

# Water Source as a Possible Novel Risk Factor for Meconium Aspiration Syndrome

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## ABSTRACT

**Introduction:** Meconium staining of the amniotic fluid is a common occurrence in pregnancy. While some risk factors have been identified, it is frequently deemed idiopathic.

**Methods:** Retrospective observational study of cases of meconium-stained fluid and meconium aspiration syndrome in geographically isolated hospital was undertaken to evaluate a possible risk factor not previously identified.

**Results:** The rate of meconium aspiration syndrome exceeded national averages prior to the change in the source of the community water and then decreased to within national averages. This change occurred temporally with a change in the source of water in the community.

**Conclusions:** While observational studies cannot determine causality, the association of a potential lethal complication of pregnancy and delivery with a water source is the first of its kind reported.

This deserves further study with larger populations.

## INTRODUCTION

Meconium staining of the amniotic fluid is a common complication of pregnancy, occurring in 10-15% of all births.<sup>1</sup> Major risk factors include post-term pregnancy and intrauterine asphyxia or fetal distress.<sup>2</sup> Meconium aspiration syndrome (MAS) is the severe sequela of meconium-stained amniotic fluid and is defined as prolonged hypoxemia and pulmonary hypertension attributed to the intrapulmonary deposition of meconium and resultant plugging. MAS occurs in 4-6% of those pregnancies affected by meconium staining, with rates partially determined by the particulate nature of the meconium and the degree of prematurity of the infant.<sup>3</sup> The role of extrauterine and environmental factors is unknown.

## INCIDENCE OF MECONIUM STAINING AND MAS IN MORGAN COUNTY

In Morgan County, Colorado, casual observation suggested that the rate of MAS exceeded national averages on a yearly basis up to calendar year 2000 and then declined precipitously. As directed by the Continuous Quality Improvement and Obstetric Committees

**Table 1.** Live Births by Selected Medical Risk Factors, Complications of Labor and/or Delivery, Abnormal Conditions of Newborn, and Clinical Estimate of Gestational Age: Morgan County Residents, 1997-2001. Deliveries Affected by Meconium-Stained Amniotic Fluid.

Year	Total Live Births	Deliveries Complicated by Meconium (%)		
		Meconium Aspiration Syndrome		Meconium Moderate Heavy
		% of Total Deliveries	% of Deliveries Complicated by Meconium	
1997	473	1.7	27.9	6.1
1998	495	2.0	32.8	6.1
1999	523	1.0	17.5	5.7
2000	452	0.9	25.7	3.5
2001	490	0.2	7.4	2.7

of the community hospital, a review of the cases was undertaken to confirm if this was in fact correct, and if so, to determine potential causes. Data was abstracted from two sources: from the Colorado Department of Health's Center for Health and Environmental Information and Statistics and from birth certificates for Morgan County. In addition, billing data used for those variables not measured by Colorado Department of Health.

Table 1 shows the rate of meconium-stained fluid and MAS as a percentage of total deliveries per annum. Considering known and possible risk factors for the passage of meconium, a second review was undertaken and with the findings shown in Table 2.

Two interesting trends were noted in the data. First, while the baseline risk of meconium-stained fluid was well within national averages at the start of the study period, the rate of MAS was four to eight times expected. Second, a decrease in the incidence of both MAS and meconium-stained fluid was noted over time. The small absolute numbers of MAS in the study period preclude definitive statistical analysis.

Concerning meconium staining, however, the relative risk was 1.94 (confidence interval (CI) 1.29, 2.92) higher in the period from 1997-1999 compared to

the 2000-2001 period. Possible confounders and causes for meconium, though, did not change substantially. Attempting to account for the 56% relative decrease in cases from 1997-2001, and the 90% decrease in MAS, the reviewers looked outside of usual, patient-centered causes.

### POTENTIAL CAUSES

Prior to 2000, Morgan County received its water from the local water table. There were certain impurities noted that led to a distinct unpleasant odor. Color was intermittently affected, such that at times there was a brownish tint to the water with some particulate debris noted. At other times, these were less evident. These changes did not follow predictable patterns of time of day, day of week, or degree of local rainfall. In December of 1999, Morgan County began to acquire its water from the Big Thompson Water project located in Granby, Colorado. The level of impurities declined, with resolution of the odor and color changes previously noted. At no point did the water in Morgan County exceed federal Environmental Protection Agency (EPA) standards of quality.

The potential relationship between water sources and MAS/meconium-

**Table 2.** Rates of Obstetrical High Risk Factors

Year	Total Live Births	Deliveries Complicated by Post-term Pregnancy* (%)	Deliveries Complicated by Fetal Distress (%)	Deliveries Complicated by Pre-eclampsia† (%)	Deliveries Classified as High-Risk (%)	
					Medical Risk Factors for Pregnancy	Alcohol or Tobacco Use During Pregnancy
1997	473	26.8	4.4	7.1	36.4	12.3
1998	495	22.0	3.6	4.9	40.8	11.9
1999	523	19.1	4.2	4.7	36.3	13.8
2000	452	20.8	4.4	5.1	45.4	12.6
2001	490	18.8	4.7	7.0	49.8	12.2

\*Post-term pregnancy is defined as clinical estimate of gestational age 41+ weeks.  
†Pre-eclampsia not available from birth certificate. Information concerning this variable obtained through billing data.

stained fluid seems to follow divergent directions. The rate of meconium-stained fluid seemed to follow a possible dose-response phenomenon with water exposure, gradually decreasing over the year after the change in water supply. As pregnancy typically lasts approximately 40 weeks, many women who delivered in 2000 would potentially have had varying levels of exposure in 1999, depending on the length of pregnancy remaining and the quantity of water consumed by the individual. Unfortunately, it is impossible to determine a dose-response relationship specifically without querying patients as to the quantities of local vs. bottled water that they consumed. This was not possible given the retrospective design of the study.

With MAS, the relationship appeared to be an “all or none” response to exposure. That is, after the change in water usage in December 1999, the high rate of MAS persisted throughout 2000. A possible explanation for this may be that if pregnant women were exposed at all to the water in use before December 1999, the meconium generated may have been more toxic in nature, leading to the increased rate of MAS despite a decreasing rate of meconium-stained fluid overall.

Another interesting trend noted was that the rate of meconium-stained fluid was within national averages at the start of the study period and decreased to less-than-expected levels at study end. Whether this represents inaccurate coding of meconium, a community-based lower-risk obstetric population, or a true potentially protective effect of the water source in the second phase of the study is unclear.

## CONCLUSION

While an observational study of this type cannot assume causality, it is an interesting association that was noted between cases of MAS and meconium-stained amniotic fluid and the source of the drinking water. Whether this association will be found persistently over time or confirmed in a larger study is uncertain. Strengths of the current study include the geographic isolation of the hospital. As the only hospital in the county that performs deliveries, it is unlikely that a large segment of the pregnant population was served elsewhere. Even if a significant percentage of pregnant women were cared for at hospitals outside of Morgan County, there is no reason to suspect these women to have different risk factors or

demographic make-up than the population served in Fort Morgan. Further, it is unlikely that those risk factors would change year by year without being reflected in the data above.

Several limitations are apparent in the data as well. First, this is an observational study and causality cannot be assured. Second, some data were extracted from hospital billing records. Should records be incomplete or inappropriately coded, data may be misreported potentially biasing the results. It is unlikely, though, that miscoding would have occurred in a systematically different fashion from one year to the next. As such, any errors would have been through the years, not changing overall trends. Lastly, the study is limited by its small numbers. This is an inherent risk in performing research in low-volume settings. As the water supply for the region is specific for Morgan County only, it

would be inappropriate to expand the study beyond the coverage area for the water project.

From the above data, it appears that the source, quality, and type of water ingested during pregnancy may be a risk factor for MAS and meconium-stained amniotic fluid noted at birth. Larger, controlled trials will be needed to assess if this is indeed the case.

## REFERENCES

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