Clinical question.

In children requiring assisted ventilation (prehospital, in-hospital) (P), does the use of bag-valve-mask (I) compared with endotracheal intubation (C) improve therapeutic endpoints (oxygenation and ventilation), reduce morbidity or risk of complications (eg, aspiration), or improve survival (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 of WKS C2005

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?
I am the author of the C2005 wks on the same subject.
Potential intellectual conflicts: Editor of ERC paediatric guidelines. Co-editor of ERC EPLS and EPILS manual

Search strategy (including electronic databases searche

Between november 2004 and 15/10/2009
SCOPUS
Intubation and prehospital: 256 hits : 69 reviewed abstracts : 5 hits

PUBMED
MESH
("Child"[Mesh] AND "Intubation, Intratracheal"[Mesh]) AND "Emergency Medical Services"[Mesh]) AND ("2004/11/30"[PDat]:"3000"[PDat])): 58 hits : 10 reviewed abstracts: 5 hits

Respiration, Artificial AND (prehospital OR paramedic OR emergency medical) AND child: 26 hits 3 reviewed :0 hit

("Child"[Mesh] AND "Intubation, Intratracheal"[Mesh]) AND "Emergency Medical Services"[Mesh])) 58 hits :13 abstracts reviewed : 4 hits

child intubation prehospital emergency 20 hits: 7 reviewed 1 hit

Pediatric emergency airway 136 hits 3 reviewed 1 hit

child and intubation and paramedics 19 hits - 6 reviewed 5 hits

Emergency airway 1321 hits 33 abstracts reviewed : 5 hits
Google scholar “prehospital pediatric intubation “ 118 hits 0 reviewed
• State inclusion and exclusion criteria

Included: studies comparing intubation with BMV in prehospital setting or in emergency department; intubation success and complications rates
Excluded: reviews, non-pediatric studies or studies with children and adults conglomerated for the results (children results not being indentified separately); comparison with laryngeal mask or devices other than BMV, cases reports, intubation training methods, confirmation tests for intubation, comparison between different types/methods of sedation for intubation
One article in croate Stanic Acta Chir Iugosl 2006-45;

• Number of articles/sources meeting criteria for further review:

LOE1: Lecky 2008 CD001429
LOE2: DiRusso 2005-84; Gerritse 2008-225
LOE3: Tam 2009-311
LOE5: none

Summary of evidence

**Evidence Supporting Clinical Question**

In children requiring assisted ventilation (prehospital, in-hospital) (P), does the use of bag-valve-mask (I) compared with endotracheal intubation (C) improve therapeutic endpoints (oxygenation and ventilation), reduce morbidity or risk of complications (eg, aspiration), or improve survival (O)

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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*
**Evidence Neutral to Clinical question**

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A = Return of spontaneous circulation  
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**Evidence Opposing Clinical Question**

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A = Return of spontaneous circulation  
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**REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:**

Previous consensus on sciences (CoSTR, Resuscitation 2005-277) stated that in an EMS system with short transport times, BMV resulted in equivalent survival to hospital discharge rates and neurological outcome in children requiring airway control when compared with tracheal intubation including children with cardiac arrest and trauma (Gausche JAMA 2000-783). This statement was based on one LOE 1 (Gausche JAMA 2000-783), one LOE 4 study on cardiac arrest (Pitetti 2002-283) and four LOE3 (Cooper 2001-3, Eckstein 2000-643) and LOE 4 (Stockinger 2004-535, Perron 2001-6) studies on trauma patients.

The low rate of intubation of the Gauche study (42% intubation success in the group randomised to intubation) in this intention-to-treat study may partially account for the absence of benefit of prehospital intubation compared with BMV. Lower intubation success rate were also observed in children compared with adults in several studies (DeLeo 1977-851; Losek 1987-370; Aijian 1989-489; Losek 1994-429; Kumar 1997-243)

Prehospital intubation had an increased risk of tracheal tube misplacement, displacement, obstruction or other less frequent complication (aspiration, pneumothorax right mainstem intubation, oral trauma...) from 2 to 77% (Losek 1987-
Prehospital intubation lead to longer scene time (Gausche 2000-783; Ramenofsky 1984-818; Demetriades 1996-133; Reisdorff 1998-180; Paul 1999-455) due to the time needed to perform the intervention without evidence for any substantial benefit on survival at discharge of the hospital.

In trauma patients, prehospital intubation by paramedics in an urban area was associated with a higher mortality risk than BVM techniques even when the patients were stratified according to their severity of injury score (Eckstein 2000-643, Perron 2001-6, Stockinger 2004-535). However, in Perron 2001-6 study, intubation was not shown to be a cause but could be only an indicator of a worse prognosis. In severe head trauma pediatric patients, no advantage of endotracheal intubation over BVM was shown (Cooper 2001-3).

Pediatric intubations are infrequent and a small number of providers will meet minimum ETI utilization requirements (Burton 2003-34). Among the calls to an EMS system, less than 10% are pediatric (Sirbaugh 1999-174) and among those, 5% concern life-threatening problems (Lewis, 1998-428). Less than 1% are cardiorespiratory arrests (Kumar 1997-743) and 0.1 to 4% of cases will require acute airway management (Gausche 2000-783; Vilke 2002-71, Richard 2006-6; Eich 2009-x) Because of the lack of opportunity to become experienced, EMS providers may prefer to avoid this complicated technique in children (Kumar1997-743; Gausche 1998-428; Scribano, 2000-745 ; Paul 1999-455).

In the present review of the literature from November 2004 to October 2009, one LOE 1 Cochrane systematic review (Kechy 2008) found only one randomized study (Gausche, 2000-763) and concluded that current evidence provide no support for prehospital intubation within urban or short transit systems.

The LOE 2 study of Gerrits 2008-225 analysed prospectively a pediatric cohort of 155 prehospital intubated children among 300 children (83% of trauma incidents) examined and treated in the field by EMS paramedics who requested a helicopter transported medical team. Among these children 41 were intubated by EMS paramedics and 54 were BVM ventilated by paramedics and intubated by the helicopter team physicians. Among the children intubated by paramedics 15 intubations required resvission by physician compared to none of the children intubated initially by physicians (p<0.001). Survival to hospital discharge was significantly lower in the group intubated by paramedics compared to the group intubated by the physicians (p<0.001). the two groups didn’t differ significantly by Glasgow Coma Score or revised trauma score.

The LOE 2 study of Di Russo 2005-84 confirmed the results of the previous studies on pediatric trauma (Cooper 2001-3 ; Perron 2001-6, Stockinger 2004-531 ; Eckstein 2000-643). This study of pediatric trauma analysed retrospectively 5460 children (11.6% of the entire cohort of the US National Pediatric Trauma Registry) who were intubated either in the field, at non-trauma center hospitals or at trauma centers hospitals. Unadjusted mortality rates were higher for the children intubated in the field (38.5%) compared with those intubated at either a trauma (13.2%) or non-trauma center hospital (16.7%). Odd ratios of mortality for field intubation, non-trauma center and trauma center were respectively 14.4, 5.8 and 4.8. Stratification by degree of injury, degree of head injury for the risk of death showed the same results with a higher mortality risk for field intubation compared to both hospitals intubation. Expected death rate was lower than actual death rate in field intubated children but there was no difference for hospital intubation. This means that field intubation might be responsible for a excess deaths of 11.4 per 100 field intubated children.

Similarly, the studied patients intubated in the field had a greater functional impairment at discharge than those intubated at hospital even after stratification by severity of injury and degree of head injury.

The transport time was 30 minutes higher for field intubation compared any hospital intubation.

Emergency intubation in children remains a difficult skill and out-of-hospital settings are not confortable environments to intubate. One LOE 4 study (Wang 2006-501) showed in an EMS system that ETI errors (tube misplacement or dislogment from the trachea; multiple attempts to intubate or failed intubation) occurred in 22% of the 444/1953 patients intubated in the field. Errors were more frequent in children younger than 6 years, trauma and non arrested
patients. Errors occurred in 17/38 of children (44%) odds ratio 4.0 (95% CI 2.1-7.9 p<0.05) compared to the reference level (patients older than 70 years). In another article from the same team, the cohort was analysed for outcome and field intubation increased the risk for pneumonitis but not for mortality. Children were not identified in this part of the study (Wang 2009-50)

The LOE 4 Denver Metro Airway study 2009-304 showed also an increased risk of tracheal tube malposition with 9 (39.1%) of failed intubation and 3(13%) of misplaced tubes among the 23 children aged less than 13 years compared to adults (OR 6.9 (CI 95% CI1.42-26.2) after prehospital intubation by paramedics. The LOE 4 study of Garza 2005-163 compared intubation non attempts and failure rates in pediatric, traumatic and adult non-traumatic cardiac arrests.

There were 120 pediatric cardiac arrests of which 71 % had an intubation attempt with a failure rate of 44.2%. The risk of intubation non attempts in pediatric cardiac arrest was significantly higher compared with adult cardiac arrests (OR 6.52 - 95% CI 4.65-9.15 p<0.001). The LOE 3 study of Tam 2009-311 failed to show a difference in failure rate in children compared with adults but the number of children was very small (16 children and 1013 adults). The LOE4 study of Warner 2009-257 considered 6.1% of the children (n=49) as difficult airway in a cohort of of out-of-hospital patients requiring intubation (n= 4091) with 3.2 % of adults considered as difficult airway (ns). The LOE4 of Hon 2005-662 showed that hyperventilation was frequent in intubated children before and after transport.

**Conclusion**

The revision of the 2005 worksheet confirms that endotracheal intubation in out-of-hospital setting with short transport times does not improve survival and may be associated with significant complications.

In trauma paediatric patients, intubation in the field leads to higher mortality than in hospital intubation (trauma or non trauma centers) even after stratification for severity of the trauma and degree of head injury, with a significant excess in mortality compared with the expected death rate. The neurological outcome of children intubated in the field is also significantly worse than the outcome of children intubated at the hospital. Transport times are longer when children are intubated in the field than when they are intubated in hospital.
For children intubation in the field, the success rate is lower and the complication rate is higher than in adults.

**Acknowledgements:**

**Citation List**


**LOE 4 Fair Supports**

Very large prospective cohort study of patients having attempts of intubation in the field. The analyse showed that in children less than 13 year old, more malpositions of the tracheal tube occurred than in adults (OR 6.90 95%CI 1.42-26.2)


**LOE 2 Good Supports**

This very large retrospective cohort studied the National Pediatric Trauma Registry from 1994 to 2002.
On a total of 4974 children, 5449 were intubated for trauma injury. The cohort was analysed for the place of intubation: in the field, at the non trauma center hospital or at the trauma center. Children were stratified for severity of injury and degree of head injury and for mortality and neurological impairment at hospital discharge.

The risk of mortality and of neurological impairment was significantly increased when the child was intubated in the field compared with both types of hospitals and these results remain after risk stratification.

LOE 4 Fair supports
Retrospective observational study examined all oral intubations performad on pediatric cardiac arrests, adult cardacs arrest and adult trauma cardiac arrests. Among 120 pediatric cardiac arrests, intubation attempts were performed in 86 (71%); the non-attempt rate was 29% and the failure rate was 44.2%. Adult cardiac arrests (n=2510) had an attempt rate of 96% a non attempt rate of 4% and a failure rate of 14.7% and adult traumatic arrest (n=271) respectively 67%, 33% and 29.7%. Relative risk of non attempt and intubation failure for Pediatric cardiac arrest compared to adult cardiac arrest were (RR 6.52, 95% CI 5.74-65-9.15 p<0.001 for nonattempt); RR = 3.01 95% CI 2.33 – 3.88 p<0.001 for intubation failure). Pediatric patients in cardiac arrests had a significantly increased risk of non attempt intubation and of intubation failure compared to adult cardiac arrests.


LOE 2 Fair supports
Prospective observational study that analyses a cohort of children who were intubated on the field either by paramedics directly or were BMV ventilated by the paramedics waiting the medical team and were intubated by the medical team before helicopter transport.
Mortality was higher in the group of children intubated by the paramedics, the revised trauma score being identical in both groups.


LOE 4 Poor Supports
Case series that analysed blood gases before and after transportation. 35% of the children were hyperventilated before transport and 32% after transport.


LOE 1 Fair supports
This analyse of the published RCTs found only one pediatric RCT comparing BMV and intubation


LOE 3 Fair neutral
Retrospective analyse of prehospital intubation showing success rates in pediatric and adult patients
On the 1029 patients intubated, 1.6% were children. The number of attempts per patient was 2. Success rate in pediatric patinets was 68.8% (CI 44.2-86.1) compared to success rate of 82.3 % (79.8-84.5) p=0.19 NS.


LOE 4 Fair supports
Prospective observational study of prehospital intubations provided by EMS systems from January 2003 to June 2004.
Among 1953 intubated patients 38 were children < 6 years. In the total population 444 errors (tube misplacement, multiple ETI attempts and failed ETI). Children had a error rate of 17/38 (44%) with a odd ratio of 4.0 (95%CI 2.1-7.9) compared with adult error rate 152/911 (16.7%) (p<005).


LOE 4 Fair neutral
Prospective cohort study analysing the incidence of difficult airway in the field and at the emergency department. Incidence of difficult airway was 6.1% among 49 pediatric intubations (≤ 14 years). The difficult airway rate was 3.2% in adult (ns)

BIBLIOGRAPHY used for the comment