Clinical question.
"In depressed neonates born through meconium stained amniotic fluid (P), does endotracheal suctioning (I) versus no suctioning (C) improve outcome (O)?"

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention/ therapy

State if this is a proposed new topic or revision of existing worksheet: Revision

Conflict of interest specific to this question
Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No

Search strategy (including electronic databases searched).

PUBMED:
4. “Endotracheal intubation” OR “Intubation, tracheal (MESH) AND “Meconium stained amniotic” OR “Meconium (MESH)”. Got 67 hits.
5. “Endotracheal intubation” OR “Intubation, tracheal (MESH) AND “Meconium” OR “Meconium (MESH)”. Got 112 hits.

COCHRANE:
All the searches below were done under MESH Search
Suction explode all trees- 648
Intubation, intratracheal explode all trees- 2712
Meconium explode all trees- 57
Meconium aspiration syndrome explode all trees- 60
“Suction explode all trees” OR “Intubation, intratracheal explode all trees” AND “Meconium explode all trees” OR “Meconium Aspiration Syndrome explode all trees”. – Got 1 Cochrane Review, 10 Clinical trials.

EMBASE
“Intubation, intratracheal/exp/mj” OR “Intubation, intratracheal” AND (“meconium/ exp/mj” OR meconium” OR “meconium aspiration syndrome/exp/mj” OR “meconium aspiration syndrome”). Got 28 hits.

ECC ENDNOTE: “Endotracheal suctioning”, “Meconium aspiration”, “Depressed infant”. Got 600 hits

State inclusion and exclusion criteria
All English articles were included, for non-English articles only those with abstracts and translated in English were reviewed. Studies that were excluded are those where intubation was for purposes other than suctioning (31), Suctioning on in vigorous infants (6), case reports (15), letters and comments (62), reviews (40).
<table>
<thead>
<tr>
<th>Number of articles/sources meeting criteria for further review:</th>
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<td>A total of 21 studies were reviewed.</td>
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### Summary of evidence

#### Evidence Supporting Clinical Question

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<thead>
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<th>Good</th>
<th>Fair</th>
<th>Poor</th>
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**Evidence Neutral to Clinical question**

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### Level of evidence

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint
- **Italics** = Animal studies

**E1** - Meconium aspiration syndrome, **E2** - Need for Mechanical ventilation, **E3** - Need for ECMO,
# Evidence Opposing Clinical Question

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>1</th>
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<tbody>
<tr>
<td><strong>Good</strong></td>
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<tr>
<td><strong>Fair</strong></td>
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<td>Usta, 1995 E1</td>
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<td><strong>Poor</strong></td>
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**Level of evidence**

- A = Return of spontaneous circulation
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*Italics = Animal studies*

E1- Meconium aspiration syndrome, E2- Need for Mechanical ventilation, E3- Need for ECMO,
**Background**
Meconium staining of the amniotic fluid (MSAF) occurs in 7-22% of live births (Davis 1985, Dooley 1985, Falciglia 1988, Wiswell 1992). If the MSAF is aspirated by the fetus before or during birth, meconium can obstruct the airways, cause inflammation, interfere with surfactant function and cause respiratory difficulties resulting in meconium aspiration syndrome (MAS). Meconium is found below the cords in 10-40% infants born through MSAF (Dooley 1985, Falciglia 1988, Rossi 1989, Peng 1996). MAS occurs in 2-9% of all cases of MSAF (Rossi 1989, Falciglia 1988, Wiswell 2000). This syndrome carries a mortality rate up to 40% (Davis 1985). Meconium aspiration can occur in utero or immediately after delivery when the infant takes the first breaths. Finding of meconium below the cords or in the trachea has been associated with development of MAS (Gregory 1974, Hageman 1988, Wiswell 2000); therefore suggesting that if meconium can be suctioned out of the trachea there will be reduction in incidence of MAS. Some studies have supported this as they reported that intubation and tracheal suctioning is associated with reduction in MAS and/ or mortality (Gregory 1974, Ting 1975, Fox 1977, Wiswell 1992, Chishty 1996, Manganaro 2001). This resulted in it being used in combination with oro-nasopharyngeal suctioning in all infants born to mothers with MSAF (Carson 1976, Davis 1985, Dooley 1985, Falciglia 1988). A number of these studies did not show reduction in incidence of MAS and/ or mortality (Davis 1985, Dooley 1985, Falciglia 1988). Subsequent to a number of studies that showed it has no benefit in those who are vigorous it has been recommended to be selectively used only in depressed infants (Yoder 1994, Gupta 1996, Peng 1996, Al Takroni 1998, Manganaro 2001). The reason for its selective use in depressed infants is because of increased incidence of MAS in these infants (Rossi 1989, Bhutta 1992, Usta 1995, Peng 1996, Wiswell 2000, Dargaville 2006). Some studies have suggested that aspiration of meconium occurs in-utero and that the damage in the lungs might be related to hypoxia and that it has already taken place by the time the baby is born. Therefore suctioning of depressed infants might have no effect on incidence of MAS.

**Evidence/ Reviewers comments:** A number of studies have reported on incidence of MAS and mortality in infants who were intubated for tracheal suctioning. Some studies have supported tracheal suctioning in infants born through MSAF (Chishty 1996, Fox 1977, Gregory 1974, Tinge 1975, Wiswell 1990, Wiswell 1992) while some have continued to report cases of MAS and mortality in infants born through MSAF despite tracheal suctioning (Davis 1985, Dooley 1985, Falciglia 1988). Most of these studies did not differentiate the effect of tracheal suctioning between those who were depressed and those who were not therefore did not address the question we are trying to answer in this worksheet. Therefore all these studies were grouped as LOE 5. The studies that reported its use in depressed infants were either retrospective or prospective non-randomized clinical studies and were put under LOE 4. Most of them reported that MAS continued to occur with its associated mortality in depressed infants despite tracheal suctioning (Yoder 1994, Gupta 1996, Peng 1996, Al Takroni 1998). These studies did not make comparison between tracheal suctioning and no tracheal suctioning among depressed infants. So far there have been no published randomized clinical studies that compared intubation with tracheal suctioning to no tracheal suctioning in depressed neonates.

**Acknowledgements:**
Citation List

1. Selective tracheal suctioning to prevent meconium aspiration syndrome.  
   Al Takroni AM, Parvathi CK, Mendis KB, Hassan S, Reddy I, Kudair HA.  
   Comments: There was a high incidence of MAS in intubated infants in this study. Meconium aspiration syndrome was more severe in depressed infants despite tracheal intubation. There was no comparison between endotracheal suctioned and non-suctioned group among the depressed infants. It is not stated on whether meconium was retrieved below the cords or not during suctioning. Fair, Neutral, LOE 4

   Bhutta ZA, Jalil S  
   Comments: MAS more severe in depressed infants despite tracheal intubation, no comparison between endotracheal suctioned and non-suctioned group in depressed infants. Presence of meconium in the trachea was not associated with severity of lung disease. This is different from other studies where they related presence of meconium below the cords to infants being sick. This is one of the studies that suggest MAS as an intra-uterine event. Fair, Neutral, LOE 4.

3. Combined obstetric and pediatric approach to prevent meconium aspiration syndrome  
   Carson BS, Losey RW, Bowes WA Jr, Simmons MA  
   Comments: MAS occurred despite endotracheal suctioning, included all infants, therefore not all were depressed. It is not stated how many of the infants with MSAF had tracheal suctioning, therefore making it difficult to relate MAS and mortality reported in this study to tracheal suctioning. Poor, Neutral, LOE 5.

4. Meconium aspiration in neonates: combined obstetric and paediatric intervention improves outcome  
   Chishty AL, Alvi Y, Iftikhar M, Bhutta TI  
   J Pak Med Assoc 1996; 46:104-8
   Comments: Less mortality in the suctioned group. Included all infants, not all were depressed in the group that was suctioned. Patients came from different hospitals with different rates of tracheal intubation. Though the overall mortality rate was reduced with tracheal suctioning, patients who had low rates of tracheal suctioning had high mortality, but most of these patients were born outside the main center therefore some of the deaths could be due to the fact that they were outborns. Fair, Supportive, LOE 5.

5. The epidemiology of meconium aspiration syndrome: incidence, risk factors, therapies, and outcome.
Dargaville PA, Copnell B; Australian and New Zealand Neonatal Network. Pediatrics 2006;117:1712-1721

Comment: It is a population-based rather than hospital based study. This study focused on infants with severe MAS (intubated and ventilated) and found that depressed infants were more likely to have severe disease. There was no comparison on effect of suctioning. Fair, supportive, LOE4

6. Fatal meconium aspiration syndrome occurring despite airway management considered appropriate
Davis RO, Harris BA Jr, Wilson ER, Huddleston JF

Comments: Lung pathology on postmortem showed evidence of MAS despite suctioning. Some of the patients had no evidence of meconium aspiration on post-mortem though they were clinically diagnosed as MAS. This brings into question whether clinical presentation of respiratory distress among infants born through MSAF is due to MAS. Not all were depressed infants. No comparisons. Not all deaths had post-mortem. Poor, Neutral, LOE 5.

7. Meconium below the vocal cords at delivery: correlation with intrapartum events
Dooley SL, Pesavento DJ, Depp R, Socol ML, Tamura RK, Wiringa KS
Comments: Retrospective review, endotracheal suction did not prevent MAS. Not all infants were depressed. There were no differences in pH and base deficit between those who had meconium below the cords and those who did not. This suggest that meconium aspiration is occurring before delivery- not linked to events around time of delivery. Apgar scores were not documented for one to assess if the normal pH in infants with meconium below the cords was backed up by normal Apgar scores. Poor, Neutral, LOE 5.

8. Failure to prevent meconium aspiration syndrome
Falciglia HS, 1988

Comments: Retrospective study, assessing the combined approach. The effect of tracheal suctioning was not assessed independently. Though there was no change in incidence of MAS before and after using the combined approach the mortality rate decreased between the two periods supporting effect of tracheal suctioning on mortality. Fair, Neutral on MAS, LOE3, Fair, Supportive on mortality, LOE3.

9. A delivery room approach to the meconium aspiration syndrome (MAS). Immediate intubation, endotracheal suction, and oxygen administration can reduce morbidity and mortality
Fox WW, Gutsche BB, DeVore JS
**Comments**: All infants who did not immediately breathe spontaneously (no numbers given) were intubated and suctioned through the endotracheal tube. 35 infants developed MAS. There were no deaths. This is compared to other studies that had high mortality. Poor study, information incomplete. No comparisons to no suctioned group.

**Poor, Supportive, LOE 5.**

10. **Meconium aspiration in infants- a prospective study**
   Gregory GA, Gooding CA, Phibbs RH, Tooley WH
   J Pediatr 1974;85:848-852

**Comments**: Eighty infants were suctioned with 46 having meconium below the cords and 34 not. Though 34 did not have meconium below the cords, 7 had abnormal X-rays, but none got sick. Fifty percent (23) of those with meconium below the cords had abnormal X-rays with 16 of them getting sick. There were no deaths amongst these 80 patients who were suctioned compared to 2-3 deaths observed before suctioning was introduced. It would appear that suctioning did not prevent MAS occurring but reduced its severity therefore reducing mortality.

**Fair, Neutral for MAS, LOE 3; Fair, Supportive for mortality, LOE 3.**

11. **Meconium stained amniotic fluid: antenatal, intrapartum and neonatal attributes**
    Gupta V, Bhatia BD, Mishra OP
    Indian Pediatr 1996; 33:293-7

**Comments**: Depressed infants developed MAS despite having been suctioned. The Apgar score of suctioned infants is not stated, neither is the number of patients that were depressed and those who were suctioned.

**Poor, Neutral, LOE 4.**

12. **Delivery room management of meconium staining of the amniotic fluid and the development of meconium aspiration syndrome**
    J Perinatol 1988;8:127-31

**Comments**: A large number of patients had meconium below the cords with a high number developing MAS, but there were no deaths. This is one of the studies that support the effect of tracheal suctioning in reducing mortality in those with MAS. Endotracheal intubation did not prevent MAS.

**Fair, Neutral for MAS, LOE 5. Fair, Supportive for mortality, LOE 5**

13. **Incidence of meconium aspiration syndrome in term meconium-stained babies managed at birth with selective tracheal intubation**
    Manganaro R, Mami C, Palmara A, Paolata A, Gemelli M
Comments: Only one depressed infant developed MAS. The number of infants who were depressed and therefore required intubation is not stated.
Fair, Supportive, LOE 4.

14. A selective aggressive approach to the neonate exposed to meconium-stained fluid
   Peng TC, Gutcher GR, Van Dorsten JP
   Am J Obstet Gynecol 1996;175:296-301

Comments: The patients who developed MAS were from the group that was intubated (depressed infants). That means tracheal suctioning did not stop development of MAS among the depressed infants. Comparison made in this study does not address the question in this worksheet.
Fair, Neutral, LOE 4.

15. Meconium aspiration syndrome: intrapartum and neonatal attributes
   Rossi EM, Philipson EH, Williams TG, Kalhan SC

Comments: MAS occurred despite tracheal suctioning. Depressed infants are at high risk of developing MAS.
Poor, Neutral, LOE 4.

16. Tracheal suction in meconium aspiration
   Ting P, Brady JP
   Am J Obstet Gynecol 1975;122:767-71

Comments: This study compared the outcomes of patients who were suctioned to those who were not suctioned. It is not clear as to why some were suctioned and some were not. Tracheal suctioning reduced number of symptomatic (MAS) patients and mortality.
Fair, supportive, LOE 5.

17. Risk factors for meconium aspiration syndrome
   Usta IM, Mercer BM, Sibai BM
   Obstet Gynecol 1995;86:230-4

Comments: Depressed infants are at high risk of developing MAS. Need for tracheal intubation and suctioning increases the risk of MAS. Fair, Opposing, LOE 4.

18. Meconium aspiration syndrome: have we made a difference?
   Wiswell TE, Tuggle JM, Turner BS.

Pediatrics 1990; 85:715-21

Comment: Combined approach did not reduce incidence of MAS but did lead to reduction in deaths. Tracheal suctioning not studied separately. This study has compared two periods, therefore using some retrospective controls. It is not clear if reduction in mortality was due to changes in perinatal care or to implementation of combined approach.
Fair, Neutral for MAS, LOE 3, Fair, Supportive for mortality, LOE 3
19. Intratracheal suctioning, systemic infection, and the meconium aspiration syndrome

Wiswell TE, Henley MA
Pediatrics 1992; 89:203-6

Comments: Infants born with meconium stained amniotic fluid and suctioned had better outcome than those not suctioned. Fair, Supportive, LOE 5.

20. Delivery room management of the apparently vigorous meconium-stained neonate: results of the multicenter, international collaborative trial.
Pediatrics 2000; 105:1-7

Comment: Though this study excluded depressed infants which are the focus of our worksheet, of note is that the depressed infants were noted to be at high risk of developing MAS. Fair, supportive, LOE 4

21. Meconium-stained amniotic fluid and respiratory complications: impact of selective tracheal suction
Yoder BA, 1994
Obstet Gynecol 1994;83:77-84

Comments: Selective tracheal suction in meconium stained amniotic fluid was not associated with increased morbidity. Meconium aspiration syndrome more common in suctioned infants, suctioning does not prevent adverse pulmonary outcomes. Fair, Neutral, LOE 4.