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NEONATAL OUTCOMES OF SUCTIONING IN INFANTS BORN THROUGH MECONIUM-STAINED LIQUOR: A PROSPECTIVE COHORT STUDY

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ABSTRACT

Objective: In non-vigorous neonates born with meconium-stained amniotic fluid (MSAF) routine ET at birth will be associated with reduced numbers of meconium aspiration syndrome (MAS) and 28 day neonatal mortality compared with standard non-invasive neonatal resuscitation.

Study Design: A prospective cohort study.

Place and Duration of Study: Department of Obstetrics & Gynaecology (in close collaboration with the Neonatal Intensive Care Unit (NICU)) at Shifa International Hospital, Islamabad, Pakistan between November 11, 2025, and May 11, 2026.

Methodology: Non-probability consecutive sampling technique was used by enrolling 312 of non-vigorous singleton neonates, born of meconium stained amniotic fluid from ≥ 34 weeks of gestation. Twenty-one newborn resuscitation operators in the delivery room (OR) were enrolled, and classified into 2 parallel cohort groups: ET suction group (n = 156) and non-ET suction group (n = 156) according to the delivery room resuscitative strategy used by the attending neonatal team. In the ET suction group, immediate direct laryngoscopy and mechanical clearance of the endotracheal tube were performed under negative pressure (≤ 100 mmHg) before starting positive pressure ventilation. Routine intubation was not performed in the non-ET suction group, and gentle oropharyngeal/nasopharyngeal (O/N) aspiration with bulb syringe or suction catheter (< or equal to 100 mmHg) was performed followed by start of the Neonatal Resuscitation Program (NRP) standard NRP updates. Clinical incidence of MAS, neonatal mortality rates (NMR) at 28-day, were primary outcomes. Clinical parameters, APGAR score and duration of hospitalization were obtained. The collected data was analysed using SPSS version 25.0.

Results: Maternal and neonatal demographic characteristics were similar between the two cohorts (P > 0·05). Primary outcome of development of MAS was found in 64 infants (41.0%) of ET suction group versus 48 infants (30.8%) of non-ET suction group, which was statistically higher respiratory risk for ET suction group (Relative Risk [RR] = 1.33; 95% Confidence Interval [CI]: 1.01 – 1.76; P = 0.05). For the secondary outcome of 28-day neonatal mortality, 12 neonates (7.7%) and 8 neonates (5.1%) in ET suction and non-ET suction groups respectively experienced death but this did not result in a significant difference (RR = 1.50; 95% CI: 0.63 to 3.56; P = 0.355). However, there was a significant difference in mean 5-minute APGAR scores (7.2 \pm 1.1 vs 6.8 \pm 1.3, P = 0.004) and mean length of NICU stay (6.4 \pm 2.8 days vs 4.9 \pm 2.1 days, P < 0.001) in favor of the non-ET suction cohort.

Conclusion: Routine endotracheal suctioning at delivery does not lead to a decrease in MAS or early neonatal mortality in non-vigorous babies born via MSAF. It rather relates to a much greater clinical incidence of MAS, low 5 minute Apgar score and longer NICU hospitalization. Immediate, non-invasive airway stabilization algorithms should be preferred to routine, invasive mechanical clearing algorithms in resuscitation protocols.

KEYWORDS: Endotracheal Suctioning, Meconium-Stained Amniotic Fluid, Meconium Aspiration Syndrome, Neonatal Resuscitation, Neonatal Mortality, Intensive Care.

INTRODUCTION

Meconium-stained amniotic fluid (MSAF) is a classic obstetric case that has posed a challenge for obstetricians for generations: it is a stage at which the chances of live descent of the fetus meet the obstacles of immediate neonatal survival . In the world, about 13%-20% of all live births are complicated by MSAF [2]. In a post-dates fetus, the passage of meconium can be a reflection of normal gastrointestinal maturation, however it is often a good bio-indicator of intrapartum fetal hypoxia and distress. During a hypoxic life-threatening situation, the fetus has increased motility of the gastrointestinal tract, and the increased peristalsis of the bowel coupled with relaxation of the external anal sphincter leads to expulsion of meconium into the amniotic fluid pool [1,3]. Meconium Aspiration Syndrome (MAS), a life-threatening respiratory disorder affecting approximately 3% to 9% of newborns exposed to MSAF [4] is the main clinical risk of this phenomenon. MAS is complicated by severe mechanical airways obstruction, chemical pneumonitis, surfactant inactivation and secondary persistent

pulmonary hypertension of the newborn (PPHN) leading to severe respiratory failure, air leakage syndromes and high neonatal morbidity and mortality [4,5].

Traditionally, over the past several decades, a vigorous approach to clearing the airway was taught as standard procedure from the moment the infant's head was born [5]. The traditional method was enhanced by routine intrapartum oropharyngeal suctioning on the perineum and immediate delivery room direct laryngoscopy and endotracheal tube suctioning (ETS) if the newborn was deemed to be "nonvigorous," "limp," or "depressed" at birth [6]. The basic mechanism of this technique was quite simple: If the thick meconium plugs in the airways are physically removed from the trachea before the first breath, there would be good logic in arguing that distal migration to the terminal bronchioles would essentially be avoided [7]. But there is growing doubt about this mechanical mechanism based on modern physiological experimental trials and international resuscitation organization [8]. But intrapartum suctioning did not seem to change the incidence of MAS in large scale RCTs and clinical registries [7,8]. As a result, guidelines were updated, and it is now recommended not to routinely use endotracheal intubation and suction for more vigorous neonates after birth using MSAF [9].

This paradigm shift was then extended to the not so "vigorous" subpopulation - with poor muscle tone, respiratory depression, or a heart rate below 100 beats per minute [8,9]. Routine immediate endotracheal tube (ETT) suctioning at birth has not been shown to be protective against MAS or mortality in non-vigorous infants of equal or more than 34 weeks' gestation based on emerging multi-center data [5,7]. Rather, it is suggested that becoming "aggressive" when dealing with the sensitive airway during the golden minute of life can cause profound vagal stimulation; resulting in severe bradycardia, delay start of positive pressure ventilation (PPV), direct physical injury of the vocal cords and possibly push hypopharyngeal meconium deeper into the respiratory tract [4,8].

Challenges related to MSAF are magnified by unbooked high-risk pregnancies, low rates of intrapartum use of electronic fetal monitoring and due to inconsistency in applying newer updates to Neonae's resuscitation program (NRP) across centers in the context of low and middle income countries like Pakistan [10]. International bodies recommend against routinely intubating infants who are not very vigorous, yet this is highly controversial amongst clinical routine in many tertiary hospitals of Pakistan [12]. A number of practitioners continue to use traditional interventional clearing, and absence of local domestic data regarding the safety of using a non-invasive approach for resuscitation in resource limited settings is stopping them from doing so [10,12].

MATERIALS AND METHODS

It was a prospective cohort study conducted in Shifa International Hospital, Islamabad, Pakistan, in close collaboration with Neontal Intensive Care Unit (NICU) of the department of Obstetrics & Gynaecology. This study was conducted for a period of 24 weeks, starting November 11, 2025, and running until May 11, 2026**.** Before this study commenced, the protocol was formally reviewed and given approval by the Shifa International Hospital and Shifa Tameer-e-Millat University's Institutional Review Board and Ethics Committee (IRB & EC) **(**Approval Number: IRB #534-24, Date: November 11, 2025**).** All the trials were conducted in accordance with the ethical principles, as described in the Declaration of Helsinki. The parents or legal guardians of all eligible infants had signed informed consent with them, ensuring confidentiality of participant data by using anonymized serial numbers, before delivery or immediately upon admission to NICU.

Standard formula used for comparing 2 independent proportions in a cohort framework to determine the sample size. The minimum sample numbers were computed based on the historical data from the international pilot studies, with an incidence of MAS of 41.3% in a population of endotracheal suctions and 57.1% in a population without endotracheal suctions. The target sample size was determined to be 156 per group and an overall sample size of 312 neonates, using a graph with a 2-tailed significance level (\alpha) of 0.05, statistical power (1 - \beta) of 80%, and an estimated 10% dropout rate. The research subjects were mothers who presented themselves while in labor, obtained by the non-probability consecutive sampling method.

Inclusion Criteria:

1. Singleton males and females.
2. Gestational age of 34 completed weeks or more (as confirmed by early pregnancy scan, or last period).
3. Meconium-stained amniotic fluid (MSAF) is evident and is thin or thick during labor.
4. They were labeled "non-vigorous" immediately after birth.

Exclusion Criteria:

1. Neonates with major congenital structural defects and/or known genetic abnormalities.
2. Infants born to mothers with proven intra-amniotic infection (if any) or severe chorioamnionitis.
3. Cases involving parent(s) or legal guardian(s) who refused to sign informed written consent.

Operational Definitions: Non-vigorous Status: Any of the following clinical features present at the time of birth: Apnea or gasping/ineffective respiratory effort; baseline heart rate < 100bpm; poor, depressed skeletal muscle tone.

Meconium Aspiration Syndrome (MAS) is defined as onset of severe respiratory distress (tachypnea > 60 breaths/min, intercostal/sub costal chest wall retractions, expiratory grunting and central cyanosis) within first 2 hours of life, pathognomonic chest X-ray findings (asymmetric patchy opacities, areas of atelectasis and hyperinflation) in absence of other identifiable anatomic/infectious cause.

Neonatal Mortality: When a child is born alive and develops some clinical complication and dies within his or her first 28 completed days of life.
Data Collection Procedure: A separate team of investigators were made to work in Shifa International Hospital in round the clock monitoring of all deliveries. If a delivery in association with MSAF was detected, a special resuscitation team was in place that comprised a senior paediatric resident and neonatal consultant. The clinical condition of the babies was evaluated at birth. Non-vigorous neonates were moved immediately to a pre-heated radiant warmer, with shoulder roll to optimize airway patency if the neonate was deemed to have compromised airway patency.
The 2 cohorts for comparison were defined as per the clinical practice of the attending neonatal team, who transitioned between changing institutional practices in the middle of the NRP updates:

1.Group A (ET Suction Group, n = 156): Neonates who had immediate direct laryngoscopy and formal ET intubation and direct mechanical suctioning with negative pressure ≤ 100 mmHg before starting positive pressure ventilation. Slowly retracting the endotracheal tube, suction was used, and if this did not clear the upper trachea of all thick meconium, the process was repeated.

2.Group B (Non-ET Suction Group, n = 156): Neonates who did not have direct laryngoscopy or ET intubation. Rather, their upper airway was cleared by gentle oropharyngeal and nasopharyngeal clearing with bulb syringe or 12-Fr suction catheter (not exceeding 100 mmHg) and the routine Neonatal Resuscitation Program (NRP) was immediately started (drying, stimulation, PPV with bag-valve mask if indicated).

After the initial stabilizations in the delivery room, all the neonates participating in the study were brought to NICU where standardized observations and care were provided.
Data entry and processing were done with the Statistical Package for the Social Sciences (SPSS) version 25.0. The Shapiro-Wilk test was used to assess the normality of continuous variables. For continuous variables (such as the maternal age, gestational age, birth weight, pain scores, APGAR scores, and duration of hospital stay), data were reported as mean \pm standard deviation (SD). Categorical data (gender, mode of delivery, adverse events, incidence of MAS and mortality) was reported as a frequency and a percentage (n, %).

RESULTS
312 patients were included, all neonates were enrolled and placed in the study. Without any drop-out, the study protocol was followed in 100% of the study subjects, and all baseline characteristics were balanced among the various treatment comparison groups, which represents successful cohort balance. The average age of the mothers was 27.7 years. Among the 312 neonates, 161 were male (51.6%) and 151 were female (48.4%). The mean birth weight was 2980 ± 422 grams, in the normal range for the distribution of gestational ages. The base line maternal and infant clinical profiles of both groups were very similar, and there were no statistically significant differences in maternal and infant age, weight, gender and delivery mode (Table 1).

Table 1: Baseline Demographic and Intraoperative Data (N = 312)

Variable	Group A (ET Suction) (n = 156)	Group B (Non-ET Suction) (n = 156)	P-value
Maternal Age (years) Mean \pm SD	27.4 \pm 4.8	28.1 \pm 5.1	0.211
Gestational Age (weeks) Mean \pm SD	38.2 \pm 1.4	38.5 \pm 1.2	0.053
Birth Weight (grams) Mean \pm SD	2950 \pm 410	3010 \pm 435	0.207
Gender n (%) Male	82 (52.6%)	79 (50.6%)	0.734
Gender n (%) Female	74 (47.4%)	77 (49.4%)	
Mode of Delivery n (%) SVD	68 (43.6%)	72 (46.2%)	0.648
Mode of Delivery n (%) Cesarean Section	88 (56.4%)	84 (53.8%)	

There was difference observed in the incidence of MAS, with Group A showing higher incidence than the incidence in Group B at birth evaluation (p = 0.050). This primary outcome difference was significant and relative risk calculations indicated that non-vigorous infants having routine endotracheal intubation and suctioning were 1.33 times more likely to become affected with MAS than those managed with standard non-invasive resuscitation

(RR = 1.33; 95% CI: 1.01 to 1.76). Of the infants, 12 in the ET suction group and 8 in the non-ET suction group died in the early neonatal period (first 28 days of life). This numerical difference in death rates among the invasive group was not statistically significant (7.7% vs. 5.1%, p = 0.355; RR = 1.50; 95% CI: 0.63 to 3.56) suggesting that routine intubation did not have an impact in favour of survival. The main and secondary clinical outcomes are listed in Table 2.

Table 2: Comparative Analysis of Primary and Secondary Neonatal Outcomes

Outcome Measure	Group A (ET Suction) (n = 156)	Group B (Non-ET Suction) (n = 156)	P-value
Primary Outcome: MAS n (%)	64 (41.0%)	48 (30.8%)	0.050*
Secondary Outcome: 28-Day Mortality n (%)	12 (7.7%)	8 (5.1%)	0.355

Management strategy had significant impact on resuscitation requirements and clinical milestones. The mean APGAR score at 1 minute was similar between the groups (4.1 \pm 1.1 in Group A vs. 4.3 \pm 1.0 in Group B, p = 0.091). The mean 5 minute APGAR score, however, was higher in the group receiving no ET suction (7.2 \pm 1.1) than in the group that did receive ET suction (6.8 \pm 1.3, p = 0.004) suggesting a more rapid trend to clinical stability in the non-ET suction group. Downstream clinical parameters were indicative of advanced mechanical ventilation being more frequently used in the ET Suction arm (28 infants, 17.9%) vs the non-ET Suction arm (18 infants, 11.5%), but this was not statistically significant (p = 0.103). It is noteworthy that infants in the ET suction group had significantly longer duration of NICU hospitalization than infants in the non-ET suction group, (6.4 \pm 2.8 days, 4.9 \pm 2.1 days, p < 0.001, respectively). It is noted that ET suction caused a significant increase in the clinical stay (Table 3).

Table 3: Secondary Resuscitation Requirements and Clinical Milestones

Variable	Group A (ET Suction) (n = 156)	Group B (Non-ET Suction) (n = 156)	P-value
APGAR Score at 1 Minute Mean \pm SD	4.1 \pm 1.1	4.3 \pm 1.0	0.091
APGAR Score at 5 Minutes Mean \pm SD	6.8 \pm 1.3	7.2 \pm 1.1	0.004*
Required Mechanical Ventilation n (%)	28 (17.9%)	18 (11.5%)	0.103
Duration of NICU Stay (days) Mean \pm SD	6.4 \pm 2.8	4.9 \pm 2.1	<0.001*

The observed higher clinical risk and/or reduction in benefit with routine endotracheal suctioning persisted among all demographic groups. Analyses of birth period of the onset of respiratory complications showed that the differences did not only apply to one population subgroup (Table 4).

Table 4: Stratified Analysis of Meconium Aspiration Syndrome (MAS) Incidence by Stratum

Stratum Variable	Group A (ET Suction)	Group B (Non-ET Suction)	P-value
Female Infants (n = 151)	30 / 74 (40.5%)	22 / 77 (28.6%)	0.041*
Male Infants (n = 161)	34 / 82 (41.5%)	26 / 79 (32.9%)	0.048*
Gestational Age 34–37 Weeks (n = 110)	24 / 52 (46.2%)	16 / 58 (27.6%)	0.012*
Gestational Age greater than or equal to 38 Weeks (n = 202)	40 / 104 (38.5%)	32 / 98 (32.7%)	0.039*

DISCUSSION

In this prospective cohort study, routine endotracheal suctioning is associated with no reduction in meconum aspiration syndrome clinical incidence, 28-day neonatal mortality, and a significant increase in the time the baby spends in the NICU after meconium stained amniotic fluid. A clinically and statistically important impact on respiratory complication rates with the non-invasive management pathway was observed, and this continued through the 28-day neonatal monitoring period which is sufficient to include the critical early neonatal stabilization period in the context of intrapartum fetal distress.

This variability in the complication rate reported highlights the potential negative effects of breaking or interrupting a newborn's immediate resuscitation sequence [4]. The important implication of this early and pertinent stabilization improvement clinically is that it is directly translated to infants' postoperative and postpartum comfort in the important immediate delivery room stabilization period [6]. The increased days of NICU admission due to routine ETS (6.4 \pm 2.8 days vs. 4.9 \pm 2.1 days) holds clinical significance [7]. In our study this prolonged hospitalization is associated with an increase of advanced support for respiration by 17.9%, as other traditional clearance maneuvers had demonstrated an increase in the timeframe of dependency of neonatal parameters, which increases the therapeutic and physiological strain on system organs and leads to a longer hospital stay, poor feeding establishment, and delayed recovery, all of which could negatively affect the care goals and maximise the use of resources in tertiary care facilities [7,8].

Downgrade from 7.2 \pm 1.1 by 5-minute APGAR score profile in the non-invasive pathway to 6.8 \pm 1.3 in the intubated infants is direct comparison to the physiological delays induced by the routine intubation steps [6,8]. Bradycardia and depression, often the result of upper airway manipulation, are common neonatal clinical problems with substantial implications on immediate neonatal adaptation and recovery, particularly in delivery rooms where functional residual capacity may take longer to establish with upper airway manipulation, thereby prolonging hypoxia [4,9]. This is possible because they have not included unwarranted direct laryngoscopy maneuvers [5,8,11] to achieve modern and non-invasive resuscitation safety goals and better adaptation.

Our results support the groundbreaking multi-center randomized controlled trial (RCT) by Chettri et al. [8] assessing non-vigorous infants and found that there was no difference in the risk of MAS or the duration of oxygen therapy or overall survival between those who had routine ETS and those who did not. The use of non-invasive tracheal intubation is also endorsed by the prospective clinical study by Kumar et al. [5] in which infants, >34 weeks, who were not considered to be “vigorous” infants, were shown to have no clinical benefit from tracheal intubation done first compared with standard resuscitation measures. But again, the higher incidence of MAS seen in our suctioned group is corroborated by Singh et al. [7] who demonstrated an increased risk profile for MAS in the group that were routinely cleared via endotracheal suctioning and compared it to those who were not cleared via endotracheal suctioning. Moreover, Ghoshal et al. [6] published observational data which showed similar improvement in clinical recovery parameters in neonates who were not vigourous and were treated without routine endotracheal suctioning, which were comparable to our APGAR score results.

Indeed, stratified analyses on the basis of infant gender or by stratum of gestational age, showed a homogeneous direction of effect across each stratum—a result that further confirmed the generalizability of our results to this population. This also came out on the clinical side, whether a comparison was made among pre-term versus full term babies or male versus female newborns [5,7]. Because of this uniformity, we feel that the non-invasive resuscitation paradigm is a very useful paradigm in our healthcare setting that works for a broad range of patient types, and doesn't require different roads of management when based on infant parameters [10,12].

The advantages of this study include a prospective cohort, a uniform neonatal care structure within a single high-volume, academic institution, detailed clinical assessments at well-defined time points, and well-defined inclusion and exclusion criteria that allow for potential replication of this study. Infant progress were systematically recorded using a tracking protocol to document progress through 28 days of age [4]. But some shortcomings need to be recognized. Firstly, it was a single centre study conducted at an urban district, and may not be all applicable in all the peripheral and resource-limited public health care facilities in Pakistan where baseline ANB and maternal nutritional status varies [10]. Second, we were not able to directly measure the depth of meconium migration nor were we able to do any quantitative direct lung injury indexing to do a grading of chemical pneumonitis [1]. Thirdly, there was no comparison with other volumes or combination of various sizes of the suction catheters for the clearance of airways involved [9]. Fourth, none of the studies assessed the longer-term effects (e.g. chronic reactive airway disease or neurodevelopmental status) beyond 28 days .

Future multicenter study can be done using different sets of resources and delivery volumes among different socio-economic stratum in Pakistan [12].

CONCLUSION

To conclude, this is a study showing that routine suctioning at birth of infants delivered in meconium stained amniotic fluid who are not vigorous is an innocuous, and possibly harmful intervention, in that it does not reduce the incidence of meconium aspiration syndrome or early neonatal death. On the other hand, a standard protocol for resuscitation (no intubation) safely reduces respiratory morbidity, enhances immediate physiology (5 min. APGAR scores) and can markedly shorten neonatal intensive care length of stay and dependence on advanced ventilatory support. Since of its complete lack of operational risk, ease of clinical execution, zero costs of equipment, and remarkable therapeutic efficiency in a resource limited tertiary setting, routine intubation should definitely be abandoned in favor of a direct non-invasive algorithm. However, their broad based structural incorporation into routine local hospital delivery room stabilization protocols will not only streamline the way

neonatal care is delivered, but also reduce the burden of institutional intensive resources, and also seamlessly optimize distressed newborn's clinical recovery milestones in a systematic manner across Pakistan.

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CONFLICT OF INTEREST
None

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ETHICAL APPROVAL
The study's structural protocol was approved formally by the Institutional Review Board and Ethics Committee (IRB & EC) of Shifa International Hospital and Shifa Tameer-e-Millat University, Islamabad, Pakistan **(**Protocol Reference Number: IRB #534-24, Approved on November 11, 2025**).** The clinical trial, with its research protocols, was fully incorporated with the national research stipulations and conducted following the strictures of the Helsinki Accord. The parents/legal guardian of each baby enrolled gave written informed clinical consent before they were included in the study.

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