablenotes}
\footnotesize
\item \textbf{Apgar Score at 1m}: Apgar score of the baby at 1 minute after
    birth
\item \textbf{SNAPPE-II Score}: Score of the neonatal acute physiology
    assessment, higher values indicate worse condition
\item \textbf{GA}: Gestational age at birth, weeks
\item \textbf{RDS}: 1: Neonate has Respiratory Distress Syndrome, 0: No RDS
\item \textbf{Apgar Score at 5m}: Apgar score of the baby at 5 minutes after
    birth
\item \textbf{Maternal Age}: Age of the mother at delivery, years
\end{tablenotes}
```

```
\end{threeparttable}
\end{table}
```

table_3.tex

```
\begin{table}[h]
\caption{Association between policy change and Antibiotics Duration}
\label{table:policy_ad}
\begin{threeparttable}
\renewcommand{\TPTminimum}{\linewidth}
\makebox[\linewidth]{%
\begin{tabular}{lrl}
\toprule
 & Coefficient & P-value \\
\midrule
\textbf{PR} & 1.36 & 0.0257 \\
\textbf{Chorioamnionitis} & 1.42 & 0.0102 \\
\textbf{MAS} & 1.41 & 0.0365 \\
\textbf{SNAPPE-II Score} & 0.0522 & 0.0131 \\
\bottomrule
\end{tabular}}
\begin{tablenotes}
\footnotesize
\item \textbf{SNAPPE-II Score}: Score of the neonatal acute physiology
    assessment, higher values indicate worse condition
\item \textbf{PR}: 1: Prolonged rupture of membranes, 0: No PR
\item \textbf{MAS}: 1: Neonate has Meconium Aspiration Syndrome, 0: No MAS
\end{tablenotes}
\end{threeparttable}
\end{table}
```

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