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Neonatal Outcomes of Non-vigorous Neonates with Meconium-Stained Amniotic Fluid Before and After Change in Tracheal Suctioning Recommendation

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Abstract

Objective: To evaluate the short-term outcomes of non-vigorous infants born through meconium-stained amniotic fluid (MSAF) before and after implementation of no-tracheal suctioning guidelines.

Study design: Single-center retrospective study of ≥36-week gestation neonates with MSAF

Results: During routine-suction era (9/2013–12/2014), 280/2306 neonates (12%) were born through MSAF and 39 (14%) were non-vigorous. Thirty (77%) of non-vigorous infants underwent tracheal suctioning. In the no-suction era (1/2017–12/2018), 282/2918 neonates (9.7%) were born through MSAF and 30 (10.6%) were non-vigorous and one needed intubation. Admissions for meconium aspiration syndrome (15% vs 53%) and respiratory distress (18% vs 57%) were significantly higher among non-vigorous infants in the no-suction era.

Conclusions: In this single-center study, non-vigorous infants born through MSAF without routine-tracheal suctioning had a higher incidence of NICU admission for MAS and respiratory distress compared to the routine-suction era. Multicenter randomized trials evaluating tracheal suction in non-vigorous infants with MSAF are warranted.

Introduction

Meconium-stained amniotic fluid (MSAF) is a significant clinical concern in perinatal care and occurs in nearly 8–25% of all pregnancies. [1, 2, 3] In the United States, 3–10% of infants born with MSAF develop meconium aspiration syndrome (MAS). [4, 5, 6] Nearly half of these

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require mechanical ventilation and 5–12% die [1] with higher rates reported from developing countries as compared to developed countries. [4, 5, 7, 8, 9] Non-vigorous infants at birth are at higher risk of developing MAS, compared to vigorous infants born with MSAF [2, 5, 9].

Delivery room management of MSAF has evolved over the last two decades. Wiswell et al demonstrated that routine tracheal suctioning among vigorous infants did not alter the incidence of MAS. [10] Four small randomized controlled trials (RCT), and a meta-analysis by the International Liaison Committee on Resuscitation (ILCOR) neonatal life support task force, evaluated the benefits and risks of endotracheal intubation and tracheal suctioning among non-vigorous infants born with MSAF. [7, 11, 12, 13 14] No significant differences were observed in the four RCTs between the group treated with tracheal suctioning compared to immediate resuscitation for survival at discharge, hypoxic ischemic encephalopathy (HIE), and MAS.[14] Given the lack of evidence supporting the benefit of endotracheal intubation for tracheal suctioning, guidelines from ILCOR, the American Academy of Pediatrics (AAP), the American Heart Association (AHA), and the 7th and 8th edition of the Textbook of Neonatal Resuscitation (NRP) no longer suggest routine immediate tracheal suctioning in non-vigorous infants born with MSAF. [15, 16, 17, 18] The current international guidelines prioritize stimulation and positive pressure ventilation (PPV) among non-vigorous infants.

We hypothesized that there would be no difference in the incidence of MAS or NICU admissions for respiratory distress among non-vigorous and vigorous infants born through MSAF during the no-suction era compared to the routine-suction era. We performed an individual chart review of all infants born through MSAF during both epochs.

Methods

The study was approved by the Institutional Review Board of the University of California, Davis Children's Hospital. This was a retrospective chart review that screened delivery room records of infants born at ≥ 36 weeks gestation for MSAF. Individual charts were reviewed to identify whether the newborn was labelled as non-vigorous or vigorous during the delivery room provider's initial assessment. Delivery room resuscitation and hospital course of infants born with MSAF before the implementation of "no routine suction guidelines" (Routine Suction Era) were compared with the clinical course of the infants managed with the current NRP recommendations (No-Suction Era). Infants known to have a chromosomal disorder, or any major cardio-respiratory anomaly were excluded from the study. Infants born during the implementation phase of NRP 7th edition (publication of Chettri et al[11] and 2015 guidelines[16]: January 1, 2015 to December 31, 2016) were excluded. UC Davis Children's hospital adopted the revised guidelines based on the Textbook of Neonatal Resuscitation 7th edition on January 1, 2017. Reasons for not performing tracheal suctioning among non-vigorous infants in the routine-suction era were recorded. Changes in respiratory support over the six-year period were recorded as there was a general tendency towards more non-invasive support (high flow nasal cannula, continuous positive airway pressure (CPAP), and non-invasive positive pressure ventilation (NIPPV)).

The following definitions were used in this study. A non-vigorous infant was defined as the presence of poor respiratory effort, poor muscle tone, or heart rate < 100 beats per minute during the delivery room provider's initial assessment. MAS was defined as the presence of respiratory distress and receipt of respiratory support (to maintain $SpO_2 \geq 90\%$) as outlined below in presence of MSAF. Respiratory distress was defined by the presence of any of the following: respiratory rate greater than 80 breaths per minute or any signs of increased work of breathing (suprasternal/intercostal/sub-costal chest retractions, grunting, or nasal flaring) any time after delivery. Respiratory support included either oxygen therapy for more than 4 hours using nasal cannula; or any use of high flow nasal cannula (≥ 2 L/minute), CPAP, NIPPV, or endotracheal intubation and invasive mechanical ventilation for any amount of time. Chest x-ray findings suggestive of MAS were defined as presence of either patchy of fluffy infiltrates with hyper-expansion or focal or diffuse atelectasis. The official report describing the above findings by the pediatric radiologist was used for this interpretation.

Respiratory related NICU admission was defined as any NICU admission with receipt of respiratory support (see above definition of respiratory support). Admission to NICU included infants admitted for medical needs, including need for observation for unstable vital signs, respiratory distress, respiratory support, intravenous fluids, or medications. Neonates admitted for maternal health reasons or social concerns were not considered as a NICU admission.

Finally, we analyzed comparative data between the two periods for incidence of MAS, respiratory distress/support, total NICU admissions and invasive mechanical ventilation (IMV) as a percentage of non-vigorous infants, all infants with MSAF, and all births.

Statistical Analysis

Our primary outcome was the incidence of MAS among non-vigorous infants born through MSAF. Given the subjectivity in assignment of vigorous state and diagnosis of MAS,[19] our secondary outcomes included incidence of respiratory distress, MAS, mechanical ventilation, and NICU admission among infants born with MSAF (both vigorous and non-vigorous) before and after implementation of no-suction guidelines.

Sample size calculation was based on the secondary outcome of incidence of NICU admission with respiratory distress among all infants ≥ 36 weeks gestation born through MSAF. Based on data from annual reports from our NICU and published data[10, 20, 21], we estimated the incidence of NICU admission due to respiratory distress to be 4% during the routine-suction era and 10% in the no-suction era. We needed 283 infants born through MSAF to detect a difference with a power of 0.8 and type I error probability of 0.05. We estimated that 10% of infants born through MSAF would be non-vigorous.[20] We could not calculate the sample size for the primary outcome of MAS among non-vigorous infants born through MSAF as published literature, including meta-analysis by Trevisanuto et al, have shown identical incidence (100/289, 34.6% with suction and 101/292, 34.6% without suction).[14] We analyzed maternal and obstetric characteristics, baseline characteristics of neonates, and characteristics of post-delivery room respiratory support. P-values for categorical outcomes were calculated with the chi-square test or Fisher's exact test as appropriate. Unpaired T-tests were conducted to calculate the p-values for continuous outcomes. All p-values <0.05 were considered statistically significant.

Results

Infants from routine-suction era included 2306 infants ≥ 36 weeks born between September 2013 to December 2014 when routine endotracheal suctioning was recommended for non-vigorous infants born through MSAF as per the 6th edition (2010) of the Textbook of Neonatal Resuscitation. The no-suction era included 2918 infants born between January 2017 and December 2018 when routine endotracheal intubation for tracheal suctioning was not recommended for non-vigorous infants born through MSAF as per the 7th edition (2016) of the Textbook of Neonatal Resuscitation. Maternal and fetal characteristics were similar between the two eras for deliveries associated with MSAF (table 1) except for a higher incidence of hypertension during pregnancy and small for gestational age (SGA) status in the no-suction era.

Of the 2306 deliveries in the routine-suction era, 280 were born through MSAF (12%). The overall NICU admission rates and admission with respiratory distress are shown in table 2. Out of these 280 infants, 39 (14%) were classified as non-vigorous. Admission rates and respiratory support among non-vigorous infants are shown in table 3. Nine non-vigorous infants did not undergo tracheal suction secondary to improved status (crying) while attempting intubation or inability to intubate the trachea despite laryngoscopy. In one non-vigorous patient, the precise reason for not performing tracheal suctioning could not be determined. Non-respiratory indications for NICU admission among vigorous infants in the routine suction era included hypoglycemia, suspected sepsis, abnormal heart rhythm, narcotic withdrawal, SGA, and observation for low five-minute Apgar score. Non-respiratory NICU admissions in the non-vigorous group included narcotic withdrawal, SGA, suspected sepsis, meningomyelocele, HIE with therapeutic hypothermia, and observation for low five-minute Apgar score. Respiratory indications for admission are shown in tables 2 and 3.

In the no-suction era, there were a total of 2918 deliveries, 282 (9.7%) of which were born through MSAF. The overall incidence of NICU admission and admission with respiratory distress are shown in tables 2 and 3. The incidence of NICU admission with respiratory distress among infants born through MSAF was significantly higher compared to the routine-suction era (table 2). Among these 282 infants, 252 (89.4%) were classified as vigorous and none were intubated in the delivery room. There were 30 infants (10.6%) classified as non-vigorous and only one was intubated in the delivery room. The NICU admission for respiratory support and respiratory distress was significantly higher (70%) than the routine-suction era (48.7%). Non-respiratory indications for NICU admission among vigorous infants included hypoglycemia, observation for low five-minute Apgar score, suspected sepsis, abnormal heart rhythm, suspected coarctation, and narcotic withdrawal. Non-respiratory NICU admissions in the non-vigorous group included hypoglycemia, gastroschisis, and HIE with therapeutic hypothermia.

Among non-vigorous infants born through MSAF, there was a lower prevalence of low Apgar score at 1 minute (table 3), likely due to less tracheal suctioning. However, there was a higher need for non-invasive respiratory support and a three-fold increase in the incidence of MAS in the no-suction era compared to the routine-suction era (table 3).

During both periods, none of the infants received inhaled nitric oxide (iNO) or extracorporeal membrane oxygenation (ECMO). There were no deaths among these infants. Comparative data between the two periods for incidence of MAS, respiratory distress/ support, total NICU admissions, and invasive mechanical ventilation (IMV) as a percentage of non-vigorous infants, all infants with MSAF, and all births are shown in table 4. The incidence of MAS and NICU respiratory admissions as a percentage of non-vigorous infants, all infants with MSAF, and NICU admits with MSAF were significantly higher in the no-suction era. There were no differences in any outcomes as a percentage of all deliveries.

Discussion

The optimal approach to non-vigorous infants born through MSAF continues to be controversial. [22] Two meta-analyses of the four randomized controlled trials did not show a difference in the incidence of MAS or mortality among non-vigorous infants with MSAF between tracheal suction versus no-suction strategies. [14, 23] However, one of the randomized controlled trials (Singh et al) showed a tendency towards increased incidence of MAS from 41.3% to 57.1% in the no-suction arm (p=0.052). [12] A regional study evaluating prevalence of MAS in the California Perinatal Quality Control Collaborative (CPQCC) showed a decrease in MAS among all live births. [24] A national database (Vermont Oxford Network) also demonstrated a decreased incidence of MAS admissions to the NICU following the release of the 7th edition of the NRP textbook.[21] Following the implementation of no-suction guidelines, Myers et al did not see a change in the incidence of NICU admissions. However, they did show improved Apgar scores at 1 minute (similar to our study, table 3), and reduced need for respiratory support for more than 24 hours. [25] Aldhafeeri et al did not demonstrate any significant differences in MAS related complications following implementation of NRP 7th edition guidelines. [26] Oommen et al demonstrated a significant increase in the number of non-vigorous infants born through MSAF, but a reduction in proportion of non-vigorous neonates who were admitted to the NICU following implementation of no-routine suction guidelines. [27] Conversely, Chiruvolu et al documented an increase in respiratory NICU admissions, need for mechanical ventilation, oxygen therapy, and surfactant use among non-vigorous infants born through MSAF following the implementation of the 7th edition of NRP. Chiruvolu et al reported an increase in the incidence of MAS from 5 to 11% among non-vigorous infants with MSAF, although this difference did not reach statistical significance (95% CI 0.83–6.2). [20] Finally, one randomized animal study demonstrated a decrease in density of aspirated meconium in the lungs and better oxygenation with tracheal suctioning following acute meconium aspiration. [28] However, onset of PPV was delayed by approximately 100 seconds due to suctioning. [28] In the current study, we found a significant increase in MAS and respiratory related NICU admissions among both non-vigorous infants and all infants born through MSAF with revised no-routine suction guidelines. The incidence and duration of invasive mechanical ventilation decreased in the no-suction era, but this difference was not statistically significant due to a small n-value.

What is the basis of such inconsistency in the effect of no-routine tracheal suctioning of non-vigorous infants with MSAF? Several factors appear to play a role. There is an element of subjectivity in assigning non-vigorous state in retrospective studies and establishing the diagnosis of MAS (variability in x-ray findings and degree of respiratory distress) between studies. [19, 22] Before 2016, if the obstetrician noticed that the baby born through MSAF was non-vigorous, no stimulation was provided and the baby was immediately handed over to the neonatal provider (figure 1). [22] Since 2017, the obstetrician typically attempts to stimulate the non-vigorous baby and then hands the baby to the neonatal provider who continues to offer stimulation. If the neonatal provider perceives the baby to still be non-vigorous despite initial stimulation by the obstetrician, it is likely that the infant is more severely depressed than an initially non-vigorous baby that becomes vigorous with obstetrician stimulation (figure 1 and table 3). Our study shows that with implementation of revised guidelines, the prevalence of "non-vigorous" state decreased from 14 to 10.6% (not significant) but these infants were sicker with 70% needing NICU admission (compared to 49% in the routine-suction era, p=0.076). In retrospective studies such as ours, differences in the degree of depression among infants with MSAF labeled "non-vigorous" in the two epochs may potentially be different (figure 1). We speculate that in randomized controlled trials the baseline severity of illness in both arms is similar, further emphasizing the need for a large multicenter trial evaluating tracheal suctioning among non-vigorous infants born through MSAF.

A second cause of inconsistency is the variability in the numerator and denominator while analyzing the impact of no-routine suction recommendation (table 4). The choices for the numerator are incidence of MAS, NICU respiratory admissions, NICU admissions requiring invasive mechanical ventilation, or all NICU admits among term infants born through MSAF. As it may be difficult to differentiate MAS from other respiratory disorders such as transient tachypnea of the newborn (TTN), it may be prudent to include all term infants born with MSAF requiring a NICU admission due to respiratory distress as the numerator. Similarly, the denominator can vary from all births, all late preterm/term/post-term births, births with MSAF, and only non-vigorous neonates with MSAF.

This study confirms the findings of Chiruvolu et al showing an increase in respiratory admits to the NICU among non-vigorous infants born through MSAF. [20] Our results contradict the findings of Oommen et al as they documented an increase in non-vigorous infants born through MSAF and a reduction in NICU admissions among these infants. [27] As shown in table 4, retrospective, observational studies can provide all data based on different numerators and denominators to enable comparison between studies.

The Apgar score at 1 min was ≤3 in 74% of infants during the "routine-suction" era compared to 43% of babies in the "no-suction" era. At 5 minutes after birth, Apgar scores were similar between the two epochs. We speculate that the infants that did not undergo suctioning were dried and stimulated immediately after birth followed by PPV (if needed), which might have contributed to them becoming vigorous with better Apgar score initially at 1 minute after birth. In addition, direct laryngoscopy, intubation, and delay in initiating PPV may play an important role in low Apgar scores at 1 minute in the routine-suction group.

There are several limitations to the current study. It is a single center study with relatively small numbers. Also, a three-year gap between the two epochs may be associated with changes in acuity and management. We conducted an in-depth review of individual charts of all infants with MSAF. We may have ruled out mild cases of MAS by using a strict definition, but stringent guidelines were applied uniformly to both epochs to avoid inclusion of transient tachypnea due to retained lung liquid and other disorders of transition at birth. The incidence of maternal hypertension and SGA status was higher in the no-suction era contributing to higher baseline risk. Due to a low n-value, small differences in the number of MAS subjects led to large differences in the percentage of non-vigorous infants with MAS. Given these limitations, retrospective trials may not be able to effectively address the controversy of tracheal suctioning in non-vigorous infants born through MSAF.

Conclusion

With a recent NRP guideline change in the delivery room management of newborns who are non-vigorous and born through MSAF, we noted an increase in the incidence of MAS. This change was also associated with a higher incidence of NICU respiratory admissions and need for respiratory support in non-vigorous infants. The data from observational before-and-after studies are difficult to interpret because of the use of different numerators and denominators and changes in obstetric approach to non-vigorous infants born through MSAF. [20, 21, 24, 25, 26, 27] These findings strongly favor the conduct of additional large, multicenter randomized controlled trials to validate the safety and efficacy of this practice change.

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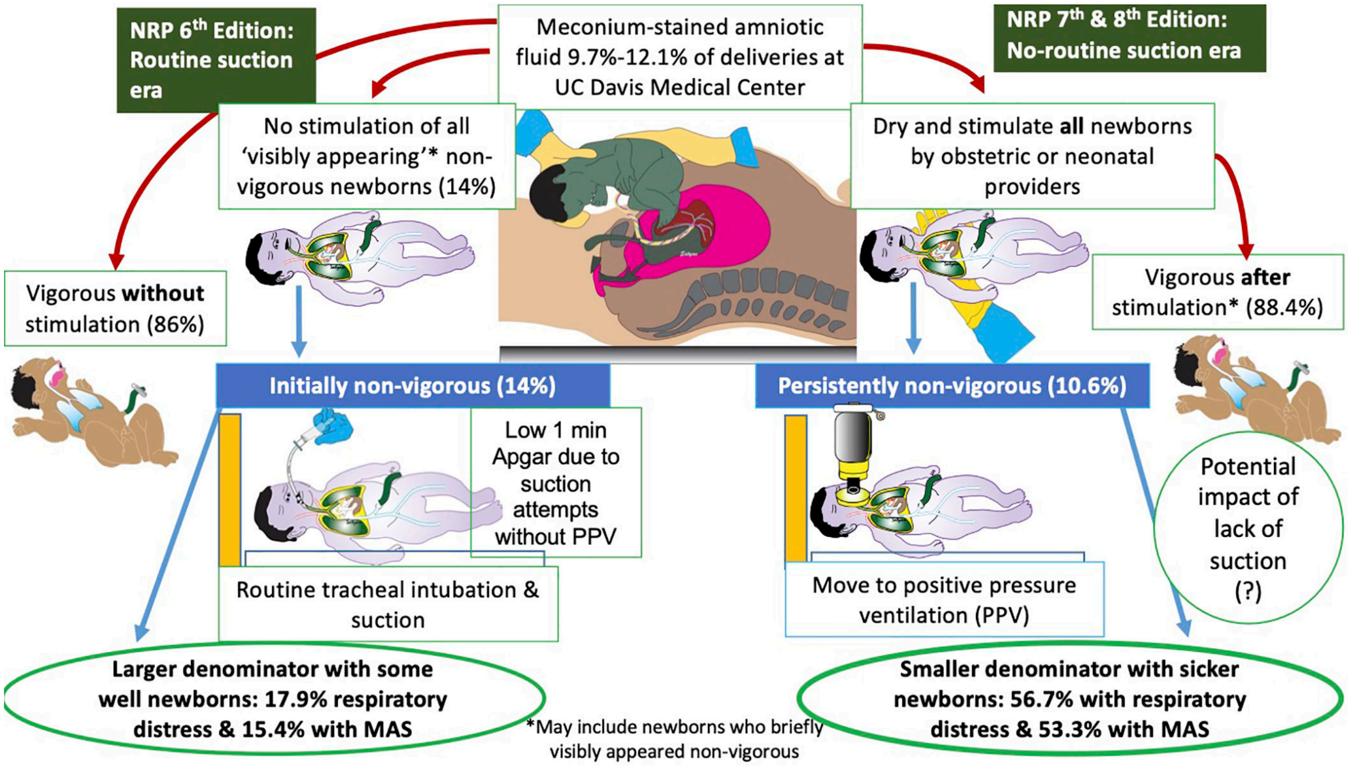

Figure 1.

Difficulties in interpreting before-and-after studies with implementation of no-routine tracheal suctioning guidelines for infants born through meconium-stained amniotic fluid (MSAF). In the routine-suction era, when the 6th edition of the Textbook of Neonatal Resuscitation guidelines were followed, the obstetrician would not stimulate a baby for fear of aspiration and would hand them over to the neonatal resuscitator. These infants would then be tracheal suctioned leading to a low Apgar score at 1 min. In the no-suction era, when the 7th (and 8th) edition of the Textbook of Neonatal Resuscitation guidelines were followed, the obstetrician (and neonatal providers) would stimulate the baby to initiate respirations. If these attempts failed, the baby is then deemed "non-vigorous" and positive pressure ventilation (PPV) is provided. Hence when the denominator of non-vigorous infants is used, there may be a difference in severity of depression. The potential impact of lack of tracheal suction on respiratory distress cannot be ignored but the lack of difference in randomized trials questions this association. NRP - Neonatal Resuscitation Program

Table 1.

Baseline maternal and infant characteristics of all infants ≥ 36 weeks' gestation with meconium-stained amniotic fluid (MSAF).

	Routine-suction era (280)	**No-suction era (282)**
Maternal age (y)	29.7±−5.8	30.1± 5.7
Hypertension during pregnancy	17 (6.1%)	33 (11.7%) *
Maternal diabetes	38 (13.6%)	37 (13.1%)
Mode of Delivery		
Vaginal	201 (71.7%)	199 (70.6%)
Assisted Vaginal	19 (6.7%)	12 (4.2%)
Cesarean	60 (21.4%)	71 (25.2%)
Male	142 (50.7%)	136 (48.2%)
Gestational age (weeks)	39.5 ± 1.2	39.2 ± 1.3
Late Preterm	9 (3.2%)	11 (3.9%)
Post term	2 (0.7%)	3 (1.1%)
Birth weight (grams)	3457 ± 468	3411 ± 475
SGA status	8 (2.8%)	21 (7.4%) *

Data are shown as mean ± SD or number (%)

* denotes $p < 0.05$ compared to routine-suction era.

SGA – small for gestational age

Table 2.

Delivery room characteristics and outcomes of all infants born through MSAF (vigorous and non-vigorous)

	Routine-suction era (280)	No-suction era (282)
Non-vigorous	39 (14%)	30 (10.6%)
Vigorous	241 (86%)	252 (89.4%)
Gestational age (weeks)	39.5 ± 1.2	39.2 ± 1.3
Cord gas †		
Umbilical arterial pH	7.23 ± 0.07	7.208 ± 0.08
Umbilical arterial base deficit (mEq/L)	3.9 ± 3.1	5.9 ± 3.5
Apgar score ≤ 3 at 1 min	30 (10.7%)	12 (4.3%) *
Apgar score ≤ 7 at 5 mins	11 (3.9%)	6 (2.1%)
SGA	8 (2.9%)	21 (7.4%) *
Intubation in the delivery room	35 (12.5%)	1 (0.35%) *
NICU admissions	45 (16.1%)	51 (18.1%)
NICU admission due to respiratory distress or needing respiratory support	13 (4.6%)	27 (9.6%) *
MAS	11 (3.9%)	25 (8.9%) *
TTN	11 (3.9%)	5 (1.8%)
Duration of respiratory support (days)	2.1 ± 1.6	1.7 ± 4.1
Invasive mechanical ventilation	3 (1.1%)	1 (0.35%)
Duration of invasive mechanical ventilation (days)	3.7 ± 2.1	2
Highest non-invasive support		
- Low flow nasal cannula	0	2
- HFNC/CPAP	8	25 *
- NIPPV	0	2
PPHN	0	1 (0.35%)
Pneumothorax	1 (0.36%)	3 (1.1%)
Therapeutic Hypothermia (HIE)	3 (1.1%)	3 (1.1%)

† Cord gas information was available for 32 patients in routine-suction era and 30 patients in no-suction era

* - $p < 0.05$ compared to routine-suction era

SGA – small for gestational age; MAS – meconium aspiration syndrome: defined as the presence of respiratory distress and receipt of respiratory support (to maintain $SpO_2 \geq 90\%$) in presence of MSAF; TTN – transient tachypnea of the newborn; HFNC – high flow nasal cannula; CPAP

– continuous positive airway pressure; NIPPV – non-invasive positive pressure ventilation; PPHN – persistent pulmonary hypertension of the newborn; HIE – hypoxic ischemic encephalopathy

Table 3.

Delivery room characteristics and outcomes of non-vigorous infants born through MSAF

	Routine-suction era (39)	No-suction era (30)
Gestational age (weeks)	39.3 ± 1.5	38.8 ± 1.8
Cord gas *		
Umbilical arterial pH	7.2 ± 0.09	7.19 ±−0.1
Umbilical arterial base deficit (mEq/L)	4.75 ±−4.1	6.77 ± 4.26
Apgar score ≤ 3 at 1 min	29 (74.4%)	13 (43.3%) *
Apgar score ≤ 7 at 5 mins	14 (35.9%)	16 (53.3%)
Delivery room intubation	30 (76.9%)	1 (3.3%) *
SGA	2 (5.1%)	5 (16.7%)
NICU admission	19 (48.7%)	21 (70.0%)
NICU admission due to respiratory distress or requiring respiratory support	7 (17.9%)	18 (60.0%) *
Babies requiring respiratory support	6 (15.4%)	18 (60.0%) *
Highest Respiratory Support		
- Low flow nasal cannula	0	0
- HFNC/CPAP	3	15
- NIPPV	0	2
- Intubated ventilation	3	1
Duration of respiratory support (days)	2.33 ± 1.97	1.81 ± 1.91
Duration of MV (days)	3.67 ± 2.08	2
Duration of hospital stay (days)	9 ± 9.49	6.24 ± 6.1
MAS	6 (15.4%)	16 (53.3%) *
TTN	3 (7.7%)	2 (6.7%)
Incidence of PPHN	0	0
Pneumothorax	1 (2.5%)	2 (6.7%)
Therapeutic Hypothermia (HIE)	3 (7.7%)	3 (10.0%)

Data are shown as mean ± SD or number (%)

* denotes $p < 0.05$ compared to routine-suction era

SGA – small for gestational age; HFNC – high flow nasal cannula; CPAP – continuous positive airway pressure; NIPPV – non-invasive positive pressure ventilation; MV – mechanical ventilation; MAS – meconium aspiration syndrome: defined as the presence of respiratory distress and receipt of respiratory support (to maintain $SpO_2 \geq 90\%$) in presence of MSAF; TTN – transient tachypnea of the newborn; PPHN – persistent pulmonary hypertension of the newborn; HIE – hypoxic ischemic encephalopathy

Table 4.

Impact of choosing different numerators and denominators on the incidence of MAS, NICU admissions with respiratory distress/support, all admissions and invasive mechanical ventilation as a percent of non-vigorous babies, all infants with MSAF, and all births

Numerator	Denominator	Routine-suction era	No-suction era	P value
MAS	Non-vigorous with MSAF	15.4% (6/39)	53.3% (16/30)	0.0008
	Vigorous and non-vigorous with MSAF	3.9% (11/280)	8.9% (25/282)	0.017
	NICU admits with MSAF	24% (11/45)	49% (25/51)	0.013
	All deliveries	0.48% (11/2306)	0.86% (25/2918)	0.099
NICU admit with respiratory distress/ support following MSAF	Non-vigorous with MSAF	17.9% (7/39)	60% (18/30)	0.0008
	Vigorous and non-vigorous with MSAF	4.6% (13/280)	9.6% (27/282)	0.023
	NICU admits with MSAF	28.9% (13/45)	52.9% (27/51)	0.017
	All deliveries	0.56% (13/2306)	0.93% (27/2918)	0.136
NICU admits with MSAF	Non-vigorous with MSAF	48.7% (19/39)	70% (21/30)	0.076
	Vigorous and non-vigorous with MSAF	16.1% (45/280)	18.1% (51/282)	0.53
	All deliveries	1.95% (45/2306)	1.75% (51/2918)	0.58
Invasive mechanical ventilation for MAS	Non-vigorous with MSAF	7.7% (3/39)	3.3% (1/30)	0.63
	Vigorous and non-vigorous with MSAF	1.1% (3/280)	0.4% (1/282)	0.37
	All deliveries	0.13% (3/2306)	0.04% (1/2918)	0.45

MAS – meconium aspiration syndrome; MSAF – meconium-stained amniotic fluid