A rapid evidence review for the Zealand Health Board

Evidence on impact of skill level of pre-hospital providers

Evidence on impact of pre-hospital intubation

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Executive Summary

Background

This review has been written at the request of the Region Zealand Health Board, Denmark. Pre-hospital care constitutes an important and sensitive part of the Danish health care system. Up-to-date knowledge about the evidence base on the impact of different approaches to providing pre-hospital services constitutes one of the fundamental preconditions for delivering effective and efficient pre-hospital care of high quality. The purpose of this work is to provide an independent review of the current evidence base for two aspects of pre-hospital care that are particularly pertinent to current health policy in Denmark and provide an overview of relevant information to support future planning and service design.

Region Zealand has commissioned an independent and structured review of the scientific and "grey" literature on the following two study questions:

1) What is the association between pre-hospital personnel's education (MD, nurse, paramedic, ambulance technician, advanced first-aid training for laymen etc.) and training and the outcome for patients?

2) What is the association between advanced pre-hospital interventions for airway management (specifically endotracheal intubation) and patient outcome?

Review Approach and methods

An appraisal of the existing research evidence is an essential first step when considering changes to health policy and practice providing decision makers with the information they need to guide this process. A full systematic review was not within the scope and timescales needed for Region Zealand activities. Instead, we have conducted scoping reviews for the two topic areas specified by Region Zealand that allow identification of relevant literature and a rapid assessment of the evidence using the principles set out in the Rapid Evidence Assessment (REA) toolkit. For each review a number of steps have been undertaken to provide a structured evidence assessment including definition of the question; development of specific inclusion and exclusion criteria; highly structured and comprehensive search strategies of information databases and research registers; screening and selection of retrieved studies; detailed summaries of included studies and a simple quality appraisal of selected studies using criteria relevant to each review.

Review 1 – Evidence on skill levels in pre-hospital care

A systematic search was carried out in 14 databases (biomedical, nursing and multi-disciplinary) and research registers in mid-August 2011 producing 1493 potential studies. After screening 26 studies were included in the final analysis. The majority of these studies were on trauma patients and cardiac arrest patients. The main findings were;

- The evidence on the type of health professional required is equivocal. Three previous systematic reviews have found no evidence in favour of one particular level of care and the results of this review concur with this view.

- Comparative studies of different levels of care have predominately concentrated on physician and ambulance technician or paramedics. We examined 19 studies making a direct comparison between skill levels and of these 11/19 reported a physician advantage, 9/19 no difference and 3/19 a disadvantage with physician care.
- Physician advantage is confined to a well defined group of patients with serious, life-threatening injury.
- The quality of the evidence is poor. There have been no randomised trials assessing the impact of physician versus other care on patient outcome. Many of the included studies were confounded by comparing helicopter with ground transport and physician care with basic life support care making it impossible to exclude the effects of transport method or to distinguish if effects are the result of interventions or the personnel performing those interventions.
- Little attention has been paid to assessing the costs and cost-effectiveness of different levels of care. This is an important factor to consider where potential benefits are for a small number of patients.
- There is only a small number of European studies that have included nurses as providers of pre-hospital care and very few studies that have assessed the impact of lay community response schemes.

Review 2 – Evidence on pre-hospital intubation

A systematic search was carried out in 14 databases (biomedical, nursing and multi-disciplinary) and research registers in mid August 2011 producing 1092 potential studies. After screening 22 studies were included in the final analysis. The majority of these studies were on trauma patients and cardiac arrest patients. The main findings were;

- The evidence on pre-hospital ETI tends towards worse outcomes that simple BLS airway management and deferral of intubation until arrival at hospital with 90% of included studies reporting no overall survival benefit with use of pre-hospital ETI
- Two previous systematic reviews have found no evidence in favour of pre-hospital ETI and the results of this review concur with this view
- No studies of ETI in cardiac arrest showed any benefit
- The majority of studies on trauma patients showed no benefit in terms of mortality when non drug assisted pre-hospital ETI was used.
- Where there is a survival advantage this may be due to increased exposure to suitable patients so skills are used more often and is more associated with RSI
- A small number of studies have demonstrated a potential advantage to pre-hospital RSI in terms of reducing morbidity survivors of head injury. There is scope for more research in this area
- In general the quality of studies was poor with 70% being retrospective analyses. There are few prospective studies and we found only 3 controlled trials assessing the impact of pre-hospital ETI on patient outcome.

1. Introduction

1.1 Background and Purpose

This review has been written at the request of the Region Zealand Health Board, Denmark. Administratively, Denmark comprises 5 regions and, with respect to healthcare, each region is responsible for the planning, organisation and delivery of health services to their constituent populations. Region Zealand covers an area of 7,273 sq km and serves a population of 800,000 residents across a predominantly rural area with an extensive coastline and a number of islands. The Region Zealand Health Board is currently reviewing health care provision including pre-hospital care.

Pre-hospital care constitutes an important and sensitive part of the Danish health care system. A current centralization of hospital services in Denmark has added to the media's interest in pre-hospital care and hence to the topic's political sensitivity.

Up-to-date knowledge about the evidence base on the impact of different approaches to providing pre-hospital services constitutes one of the fundamental preconditions for delivering effective and efficient pre-hospital care of high quality. The purpose of this work is to provide an independent review of the current evidence base for two aspects of pre-hospital care that are particularly pertinent to current health policy in Denmark and therefore provide an overview of relevant information to support future planning and service design.

1.2 Objectives

Region Zealand requires an independent and structured review of the scientific and "grey" literature on the following two study questions:

3) What is the association between pre-hospital personnel's education (MD, nurse, paramedic, ambulance technician, advanced first-aid training for laymen etc.) and training and the outcome for patients?

4) What is the association between advanced pre-hospital interventions for airway management (specifically endotracheal intubation) and patient outcome?

1.3 Review Approach

An appraisal of the existing research evidence is an essential first step when considering changes to health policy and practice providing decision makers with the information they need to guide this process. It provides a summary of not only what is known but also the evidence gaps which may require further research. Evidence reviewing is, like any research activity, susceptible to the risk of bias in its execution. To minimise this risk methods have been developed to "systematically" review research literature by adopting an explicit framework to identify, select and appraise available evidence. A full systematic review is requires significant time and resources to complete and was not within the scope and timescales needed for Region Zealand activities. Instead, we have replicated the methods successfully used to produce a set of evidence reviews for the UK Department of Health Ambulance Policy Team[1].
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_117194

We have conducted scoping reviews for the two topic areas specified by Region Zealand that allow identification of relevant literature and a rapid assessment of the evidence using the principles set out in the Rapid Evidence Assessment (REA) toolkit[2].

http://www.civilservice.gov.uk/my-civil-service/networks/professional/gsr/resources/gsr-rapid-evidence-assessment-toolkit.aspx

REAs are carried out more speedily than systematic reviews but they need be no less rigorous as they follow a structured process but in order to be rapid do, for example, impose restraints on factors such as inclusion criteria.

The scoping reviews have been conducted using the following steps:

1. Development of the review questions and context which then guide the review processes with Region Zealand clients.
2. Development of a protocol for a priori rapid evidence review with agreed inclusion and exclusion criteria
3. Construction of the search strategies and information sources to be used (including grey literature) in line with 1&2 and conduct searches.
4. Screening and selection of studies using screening criteria derived from the question and inclusion criteria.
5. Presentation of final included studies as summary tables
6. Quality appraisal
7. Discussion of main findings.

2. Rapid scoping review on skill level requirements for pre-hospital care

2.1 Context and Review Question

The first review is concerned with the question about who should deliver pre-hospital care and the evidence about the relative advantages and disadvantages associated with different types of pre-hospital personnel in terms of the effect on patient outcome.

Pre-hospital care services have developed significantly over the last 30 years and during this time demand for services and the range of clinical conditions for which people use the ambulance service as their gateway to healthcare have also increased. For example, in 1975 ambulance services in England responded to 1.5 million calls a year. By 2011 this had increased to 8 million emergency calls and over 6 million responses a year[3]. Pre-hospital care services internationally have historically been developed and organised to meet the needs of patients with life threatening emergencies, specifically patients with cardiac arrest and serious trauma, with a focus on speed of response[4]. However, it is estimated that only about 10% of these calls are for truly life-threatening conditions [5] with the remainder being for urgent or non-serious health problems[6,7]. Internationally there is recognition that pre-hospital care services for the future will need to be more diverse and responsive to the challenges of increased demand and varied case mix and key policy documents in England[8], Canada[9] and the USA[10] have set out aspirations to create pre-hospital care services that move away from focusing primarily on trauma and resuscitation and instead provide comprehensive mobile health care services that can meet the needs of a diverse population of patients with a complex case-mix of conditions and variable levels of acuity. This approach requires a system model for pre-hospital care which is integrated with the wider health service. However, despite this vision there is no empirical evidence about how a system should be designed and what services should be provided[11]. Instead research studies have concentrated on individual components of pre-hospital care and there are still questions about the fundamental concepts around what services should be provided, how they should be provided and who should provide them.

The question of <u>who</u> should provide services and the clinical skills required is an area of importance for Region Zealand. The broadest distinction of pre-hospital care systems is whether the system is physician based (as in some European Countries) or paramedic based (the model used in the USA, UK, Australia and a range of other countries). A recent review of the international evidence on best practice for Emergency Medical Services found a limited number of comparative studies that have attempted to evaluate which, if any, model is superior. Comparative studies of different models of care have been limited to specific conditions such as cardiac arrest and trauma and have failed to demonstrate any clear advantage of a physician model over a paramedic model[12]. This lack of evidence about the relative benefits of one model compared to another at a system level means that in order to synthesise and summarise the evidence available on the relationship between pre-hospital skill levels and patient outcomes, primary research studies that have examined different components of pre-hospital care provision is needed. This therefore forms the focus of this review.

The review question has been framed as an impact question, that is, it is concerned with evidence about what works[2].

Review Question

What is the association between pre-hospital provider service personnel's education (MD, nurse, paramedic, ambulance technician, advanced first-aid training for laymen etc.) and training and the impact on outcome for patients?

As the question is aimed specifically to inform development of a pre-hospital response for acute care following a call to a national emergency service number (e.g 112, 999,911) it is only concerned with evidence about responses activated by associated pre-hospital providers. It therefore includes all responses by personnel working in ambulances and vehicles carrying specialized personnel to acute patients. This can include lay (community) responders with some advanced first aid training but only if they are activated by a pre-hospital care service such as the ambulance service. It does not include:

- Health care personnel working outside hospitals who may happen to be present when patients need acute care (e.g. general practitioners and home nurses)
- Health care personnel requested on an *ad hoc*–basis to assist in emergencies (e.g. in response to disasters or major incidents
- Health care or other personnel (including lay people) who initiate care (for example by using Public Access Defibrillation equipment) independently of any pre-hospital care response.

2.2 Review Protocol

Rapid evidence assessments require explicit and well defined inclusion and exclusion criteria to provide focus for searching strategies and the screening and selection process. The imposition of constraints, for example on the time period to be included, is needed if the review is to be carried out quickly.

The inclusion and exclusion criteria were defined from the question and scope set out by Region Zealand Health Board using the PICO framework (Population, Intervention, Comparison, Outcome).

<u>Inclusion criteria</u>

- **Population** - Studies concerned with pre-hospital care. This can be an ambulance service or what is internationally referred to as EMS (Emergency Medical Service) and includes providers of pre-hospital care. Other parts of the emergency care system (e.g Emergency Departments) were not considered unless it was in the context of a relationship with pre-hospital service delivery. Any type of pre-hospital care patient was included and no restriction imposed on condition types.

- **Intervention** – Although not strictly an intervention the item of interest was defined as the educational level or professional group delivering pre-hospital care. Included are physicians, nurses, paramedical staff and lay people responding on behalf of a pre-hospital care service. The focus of included studies was the skill level of the provider not specific interventions.

- **Comparison** - Research evidence included was confined to the results of controlled evaluative type studies which have compared at least two different levels of pre-hospital care provider to measure differences in the effects of care delivered. Systematic reviews in the topic area were included. There were two exceptions to this criteria, comparisons of Advanced Life Support (ALS) and Basic Life Support (BLS) within the single level provider group of paramedics and some related volunteer responders. The rational is given below under exclusions.

- **Outcome** – Studies included were required to have at least one patient outcome measure to assess impact of care, for example survival, quality of life, adverse events.

- **Inclusion dates** - Pre-hospital care has developed and changed significantly in the recent past a cut off of 15 years was set to retain context and applicability to present day operations. Studies published between 1996 – 2011 were included.

- **Language** – Because of time constraints only English language publications were included.

Exclusion Criteria

- Studies concerned with other parts of the emergency care system and not including pre-hospital care.

- Descriptive studies which are only concerned with a single level of care (for example physicians) with no comparison against another group.

- Studies describing and assessing differences between different provider groups but with a focus on a specific skill e.g. testing protocols to recognise stroke.

- Comparative studies with more than one provider level but which only describe differences in processes (e.g. response times) or frequency of interventions and no patient outcomes.

- Comparative studies with more than one provider level but where the focus is on a specific intervention rather than the skill level of the provider. This is predominately concerned with the use of endotracheal intubation which is considered in a separate review (see section 3).

- Studies comparing ALS and BLS care by Emergency Medical Technician (EMT) and paramedics. This item posed a dilemma as it is a comparison of different skill sets. However it is confined to a single professional group (paramedical staff) with increasing skill levels in much the same way that other professional groups develop within their professional boundaries. The focus of this review is primarily comparisons of different professional groups with different educational programmes. In addition, there is a very large number of published research studies that have focussed on comparing ALS and BLS care and to include all of these within this review would have made the task unmanageable. We have therefore excluded primary research studies concerned with comparisons of ALS and BLS care by paramedical staff but have included systematic reviews on this topic to provide context and a consideration of this subject area in the analysis. There are developments in extending the role of paramedics beyond ALS care and comparative studies in this subject area have been included.

- Similarly, within the research literature from the USA there are comparative studies of “volunteer” responders. However, within the EMS system in the USA volunteer and regular BLS responders (usually fire services) are an integrated part of the EMS service and are a standard response. This is not the same as the context of interest to Region Zealand which is the use of lay volunteer community responders who respond on an ad hoc basis in isolated areas where an ambulance response may be some distance away. Comparative studies including US volunteer BLS fire responders have not been included in this review although they are taken in to account in the systematic reviews of ALS versus BLS care.

- Studies published before 1996

- Studies published in languages other than English

Searches strategies were then designed using the inclusion and exclusion criteria and searches conducted. This process is described in more detail in the next section.

Screening and Selection

The references generated by the searches were screened and final studies for inclusion selected in three stages;

1. An initial rapid screening of titles and abstracts to determine the focus of the study area. Any references clearly not meeting the area of interest or inclusion criteria at this stage were excluded from further consideration.
2. A more detailed screening of abstracts against the inclusion and exclusion criteria. Where there was no abstract or insufficient information to make a decision the full paper was retrieved. References not meeting the inclusion criteria were excluded from further consideration.
3. A provisional list of inclusions was constructed and full papers retrieved. From these a final list of inclusions was constructed. Reference lists of included studies were screened and any additional relevant references retrieved and checked against the inclusion and exclusion criteria. Any references meeting the criteria were added to the final list of included studies.

Summary tables were then constructed for the final list of included studies.

Quality Assessment

A simple quality assessment tool of final included studies was constructed based on study design and criteria identified as relevant to the comparisons made within the final studies. Relevance criteria have been identified separately for each review and details are given in the results sections.

2.3 Search methods

A systematic search was carried out in 14 databases (biomedical, nursing and multi-disciplinary) and research registers in mid-August 2011. For completed or ongoing and unpublished studies, the UKCRN and ClinicalTrials.gov online databases were searched. Conference proceedings were searched via the Web of Science. Table 2.1 provides details of the database host and coverage dates.

Table 2.1 – Information sources used

Database/website		Provider/Interface	Coverage
1.	Medline and Medline in Process & Other Non-Indexed citations	Ovid	1948-present
2.	EMBASE	Ovid	1996-present
3.	Science Citation Index Expanded (SCI-EXPANDED)	Web of Science	1899-present
4.	Conference Proceedings Citation Index - Science (CCPI-S)	Web of Science	1990-present
5.	Social Science Citation Index (SSCI)	Web of Science	1956-present
6.	Conference Proceedings Citation Index – Social Science & Humanities (CCPI-SSH)	Web of Science	1990-present
7.	Cochrane Database of Systematic Reviews (CDSR)	Wiley Interscience	1996-present
8.	Cochrane Central Register of Controlled Trials (CCRCT)	Wiley Interscience	1898-present
9.	NHS Health Economic Evaluation Database (NHS EED)	Wiley Interscience	1995-present
10.	Health Technology Assessment Database (HTA)	Wiley Interscience	1995-present
11.	Database of Abstracts of Review of Effects (DARE)	Wiley Interscience	1995-present
12.	*Cumulative Index to Nursing and Allied Health Literature (CINAHL)*	EBSCO	1982-present
13.	UK Clinical Research Network (CRN) Portfolio Database[1]	NIHR	2001- present
14.	ClinicalTrials.gov	US NIH	2000- present

<u>Searches by study design</u>

Highly sensitive search filters were applied to limit searches by study design. Tables 2.2 and 2.3 show the databases and the filters applied in the searches.

Table 2.2 – Search filters used

Database	Study design			
	RCTs	**Observational studies**	**Systematic reviews**	**Economic evaluations**
Medline and Medline in Process & Other Non-Indexed citations	✓	✓	✓	✓
EMBASE	✓	✓	✓	✓
SCI-E, SSCI, CPI-S & CPI-SSH	✓	✓	✓	✓
CDSR	✘	✘	✘	✘
HTA & DARE	✘	✘	✘	✘
CCRCT	✘	✘	✘	✘
NHS EED	✘	✘	✘	✘
CINAHL	✓	✓	✓	✓
UK CRN	✓	✘	✘	✘
Clinical Trials.gov	✓	✘	✘	✘

Table 2.3 - Search limits used

Limits	**RCTs**	**Observational studies**	**Systematic reviews**	**Economic evaluations**
Date	1996 to present	1996 to present	1996 to present	1996 to present
Language	English	English	English	English
Filter	RCT filter where applicable	Observational studies (Obs) filter where applicable	SR filter where applicable	Economic filter where applicable
Country	NA	NA	NA	NA

Search strategies

Terms for “training” or “education” of pre-hospital personnel (statements 1-4 in Medline) were combined with terms for “pre-hospital care” or “emergency care” (statements 6-10). Searches for specific types of pre-hospital personnel (e.g. doctors, nurses, paramedics, lay person etc.) were not necessary as this is implied in the training terms. Highly sensitive filters were applied to limit the searches by study design . All searches were limited by date from 1996 onwards and English language. An example search strategy for Medline is given below. The complete list of search strategies used for all searched databases is given in Appendix 1.

Medline

1. (train$ or competence$ or educat$ or skill$ or certif$ or credential$).tw.
2. Emergency Medical Technicians/ed [Education]
3. *Emergency Medicine/ed [Education]
4. *Traumatology/ed [Education]
5. or/1-4
6. ((pre-hospital or pre-hospital) and care).tw.
7. Emergency Medical Services/mt [Methods]
8. (emergency medical service$ and (pre-hospital or pre-hospital)).tw.
9. (EMS and (Pre-hospital or pre-hospital)).tw.
10. (emergency adj2 care).tw.
11. or/6-10
12. 5 and 11
13. limit 12 to yr="1996 -Current"
14. limit 13 to english language

Search results were exported in to the reference management software package EndNote version 9.

2.4 Results

2.4.1 Search results

The searches generated a total of 1493 references.

Table 2.4 – Search results from each database

Database	Keywords in database	RCTs	Obs	SRs	Economic	Total
Medline and Medline in Process & Other Non-Indexed citations	$$medline	144	593	52	76	755
EMBASE	$$embase	124	272	41	256	597
SCI-E, SSCI, CPI-S & CPI-SSH	$$wos	136	386	75	298	751
CDSR	$$cochrane	-	-	3	-	3
HTA & DARE	$$cochrane	-	-	4	-	6
CCRCT	$$cochrane	145	-	-	-	145
NHS EED	$$nhseed	-	-	-	2	2
CINAHL	$$cinahl	68	**174**	**23**	**116**	**328**
Total retrieved	**-**	**-**	**-**	**-**	**-**	**2593**
Number of unique records in database	**$$filters**	**-**	**-**	**-**	**-**	**1494**
UK CRN	N/A	2	-	-	-	2
Clinical Trials.gov	N/A	10	-	-	-	10
Records in Word file	**-**	**12**	**-**	**-**	**-**	**12**

Initial Screening and selection

Initial rapid screening of study titles and abstracts (question and methods) using the inclusion and exclusion criteria excluded 1422 studies. The main reasons for exclusion were, not pre-hospital care;

descriptive studies with no outcome measurement, policy discussions; single level provider studies with no comparison of different levels of care. Studies where there was insufficient detail in the title (where no abstract was available) or abstract to apply inclusion or exclusion criteria at this point were included and the full abstract or paper retrieved. This left 72 references for further consideration. Abstracts and full papers were scrutinised in more detail for these studies and a further 51 were excluded for the following reasons:

- 1 study was a literature review (not systematic)
- 5 studies were scope of practice reviews with no patient outcome component
- 18 studies were single provider level studies (e.g studies of recognition or management of specific conditions such as stroke, acute myocardial infarction or therapeutic intervention skills within a single group e.g ultrasound by paramedics)
- 13 were descriptive studies of a single provider group measuring rate of interventions or process only measures such as response time
- 10 were descriptive studies of different pre-hospital care systems or levels of care but only process measures were considered and no analysis of patient outcomes
- 3 studies were comparisons of ALS versus BLS care within a single provider group – this has been considered only by related systematic reviews.

This left 21 studies for further review. From these studies an additional 5 studies were identified from full paper review but one of these was a general (not systematic) review article and excluded from further analysis giving a total 26 studies included in the final more detailed review.

2.4.2. Summary of included studies

The 26 included studies were highly variable in terms of the comparisons made, for example some studies involved comparisons with helicopter emergency medical services (HEMS) whilst others were only concerned with pre-hospital ground services. For clarity included studies have been categorised in to broad groups and summary details presented in separate tables. The studies have been categorised as:

1. Systematic reviews and meta-analysis

2. Comparative studies of physician staffed HEMS services

3. Comparative studies of physician and EMS ground services

4. Other studies

The related tables are given below. The following abbreviations have been used in the tables for brevity

ALS	Advanced Life Support
BLS	Basic Life Support
EMT	Emergency Medical Technician (usually BLS level)
EMS	Emergency Medical Service (usually refers to an ambulance service)
RCT	Randomised Controlled Trial

ISS	Injury Severity Score (ISS >15 is by convention serious injury)
AIS	Abbreviated Injury Score
OR	Odds Ratio
rr	Relative Risk
HEMS	Helicopter Emergency Medical Service
GCS	Glasgow Coma Score
GOS	Glasgow Outcome Score
QALY	Quality Adjusted Life Year
QoL	Quality of Life
ROSC	Return of Spontaneous Circulation
AMI	Acute Myocardial Infarction

Table 2.5 – Systematic reviews and meta-analysis

Reference number	Author, Year,	Population	Methods	Outcomes	Main Findings
13	Jayaraman, 2010	Trauma patients Ambulance paramedics and technicians only	Systematic review of ALS versus BLS training for ambulance staff	Mortality Morbidity	Only 3 studies met inclusion criteria. 1 RCT, 1 controlled before & after, 1 uncontrolled before & after. None demonstrated benefit for ALS training.
14	Ryynanen, 2010	All pre-hospital care patients Any pre-hospital provider level	Systematic review of ALS v BLS care	Mortality Quality of Life Activities of daily living	46 studies included. 5 studies on unselected patients – 3 no difference between ALS & BLS, 2 had no comparator 5 studies on pre-hospital thrombolysis showed survival advantage with ALS 9 studies on cardiac arrest – 6/9 showed survival advantage for ALS but non-significant 25 trauma studies - 10 no difference between ALS & BLS, 9 BLS better, 5 ALS better but confounded by helicopter transport 3/4 other studies showed ALS advantage for respiratory problems and epilepsy ALS advantageous for pre-hospital thrombolysis. BLS best for most trauma but possible ALS advantage for serious injury.
15	Botker, 2009	Trauma and any acute illness Physicians and paramedical staff	Systematic review of controlled studies comparing physician care with paramedical care	Mortality	26 studies included. Overall 11 showed survival advantage with physicians, 2 with paramedical, 13 no difference. 9/19 trauma studies and 4/5 cardiac arrest showed physician advantage. Helicopter systems included.
16	Liberman, 2000	Trauma patients Ambulance personnel only	Meta-analysis of ALS v BLS care. Calculated Odds Ratios for survival for aggregated data and weighted for study design and methodological assessment method	Mortality	15 studies included. Overall 12/15 studies favoured BLS and 3/15 ALS. Crude OR for dying 2.92 and weighted OR 2.59 for patients receiving ALS care. Aggregated data failed to demonstrate a benefit of ALS care for trauma patients.

Table 2.6 – Comparative studies of physician staffed HEMS services

Reference number	Author, Year, Country	Population	Methods	Outcomes	Main Findings
17	Bartolacci, 1998, Australia	Serious trauma ISS>15 Physician staffed HEMS (n=77) Paramedic ground (n=308)	Retrospective cohort study comparing physician staffed HEMS with matched control ground paramedic response	Mortality Frequency of interventions	HEMS patients needed significantly more interventions in ED. Paramedic group more likely to die in first 48 hours rr 1.43 (95%CI 0/74, 2.78) Using TRISS methodology HEMS group had fewer predicted deaths and 12 additional survivors per 100 patients. Longer pre-hospital times but survival benefit for HEMS.
18	Garner, 1999, Australia	Trauma ISS>10 Physician HEMS(n=67) Paramedic HEMS(n=140)	Retrospective review study comparing physician v paramedic staffed HEMS	Mortality Frequency of interventions	More interventions in physician group (intubation, IV fluids, thoracic decompression). Difference between observed and predicted deaths significant in physician group with fewer deaths. Adjusted W statistic comparing physicians with paramedics 13.44 (95% CI: 7.80 to 19.08), suggesting between 7 and 19 extra lives saved per 100 patients.
19	Garner, 2001, Australia	Serious blunt head injury GCS<9 Physician staffed HEMS (n=46) Paramedic ground (n=250)	Retrospective review study comparing physician staffed HEMS with ground paramedic response	Morbidity (Glasgow Outcome Score) Frequency of interventions	Physician group had better neurological outcome than paramedic group (OR 2.70, 95%CI 1.48-4.95). Intubation not associated with better outcome.
20	DiBartolomeo, 2001, Italy	Patients with severe head injury ISS>15, AIS>3 Group A – Physician staffed HEMS (n=92) Group B – Nurse +EMT staffed ground (n=92)	Prospective cohort study comparing outcomes for Physician HEMS with nurse ground response	Mortality at 30 days Glasgow Outcome Score	OR for mortality helicopter/ambulance 1.39 (95%CI 0.72, 2.67). Median GOS 4 in each group. Sub group analyses for low BP, neurosurgical intervention and urban rescue did not change this. Weak evidence of a survival benefit in ambulance patients with GCS 10-12. No survival or disability benefit detected for HEMS.
21	Frankema, 2004, Netherlands	Blunt trauma patients ISS>15 Physician staffed HEMS + EMS ground (n=107) EMS (nurse paramedic)	Prospective observational study comparing outcomes for Physician HEMS with EMS ground response	Mortality	Mortality for HEMS 34.6%, EMS ground 24.3%. Unadjusted OR for survival 0.61 (95% CI 0.37,1) 1.7, adjusted OR 2.2 (95%CI 0.92,5.9) for HEMS. HEMS produced a survival benefit for severely injured patients.

		ground (n=239)			
22	DiBartolomeo, 2005, Italy	Traumatic cardiac arrest Group A – Physician staffed HEMS (n=56) Group B – Nurse +EMT staffed ground (n=73)	Prospective cohort study comparing outcomes for Physician HEMS with nurse ground response	Mortality	Mortality Physician HEMS 96%, Nurse ground 100%. Two survivors in HEMS group. No benefit from physician HEMS.
23	Lirola, 2006, Finland	Blunt trauma patients Physician staffed HEMS (n=81) BLS ground (n=77)	Uncontrolled before and after study comparing physician HEMS and BLS ground response	Mortality QoL 3 years later	Mortality for HEMS 31%, Ground BLS 18%. Trend (p=0.065) to lower mortality in ground BLS group. No difference in health related QoL. Physician HEMS conferred no benefit in this setting.
24	Shepherd, 2008, Australia	Trauma Physician (n=28) ALS ambulance officer (n=101_	Retrospective case study comparing a physician helicopter response with ALS ambulance staff helicopter response	Mortality Process measures	No difference in mortality between physician and ALS groups but small numbers – only 1 death in each group.
25	Ringburg, 2009, Netherlands	Trauma patients with severe injury ISS>15 Physician HEMS (n=310) EMS nurse paramedic ground n=471)	Prospective cohort study to assess cost-effectiveness of physician staffed HEMS	Mortality QoL (EQ-5D)	HEMS patients more severely injured. Estimated HEMS saved an additional 29 lives. No difference in QoL after 2 years. Incremental cost-effectiveness ratios for HEMS v EMS 28,327 Euro per QALY. HEMS cost per QALY within accepted limits.
26	Berlot, 2009, Italy	Serious blunt head injury ISS >14, AIS head >2 Physician HEMS (n=89) BLS ground n=105)	Retrospective case study comparing a physician helicopter response with BLS ground ambulance	Mortality Neurological function	More interventions in physician group. Mortality and serious neurological disability lower in physician group (mortality 21% v 25% p<0.05 and disability 25% v 31% p<0.05).

Table 2.7 - Comparative studies of physician and EMS ground services

Reference number	Author, Year, Country	Population	Methods	Outcomes	Main Findings
27	Dickinson, 1997, USA	Nontraumatic, nonaysystolic cardiac arrest Physician attended (n=9) Paramedic attended (n=40)	Retrospective case series comparing on-site physician management with paramedic management of cardiac arrest	ROSC and survival to hospital discharge	Groups matched for age, response time, initial rhythm, bystander CPR, time to 1st defibrillation. Physician group had twice as many drugs administered. No significant difference between groups for ROSC but significantly higher survival to discharge in physician group (44% v 5% p=0.009).
28	Suominen, 1998, Finland	Paediatric trauma age <16years Physician (n=49) BLS (n=72) Some possible helicopter cases in physician group	Retrospective case series comparing physician management with BLS management	Mortality	Trend towards higher overall survival in physician group 22.4% v 31.9% and within first 6 hours 36.4% v 60.9% but non-significant. Significant survival advantage in physician cases in subgroup ISS 25-49. Improved outcome with physician care for severe but survivable injury.
29	Liberman, 2003, Canada	Trauma Physician ALS (n=801) Paramedic ALS(n=1000) BLS (n=7604)	Observational study comparing 3 cohorts of patients from 3 cities with different levels of pre-hospital care. Comparisons between cities and provider level.	Mortality	Mortality in BLS only city significantly lower than ALS cities. Overall mortality 35% for physicians, 24% ALS paramedics and 18% BLS. For major survivable injury mortality 30% ALS, 26% BLS. Adjusted odds of dying 36% greater for Physician care compared to BLS and 21% for ALS care compared to BLS. No benefit from ALS care for trauma patients in an urban environment.
30	Christenzen, 2003, Denmark	Emergency ambulance users Before (n=2950) After (n=2869 with 795in physician group)	Uncontrolled before and after study comparing outcomes between BLS care and a physician response unit	Hospital admission Mortality at 6 months	Fewer patients taken to hospital after introduction of physician response (before 93.8%, after 87.9% p<0.0001). Overall mortality was the same in each time period but lower mortality in subgroups in after phase. AMI 6 month mortality 40.5% before, 13.3% after p<0.001, respiratory conditions 0-1 day mortality 2.4% before, 0% after p<0.05. Some advantage using physician for specific subgroups.

31	Osterwalder, 2003, Switzerland	Trauma Physician (n=196) BLS EMT (n=71)	Prospective observational cohort study comparing physician care with BLS	Actual v predicted mortality	Overall mortality physician group 11.2%, BLS 14.1% non-significant. Physician group 1.3 (95% CI-5.9-8.5) fewer deaths than predicted compared to 3.4 (95% CI -0.2-7) more deaths than predicted in BLS group (p=0.06). OR of death 37 (95%CI 2-749) for BLS compared to physician. Higher trend to mortality in BLS group.
32	Estner, 2007, Germany	Cardiac arrest First resuscitation attempt: Physician (n=117) EMT-ALS (n=177) Bystander (n=118)	Prospective observational study of out of hospital cardiac arrest in one city with two levels of ALS provider.	Survival to hospital discharge Neurological status of survivors at discharge	18.6% of physician treated, 8% EMS and 16% bystander survived to discharge from hospital (p=0.8 for physician treatment). Multivariate analysis showed level of response was not an independent predictor of survival (OR 0.89 95% CI 0.43-1.84). No difference in neurological status of survivors between groups. No advantage from physician care.
33	Olasveengen, 2009, Norway	Cardiac arrest Physician (n=232) Paramedic (n=741)	Prospective observational study of out of hospital cardiac arrest in one city with two levels of ALS provider.	Quality of CPR ROSC Survival to hospital discharge Neurological status at discharge	Physician group had more favourable prognostic indicators (witnessed arrest, initial VF/VT). No difference in outcomes: ROSC Physician 34% v Paramedic 33%, Survival to discharge 13% v 11% and good neurological outcome 94% v 96% in survivors. No advantage from physician care.

Table 2. 8 – Other studies

Reference number	Author, Year, Country	Population	Methods	Outcomes	Main Findings
34	Murad, 1997, Iraq	Trauma Paramedics (n=1016) Lay first responders (n=325)	Case control study comparing paramedic only with lay first response and paramedic care in a single trauma system with long transport times	Mortality	Mortality significantly lower in group initially managed by lay first responders (9.8% v 15.6%, 95% CI 1.3-10). Simple interventions done early contribute to survival where transport times are long.
35	Turner, 2004, UK	999 callers with potentially life threatening conditions	Audit of 999 calls with and without community first response	Response times ROSC Patient satisfaction	Community response improved response time performance by 35% in the rural areas ROSC was 20% for cases attended by community responders and receiving defibrillation Users of the ambulance service who received a community first response show a high level of satisfaction
36	Mason, 2007, UK	999 callers age>60 Advanced paramedic practitioner (n=1549) Paramedic (n=1469)	Cluster RCT comparing management of minor illness or injury by paramedics with extended skills and standard paramedic care	ED attendance Admission to hospital within 28 days Time of call to discharge Patient satisfaction 28 day mortality	Intervention group less likely to visit ED (rr 0.72, 95%CI 0.68-0.75) or be admitted (rr 0.87, 95% CI 0.81-0.94 and had shorter episode time (325v278 minutes). Patients in intervention group more likely to be highly satisfied with care (rr 1.16, 95% CI 1.09-1.23). No difference in 28 day mortality.
37	Engel, 2011, Germany	Traumatic brain injury AIS head >2, AIS other >2 Germany physician attended (n=5665) Australia paramedic attended (n=4518)	Retrospective study comparing two EMS systems	Interventions Mortality	More serious injury and interventions in German cases. Adjusted mortality greater in German patients and also had longer hospital and ICU stay. Variation between systems in data collection, coding and injury profile make international comparisons difficult.
38	Fischer, 2011, Germany	Cardiac arrest, chest pain & dyspnoea Germany physician system (n=1261) Spain physician system (n=489)	Prospective cohort study comparing outcomes in 4 city EMS systems with mixed response levels	Therapies ROSC	Drug therapy highest and pain management most effective in physician systems. No difference in management of oxygen saturation. ROSC highest in physician groups (Germany 35.6%, Spain 30.1%, UK 11.9%, USA 9.2%).

		UK paramedic system (n=794) USA paramedic system (n=3733(			

2.4.3 Discussion

Main findings on skill level evidence

The conclusions of the included studies are equivocal in terms of supporting any particular level of skill producing benefits on patient outcome. There were 3 systematic reviews, 2 examining the relationship between Advanced Life Support or Basic Life support and patient outcome[13,14] and 1 examining the relationship between physician care and patient outcome[15]. There was also one meta -analysis using pooled data to examine the relationship between Advanced Life Support or Basic Life support and patient outcome[16]. None of these reviews detected any overall advantage for one level of care compared to another. The review by Jayaraman[13] used the stricter inclusion criteria applied to trial based systematic reviews and only 3 studies were of sufficient quality to be included. The review by Ryynanen[14] found an advantage for ALS care in patients requiring pre-hospital thrombolysis but no significant effect for the most common groups of patients studies, cardiac arrest and trauma, indeed this review and the meta-analysis by Liberman[16] have both highlighted consistent findings that BLS care produces better outcomes for most trauma patients than ALS care although there may be some benefits for very serious injury. The review by Botker[15] specifically on physician care found included studies were equally divided between favouring physician care and detecting no advantage from physician care.

Most of the individual studies included in this review were also included in these reviews although differences in inclusion and exclusion criteria means there are exceptions. The overall findings of this rapid review concur with the previous systematic reviews, that is, that there is no conclusive evidence with respect to any one skill level producing advantages to patient outcome and considerable heterogeneity in the findings of individual studies. Table 2.9 provides a summary of the main findings of the studies included in tables 6 and 7 in terms of reported advantages or disadvantages for physician care compared to ALS or BLS ambulance care.

Table 2.9 – Summary of main message from included studies

Skill level	Advantage detected (reference number)	No difference detected (reference number)
Physician	Compared to BLS - 26,27,*28*,*30*,31 Compared to ALS – 17,18,19,*21*,25,38	20, 21,22,23,24,28,30,32,33
ALS ambulance	*20*,37	
BLS ambulance	29	

References 20,21, 28, 30 are included twice as they show an advantage for subgroups but not the whole included study populations

The majority of studies (13/19) were conducted on patients with trauma, 5/19 were on patients with cardiac arrest and only 1 study included a broad population of all ambulance calls with variable conditions[30].

Of the 19 primary research studies comparing physician with other care 11/19 show an advantage for physicians although in 3 studies this was for subgroups only, 3/19 studies detected an advantage with ambulance care (with one of these a subgroup) and 9/19 detected no difference on patient outcome related to the skill level of care. Six of the eleven studies reporting a physician advantage compared a physician HEMS service with patients carried by ground ambulance[17,18.19.21.25.26]. This is a major limiting factor as the different methods of transport may produce an effect on patient outcome and it is impossible to distinguish the possible confounding effects of, for example, the faster transport to hospital times or ability to bypass hospitals and take patients directly to a trauma centre that result from using a HEMS service. Only one study (Garner,1999)[18] used comparable groups of HEMS only patients. A more robust assessment of effect is made when the method of transport is the same and 5/11 studies reporting a physician advantage with other care for used ground cases only[27,28,30,31,38]. However these studies introduce another limiting factor which is that the comparison made is between physician care and BLS care. Three of these five studies used this comparison[28,30,31] and raise a fundamental question about the factors which may have an impact on patient outcome which is, is it the advanced level skills or the person using them that is producing any measured benefit? Comparing physician care with BLS care leaves open questions about whether the same effects could be achieved if pre-hospital providers other than physicians provided the advanced skills. Only 2 studies using ground only cases and reporting an advantage with physician care used ALS care as the comparator. The study by Fischer (2011)[38] is an international comparison of outcome from cardiac arrest in 4 countries with different EMS systems and showed a higher return of spontaneous circulation rate for cardiac arrest in physician led services. However no data was reported on the more important outcome of discharge from hospital alive and could not therefore if this initial advantage is maintained. In addition controlling for differences and confounding effects between different populations, operating environments and systems is notoriously difficult. The study by Engel (2011)[37] comparing the German and Australian systems highlighted these difficulties. Internationally there can be many differences in the skill levels associated with different levels of care even though similar terminology, for example paramedic or ALS, may be used and a limitation to many of the included studies is the lack of a clear description about the similarities and differences in the clinical skill sets being used by each group being compared. Dickinson (1997)[27] also compared physician care with ALS care for cardiac arrest and showed a substantial advantage in survival to discharge in the physician group however this sample is hampered by small study numbers with only 9 cases in the physician group. Adequacy of sample size is another limiting factor in the interpretation of the findings of included studies. Of the 19 physician comparison studies examined in this review 11 had sample sizes of less than 100 in at least one of the study groups and 5/19 had less than 100 participants in both groups. Of the 8 studies with greater than 100 cases in each study group 6 detected either no difference between the compared populations[21,30,32,33] or an advantage for ambulance personnel care over physician care[29,37]. However, the limitations of small sample sizes can be offset by good study design and analysis so sample size alone is not a good indicator of study quality.

Quality Assessment

The equivocal findings of the group of primary research studies examining the impact of skill level on patient outcome is unsurprising given the variation in the research approaches taken to address this question. The potential confounding effects of comparing HEMS to ground transport and physician care with BLS make drawing any clear conclusions difficult. This is further limited by the types of study design used. We identified no randomized controlled trials and the study designs used have been confined to retrospective case reviews, prospective case studies and uncontrolled before and after studies. The latter is the weakest design as there is no control for potential confounding effects on outcome. Retrospective case reviews do attempt to use a matched control group but are prone to selection bias when selecting cases and are limited by the information available to conduct analyses. Prospective designs are more robust in that the populations to be included can be pre-specified and recruited sequentially and data collection systems put in place to ensure suitable outcome measures are included but the lack of randomization means there may still be confounding effects due to differences in, for example, case mix. In order to judge the impact of these limiting factors we have developed a simple quality assessment system that takes in to account the study design used and the presence or absence of the limiting factors identified and gives a score for each component. This is given in Figure 2.1 and the scores for the 19 included studies comparing skill level are presented in table 2.10.

Figure 2.1 – Quality assessment scoring system

Item	Characteristics	Score
Study Design*	Uncontrolled before and after Retrospective case review Prospective observational/cohort	0 1 2
Transport method comparison	HEMS v Ground HEMS v HEMS Ground v Ground	0 1 1
Skill level comparison	Physician v BLS Physician v ALS	0 1

*Conventionally systematic reviews use a hierarchical appraisal system spanning multicentre randomised trials down to descriptive case studies but we have confined this to the 3 types of design identified.

Table 2.10 – Quality appraisal scores for 19 studies comparing pre-hospital skill level

Reference Number	Design	Transport comparison	Skill comparison	Total
17	1	0	1	2
18	1	1	1	3
19	1	0	1	2
20	2	0	1	3
21	2	0	0	2
22	2	0	1	3
23	0	0	0	0
24	1	1	1	3
25	2	0	1	3
26	1	0	0	1
27	1	1	1	3
28	1	1	0	2
29	2	1	1	4
30	0	1	0	1
31	2	1	0	3
32	2	1	1	4
33	2	1	1	4
37	1	1	1	3
38	2	1	1	4

Of the four highest scoring studies 3 were concerned with cardiac arrest patients. Two detected no difference between physician and other care[32,33] and one an advantage for physician care[38] although, as discussed earlier, this international comparative study is confined to ROSC as the outcome measure. The fourth study by Liberman (2003)[29] was concerned with trauma patients and uniquely made a 3 way comparison between BLS, ALS (paramedic) and physician care in 3 Canadian cities. This study is one of the most robust included as it is prospective, not confounded by HEMS and has large sample sizes with almost 9000 cases included. This study found no advantage to physician care and in fact outcomes were worse for physician attended patients than BLS attended patients. The limiting factor in this study is the inability to exclude the effects of hospital care on outcome in 3 different settings although the sites were matched, for example all were urban and all patients went to a single level 1 trauma centre in each setting. Eight studies scored 3 points and 3 of these showed no difference between physician and other care[20,22,24] whilst one study reported worse outcomes for physician care[37] although this was an international comparative study with substantial casemix differences. The study by DiBartolomeo (2001)[20] found no overall difference between physician care and a nurse ground response but a survival advantage for moderately injured patients (GCS 10-12) with nurse care. This supports the findings of other studies that any benefit from physician care is confined to the most seriously injured [14,16,21,25,28]. Four studies scoring 3 reported a physician advantage although one, despite better study design and using an ALS comparator, is confounded by comparing a HEMS physician service with a ground response[25]. The only study comparing HEMS physicians with HEMS paramedics reported a survival advantage for the physician group, however the patients in each group were treated at different hospitals and therefore hospital care effects cannot be excluded. The remaining 2 studies scoring 3 also showed a physician advantage but one study had a small sample size of only 9 cases in the physician group[27] and the other compared physician care with BLS care[31].

In summary, three out of four of the most robust studies detected either no difference between physician and other care or disadvantage for physician care. Of 11 studies reporting a physician advantage 10 are compromised by use of a HEMS versus ground or physician versus BLS comparison and 3 by both confounding comparisons. There is no substantial evidence base which unequivocally favours any one skill level for the provision of pre-hospital care.

The analysis of included studies has also revealed the predominance of two models of pre-hospital care – the physician model and the ambulance EMT/paramedic model. Only a small number of European studies have included nurses as the alternative to physician care [20,22,25] and two of these detected no difference in outcomes[20,22]. We have identified no studies that directly compare nurse care with EMT or paramedic care. Similarly, there is little evidence about the role that can be played by lay responders in the community to support pre-hospital care services. We excluded North American studies where volunteer fire service BLS response has a longstanding and integrated role as a first response in EMS systems. The interest for this review was community lay schemes and only two studies were found which had investigated the effect of this type of support. The study by Murad (1997)[34] showed that simple first aid interventions by lay first responders had a positive impact on outcome in trauma patients where response and transport times for EMS are long. One other study (Turner, 2004)[35] reported a significant reduction in response times where lay community first responders were used in a rural area and a high level of patient satisfaction with this community service.

<u>Other outcomes</u>

Unsurprisingly, the majority of studies carried out to assess whether or not level of care has an impact on patient outcome have used mortality as the primary outcome measure. Whilst mortality is an important outcome there has been little exploration of the impact of level of care on other related outcomes such as morbidity and quality of life, or of the differences in costs associated with providing different systems of care. Of the studies included in this review only 5 have considered these issues. Garner (2001)[19], DiBartolomeo (2001)[20] and Berlot (2009)[26] measured neurological status as an outcome. Two of these studies reported better neurological outcome with physician care[19, 26] and one no difference when compared to nurse care. Lirola (2006)[23] and Ringberg[25] included quality of life outcome measures in their studies. Lirola found no difference in quality of life comparing physician with BLS care. The study by Ringberg used EQ-5D quality of life scores to calculate the cost-effectiveness of a HEMS service compared to ground EMS and concluded that HEMS is a cost-effective option, however the analysis is based on the provision of the service and not the costs of individual components such as the use of a physician. The lack of cost-effectiveness studies on different levels of pre-hospital care providers makes decision making on EMS system development difficult, particularly if the potential benefits of one level of care such as that provided by physicians, may be confined to only a small group of patients. Resource decisions have to be made taking in to account the needs of the whole EMS population. The evidence on the impact of physician compared to other care has centred on trauma and out of hospital cardiac arrest as it is these 2 groups that are commonly perceived to be time critical, life-threatening emergencies that may benefit from early clinical intervention. However, these patients comprise only a very small proportion of EMS workload. In the UK it has been estimated that only 10% of emergency ambulance calls are for life-threatening emergencies including chest pain and severe respiratory problems as well as serious injury and cardiac arrest[5]. The scope for impact of advanced clinical care is therefore limited to a relatively small proportion of the pre-hospital care population. Furthermore, not all of these patients will need advanced interventions. A number of studies have examined the frequency with which advanced interventions are used and found them to be rare events. Nagele (2004)[39] conducted an epidemiological study of paediatric trauma and found only 13 cases of serious injury in 3 years concluding that the physician ALS unit may not gain sufficient experience in the management of this patient group. Gries (2006)[40] assessed the frequency of use of advanced clinical interventions in a German physician EMS system and found that life-threatening emergencies were rare with conditions such as acute coronary syndrome, stroke, head injury and multiple trauma being treated once every 0.4-14.5 months. CPR and intubation were carried out once every 0.5-1.5 months and a chest tube placed up to only once every 6 years. So, whilst it is possible that a small number of patients may benefit from advanced level pre-hospital care, more and better research on impact and costs is needed to inform decision making about whether or not providing high level services that can only benefit small numbers of patients are the best way of using scarce resources.

Only one study (Christenzen, 2003)[30] has explored the potential effects of physician care on a wider population of patients requesting emergency pre-hospital care. This study measured changes in patient outcome after the introduction of a physician response unit in one Danish city found both a reduction in patients taken to hospital and a survival advantage for subgroups of patients with AMI and respiratory problems. The limiting factors of this study are that the comparator was BLS care and hence the question of whether the effects could be achieved by up-skilling other staff, and the use of an uncontrolled before and after study design which cannot take account of confounding effects that may also be having an impact on outcome. However, this study does demonstrate the potential for improving care by providing higher level pre-hospital care for other patient groups and is an area worth further investigation. This is supported by the one study included in this review which has examined the impact of providing advanced level paramedic care for minor illness and injury. Mason (2007)[36] conducted a cluster randomised trial comparing patients attended by advanced paramedic practitioners with patients attended by paramedics and found the advanced practitioner patients had fewer ED attendances and hospital admissions and were more satisfied with their care. It has also been shown to be a cost-effective option[41]. Given the relatively small proportion of life-threatening emergencies in pre-hospital care workload, these studies show that there is further scope to improve care for a much broader group of patients than the historically important but limited populations of cardiac and trauma that have dominated the current evidence base.

2.4.4 Summary

We have conducted a rapid review of the evidence base on skill levels required to provide pre-hospital care. The main findings are:

- The evidence on the type of health professional required is equivocal. Three previous systematic reviews have found no evidence in favour of one particular level of care and the results of this review concur with this view.

- Comparative studies of different levels of care have predominately concentrated on physician and ambulance technician or paramedics. We have examined 19 studies making a direct comparison between skill levels and of these 11/19 reported a physician advantage, 9/19 no difference and 3/19 a disadvantage with physician care. Four studies showed differences for subgroups only.
- Physician advantage is confined to a well defined group of patients with serious, life-threatening injury.
- The quality of the evidence is poor. There have been no randomised trials assessing the impact of physician versus other care on patient outcome. Many of the included studies were confounded by comparing helicopter with ground transport and physician care with basic life support care making it impossible to exclude the effects of transport method or to distinguish if effects are the result of interventions or the personnel performing those interventions.
- Little attention has been paid to assessing the costs and cost-effectiveness of different levels of care. This is an important factor to consider where potential benefits are for a small number of patients.
- There is only a small number of European studies that have included nurses as providers of pre-hospital care and very few studies that have assessed the impact of lay community response schemes.
- Almost all of the studies included were for a small subset of pre-hospital care patients – out of hospital cardiac arrest and trauma. However there is some evidence from 2 studies that different skill levels may produce benefits for other patient groups.

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3. Rapid scoping review on advanced airway management in pre-hospital care

3.1 Context and Review Question

The first review has considered is the question of who should deliver pre-hospital care and the evidence about the relative advantages and disadvantages associated with different skill levels of pre-hospital personnel. The principle issue associated with skill level is the range of clinical interventions that can be used in the pre-hospital environment and which may have an impact on patient outcome. In this second review we have focussed on provision of the critical skill of airway management.

A key aim of pre-hospital care for critically ill or injured patients is to maintain adequate oxygenation until the patient reaches definitive care. To achieve this, pre-hospital care providers need to maintain a clear airway with adequate oxygenation and ventilation. The groups of patients most commonly requiring airway management are those with cardiac or respiratory arrest, where oxygenation is a component of cardiopulmonary resuscitation, and patients with trauma and particularly head trauma as hypoxia can lead to secondary brain injury. A range of techniques are available for airway management ranging from simple oral airways, through a variety of supraglottic airway devices to insertion of a cuffed endotracheal tube (endotracheal intubation ETI)[1,2]. Endotracheal intubation is the most advanced technique and has been practised in the pre-hospital environment for over 30 years. The perceived advantages of this technique are that it allows effective and uninterrupted ventilation during CPR, protects against gastric regurgitation and aspiration of gastric contents and control over oxygenation. However the technique is not without risks including inducing hypoxia during the procedure particularly if it is prolonged, tube misplacement and patient distress[3].

For many years ETI has been viewed as the “gold standard” for airway management and a number of guidelines have recommended intubation and ventilation for any patient with a Glasgow Coma Score (GCS) of 8 or less[4,5]. However, in recent years the use of ETI has been called in to question as research evidence has emerged that patient benefits may not be realised and, in certain circumstances, ETI may actually be harmful[3,6]. Factors associated with successful ETI include training and competence, frequency of practice of individual practitioners and whether or not drugs are used to assist ETI. Intubation can be carried out by both pre-hospital physicians and paramedics. Historically the use of drugs, or not, has defined the difference in skill level between these two groups. In the UK and other paramedic led pre-hospital care services paramedics can perform endotracheal intubation but only without the assistance of any drugs. This means that in practice only patients with cardiac arrest or the most deeply unconscious injured patients with a GCS of 3 and no gag reflexes can be intubated. These patient groups have a high mortality rate regardless of any interventions. Head injured patients with a reduced GCS but not deep coma are at risk of the effects of poor oxygenation, they are often combative which exacerbates the problem and better control of their airway and oxygenation may improve survival and subsequent morbidity but cannot currently be intubated by most ambulance service paramedics. Airway control for these patients can be achieved by using rapid sequence intubation (RSI) using sedation, neuromuscular blockade and ETI[7]. This is a technique that has predominantly carried out by physicians but more recently the use of RSI by paramedics has also been tested. The issue of whether or not pre-hospital ETI, rather than other airway management techniques, should be used for critically ill or injured patients remains controversial and the current evidence on airway management forms the focus of this review.

The review question has been framed as an impact question, that is, it is concerned with evidence about what works.

Review Question

What is the association between pre-hospital advanced airway management using endotracheal intubation and the impact on outcome for critically ill or injured patients?

3.2 Review Protocol

Rapid evidence assessments require explicit and well defined inclusion and exclusion criteria to provide focus for searching strategies and the screening and selection process. The imposition of constraints, for example on the time period to be included, is needed if the review is to be carried out quickly.

The inclusion and exclusion criteria were defined from the question and scope set out by Region Zealand Health Board using the PICO framework (Population, Intervention, Comparison, Outcome).

Inclusion criteria

- **Population** - Studies concerned with pre-hospital care. Other parts of the emergency care system (e.g Emergency Departments) were not considered unless it was in the context of a comparator with pre-hospital care. Any type of pre-hospital care patient was included and no restriction imposed on condition types or service type, for example HEMS operations.

- **Intervention** - The item of interest was use of the advanced clinical intervention of endotracheal intubation in the pre-hospital setting. Both drug assisted and non-drug assisted intubation was included. Use of other types of advanced airway (for example Laryngeal Mask Airways – LMA) were included if it was within a study also considering use of ETI. These were no constraints imposed on the educational level of the practitioner with any professional group who carry out ETI included. The focus was the intervention rather than the provider.

- **Comparison** - Research evidence included was confined to the results of controlled evaluative type studies which have compared at least two different levels of airway management one of which is ETI. Systematic reviews in the topic area were included.

- **Outcome** – Studies included were required to have at least one patient outcome measure to assess impact of care, for example survival, quality of life. Studies reporting secondary outcomes were only included if there was also a primary mortality or morbidity patient outcome.

- **Inclusion dates** - Pre-hospital care has developed and changed significantly in the recent past a cut off of 15 years was set to retain context and applicability to present day operations. Studies published between 1996 – 2011 were included.

- **Language** – Because of time constraints only English language publications were included.

Exclusion Criteria

- Studies concerned with other parts of the emergency care system and not including pre-hospital care.

- Descriptive studies only considering a single method of airway management, including ETI, with no comparison against another group.

- Studies describing and assessing ETI skills, including comparisons with other methods of airway management, in simulation settings.

- Comparative studies which only describe differences in processes (e.g. response times) or frequency of interventions and no patient outcomes.

- Comparative studies with a focus on whole service level, for example HEMS, ALS unless there was a specific ETI subgroup analysis with primary patient outcome measures.

- Comparative studies with primary outcomes such as intubation success rates and complications such as hypoxia.

- Studies published before 1996

- Studies published in languages other than English

Searches strategies were then designed using the inclusion and exclusion criteria and searches conducted. This process is described in more detail in the next section.

Screening and Selection

The references generated by the searches were screened and final studies for inclusion selected in three stages;

1. An initial rapid screening of titles and abstracts to determine the focus of the study area. Any references clearly not meeting the area of interest or inclusion criteria at this stage were excluded from further consideration.
2. A more detailed screening of abstracts against the inclusion and exclusion criteria. Where there was no abstract or insufficient information to make a decision the full paper was retrieved. References not meeting the inclusion criteria were excluded from further consideration.
3. A provisional list of inclusions was constructed and full papers retrieved. From these a final list of inclusions was constructed. Reference lists of included studies were screened and any additional relevant references retrieved and checked against the inclusion and exclusion criteria. Any references meeting the criteria were added to the final list of included studies.

Summary tables were then constructed for the final list of included studies.

Quality Assessment

A simple quality assessment tool of final included studies was constructed based on study design and criteria identified as relevant to the comparisons made within the final studies. Relevance criteria have been identified separately for each review and details are given in the results sections.

3.3 Search methods

A systematic search was carried out in 14 databases (biomedical, nursing and multi-disciplinary) and research registers in end-August 2011. For completed or ongoing and unpublished studies, the UKCRN and ClinicalTrials.gov online databases were searched. Conference proceedings were searched via the Web of Science. Table 3.1 below provides details of the database host and coverage dates.

Table 3.1 Databases and dates used

Database/website		Provider/Interface	Coverage
15.	Medline and Medline in Process & Other Non-Indexed citations	Ovid	1948-present
16.	EMBASE	Ovid	1996-present
17.	Science Citation Index Expanded (SCI-EXPANDED)	Web of Science	1899-present
18.	Conference Proceedings Citation Index - Science (CCPI-S)	Web of Science	1990-present
19.	Social Science Citation Index (SSCI)	Web of Science	1956-present
20.	Conference Proceedings Citation Index – Social Science & Humanities (CCPI-SSH)	Web of Science	1990-present
21.	Cochrane Database of Systematic Reviews (CDSR)	Wiley Interscience	1996-present
22.	Cochrane Central Register of Controlled Trials (CCRCT)	Wiley Interscience	1898-present
23.	NHS Health Economic Evaluation Database (NHS EED)	Wiley Interscience	1995-present
24.	Health Technology Assessment Database (HTA)	Wiley Interscience	1995-present
25.	Database of Abstracts of Review of Effects (DARE)	Wiley Interscience	1995-present
26.	*Cumulative Index to Nursing and Allied Health Literature (CINAHL)*	EBSCO	1982-present
27.	UK Clinical Research Network (CRN) Portfolio Database[1]	NIHR	2001- present
28.	ClinicalTrials.gov	US NIH	2000- present

Searches by study design

Highly sensitive search filters were applied to limit searches by study design. Tables 3.2 and 3.3 below shows the databases and the filters applied in the searches.

Table 3.2 Filters applied to databases

Database	Study design			
	RCTs	**Observational studies**	**Systematic reviews**	**Economic evaluations**
Medline and Medline in Process & Other Non-Indexed citations	✓	✓	✓	✓
EMBASE	✓	✓	✓	✓
SCI-E, SSCI, CPI-S & CPI-SSH	✓	✓	✓	✓
CDSR	✗	✗	✗	✗
HTA & DARE	✗	✗	✗	✗
CCRCT	✗	✗	✗	✗
NHS EED	✗	✗	✗	✗
CINAHL	✓	✓	✓	✓
UK CRN	✓	✗	✗	✗
Clinical Trials.gov	✓	✗	✗	✗

Table 3.3 Search Limits

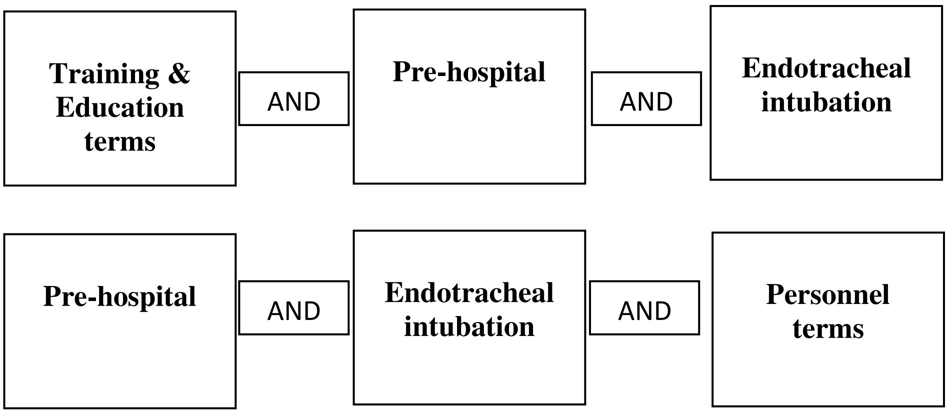
Limits	RCTs	Observational studies	Systematic reviews	Economic evaluations
Date	1996 to present	1996 to present	1996 to present	1996 to present
Language	English	English	English	English
Filter	RCT filter where applicable	Observational studies (Obs) filter where applicable	SR filter where applicable	Economic filter where applicable
Country	NA	NA	NA	NA

Search approach

The search strategy comprises two approaches:

1. Terms for training and education (statements 1-6 in Medline) were combined with pre-hospital/emergency care (statements 8-16) terms and the endotracheal intubation terms (statement 18-31).
2. Terms for pre-hospital/emergency care terms (statements 8-16) were combined with endotracheal intubation (18-31 statements) and specific personnel terms (statements 33-52).

Highly sensitive filters were applied to limit the searches by study design (see end). All searches were limited by date from 1996 onwards and English language.



An example search strategy for Medline is given below. The complete list of search strategies used for all searched databases is given in Appendix 1.

Medline

1. (train$ or competence$ or educat$ or skill$ or certif$ or credential$).tw. 2. Emergency Medical Technicians/ed [Education] 3. *Emergency Medicine/ed [Education] 4. *Traumatology/ed [Education] 5. Education, Professional/mt [Methods] 6. Clinical Competence/	**Training**
7. or/1-6	
8. Emergency Medical Services/ 9. ((care or emergency medical service$ or EMS) and (pre-hospital or pre-hospital)).tw. 10. ((emergency or trauma) adj2 care).tw. 11. ((Pre-hospital or pre-hospital) adj3 (airway or management)).tw. 12. airway management.tw. 13. trauma management.tw. 14. Emergency Treatment/mt [Methods] 15. air ambulance service$.tw. 16. (out-of-hospital adj2 (emergenc$ or care)).tw.	**Pre-hospital**
17. or/8-16	

Search results were exported in to the reference management software package EndNote version 9.

3.4 Results

3.4.1 Search results

A total of 1092 references were retrieved by the searches.

Table 3.4 Results of searches for each database

Database	Keywords in database	RCTs	Obs	SRs	Economic	Total
Medline and Medline in Process & Other Non-Indexed citations	$$medline	177	521	23	11	592
EMBASE	$$embase	164	237	34	45	404
SCI-E, SSCI, CPI-S & CPI-SSH	$$wos	141	234	39	32	402
CDSR	$$cochrane	-	-	6	-	6
HTA & DARE	$$cochrane	-	-	1	-	1
CCRCT	$$cochrane	196	-	-	-	196
NHS EED	$$nhseed	-	-	-	2	2
CINAHL	$$cinahl	74	**161**	**13**	**25**	**234**
Total retrieved	**-**	**-**	**-**	**-**	**-**	**1837**
Number of unique records in database	**$$review 2**	**-**	**-**	**-**	**-**	**1092**
UK CRN (see appendix 2)	N/A	-	1	-	-	1
Clinical Trials.gov (see appendix 2)	N/A	15	-	-	-	15

Initial Screening and selection

Initial rapid screening of study titles and abstracts (question and methods) using the inclusion and exclusion criteria excluded 1032 studies. The main reasons for exclusion were, not pre-hospital care; descriptive studies with no outcome measurement; policy discussions and guidelines; simulation and training studies. Studies where there was insufficient detail in the title (where no abstract was available) or abstract to apply inclusion or exclusion criteria at this point were included and the full abstract or paper retrieved. This left 46 references for further consideration. Abstracts and full papers were scrutinised in more detail for these studies and a further 28 were excluded for the following reasons:

- 4 studies were literature reviews (not systematic)or guidelines
- 2 were systematic reviews of processes
- 3 studies were concerned with procedural skills or processes with no patient outcome component
- 4 were descriptive studies of ETI with no comparator
- 8 were comparisons of a range of ALS skills not specifically airway management
- 2 were conference abstracts
- 3 were registry based studies with mixed intervention groups (drug and non drug assisted intubation) and transport methods (HEMS and Ground)

This left 18 studies for further review. From these studies an additional 4 studies were identified from full paper review but one of these was a general (not systematic) review article and excluded from further analysis giving a total 22 studies included in the final more detailed review.

3.4.2. Summary of included studies

The 26 included studies were variable in terms of the study type and focus. For clarity included studies have been categorised in to three broad groups and summary details presented in separate tables. The studies have been categorised as:

1. Systematic reviews

2. Comparative studies of non-drug assisted intubation

3. Comparative studies of drug assisted intubation

The related tables are given below. All included studies are paramedic performed intubation unless otherwise described. The following abbreviations have been used in the tables for brevity

ALS	Advanced Life Support
BVM	Bag Valve Mask device
ED	Emergency Department
EMS	Emergency Medical Service (usually refers to an ambulance service)
ETI	Endotracheal Intubation
LMA	Laryngeal Mask Airway

EOA	Esophageal Obdurator Airway
RCT	Randomised Controlled Trial
RSI	Rapid Sequence Intubation
ISS	Injury Severity Score (ISS >15 is by convention serious injury)
AIS	Abbreviated Injury Score
OR	Odds Ratio
rr	Relative Risk
HEMS	Helicopter Emergency Medical Service
GCS	Glasgow Coma Score
GOS	Glasgow Outcome Score
ROSC	Return of Spontaneous Circulation

Table 3.5 – Systematic reviews

Reference number	Author, Year, Country	Population	Methods	Outcomes	Main Findings
8	Lecky, 2009,UK	Emergency use of ETI in acutely ill or injured patients	Systematic review of randomised controlled trials comparing ETI with other airway management techniques	Survival, disability at discharge, complications in hospital	3 RCT's included in urban settings. 2 involved adults with out of hospital cardiac arrest. 1 found a non significant survival disadvantage for physician operated ETI compared to combitube. 1 found a non significant survival disadvantage for paramedic intubation compared to oesophageal gastric airway. One study on children found no difference in survival or neurological outcome between paramedic intubation and BVM ventilation and intubation by physician at hospital. Conclusions -In non-traumatic cardiac arrest intubation to produce same life saving benefit as CPR & defibrillation. For trauma and children no imperative to extend intubation skills to pre-hospital setting in urban areas.
9	Von Elm, 2009, Germany	Pre-hospital ETI in patients with traumatic brain injury.	Systematic review of interventional and observational studies comparing ETI with other airway management techniques	Survival, functional outcome, complications	17 studies included, 12 retrospective studies, 3 cohort studies, 1 case control and one uncontrolled trial. 8/13 studies reported unadjusted OR for in hospital mortality in favour of other airway management and 5/13 in favour of pre –hospital intubation. 7 studies reported adjusted OR for in hospital mortality with 5/7 favouring other airway management. Reported functional outcomes were equivocal. 7 studies reported harmful effects of intubation including failure rates and in hospital pneumonia. Conclusions – Generally low level studies, many failed to adjust for confounders in analyses, overall evidence does not support benefit from pre-hospital intubation for brain injury.

Table 3.6 Studies comparing non drug assisted ETI with no ETI or ETI at hospital only

Reference number	Author, Year, Country	Population	Methods	Outcomes	Main Findings
10	Adams, 1997, UK	Out of Hospital Cardiac Arrest (n=8651) ETI attempted (n=3427) Not intubated (n=5224)	Retrospective analysis comparing outcomes in patients with attempted ETI and no ETI	Survival to discharge	3.7% of intubated and 9.1% of non intubated patients survived to discharge from hospital (p<0.01). Survival lower for intubated patients with similar numbers of defibrillator shocks (p<0.01) and intubation rate highest in unwitnessed arrests with worst survival. Intubated patients had lower survival rates but may reflect difficulty of resuscitation attempt rather than intubation.
11	Frankel, 1997, USA	Trauma patients intubated pre-hospital or within 30 minutes of hospital arrival (n=134) ETI pre-hospital (n=47) ETI ED (n-87)	Retrospective analysis comparing outcomes in patients with pre-hospital ETI and ED ETI	Survival, success rates, neurological status	81% of pre-hospital intubations successful v 98% by hospital staff. No pre-hospital intubations were drug assisted but 76% of ED intubations were drug assisted. Survival for pre-hospital intubation 11% v 40% for ED intubation but expected survival 2% v 45% so pre-hospital group had additional survivors. No difference in neurological status between groups at discharge.
12	Winchell, 1997, USA	Head injury GCS <9 Head AIS >3 (n=671) ETI (n=387) No ETI (n=284)	Retrospective case control study comparing ETI with no ETI	Survival to discharge home	Mortality in ETI group 35.6% compared to non-ETI 57% (unadjusted OR 2.43 95%CI 1.75- 3.37).
13	Eckstein, 2000, USA	Major trauma ETI (n=93) BVM (n=403)	Retrospective study comparing outcomes in patients with pre-hospital ETI and BVM	Mortality, scene times	BVM patients mean ISS 29 & mortality 67%, ETI mean ISS 35 & mortality 93%. Survival more likely in BVM group (adjusted OR 5.3 95%CI 2.3 – 14.2, p=0.00). No difference in scene times.
14	Murray, 2000, USA	All head injured patients AIS>2 or GCS<9 admitted to a trauma centre (n=795)	Retrospective analysis comparing outcomes in patients with ETI failed ETI and no ETI	Survival to discharge	Patients with pre-hospital ETI or attempted ETI had higher mortality than non-intubated (81%v 77% v43%). Risk of mortality greater for intubated patients (rr 1.74, p<0.001) and attempted intubation (rr 1.53, p=0.008)

15	Gausche, 2000, USA	Paediatric patients aged <13 and requiring ETI (n=830) ETI (n=420) BVM (n=410)	Controlled clinical trial with patients assigned to ETI or BVM on odd and even days in 2 urban EMS systems	Survival to discharge, neurological outcome	No significant difference in survival between BVM (30%) and ETI groups (26%) (OR 0.82 95%CI 0.61-1.11) or in good neurological outcome BVM23% v ETI 20% (OR 0.87 95% CI 0.62-1.22).
16	Cooper, 2001, USA	Paediatric trauma with serious head injury (n=578) Pre-hospital ETI (n=479) BVM (n=99) Ground & HEMS	Retrospective analysis of trauma registry comparing outcomes in patients with pre-hospital ETI or BVM	Mortality, complications, functional outcome	No difference in mortality between RTI (48%) and BVM (48%) groups. RTI group were significantly older and more likely to be transported by helicopter. Fewer body system & organ complications in ETI group (58% v 71%, p<0.05). No difference in functional outcome.
17	Rabitsch, 2003, Austria	Adult out of hospital cardiac arrest (n=172) ETI (n=83) Combitube (n=89) All physician administered	Controlled trial comparing ETI or combitube with patients assigned to each intervention on odd and even days	Survival to ICU, Survival to discharge, time to insertion, failed intubation	Time to insertion was 6 minutes shorter with combitube (p=0.05) and was more successfully inserted in patients with difficult access. There was no significant difference in survival to ICU (ETI 6% v Combitube 10%) or survival to discharge from hospital (ETI 3% v Combitube 6%). Comitube at least as effective as ETI for airway management in cardiac arrest.
18	Shafi, 2005, USA	Trauma patients GCS<8, ISS>16 Pre-hospital ETI (n=871) Intubated ED (n-6581)	Retrospective analysis of trauma data bank comparing outcomes in patients with pre-hospital ETI and ED ETI	Mortality, hypotension	Patients with pre-hospital intubation more likely to be hypotensive on arrival at ED and had worse survival (24% v 45% for ED intubation, p<0.001). After adjustment for confounders pre-hospital ETI was a predictor for hypotension at ED (OR 1.7, 95%CI 1.46-2.09 p<0.001) and mortality (OR 0.51, 95%CI 0.43-0.62, p<0.001). Pre-hospital ETI patients were more severely injured (p<0.001).
19	Hanif, 2010, USA	Adult out of hospital cardiac arrest (n=1294) Pre-hospital ETI (n=1027) Pre-hospital other airway (BVM/combitube/OEA)n=262)	Retrospective cohort study comparing outcomes in patients with pre-hospital ETI and BVM	Survival to discharge	55/1294 survived (4.3%). Survival to discharge better in patients receiving BVM than ETI (adjusted OR 4.5 95%CI 2.3-8.9).

20	Studnek, 2010, USA	Adult out of hospital cardiac arrest (n=1142) Pre-hospital ETI (n=709) Pre-hospital ETI attempted but failed (n=230) Not attempted (n=203)	Retrospective analysis comparing outcomes in patients with ETI, attempted ETI and no ETI	ROSC, Survival to discharge	Patients with no attempted ETI were more likely to have ROSC than patients with actual or attempted intubation (adjusted OR 2.33 95%CI 1.63-3.33) and more likely to be discharged from hospital alive (adjusted OR 5.46 95%CI 3.36-8.9).
21	Davis, 2011, USA & Canada	Adults with injury and GCS <9 in 10 major research centres (n=1555) Intubated (n=758 RSI =324) Not intubated (n=797)	Prospective cohort study comparing outcome in patients receiving pre-hospital ETI or RSI and no intubation	Survival to discharge	Attempted intubation associated with higher mortality (adjusted OR 2.91 95%CI 2.13-3.98 p<0.01). Adjusted OR for RSI 1.33 95%CI 0.78-2.26 p=0.3). Sites with high rates of intubation had better survival rates suggesting frequency of skill use may be a contributing factor.
22	Egly, 2011, USA	Out of Hospital Cardiac Arrest (n=1414) ETI attempted (n=1220) Not intubated (n=183)	Retrospective analysis comparing outcomes in patients with attempted ETI and no ETI	Survival to admission and to discharge	No significant difference in overall mortality between intubated and non intubated groups. Patients initially in VT/VF had significantly decreased survival to discharge in intubation group (adjusted OR 0.52 95%CI 0.27-0.998). Intubated patients in non-VF more likely to survive to admission but not discharge.

Table 3.7 Studies of drug assisted (RSI) endotracheal intubation

Reference number	Author, Year, Country	Population	Methods	Outcomes	Main Findings
23	Sloane, 2000, USA	Adult trauma (n=314) Pre-hospital RSI (n=47) ED RSI (n=267)	Retrospective before and after study comparing HEMS RSI (physicians and flight nurses) with ED RSI	Mortality Success rates Complications - pneumonia	No differences in success rates. Higher incidence of pneumonia in pre-hospital RSI group (28% v 6%, p<0.001) but RSI group more critically ill. Subgroup analysis of isolated head injury (GCS<9, AIS head>2) showed no difference in mortality or length of stay.
24	Suominen, 2000, Finland	Paediatric head trauma age < 16, AIS head >3 intubated at scene or in hospital (n=176) Pre-hospital ETI (n=24) ED ETI (n=13) trauma centre (n=22) Physician pre-hospital service	Retrospective case note analysis of children requiring intensive care or who died	Survival to discharge	Mortality greater in pre-hospital ETI and ED group then trauma centre ETI group (58% v 92% v 27%). Children intubated pre-hospital and ED had significantly worse AIS head score, ISS and GCS.
25	Davis, 2003, USA	Adult serious head injury GCS 3-8 and unable to intubate without RSI (n=836) Paramedic RSI (n=209) No ETI (n=627)	Before and after study comparing paramedic RSI patients with historical non-intubated controls	Mortality Discharge home or rehab	Mortality higher in paramedic RSI group compared to controls (RSI 33% v no intubation 24.2%, p<0.05) and in patients with head/neck AIS >2 (41.4% v 30.3%, p<0.05). Good outcome (home or rehab) lower in RSI group (45.5% v 57.9%, p<0.01). Outcomes worse in RSI group.
26	Bochicchio, 2003, USA	Adult head injury GCS <9, AIS head >2 (n=191) Paramedic RSI (n=78) ED ETI (n=113)	Prospective observational study comparing outcomes in patients with paramedic RSI or ED ETI	Mortality Morbidity – pneumonia Ventilator and ICU days	Mortality higher in paramedic RSI group (23%v12.4% p=0.05). Paramedic RSI group had more ventilator days (14.7 v 10.4, p=0.03), more ICU days (15.2 v 11.7, p=0.005) and higher incidence of pneumonia (49% v 32%, p=0.02).
27	Davis, 2005, USA	All head injured patients AIS>2 in a county trauma system (n=10413) GCS 3-8	Retrospective study of effects of HEMS. Subgroup analysis comparing outcomes in patients with pre-hospital ETI by HEMS	Survival to discharge	Subgroup only. Improved survival in moderate to severe head injured patients with pre-hospital RSI by HEMS compared to intubation in ED (adjusted OR 1.42 95%CI 1.13-1.78, p<0.01)

		Intubated field RSI by physician or flight nurse (n=1250) intubated ED (n=993)	and ETI in ED for ground transported patients		
28	Klemen, 2006, Slovenia	Adult Severe Head Injury with GCS<9, ISS >15 (n=124) RSI (n=64) No intubation (n=60)	Retrospective cohort study comparing physician pre-hospital RSI with no intubation	Survival to discharge Neurological outcome at 6 months (GOS) Length of stay	RSI group had better short term survival (1 day survival 90% v no intubation 72%, p=0.02) and shorter hospital stay. Better neurological outcome in pre-hospital RSI group (GOS2-3 v GOS 4-5, adjusted OR 2.01, 95% CI: 1.34–3.12, P < 0.001). No difference in total mortality between groups (pre-hospital RSI 40% v no intubation 42%) but lower mortality in RSI group for subgroup GCS 6-8 (24% v 78%, p<0.01).
29	Bernard, 2010,Australia	Adult Severe Head Injury with GCS<10 and intact airway reflexes (n=312) RSI (n=157) RSI ED (n=142)	Randomised controlled trial comparing outcomes in patients randomly assigned to paramedic pre-hospital RSI or ED RSI	Neurological outcome at 6 months (GOS), Survival to discharge	Success rate for paramedic intubation 97%. No differences in length of stay or survival (survival paramedic RSI 67% v ED RSI 64%). Glasgow Outcome score at 6 months paramedic RSI 5 v ED RSI 3 (p=0.28). Proportion of patients with favourable outcome (GOS 5-8) 51% in paramedic group v 39% ED RSI group (risk ratio 1.28 95% CI 1.00-1.64, p=0.046).

3.4.3 Discussion

Main findings on impact of pre-hospital ETI

The conclusions of the included studies are unequivocal in terms of identifying any consistent, robust evidence that pre-hospital endotracheal intubation produces significant benefits for patients. There were 2 systematic reviews identified. The systematic review by Lecky[8] only included clinical trials and hence only 3 studies were eligible for analysis. This review found no evidence to support ETI in an urban setting. The systematic review by von Elm[9] considered the evidence on pre-hospital ETI for a specific group of patients, those with traumatic brain injury, but considered studies other than trials. Over half of the studies included in this review (8/17) found no advantage with pre-hospital ETI and most studies were considered to be of poor quality with poor study design and analyses.

Most of the individual studies included in this review were also included in these reviews although differences in inclusion and exclusion criteria means there are exceptions and we have included more recent studies published since the previous systematic reviews were conducted. Table 3.8 provides a summary of the main findings of the studies included in tables 3.6 and 3.7 in terms of reported advantages or disadvantages for pre-hospital ETI using the main outcome of mortality.

Table 3.8 – Summary of main message from included studies

Advantage detected for ETI (reference number)	No difference detected (reference number)	Disadvantage detected for ETI (reference number)
12, 27 *11 (unexpected survivors in ETI group))* *21 (better outcome in subgroup with highest frequency of ETI)* *28 (better morbidity outcomes and better mortality in serious injury subgroup)* *29 (better morbidity outcomes)*	15, 16, 17, 23, 28, 29	10, 11, 13, 14, 18, 19, 20, 21, 22, 24, 25 *23 (worse complication rate)*

Studies on RSI

References 11, 21, 23, 28, 29 are included twice as they show an advantage for subgroups but not the whole included study populations

The majority of studies (13/20) were conducted on patients with trauma, with a focus on head trauma or decreased consciousness, 5/20 were on patients with cardiac arrest and 1 study included any condition[15]. Three studies were on paediatric populations. Twelve studies (60%) reported worse mortality outcomes with pre-hospital ETI and 6 found no difference between pre-hospital ETI and no intubation or ED ETI, so, 90% of included studies found no benefit from ETI for patients in terms of improving mortality. None of the studies on cardiac arrest patients demonstrated any advantage with pre-hospital ETI. Only 3 studies found improved survival for pre-hospital RTI. One was a retrospective case review[12]. The study by Davis[2] examined the impact of a HEMS service on outcome and a subgroup analysis showed better survival in the group receiving pre-hospital RSI by physicians and flight nurses compared to ground transported patients intubated at hospital, so is not possible to determine if the reported improved outcome is a consequence of RSI or the different skill levels and method of transport in the two compared groups. Another study by Davis[21] looked at outcomes from pre-hospital ETI across a number of US and Canadian systems. Both drug assisted and non-drug assisted cases were included and the effects of type of ETI not distinguished but the analysis did find that outcomes were better in areas where there is a high frequency of intubation suggesting that frequency of skill use may be a contributory factor. Two studies[28,29] including a randomised controlled trial[29] found pre-hospital RSI did not improve mortality but that neurological outcome in survivors was better at 6 months in the pre-hospital RSI group than in patients receiving ETI at hospital. In the study by Klemen[28] pre-hospital RSI was performed by physicians whereas RSI was performed by paramedics in the trial conducted by Bernard[29]. Drug assisted intubation by paramedics has been a contentious issue. Two US studies have also investigated paramedic RSI[25,26]. Both found that mortality was higher in the paramedic RSI group than control groups with ETI at hospital. Bochiccio conducted a prospective study comparing paramedic RSI with in hospital ETI and reported worse mortality in the paramedic RSI group, however the analysis was not adjusted for casemix differences. Davis conducted a study of paramedic RSI and compared outcomes for this group with matched historical controls who were not intubated before arrival at hospital. The before and after design means that confounding factors such as other changes in the EMS or hospital systems which may be influencing outcome cannot be accounted for. Two other studies have examined the impact of physician[24] and physician and flight nurse[23] pre-hospital RSI on outcome and found no difference in mortality[23] or worse mortality compared to trauma centre ETI[24] in the pre-hospital RSI group although in this study survival was better in the prehospital RSI group when compared to ETI at an ED. In both studies it was reported that the RSI group patients were more critically ill than the comparator which may explain some of the difference in outcome.

Study Quality

The included studies are heterogeneous in their design although weighted towards retrospective rather than prospective studies. To robustly identify the true impact of pre-hospital ETI on patient outcome requires well controlled prospective studies that compare well matched patient groups so that other confounding effects such as other advanced interventions, differences in skills, transport methods and hospital effects can be accounted for. We have conducted a simple quality appraisal of the 18 primary research studies included to assess the strength of the evidence presented. The quality appraisal comprises 3 items:

1. Study design used

2. Comparator group selection – ideally the two groups should be selected on the basis on differences in pre-hospital management of airway, e.g patients intubated compared with patients not intubated or managed with an alternative airway device such as BVM. Selection of both groups is based in the pre-hospital phase of care. Some studies have identified a comparison group based on hospital rather than pre-hospital care, e.g patients receiving ETI in the ED. This creates a selection bias as not all patients intubated in hospital may have been eligible for pre-hospital intubation, for example if hospital intubation required RSI but pre-hospital providers could only perform non drug assisted ETI. The exception is where patients are allocated at the scene to pre-hospital or hospital ETI as both groups are drawn from the same pool of patients.

3. Differences in other EMS factors within or between groups, for example if both RSI and non drug assisted cases are included or there are differences in transport methods.

This quality assessment scoring system is given in Figure 3.1 and the scores for the 18 included primary research studies are presented in Table 3.9.

Figure 3.1 – Quality assessment scoring system

Item	Characteristics	Score
Study Design*	Uncontrolled before and after or historical controls	0
	Retrospective studies using contemporary controls	1
	Prospective observational/cohort	2
	Controlled trial	3
	Randomised controlled trial	4
Comparator selection	Hospital	0
	Pre-hospital	1
Intervention or system differences	Within or between group differences	0
	Single intervention/Comparable systems in both groups	1

Table 3.9 – Quality appraisal scores for 20 studies on pre-hospital ETI

Reference Number	Design	Comparator selection	Intervention/system differences	Total
10	1	1	1	3
11	1	0	1	2
12	1	1	1	3
13	1	1	1	3
14	1	1	1	3
15	3	1	1	5
16	1	1	0	2
17	3	1	1	5
18	1	0	1	2
19	1	1	1	3
20	1	1	1	3
21	2	1	0	3
22	1	1	1	3
23	0	1	0	1
24	1	1	1	3
25	0	1	1	2
26	2	1	0	3
27	1	1	0	2
28	1	1	1	3
29	4	1	1	6

The overall quality of included studies was poor with 14/20 studies (70%) being retrospective or before and after studies. There were only 2 prospective observational studies using contemporary controls[21, 26] but one of these included both RSI and non drug assisted ETI in the intervention group. Neither of these studies found any survival advantage although one found an advantage in areas of high levels of intervention[21]. There were 3 controlled trials, with one of these comparing ETI to combitube rather than no intubation or basic airway management but did demonstrate that an alternative advanced airway device is as effective as ETI[17]. The controlled trial conducted by Gausche compared pre-hospital non drug assisted ETI by paramedics with BVM in paediatric patients and found no difference between groups in mortality rates. A limitation of this study is that only 42% of eligible patients in the ETI group received the intervention suggesting a selection bias. Nevertheless the design and analyses of comparable groups makes the findings more applicable than other included studies. The most robust study was the trial by Bernard[29] which compared pre-hospital RSI by paramedics with ED RSI. Patients were randomised at the individual level and this was the strongest study design of all the included studies. The trial did not detect any difference in mortality between groups but did find better neurological outcomes in head injured patients in the pre-hospital RSI group. This was also reported by Klemen[28] in pre-hospital RSI patients and is an important finding as most studies of ETI have used mortality as the primary outcome. Given that any patient requiring pre-hospital ETI is, by definition, seriously ill or injured, then there will always be significant mortality in this patient group. Whilst it would clearly be desirable to find interventions that can reduce deaths, even if this is not achievable there are potential benefits for patients if morbidity can be reduced in survivors. There is scope for future studies to investigate morbidity effects in more detail.

The findings of this rapid review show that, overall, the current published evidence does not indicate that use of pre-hospital ETI provides any clear advantage for patients in terms of improving survival. In particular the evidence on non drug assisted ETI shows predominantly worse outcomes where pre-hospital ETI is used. Any patient so profoundly compromised that non drug assisted ETI can be performed will have a high risk of mortality and rapid delivery to definitive care may be their best option. There may also of course be other factors which influence the effect of pre-hospital ETI including the type of practitioner and skill level of individuals[30]. The latter is highlighted in the findings of the study by Davis[21]. However the studies produced so far have been unable to discriminate between the effects of level of provider and skill and proficiency of provider as they are often confounded, for example the study showing an advantage for RSI in HEMS transported patients may suggest that physician or flight nurse care is better[27] but it may be that HEMS is tasked to more serious cases and therefore exposure to patients needing the intervention is greater so skills are used more often. Critically ill or injured patients requiring airway management in the field are rare events in the pre-hospital care population and consequently skills are also rarely used[3, 31]. Changes in hospital practice with increasing use of Laryngeal Mask Airway (LMA) are providing alternative, less invasive methods of airway management and as use of alternatives increases there are fewer training opportunities in conventional RSI for pre-hospital providers[3].

The current evidence on the negative impact of non drug assisted ETI has formed the basis of recommendations on airway management in the UK[3] and Scandanavia[6] with non drug assisted RTI not being recommended for use as there is no indication that any benefits are conferred. The questions around use of pre-hospital RSI for patients with decreased level of consciousness but intact airway reflexes remain controversial. The trial by Bernard[29] does suggest that this can be part of paramedic practice and that, whilst it may no confer survival benefits there may be patient benefits in terms of better recovery in survivors.

More recently it has been suggested that, particularly for paramedic practice, a less invasive method of airway management using sedation and a Laryngeal Airway Mask (LMA) may be a better way of managing the group of head injured patients with decreased consciousness and who may also be combative but with intact airway reflexes[32] but as yet there have been no studies assessing patient outcomes using pre-hospital LMA with sedation.

2.4.4 Summary

We have conducted a rapid review of the evidence base on pre-hospital endotracheal intubation. The main findings are:

- The evidence on pre-hospital ETI tends towards worse outcomes that simple BLS airway management and deferral of intubation until arrival at hospital
- Two previous systematic reviews have found no evidence in favour of pre-hospital ETI and the results of this review concur with this view
- No studies of ETI in cardiac arrest showed any benefit
- The majority of studies on trauma patients showed no benefit in terms of mortality when non drug assisted pre-hospital ETI was used.
- Where there is a survival advantage this may be due to increased exposure to suitable patients so skills are used more often and is more associated with RSI
- A small number of studies have demonstrated a potential advantage to pre-hospital RSI in terms of reducing morbidity survivors of head injury. There is scope for more research in this area
- In general the quality of studies was poor with 70% being retrospective analyses. There are few prospective studies and we found only 3 controlled trials assessing the impact of pre-hospital ETI on patient outcome.

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Appendix 1 – Search strategies for level of pre-hospital care

Medline

1. (train$ or competence$ or educat$ or skill$ or certif$ or credential$).tw.
2. Emergency Medical Technicians/ed [Education]
3. *Emergency Medicine/ed [Education]
4. *Traumatology/ed [Education]
5. or/1-4
6. ((pre-hospital or pre-hospital) and care).tw.
7. Emergency Medical Services/mt [Methods]
8. (emergency medical service$ and (pre-hospital or pre-hospital)).tw.
9. (EMS and (Pre-hospital or pre-hospital)).tw.
10. (emergency adj2 care).tw.
11. or/6-10
12. 5 and 11
13. limit 12 to yr="1996 -Current"
14. limit 13 to english language

Embase

1. (train$ or competence$ or educat$ or skill$ or certif$ or credential$).tw.
2. ((pre-hospital or pre-hospital) and care).tw.
3. (emergency medical service$ and (pre-hospital or pre-hospital)).tw.
4. (EMS and (pre-hospital or pre-hospital)).tw.
5. (emergency adj2 care).tw.
6. or/2-5
7. 1 and 6
8. limit 7 to english language

Cochrane Library

#1	(train* or competence* or educat* or skill* or certif* or credential*):ti,ab,kw
#2	MeSH descriptor Emergency Medical Technicians, this term only with qualifier: ED
#3	MeSH descriptor Emergency Medicine, this term only with qualifier: ED
#4	MeSH descriptor Traumatology explode all trees with qualifier: ED
#5	(#1 OR #2 OR #3 OR #4)
#6	(pre-hospital or pre-hospital) and care:ti,ab,kw
#7	MeSH descriptor Emergency Medical Services, this term only with qualifier: MT
#8	(emergency medical service* and (pre-hospital or pre-hospital)):ti,ab,kw
#9	(EMS and (pre-hospital or pre-hospital)):ti,ab,kw
#10	(emergency NEAR/2 care):ti,ab,kw
#11	(#6 OR #7 OR #8 OR #9 OR #10)
#12	(#5 AND #11)

Web of Science (Science Citation Index, Social Sciences Citation Index, Conference Proceedings Citation Index – Science, Conference Proceedings Citation Index – Social Science & Humanities)

# 5	#2 AND #1
Refined by: Publication Years=(2010 OR 1998 OR 1997 OR 2009 OR 2004 OR 2008 OR 2003 OR 1996 OR 2007 OR 2000 OR 2001 OR 2011 OR 2002 OR 2006 OR 1999 OR 2005) AND Languages=(ENGLISH)	
# 4	#2 AND #1
Refined by: Publication Years=(2010 OR 1998 OR 1997 OR 2009 OR 2004 OR 2008 OR 2003 OR 1996 OR 2007 OR 2000 OR 2001 OR 2011 OR 2002 OR 2006 OR 1999 OR 2005)	
# 3	#2 AND #1
# 2	Topic=((pre-hospital or pre-hospital) and care) OR Topic=("emergency medical service*" and (pre-hospital or pre-hospital)) OR Topic=(EMS and (pre-hospital or pre-hospital)) OR Topic=(emergency NEAR2 care)
# 1	Topic=(train* or competence* or educat* or skill* or certif* or credential*)

CINAHL

S10	S4 and S9 Limiters - Published Date from: 19960101-20110831; English Language
S9	S5 or S6 or S7 or S8
S8 S7 S6 S5	TI EMS AND TI (pre-hospital or pre-hospital) OR AB EMS AND AB (pre-hospital or pre-hospital) OR TI (emergency N2 care) OR AB (emergency N2 care) TI emergency medical service* AND TI (pre-hospital or pre-hospital) OR AB emergency medical service* AND AB (pre-hospital or pre-hospital) (MH "Emergency Medical Services/MT") TI (pre-hospital or pre-hospital) AND TI care OR AB (pre-hospital or pre-hospital) AND AB care
S4	S1 or S2 or S3
S3 S2 S1	(MH "Traumatology/ED") (MH "Emergency Medical Technicians/ED") TI (train* or competence* or educat* or skill* or certif* or credential*) AND AB (train* or competence* or educat* or skill* or certif* or credential*)

UK Clinical Research Network (CRN) Portfolio Database
Found 2 studies with search of Title / Acronym : pre-hospital
Found 0 studies with search of Title / Acronym : pre-hospital

ClinicalTrials.gov Found 112 studies with search of: pre-hospital
Found 112 studies with search of: pre-hospital
Found 3 studies with search of: pre-hospital AND training
Found 3 studies with search of: pre-hospital AND training
Found no studies with search of: pre-hospital AND skills/skill/skilled
Found no studies with search of: pre-hospital AND skills/skill/skilled
Found 7 studies with search of: pre-hospital AND education
Found 7 studies with search of: pre-hospital AND education
Found no studies with search of: pre-hospital AND certified/certification
Found no studies with search of: pre-hospital AND certified/certification
Found no studies with search of: pre-hospital AND competence
Found no studies with search of: pre-hospital AND competence
Found no studies with search of: pre-hospital AND credentials/credentialing
Found no studies with search of: pre-hospital AND credentials/credentialing

Methodological filters

RCT including UK filter e.g. in Medline

1. Randomized controlled trials as Topic/
2. Randomized controlled trial/
3. Random allocation/
4. randomized controlled trial.pt.
5. Double blind method/
6. Single blind method/
7. Clinical trial/
8. exp Clinical Trials as Topic/
9. controlled clinical trial.pt.
10. or/1-9
11. (clinic$ adj25 trial$).ti,ab.
12. ((singl$ or doubl$ or treb$ or tripl$) adj (blind$ or mask$)).tw.
13. Placebos/
14. Placebo$.tw.
15. (allocated adj2 random).tw.
16. or/11-15
17. 10 or 16
18. Case report.tw.
19. Letter/
20. Historical article/
21. or/18-20
22. exp Animals/
23. Humans/
24. 22 not 23
25. 21 or 24
26. 17 not 25
27. 26 and 14 (last statement of Medline strategy)

Observational studies filter e.g. in Medline

1. Epidemiologic studies/
2. exp case control studies/
3. exp cohort studies/
4. case control.tw.
5. (cohort adj (study or studies)).tw.
6. cohort analy$.tw.
7. (follow up adj (study or studies)).tw.
8. longitudinal.tw.
9. retrospective.tw.
10. cross sectional.tw.
11. cross-sectional studies/
12. (observational adj (study or studies)).tw.
13. Comparative study.pt.
14. (comparative adj (study or studies)).tw.
15. or/1-14
16. 15 and 14 (last statement of Medline strategy)

Systematic reviews filter e.g. in Medline

1. meta-analysis as topic/
2. (meta analy$ or metaanaly$).tw.
3. Meta-Analysis/
4. (systematic adj (review$1 or overview$1)).tw.
5. "Review Literature as Topic"/
6. or/1-5
7. (cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or cinhal or science citation index or bids or cancerlit).ab.
8. ((reference adj list$) or bibliograph$ or hand-search$ or (relevant adj journals) or (manual adj search$)).ab.
9. ((selection adj criteria) or (data adj extraction)).ab.
10. "review"/
11. 9 and 10
12. comment/ or editorial/ or letter/
13. Animals/
14. Humans/
15. 13 and 14
16. 13 not 15
17. 12 or 16
18. 6 or 7 or 8 or 11
19. 18 not 17
20. 19 and 14 (last statement of Medline strategy)

Economic filter e.g. in Medline

1. Cost-benefit analysis/
2. Economic value of life/
3. Quality-adjusted life years/
4. exp models, economic/
5. cost utilit$.tw.
6. cost benefit$.tw.
7. cost minim$.tw.
8. cost effect$.tw.
9. economic evaluation$.tw.
10. or/1-9
11. 10 and 14 (last statement of Medline strategy)

Appendix 2 – Search strategies for impact of pre-hospital ETI and airway management

Medline

1. (train$ or competence$ or educat$ or skill$ or certif$ or credential$).tw. 2. Emergency Medical Technicians/ed [Education] 3. *Emergency Medicine/ed [Education] 4. *Traumatology/ed [Education] 5. Education, Professional/mt [Methods] 6. Clinical Competence/	**Training**
7. or/1-6	
8. Emergency Medical Services/ 9. ((care or emergency medical service$ or EMS) and (pre-hospital or pre-hospital)).tw. 10. ((emergency or trauma) adj2 care).tw. 11. ((Pre-hospital or pre-hospital) adj3 (airway or management)).tw. 12. airway management.tw. 13. trauma management.tw. 14. Emergency Treatment/mt [Methods] 15. air ambulance service$.tw. 16. (out-of-hospital adj2 (emergenc$ or care)).tw.	**Pre-hospital**
17. or/8-16	
18. Laryngeal Masks/ 19. Laryngeal mask$.tw. 20. ILMA.tw. 21. Intubation, Intratracheal/ 22. ((pre-hospital or pre-hospital) adj intubation).tw. 23. ((tracheal or endotracheal or endo-tracheal or orotracheal or emergency) adj2 intubat$).tw. 24. ETI.tw. 25. (rapid sequence adj2 intubat$).tw. 26. RSI.tw. 27. (intubat$ and (brain injur$ or head injur$ or fac$ injur$)).tw. 28. (intubat$ and (polytrauma or trauma$)).tw. 29. rescue ventilation.tw. 30. Respiration, Artificial/ 31. Airway Obstruction/th [Therapy]	**Endotracheal intubation**
32. or/18-31	

33. ((pre-hospital or pre-hospital) adj2 personnel).tw.	**Personnel**
34. Emergency Medical Technicians/	
35. emergency medical technician$.tw.	
36. EMT$.tw.	
37. emergency care practitioner$.tw.	
38. (EMS adj (personnel or crew$ or provider$)).tw.	
39. Physicians/	
40. (physician$ or doctor$ or clinician$ or MD or practitioner$).tw.	
41. nurses/ or nurse clinicians/ or nurse practitioners/ or nursing staff, hospital/	
42. nurse$.tw.	
43. paramedic$.tw.	
44. (first-aid adj3 (responder$ or laymen)).tw.	
45. first responder.tw.	
46. Allied Health Personnel/	
47. paraprofessional$.tw.	
48. (ambulance adj (technician$ or staff or crew$)).tw.	
49. aeromedical crew$.tw.	
50. (an?esthesiologist$ or an?esthetist$).tw.	
51. firefighter$.tw.	
52. (volunteer$ or resident$).tw.	
53. or/33-53	
54. 7 and 17 and 32	
55. 17 and 32 and 53	
56. 54 or 55	
57. limit 56 to yr="1996 –Current"	
58. limit 57 to english language	

Embase

1. (train$ or competence$ or educat$ or skill$ or certif$ or credential$).tw.
2. vocational education/
3. clinical competence/
4. or/1-3
5. emergency health service/
6. ((care or emergency medical service$ or EMS) and (pre-hospital or pre-hospital)).tw.
7. ((emergency or trauma) adj2 care).tw.
8. ((Pre-hospital or pre-hospital) adj3 (airway or management)).tw.
9. airway management.tw.
10. trauma management.tw.
11. air ambulance service$.tw.
12. (out-of-hospital adj2 (emergenc$ or care)).tw.
13. or/5-12

14. laryngeal mask/
15. Laryngeal mask$.tw.
16. ILMA.tw.
17. endotracheal intubation/
18. ((pre-hospital or pre-hospital) adj intubation).tw.
19. ((tracheal or endotracheal or endo-tracheal or orotracheal or emergency) adj2 intubat$).tw.
20. ETI.tw.
21. (rapid sequence adj2 intubat$).tw.
22. RSI.tw.
23. (intubat$ and (brain injur$ or head injur$ or fac$ injur$)).tw.
24. (intubat$ and (polytrauma or trauma$)).tw.
25. rescue ventilation.tw.
26. artificial ventilation/
27. airway obstruction/th [Therapy]
28. or/14-27
29. ((pre-hospital or pre-hospital) adj2 personnel).tw.
30. rescue personnel/
31. emergency medical technician$.tw.
32. EMT$.tw.
33. emergency care practitioner$.tw.
34. (EMS adj (personnel or crew$ or provider$)).tw.
35. physician/
36. (physician$ or doctor$ or clinician$ or MD or practitioner$).tw.
37. nurse/
38. nurse$.tw.
39. paramedic$.tw.
40. paramedical personnel/
41. (first-aid adj3 (responder$ or laymen)).tw.
42. first responder.tw.
43. paraprofessional$.tw.
44. (ambulance adj (technician$ or staff or crew$)).tw.
45. aeromedical crew$.tw.
46. (an?esthesiologist$ or an?esthetist$).tw.
47. firefighter$.tw.
48. (volunteer$ or resident$).tw.
49. or/29-48
50. 4 and 13 and 28
51. 13 and 28 and 49
52. 50 or 51
53. limit 52 to english language

Cochrane Library

#1	(train* or competence* or educat* or skill* or certif* or credential*):ti,ab,kw
#2	MeSH descriptor Emergency Medical Technicians, this term only with qualifier: ED
#3	MeSH descriptor Emergency Medicine, this term only with qualifier: ED
#4	MeSH descriptor Traumatology explode all trees with qualifier: ED
#5	MeSH descriptor Education, Professional explode all trees with qualifier: MT
#6	MeSH descriptor Clinical Competence, this term only
#7	(#1 OR #2 OR #3 OR #4 OR #5 OR #6)

#8	MeSH descriptor Emergency Medical Services, this term only
#9	((care or emergency medical service* or EMS) and (pre-hospital or pre-hospital)):ti,ab,kw
#10	((emergency or trauma) NEAR/2 care):ti,ab,kw
#11	((Pre-hospital or pre-hospital) NEAR/3 (airway or management)):ti,ab,kw
#12	(airway management):ti,ab,kw
#13	(trauma management):ti,ab,kw
#14	MeSH descriptor Emergency Treatment explode all trees with qualifier: MT
#15	(air ambulance service*):ti,ab,kw
#16	(out-of-hospital NEAR/2 (emergenc* or care)):ti,ab,kw
#17	(#8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16)
#18	MeSH descriptor Laryngeal Masks, this term only
#19	(Laryngeal mask*):ti,ab,kw
#20	(ILMA):ti,ab,kw
#21	MeSH descriptor Intubation, Intratracheal, this term only
#22	((pre-hospital or pre-hospital) NEXT intubation):ti,ab,kw
#23	((tracheal or endotracheal or endo-tracheal or orotracheal or emergency) NEAR/2
#24	intubat*):ti,ab,kw
#25	(ETI):ti,ab,kw
#26	(rapid sequence NEAR/2 intubat*):ti,ab,kw
#27	(RSI):ti,ab,kw
#28	(intubat* and (brain injur* or head injur* or fac* injur*)):ti,ab,kw
#29	(intubat* and (polytrauma or trauma*)):ti,ab,kw
#30	(rescue ventilation):ti,ab,kw
#31	MeSH descriptor Respiration, Artificial, this term only
	MeSH descriptor Airway Obstruction, this term only with qualifier: TH
#32	(#18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31)
#33	((pre-hospital or pre-hospital) NEAR/2 personnel):ti,ab,kw
#34	MeSH descriptor Emergency Medical Technicians, this term only
#35	(emergency medical technician*):ti,ab,kw
#36	(EMT*):ti,ab,kw
#37	(emergency care practitioner*):ti,ab,kw
#38	(EMS NEXT (personnel or crew* or provider*)):ti,ab,kw
#39	MeSH descriptor Physicians, this term only
#40	(physician* or doctor* or clinician* or MD or practitioner*):ti,ab,kw
#41	MeSH descriptor Nurses, this term only
#42	MeSH descriptor Nurse Clinicians, this term only
#43	(nurse*):ti,ab,kw
#44	(paramedic*):ti,ab,kw
#45	(first-aid NEAR/3 (responder* or laymen)):ti,ab,kw
#46	(first responder):ti,ab,kw
#47	MeSH descriptor Allied Health Personnel, this term only
#48	(paraprofessional*):ti,ab,kw
#49	(ambulance NEXT (technician* or staff or crew*)):ti,ab,kw
#50	(aeromedical crew*):ti,ab,kw
#51	(anesthesiologist* or anaesthesiologist* or anesthetist* or anaesthetist*):ti,ab,kw
#52	(firefighter*):ti,ab,kw
#53	(volunteer* or resident*):ti,ab,kw
#54	(#33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50 OR #51 OR #52 OR #53)
#55	(#7 AND #17 AND #32)

#56	(#17 AND #32 AND #54)
#57	(#55 OR #56), from 1996 to 2011

Web of Science (Science Citation Index, Social Sciences Citation Index, Conference Proceedings Citation Index – Science, Conference Proceedings Citation Index – Social Science & Humanities)

# 43	#40 OR #39 Refined by: Languages=(ENGLISH) AND Publication Years=(2009 OR 2005 OR 1999 OR 2010 OR 2004 OR 2001 OR 2008 OR 2003 OR 1998 OR 2011 OR 2000 OR 1997 OR 2007 OR 2002 OR 1996 OR 2006)
# 42	#40 OR #39 Refined by: Languages=(ENGLISH)
# 41	#40 OR #39
# 40	#38 AND #21 AND #9
# 39	#21 AND #9 AND #1
# 38	#37 OR #36 OR #35 OR #34 OR #33 OR #32 OR #31 OR #30 OR #29 OR #28 OR #27 OR #26 OR #25 OR #24 OR #23 OR #22
# 37	Topic=(volunteer* or resident*)
# 36	Topic=(firefighter*)
# 35	Topic=(anaesthesiologist* or anaesthetist* or anesthesiologist* or anesthetist*)
# 34	Topic=(aeromedical crew*)
# 33	Topic=((ambulance NEAR (technician* or staff or crew*)))
# 32	Topic=(paraprofessional*)
# 31	Topic=(first responder)
# 30	Topic=((first-aid NEAR/3 (responder* or laymen)))
# 29	Topic=(paramedic*)
# 28	Topic=(nurse*)
# 27	Topic=(physician* or doctor* or clinician* or MD or practitioner*)
# 26	Topic=((EMS NEAR (personnel or crew* or provider*)))
# 25	Topic=(emergency care practitioner*)
# 24	Topic=(EMT*)
# 23	Topic=(emergency medical technician*)
# 22	Topic=(((pre-hospital or pre-hospital) NEAR/2 personnel))
# 21	#20 OR #19 OR #18 OR #17 OR #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10
# 20	Topic=(respiration artificial)
# 19	Topic=(rescue ventilation)
# 18	Topic=((intubat* and (polytrauma or trauma*)))
# 17	Topic=((intubat* and (brain injur* or head injur*or fac* injur*)))
# 16	Topic=(RSI)
# 15	Topic=("rapid sequence" NEAR/2 intubat*)
# 14	Topic=(ETI)
# 13	Topic=(((tracheal or endotracheal or endo-tracheal or orotracheal or emergency or intratracheal or intra-tracheal) NEAR/2 intubat*))
# 12	Topic=(((pre-hospital or pre-hospital) NEAR intubation))
# 11	Topic=(ILMA)
# 10	Topic=(Laryngeal mask*)
# 9	#8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2

# 8	Topic=((out-of-hospital NEAR/2 (emergenc* or care)))
# 7	Topic=(air ambulance service*)
# 6	Topic=(trauma management)
# 5	Topic=(airway management)
# 4	Topic=(((Pre-hospital or pre-hospital) NEAR/3 (airway or management)))
# 3	Topic=(((emergency or trauma) NEAR/2 care))
# 2	Topic=(emergency medical service*) OR Topic=(((care or emergency medical service* or EMS) and (pre-hospital or pre-hospital)))
# 1	Topic=(train* or competence* or educat* or skill* or certif* or credential*)

CINAHL

S55 S53 or S54 Limiters - Published Date from: 19960101-20110931
S54 S16 and S31 and S52
S53 S6 and S16 and S31
S52 S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45 or S46 or S47 or S48 or S49 or S50 or S51
S51 TI (volunteer* or resident*) OR AB (volunteer* or resident*)
S50 TI firefighter* OR AB firefighter*
S49 TI (anaesthesiologist* OR anaesthetist* OR anesthesiologist* OR anesthetist*) OR AB (anaesthesiologist* OR anaesthetist* OR anesthesiologist* OR anesthetist*)
S48 TI aeromedical crew* OR AB aeromedical crew*
S47 TI ((ambulance technician*) OR (ambulance staff) OR (ambulance crew*)) OR AB ((ambulance technician*) OR (ambulance staff) OR (ambulance crew*))
S46 TI paraprofessional* OR AB paraprofessional*
S45 (MH "Allied Health Personnel+")
S44 TI first responder OR AB first responder
S43 TI ((first-aid N3 responder*) OR (first-aid N3 laymen)) OR AB ((first-aid N3 responder*) OR (first-aid N3 laymen))
S42 TI paramedic* OR AB paramedic*
S41 TI nurse* OR AB nurse*
S40 (MH "Nurses+") OR (MH "Nursing Staff, Hospital") OR (MH "Emergency Nurse Practitioners")
S39 TI ((physician* OR doctor* OR clinician* OR MD OR practitioner*)) OR AB ((physician* OR doctor* OR clinician* OR MD OR practitioner*))
S38 (MH "Physicians+")
S37 TI ((EMS personnel) OR (EMS crew*) OR (EMS provider*)) OR AB ((EMS personnel) OR (EMS crew*) OR (EMS provider*))
S36 TI emergency care practitioner* OR AB emergency care practitioner*
S35 TI EMT* OR AB EMT*
S34 TI emergency medical technician* OR AB emergency medical technician*
S33 (MH "Emergency Medical Technicians")
S32 TI ((pre-hospital N2 personnel) OR (pre-hospital N2 personnel)) OR AB ((pre-hospital N2 personnel) OR (pre-hospital N2 personnel))
S31 S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30
S30 (MH "Airway Obstruction+/TH")
S29 (MH "Respiration, Artificial+")
S28 TI rescue ventilation OR AB rescue ventilation
S27 TI (intubat* AND (polytrauma OR trauma*)) OR AB (intubat* AND (polytrauma OR trauma*))
S26 TI (intubat* AND ((brain injur*) OR (head injur*) OR (fac* injur*))) OR AB (intubat* AND ((brain injur*) OR (head injur*) OR (fac* injur*)))

S25 TI RSI OR AB RSI S24 TI (rapid sequence N2 intubat*) OR AB (rapid sequence N2 intubat*) S23 TI ETI OR AB ETI S22 TI ((tracheal N2 intubat*) OR (endotracheal N2 intubat*) OR (endo-tracheal N2 intubat*) OR (orotracheal N2 intubat*) OR (emergency N2 intubat*)) OR AB ((tracheal N2 intubat*) OR (endotracheal N2 intubat*) OR (endo-tracheal N2 intubat*) OR (orotracheal N2 intubat*) OR (emergency N2 intubat*)) S21 TI ((pre-hospital intubation) OR (pre-hospital intubation)) OR AB ((pre-hospital intubation) OR (pre-hospital intubation)) S20 (MH "Intubation, Intratracheal+") S19 TI ILMA OR AB ILMA S18 TI Laryngeal mask* OR AB Laryngeal mask* S17 (MH "Laryngeal Masks")
S16 S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15
S15 TI ((out-of-hospital N2 emergenc*) OR (out-of-hospital N2 care)) OR AB ((out-of-hospital N2 emergenc*) OR (out-of-hospital N2 care)) S14 TI air ambulance service* OR AB air ambulance service* S13 (MH "Emergency Treatment (Non-Cinahl)+/MT") S12 TI trauma management OR AB trauma management S11 TI airway management OR AB airway management S10 TI ((pre-hospital N3 airway) OR (pre-hospital N3 management) OR (pre-hospital N3 airway) OR (pre-hospital N3 management)) OR AB ((pre-hospital N3 airway) OR (pre-hospital N3 management) OR (pre-hospital N3 airway) OR (pre-hospital N3 management)) S9 TI (((emergency N2 care) OR (trauma N2 care))) OR AB (((emergency N2 care) OR (trauma N2 care))) S8 TI (((care or emergency medical service* or EMS) and (pre-hospital or pre-hospital))) OR AB (((care or emergency medical service* or EMS) and (pre-hospital or pre-hospital))) S7 (MH "Emergency Medical Services+")
S6 S1 or S2 or S3 or S4 or S5
S5 (MH "Clinical Competence+") S4 (MH "Emergency Medicine/ED") S3 MH "Traumatology/ED" S2 MH "Emergency Medical Technicians/ED" S1 TI (train* or competence* or educat* or skill* or certif* or credential*train* or competence* or educat* or skill* or certif* or credential*) OR AB (train* or competence* or educat* or skill* or certif* or credential*)

UK Clinical Research Network (CRN) Portfolio Database
Found 1 study with search of Title / Acronym : **intubation**

	Failed tracheal intubation in obstetrics - UK Obstetric Surveillance System: A case control study to investigate the incidence and management of failed endotracheal intubation during rapid sequence induction for obstetric anaesthesia in the UK	Closed	Observational	N/A

ClinicalTrials.gov
Found 15 studies with search of: intubation AND pre-hospital
Found 15 studies with search of: intubation AND pre-hospital

1 Not yet recruiting Pre Hospital Evaluation of Video Laryngoscopy

Conditions: Cardiac Arrest; Respiratory Distress Syndrome; Shock; Acute Post-trauma Stress State; Drug Toxicity; Trauma, Nervous System

Interventions: Device: Classical intubation; Device: GLIDESCOPE

2 Not yet recruiting Preoxygenation Before Pre-hospital Tracheal Intubation With NIV Versus Balloon

Condition: Preoxygenation

Interventions: Device: Non invasive ventilation; Device: Classical preoxygenation

3 Recruiting Head Injury Retrieval Trial

Condition: Head Injuries, Closed

Intervention: Procedure: Extended interventions by advanced level pre-hospital providers

4 Withdrawn Measurement Of Endotracheal Tube Cuff Pressure In Emergency Department Patients

Condition: Intubation, Intratracheal

Intervention:

5 Completed Pre-hospital CPAP vs. Usual Care for Acute Respiratory Failure

Conditions: Respiratory Insufficiency; Hypoxia

Intervention: Device: Continuous positive airway pressure ventilation mask

6 Completed Ketamine Versus Etomidate During Rapid Sequence Intubation: Consequences on Hospital Morbidity

Condition: Intubation

Interventions: Drug: Ketamine; Drug: Etomidate

7 Completed Airway Scope and Macintosh Laryngoscope for Tracheal Intubation in Patients Lying on the Ground

Condition: Intubation

Intervention: Device: Airway scope intubation tube

8 Completed Effectiveness and Safety Study of Etomidate Versus Midazolam to Help Place a Breathing Tube Outside of the Hospital.

Condition: Respiratory Failure

Intervention: Drug: Etomidate (20mg) or Midazolam (7mg)

9 Withdrawn HERMES STUDY: Study on the Feasibility and Efficiency of Noninvasive Positive-Pressure Ventilation (NPPV) in Pre-hospital Care

Conditions: ARF Secondary to COPD Exacerbation; ARF Secondary to Cardiogenic Acute Pulmonary Oedema

Intervention: Device: Noninvasive Positive-Pressure Ventilation (NPPV)

10 Completed Rapid Sequence Intubation With Rocuronium-Sugammadex Compared With Succinylcholine

Condition: Rapid Sequence Intubation

Interventions: Drug: Rocuronium-Sugammadex; Drug: Succinylcholine

11 Not yet recruiting The RINSE Trial: The Rapid Infusion of Cold Normal Saline Trial During Cardiopulmonary Resuscitation (CPR)

Conditions: Resuscitation; Cardiopulmonary Resuscitation

Intervention: Procedure: Early cooling

12 Completed Utility of Bedside Ultrasound in the Prediction of Difficult Airway

Condition: Laryngoscopy

Intervention:

13 Completed Paramedic Treatment of Prolonged Seizures by Intramuscular Versus Intravenous Anticonvulsant Medications

Condition: Status Epilepticus

Interventions: Other: Intramuscular route of active treatment; Other: Intravenous route of active treatment

14 Not yet recruiting The EPIC Project: Impact of Implementing the EMS Traumatic Brain Injury Treatment Guidelines

Conditions: Brain Injuries, Traumatic; Injuries, Acute Brain; TBI (Traumatic Brain Injury)

Intervention: Other: The "bundle" of nat'l pre-hospital TBI management guidelines

15 Completed Registry of Emergency Airways Arriving at Combat Hospitals

Conditions: Trauma; Wounds and Injuries; Emergencies

Intervention:

Methodological filters

RCT including UK filter e.g. in Medline

28. Randomized controlled trials as Topic/
29. Randomized controlled trial/
30. Random allocation/
31. randomized controlled trial.pt.
32. Double blind method/
33. Single blind method/
34. Clinical trial/
35. exp Clinical Trials as Topic/
36. controlled clinical trial.pt.
37. or/1-9
38. (clinic$ adj25 trial$).ti,ab.
39. ((singl$ or doubl$ or treb$ or tripl$) adj (blind$ or mask$)).tw.
40. Placebos/
41. Placebo$.tw.
42. (allocated adj2 random).tw.
43. or/11-15
44. 10 or 16
45. Case report.tw.
46. Letter/
47. Historical article/
48. or/18-20
49. exp Animals/
50. Humans/
51. 22 not 23
52. 21 or 24
53. 17 not 25
54. 26 and 58 (last statement of Medline strategy)

Observational studies filter e.g. in Medline

1. Epidemiologic studies/
2. exp case control studies/
3. exp cohort studies/
4. case control.tw.
5. (cohort adj (study or studies)).tw.
6. cohort analy$.tw.
7. (follow up adj (study or studies)).tw.
8. longitudinal.tw.
9. retrospective.tw.
10. cross sectional.tw.
11. cross-sectional studies/
12. (observational adj (study or studies)).tw.
13. Comparative study.pt.
14. (comparative adj (study or studies)).tw.
15. or/1-14
16. 15 and 58 (last statement of Medline strategy)

Systematic reviews filter e.g. in Medline

21. meta-analysis as topic/
22. (meta analy$ or metaanaly$).tw.
23. Meta-Analysis/
24. (systematic adj (review$1 or overview$1)).tw.
25. "Review Literature as Topic"/
26. or/1-5
27. (cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or cinhal or science citation index or bids or cancerlit).ab.
28. ((reference adj list$) or bibliograph$ or hand-search$ or (relevant adj journals) or (manual adj search$)).ab.
29. ((selection adj criteria) or (data adj extraction)).ab.
30. "review"/
31. 9 and 10
32. comment/ or editorial/ or letter/
33. Animals/
34. Humans/
35. 13 and 14
36. 13 not 15
37. 12 or 16
38. 6 or 7 or 8 or 11
39. 18 not 17
40. 19 and 58 (last statement of Medline strategy)

Economic filter e.g. in Medline

12. Cost-benefit analysis/
13. Economic value of life/
14. Quality-adjusted life years/
15. exp models, economic/
16. cost utilit$.tw.
17. cost benefit$.tw.
18. cost minim$.tw.
19. cost effect$.tw.
20. economic evaluation$.tw.
21. or/1-9
22. 10 and 58 (last statement of Medline strategy)