



# Comparison of Maternity Care Outcomes Among Rural Colorado Hospitals Using Birth Certificate Data



Haylie Petrick (M.D., SOM), Mark Deutchman M.D., and Bethany Kwan Ph.D.  
Department of Family Medicine, University of Colorado School of Medicine, Denver, CO.

## Abstract

### Purpose:

- To compare maternity care outcomes between urban, rural, and frontier facilities
- To investigate population, facility, or clinical care intervention variations that could account for differences among rural hospitals' maternity care outcomes

**Methods:** Colorado Birth Certificate Data from 2016-2018 was used to compare average percentages of adverse maternity care outcomes at urban, rural, and frontier facilities. High and low performing quartiles of facilities were identified by heat mapping. Facility, population, and clinical care intervention differences were compared between high and low performing rural facilities.

**Results:** Rural facilities in Colorado reported worse average percentages of adverse maternity care outcomes compared to urban facilities. Variation in adverse maternity care outcomes among rural facilities also existed. When compared to high performing rural hospitals, low performing rural hospitals averaged fewer augmented labors, and more vaginal forceps use, clinical chorioamnionitis, unplanned hysterectomies, admissions of the mother to the intensive care unit, meconium aspiration, and hypoglycemia in the infant. Mothers who delivered babies at low performing rural hospitals tended to live at higher elevation, more often identified as non-white race, reported consuming more alcohol during the 2<sup>nd</sup> and 3<sup>rd</sup> trimesters, and were more often diagnosed with eclampsia and HELLP Syndrome.

**Conclusions:** This hypothesis-generating study suggests there were worse maternity care outcomes at rural facilities compared to urban facilities in Colorado and some rural Colorado hospitals may perform better than others. However, due to numerous limitations this cannot be definitively concluded without additional research.

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## Background

- One in five people in the United States live in a rural community
- Nearly half a million babies are born in rural hospitals each year
- From 2007 to 2015 rural residents had a 9% greater probability of severe maternal morbidity and mortality, compared with urban residents
- Challenges to rural communities in overcoming these health disparities include
  - keeping rural hospitals open
  - greater distances to travel for care with limited access to reliable transportation
  - lower socioeconomic population in rural areas
- Rural areas, like urban areas, have disparities in maternity care outcomes by race and ethnicity
- Rural communities across the United States are quite heterogeneous
- Not all rural communities have worse maternity care outcomes than their urban counterparts, but previous research has not clearly identified why



- Colorado is a largely rural state: Forty-seven of its 64 counties (73%) are designated as rural or frontier
- Colorado is home to 43 rural or critical access hospitals: 23 intentionally deliver babies
- No previous research studies investigated differences among the maternity care at these rural Colorado hospitals and possible explanations

## Methods

- Deemed exempt by the University of Colorado Institutional Review Board
- De-identified Colorado Birth Certificate Data from 2016-2018 identified 193,114 births over this time-period of which 175,797 were urban, 15,878 were rural, and 1,430 were frontier
- 30 frontier and rural facilities were identified as having delivered babies during this time, but 6 were so low volume (<5 deliveries) that they were excluded as unintentional deliveries, resulting in 24 facilities included in this study
- Variables from the Colorado Birth Certificate data were categorized as either adverse birth outcomes or population and facility characteristics, and clinical care interventions (Table 1)
- Using SAS statistical software, average percentages of birth outcomes were calculated for frontier, rural, and urban facilities in aggregate and then by facility
- The urban data was used as the standard of care against which the rural parameters were compared
- This standard of care average (urban average percent) for each adverse birth outcomes was used to create a heat map that sorted the rural and frontier facility rates into equal or better than, and worse care
- Each adverse outcome was weighted equally

**Table 1: Definition of Variables as Adverse Maternal Care Outcomes, Facility Characteristics, Population Characteristics, and Clinical Care Interventions**

Adverse Outcomes	Facility Characteristics	Population Characteristics	Clinical Care Interventions
<ul style="list-style-type: none"> <li>• maternal transfusions</li> <li>• 3rd or 4th degree perineal laceration</li> <li>• ruptured uterus</li> <li>• unplanned hysterectomy</li> <li>• maternal admission to ICU</li> <li>• c-section</li> <li>• cord prolapse</li> <li>• assisted ventilation of newborn following delivery</li> <li>• assisted ventilation of newborn for over 6 hours</li> <li>• NICU admission</li> <li>• surfactant replacement therapy</li> <li>• antibiotics for suspected neonatal sepsis</li> <li>• seizure</li> <li>• hyaline membrane disease</li> <li>• meconium aspiration</li> <li>• hypoglycemia of newborn</li> </ul>	<ul style="list-style-type: none"> <li>• facility type (hospital, home, or other)</li> <li>• median delivery volume</li> <li>• rural or frontier location</li> <li>• vaginal birth after cesarean section allowed</li> <li>• attendant type (percent MD/DO at delivery)</li> </ul>	<ul style="list-style-type: none"> <li>• mother's residence elevation</li> <li>• mother's weight gain during pregnancy</li> <li>• mother's smoking before and during pregnancy</li> <li>• mother's age</li> <li>• mother's race</li> <li>• mother's Hispanic ethnicity</li> <li>• mother born outside of United States</li> <li>• mother's marital status</li> <li>• insurance type</li> <li>• WIC receipt</li> <li>• income less than \$25,000 per year</li> <li>• mother's education level</li> <li>• receipt of pre-natal care</li> <li>• number of pre-natal visits</li> <li>• mother's alcohol use before and during pregnancy</li> <li>• mothers with diabetes/gestational diabetes</li> <li>• mothers with hypertension/gestational hypertension</li> <li>• mothers with eclampsia</li> <li>• mothers with HELLP Syndrome</li> <li>• previous pre-term birth</li> <li>• previous greater than 4000g birth</li> <li>• previous c-section</li> </ul>	<ul style="list-style-type: none"> <li>• induction of labor</li> <li>• steroids for fetal lung maturation received</li> <li>• antibiotics received by mother during labor</li> <li>• clinical chorioamnionitis</li> <li>• epidural of spinal anesthesia</li> <li>• fetal presentation</li> <li>• spontaneous vaginal delivery</li> <li>• vaginal forceps assisted delivery</li> <li>• vaginal vacuum assisted delivery</li> <li>• cesarean delivery</li> </ul>

- Based on the heat map, rural and frontier facilities were classified as "High" or "Low" performers
- These "High" and "Low" performers represented the top and bottom quartiles of facilities
- The facility and population characteristics were then compared across the High, Middle, and Low performing hospitals with a difference being defined as greater than or equal to 1 standard deviation

## Results

**Table 2: Percent of Births with Adverse Maternity Care Outcomes Among Urban, Rural, and Frontier Facilities in Colorado from 2016-2018\***

Adverse Maternity Care Outcomes	Urban Facilities	Rural Facilities	Frontier Facilities	Urban v Rural Chi-Square Test	Urban v Frontier Chi-Square Test	Rural v Frontier Chi-Square Test
Maternal Transfusions (% of births)	0.27%	0.83%	0.70%	140.68 p<0.05	9.44 p<0.05	0.26 p=0.61
Unplanned Hysterectomy (% of births)	0.07%	0.13%	0.07%	6.29 p<0.05	0.003 p=0.96	0.40 p=0.53
Cesarean Section (% of births)	26.17%	26.40%	32.87%	0.38 p=0.54	32.87 p<0.05	27.93 p<0.05
Cephalopelvic Disproportion (% of births)	0.07%	0.21%	1.47%	35.57 p<0.05	349.86 p<0.05	67.04 p<0.05
Assisted Ventilation of Newborn (% of births)	5.13%	6.74%	5.94%	75.5 p<0.05	1.92 p=0.17	1.33 p=0.25
Assisted Ventilation of Newborn for > 6 hours (% of births)	1.16%	0.79%	0.49%	17.83 p<0.05	5.55 p<0.05	1.54 p=0.22
Admission to Neonatal Intensive Care Unit (% of births)	11.22%	5.45%	1.61%	506.34 p<0.05	132.39 p<0.05	39.73 p<0.05
Surfactant Administration (% of births)	0.62%	0.84%	0.14%	11.34 p<0.05	5.29 p<0.05	8.25 p<0.05
Administration of Antibiotics to Newborn (% of births)	1.83%	2.25%	0.84%	14.1 p<0.05	7.76 p<0.05	12.49 p<0.05
Hyaline Membrane Disease (% of births)	0.82%	0.11%	0.21%	97.88 p<0.05	6.52 p<0.05	1.20 p=0.27
Meconium Aspiration (% of births)	0.15%	0.35%	0.35%	33.45 p<0.05	3.69 p=0.055	0.0004 p=0.98
Hypoglycemia of Newborn (% of births)	2.02%	2.90%	2.17%	55.63 p<0.05	0.16 p=0.69	2.57 p=0.11

\*Only includes Adverse Maternity Care Outcomes with significant Chi-Square values of p < 0.05 included in this abbreviated table

**Table 3: Comparison of Facility Characteristics of High, Mid, and Low Performing Rural and Frontier Facilities in Colorado from 2016-2018**

	High Performing Facilities	Mid Performing Facilities	Low Performing Facilities
Facility Type			
Hospital	4	13	5
Home Birth	1	0	0
Other	1	0	0
Location			
Rural	4	11	4
Frontier	2	2	1
Average Delivery Volume	315	953	606
Attendant Type (% MD/DO Provider)	61%	77%	81%

**Table 4: Comparison of Population Characteristics at High and Low Performing Rural and Frontier Hospitals in Colorado from 2016-2018 with a ≥ 1 Standard Deviation Difference\***

Population Characteristic	High Performing Hospitals Average	Low Performing Hospitals Average
Mother's Residence Elevation (m)	1166.53	1712.44
Mother's Race (% white)	92.46	81.53
Mother's Alcohol Use 2nd Trimester (drinks/week)	0	0.02
Mother's Alcohol Use 3rd Trimester (drinks/week)	0	0.02
Eclampsia (%)	0.17	1.2
HELLP Syndrome (%)	0	0.2

\*Greater than or equal to 1 standard deviation of difference based on average of all rural and frontier hospitals

**Table 5: Comparison of Maternity Care Interventions at High and Low Performing Rural and Frontier Hospitals in Colorado from 2016-2018 with a ≥ 1 Standard Deviation Difference\***

Maternity Care Interventions (% of births)	High Performing Hospitals Average	Low Performing Hospitals Average
Augmentation of Labor (%)	16.84	14.73
Clinical Chorioamnionitis (%)	0.05	1.14
Vaginal Forceps Assisted Delivery (%)	0	0.47
Unplanned Hysterectomy (%)	0.04	0.13
Admission to Intensive Care Unit (%)	0.16	0.34
Meconium Aspiration (%)	0.21	0.37
Hypoglycemia (%)	1.36	3.43

\*Greater than or equal to 1 standard deviation of difference based on average of all rural and frontier hospitals

## Conclusions

### Urban versus Rural and Frontier Facility Maternity Care Outcomes

- Rural facilities generally had a higher average percentage of births with adverse maternal and neonatal outcomes than urban facilities
- Urban facilities had a greater average percent of births with newborns that required assisted ventilation for greater than 6 hours and admissions of newborns to the neonatal intensive care unit
  - This suggests urban facilities are appropriately delivering higher risk pregnancies rather than rural or frontier facilities
- Frontier facilities had fewer adverse maternity care outcomes than rural facilities
  - This suggests they are keeping lower risk pregnancies and sending higher risk pregnancies to facilities with more resources

### Facility Characteristics of High versus Low Performing Rural Maternity Care Facilities

- Tended to be frontier rather than rural
- Lower volumes of births
- More likely to have a nurse midwife attendant
  - Likely suggests these facilities are appropriately triaging their patients and only delivering lower risk pregnancies

### Population Characteristics of High and Low Performing Rural Maternity Care Facilities

- Facilities with more patients who lived at a higher elevation had more complications
  - This is consistent with prior literature that demonstrates an increased risk for pre-term births and neonatal respiratory distress in infants born to mothers who live at high elevations
- High performing facilities tended to have a whiter population (92.46% vs 81.53%)
  - This is consistent with prior studies that have demonstrated disparities in maternity care outcomes based on race in both urban and rural centers
- Alcohol use was reported slightly higher in the 2nd and 3rd trimesters among mothers at the low performing facilities, but the same pre-pregnancy and in the 1st trimester
  - This may be a modifiable risk factor possibly improved with more patient education
- Eclampsia and HELLP syndrome were higher among the low performing facilities' patient populations despite no difference in risk factors such as hypertension/gestational hypertension, diabetes/gestational diabetes, age, or weight gain in the low and high performing facilities

### Clinical Interventions of High versus Low Performing Rural Maternity Care Facilities

- Higher performing facilities were more likely to augment labor and thus likely reduce further complications

### Limitations

- Prior studies have shown that birth certificate data is not always reliable or filled out consistently across facilities
- This study assumed urban hospitals as equivalent to the standard of care
- Reported adverse maternity care outcomes were very rare at rural and frontier facilities which may skew the found differences between rural and frontier facilities
- Adverse maternity care outcomes were weighted equally when determining the top and lower quartile performing rural and frontier facilities for maternity care which may have results in one birth causing a facility to perform worse in 2-3 related adverse maternity care outcomes

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