

**PREHOSPITAL ENDOTRACHEAL INTUBATION
PRACTICES BY PARAMEDICS IN THE
PROVINCIAL AMBULANCE SERVICE OF THE
WESTERN CAPE PROVINCE OF SOUTH AFRICA**

**UNIVERSITY OF CAPE TOWN
FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ANAESTHESIA**

RESEARCH THESIS SUBMITTED FEBRUARY 2006

**MASTER OF MEDICINE IN ANAESTHESIA
M.Med. (Anaes).**

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ABSTRACT:

It is well-established that endotracheal intubation in the field is associated with a considerably greater degree of difficulty, and a much higher complication and failure rate than intubation undertaken in the operating-theatre environment. The reasons for this are many-fold, have been quantified and discussed in detail.

This study assesses the difficulties encountered by paramedics in the field, by identifying factors contributing to difficult and failed intubation, by quantifying the incidence of difficult and failed intubations, by assessing and describing the incidence of complications and adverse outcomes, and by assessing the impact of the procedure on patient care.

This dissertation includes a comprehensive international literature review of studies related to prehospital endotracheal intubation, and discusses and compares these published findings to the results obtained from this study.

Furthermore, this study provides feedback to paramedics, paramedic-educators and managers, by offering a comprehensive strategy for improvement in the procedure of field intubation, with a view to increased safety, ease of execution, and improved patient outcome.

INTRODUCTION:

This study on endotracheal intubation practices by paramedics was undertaken throughout the Western Cape's prehospital Emergency Medical Services (EMS).

Reason for undertaking this study:

Experience:

I have been integrally involved in the Western Cape's EMS system, 'Metro Ambulance and Rescue', since 1982. I have worked within the system as paramedic, medical officer, paramedic instructor, registrar in anaesthesia and more recently as a specialist anaesthetist. This experience has included service with Metro's Advanced Life Support Unit, Metro Rescue, the Red Cross Air Mercy Service's fixed-wing and helicopter aeromedical programme, and Wilderness Search and Rescue's helicopter and ground-based activities.

Observations:

In my experience of prehospital airway management, and in my observations of paramedics' undertakings in this regard, it has been my anecdotal opinion that the difficulties encountered in the field are far greater than those encountered in the hospital environment, and that consequently the rate of difficult and failed intubation in the field is much greater than in the hospital environment.

The literature:

This has been borne out by the international literature, but there have been many conflicting international studies over the past decade that have examined prehospital endotracheal intubation in terms of difficulty and failure, adequacy of training, skills maintenance, and most importantly, on patient outcome. Notwithstanding the volume of research on the subject, there remains a quagmire of controversy.

The “San Diego Paramedic Rapid Sequence Intubation Trial” was a landmark study comparing outcomes in intubated vs. non-intubated severely head-injured patients. The authors discovered a significant degree of inadvertent hyperventilation, significant oxygen desaturation, bradycardia and hypotension during and after intubation. This trial made the international EMS community sit up and take notice, as mortality was *significantly increased* in the intubated cohort, prompting early termination of the trial on ethical grounds.

The authors postulated that transient hypoxia, hypotension and bradycardia, inadvertent hyperventilation (compromising cerebral perfusion), and longer scene times most probably contributed to the increased mortality.

In further studies by Sloane²⁴, Murray²⁵, Bochicchio²⁶ and Davis et al²⁷, the authors found that mortality in the field-intubated groups was significantly greater than in the non-intubated groups, that patients intubated in the field had significantly longer scene times in comparison to their hospital-intubated counterparts, and that they were far more likely to develop pneumonia.

In one of only two large prehospital intubation studies with positive outcomes, Winchell and Hoyt³¹ reported a 10% absolute survival benefit from paramedic intubation *without* the use of neuromuscular blockade. In the second study, Bulger et al²⁸ demonstrated lower mortality and better outcomes for the paralysed group in comparison to the non-paralysed group, suggesting a significant benefit to RSI techniques in the field.

In multiple studies^{32, 33, 34, 35}, the mortality rates between the BVM-ventilated and intubated groups were virtually identical, and in some of these the BVM-ventilated groups showed improved outcome over the intubated groups. All of the authors concluded that endotracheal intubation conferred *no demonstrable survival benefit* or functional advantage over BVM ventilation in an urban EMS system.

Whilst the benefits of field intubation appear ‘intuitively obvious’, my observations and reading around the subject have forced me to ask the question, “Are paramedic field intubation techniques and conditions optimal, and do we undertake prehospital endotracheal intubation appropriately?” Or, more simply put, “Are we helping or hurting our patients?”¹

Clinical audit and evidence-based medicine:

Since no clinical audit has ever been undertaken by our service, and since basic and advanced airway management is of paramount importance in the context of emergency medicine, it became clear that this aspect of our clinical practice would benefit from in-depth investigation.

Spaite and Criss ¹, in an editorial comment on the landmark San Diego Paramedic Rapid-Sequence Intubation Trial, state very aptly:

“...except for defibrillation, essentially no EMS intervention has been prospectively evaluated with robust methodologies that allow us to conclude that safety has been established... the vast majority of EMS systems have implemented interventions based on the ‘Mount Everest’ approach – because it’s there. We can no longer assume that, because we believe we are improving patient outcomes, this excuses us from verifying that we are *in fact* improving patient outcomes. The blind Mount Everest approach to EMS must end.”

Wang and colleagues ², accomplished researchers in the field, have left us with the following sage wisdom:

“Unfortunately, we cannot begin to fix the sinking ship until we shine bright lights on the holes in the hull. Perhaps more alarming is the fact that we often do not recognise that the ship is slowly sinking. Many EMS systems do not bother to track intubation

errors or success rates. Is it possible that we lack the courage to look because we are afraid of what we may find? Or is it that we do not care to know?"

Reasons for difficult intubation experienced by paramedics in the field:

There are multiple reasons to explain the anticipated observation that endotracheal intubation in the field is very much more difficult than intubation in the operating-theatre environment. These would include:

- The inherent dangers of a chaotic casualty scene;
- Concerns for personal safety;
- A working environment that comprises:
 - poor lighting;
 - high noise levels;
 - adverse weather conditions;
 - bright sunlight (obscuring laryngoscopy);
 - paramedics working on their knees or lying flat on the ground;
 - the ubiquitous presence of such hazards as broken glass, leaking motor fuel and oil, and body fluids on the ground.
- Patients are often found in challenging locations – crumpled on the floor of a cramped bathroom, trapped inside motor vehicle wreckage, or lying face-down in a muddy ditch, etc.
- ‘Jump bags’, oxygen cylinders, portable suction units and cardiac monitor-defibrillator units often have to be carried some considerable distance from the response vehicle, up flights of stairs, across busy freeways, or down elevator shafts, to name but a few of a paramedic’s daily challenges.
- In order to begin resuscitation, equipment first has to be unpacked from ‘jump bags’, and laid out as best as possible under the circumstances.
- Paramedics in the Western Cape work alone for much of the time, as opposed to their American counterparts, who often work doubled-up as paramedic teams. This necessitates that our paramedics work with personnel who are not trained in

advanced life support, and are unfamiliar with the practice of endotracheal intubation. Working with essentially untrained assistants under such trying circumstances is indeed enormously challenging, and would be so to any specialist anaesthetist with many years training and experience.

- Patients often have fluctuating levels of consciousness, and notwithstanding, are more often than not combative. Paramedics have an extremely limited pharmacological armamentarium, and do not have an array of intravenous anaesthetic agents at their disposal; and certainly have no access to neuromuscular blocking drugs.
- Added to this are the difficulties imposed by:
 - cervical spine immobilisation;
 - the potential full stomach and aspiration;
 - craniofacial trauma;
 - facial burns;
 - upper airway haemorrhage.

Thus, one cannot expect paramedics, who have far less training than specialist anaesthetists, and who do not perform endotracheal intubation nearly as frequently as anaesthetists do, to perform field intubation as well as anaesthetists do in the controlled 'ideal' environment of the operating-theatre.

Hypothesis:

Field endotracheal intubation by paramedics is undertaken with much greater difficulty than intubation carried out in hospital by anaesthetists, and consequently, complication rates are higher and patient care is adversely affected.

This has led me to question a number of factors associated with paramedic intubation:

- the patient-specific appropriateness of field intubation;
- whether or not we can make paramedic intubation easier and more successful through:

- Recognising factors leading to difficult and failed intubation;
- Improving the training of paramedics;
- Providing algorithm-based protocols for clearer guidance;
- Providing additional 'difficult airway' equipment to paramedics;
- Consideration of broadening the prehospital drug protocol.

In order to carry out the above, it has been necessary to attempt to:

- objectively quantify the nature and rate of difficult and failed intubation;
- identify the factors leading to, or contributing to difficult and failed intubation;
- measure physiological parameters to assess the impact of field intubation on the patient.

Aims of the study:

- Assess the difficulties encountered by paramedics in the field;
- Quantify the rate of difficult and failed intubation in the hands of paramedics;
- Assess the incidence of complications and adverse incidents;
- Provide an idea of the patient-specific appropriateness of intubation in the field;
- Assess the impact of the procedure on patient care;
- Provide feedback to paramedics, managers and educators;
- Offer a strategy for improvement in the execution of the procedure, with a view to improved patient outcome.

I have, in addition, undertaken a comprehensive literature review on the subject, in order to provide added insights, and to present a first-world backdrop against which to provide an international comparison of practices in the Western Cape.

METHOD:

The Study:

This study was limited to paramedics of 'Metro Ambulance and Rescue', the EMS system of the Provincial Government of the Western Cape. The study was conducted across all regions of the Western Cape, both rural and urban. The time period for collection of data was from 31 November 2004 to 31 May 2005. Permission for the study was obtained from the Director of Emergency Medical Services, Dr Cleeve Robertson.

The study took the form of an anonymously-returned prospective questionnaire. Each questionnaire required filling in of tick-boxes, with the occasional data-field requiring numeral inputs, such as time and oxygen saturation. One questionnaire was completed for each attempted intubation, as soon after the event as possible. Paramedic 'partners' were requested to note such parameters as times and oxygen saturation while the paramedics treated patients as they normally did.

All candidates enlisted voluntarily, and no pressure was applied to any paramedics to submit questionnaires against their will. Paramedics were urged to report honestly, and not to change existing practices for the sake of the study – the importance of documenting intubation attempts "as they happened", without altering 'routine everyday' practices, was stressed.

The voluntary and anonymous nature of the return accorded the safety and freedom that there could be no follow-up, victimisation, retribution or ridicule of any sort by peers, management, or supervising doctors. Questionnaires were returned in sealed envelopes.

As far as possible, all paramedics in Metro's employ were individually canvassed by myself. The reasons for the study, the nature of the study, and the clear instructions on how to complete the questionnaires were explained to paramedics in small groups,

gathered at individual ambulance stations throughout the province. I personally drove throughout the province with this undertaking, with one of the Metro doctors.

In addition to each paramedic being handed a pack of questionnaires, and in addition to the verbal explanations, a covering letter with written instructions was also provided with each pack of questionnaires. The covering letter, written instructions and questionnaire are provided in the addenda.

Literature Review:

I carried out a Pubmed/Medline literature search. The search criteria included the terms:

- Paramedic endotracheal intubation;
- Prehospital endotracheal intubation;
- Emergency endotracheal intubation;
- Difficult endotracheal intubation;
- Failed endotracheal intubation.

I excluded all articles that did not refer directly to the prehospital environment, and included all articles between 1 January 2000 and 31 May 2005.

I have included supplementary journal articles drawn from a wider frame of reference and time-frame, in order to illustrate or further enhance points around my discussion of the core subject.

RESULTS:

Table 1: Questionnaires:

Questionnaires:	No.	%
Documented Intubations:	140	100
Within greater Cape Town area:	102	71
Outside greater Cape Town area:	38	29
Operational paramedics:	69	100
Cape Town Metropole:	41	60
Outlying areas:	27	40
No. returning questionnaires:	20	28

Table 2: Years of Experience:

Years of experience:	No.	%
Student:	6	4
Qualified <1 year:	13	9
Qualified 1-2 years:	6	4
Qualified 2-3 years:	30	21
Qualified 3-4 years:	31	22
Qualified >4 years:	54	39

Table 3: Average Number of Intubations per Paramedic:

Average no. of intubations per paramedic	No.	%
None (except for this one):	3	2
<2 per month:	0	0
2-4 per month:	44	31
4-8 per month	70	50
>8 per month:	22	16

Comment on Table 3:

97% of returns were done by paramedics who perform at least 2 intubations per month.

Table 4: Patient Age:

Patient Age:	No.	%
>70 years:	5	4
50-70 years:	27	19
18-50 years:	80	57
10-18 years:	5	4
5-10 years:	4	3
2-5 years:	5	4
0-1 year:	14	10

Comment on Table 4:

17% of intubations comprise children under the age of 10 yrs.

Table 5: Patient Category:

Patient Category:	No.	%
Cardiac arrest:	35	25
Head injury:	39	28
Polytrauma:	17	12
Medical non-cardiac arrest:	46	32

Table 6: Indications for Intubation:

Indications for Intubation:	No.	%
Cardiopulmonary resuscitation:	48	34
GCS <8/15; for airway protection only:	38	27
Inadequate airway maintenance and inadequate ventilation:	52	37
Adequate airway maintenance but inadequate ventilation:	7	5

Table 7: Place Intubated:

Place Intubated:	No.	%
Hospital or clinic:	31	22
Doctor present:	26	19
In ambulance:	32	23
Roadside or casualty scene:	50	36
Residence or place of work:	25	18

Table 8: Time Spent in Paramedic's Care:

Mean time:	60 minutes
Maximum time:	5 hours
Minimum time:	20 minutes

Table 9: Ease of Intubation:

Ease of intubation:	No.	%
Easy:	64	45
Moderately difficult:	41	29
Very difficult:	22	16
Failed:	13	9

Table 10: Cormack and Lehane Grade:

Cormack & Lehane grade:	No.	%
Grade I:	54	39
Grade II:	37	26
Grade III:	20	14
Grade IV:	8	6

Table 11: Degree of Patient Struggling (Effort/Resistance):

Degree of struggling:	No.	%
Patient flaccid (no struggling):	66	47
Minimal struggling:	39	28
Considerable struggling:	19	14
Maximal struggling:	11	8

Table 12: Ease of Intubation vs. Cormack & Lehane vs. Patient Effort:

Ease of Intubation:	%	Cormack & Lehane:	%	Patient Effort:	%
Easy:	45	Grade I:	39	None:	47
Moderately difficult:	29	Grade II:	26	Minimal:	28
Very difficult:	16	Grade III:	14	Considerable:	14
Failed:	9	Grade IV:	6	Maximal:	8

Table 13: Difficult Intubation Related to Patient Group:

1) Head Injury:	39 patients in total
Difficult and failed intubations:	59% of this group
Failed intubations:	5% of this group
2) Other medical non-cardiac arrest:	46 patients in total
Difficult and failed intubations:	48% of this group
Failed intubations:	13% of this group
3) Polytrauma:	17 patients in total
Difficult and failed intubations:	47% of this group
Failed intubations:	12% of this group
4) Cardiac Arrest:	35 patients in total
Difficult and failed intubations:	40% of this group
Failed intubations:	3% of this group

Comment on Table 13:

It is well to note that 50% of all failed intubations occur in the 'other medical non-cardiac arrest' group.

Table 14: Cardiac Arrest Group Related to Patient Effort:

Degree of effort/struggling	No.	%
No effort (patient flaccid):	29	84
Minimal effort:	3	9
Not specified:	3	9

Table 15: Patient Group Related to ‘Considerable’ and ‘Maximal’ Struggling:

Patient group:	No./Total in group	%
Cardiac arrest:	0/35	0
Head injury:	15/39	38
Other medical:	5/46	17
Polytrauma:	4/17	24

Table 16: Difficult Intubation Related to Patient Group and Glasgow Coma Scale:

Patient group	% difficult	% failed	Mean GCS
Cardiac arrest:	37	3	3.2
Head injury:	54	5	5.1
Polytrauma:	53	12	4.6
Other medical:	35	13	5.1

Table 17: Difficulty of Intubation Related to Glasgow Coma Scale:

Degree of difficulty:	Mean GCS:
Easy:	4
Very difficult:	5.8
Failed:	5.5

No. of patients with GCS <8:	58	[41% of total]
No. of patients with GCS = 3:	73	[52% of total]

Table 18: Difficulty of intubation related to GCS of 3/15:

48 of 63 ‘easy’ intubations	76% of easy intubations
3 of 12 ‘very difficult’ intubations	25% of very difficult intubations
6 of 13 failed intubations	46% of failed intubations

Comment on Table 18:

Only 7% of patients had a Glasgow Coma Scale above 8.

Table 19: Difficult Intubation Related to Cricoid Pressure:

Degree of difficulty:	Cricoid pressure applied:	%
Very difficult:	Applied in 6 of 20 patients	30
Failed:	Applied in 4 of 13 patients	31

Table 20: Cricoid Pressure Related to Cormack & Lehane Grade:

Cormack & Lehane:	Cricoid pressure applied:	%
Grade III:	Applied in 6 of 19 patients	32%
Grade IV:	Applied in 5 of 8 patients	63%

Table 21: Failed Intubation Related to Patient Age:

Age:	No. of failed intubations:	%
0-1 year:	2 of 14 intubations failed	14
18-50 years:	9 of 80 intubations failed	11
50-70 years:	1 of 27 intubations failed	4

Table 22: Failed Intubation Related to Geographic Area:

Area:	No. of failed intubations:	%
Within greater Cape Town metropole:	6 of 102 intubations failed	6
Beyond greater Cape Town metropole:	6 of 38 intubations failed	16

Thus, from the above data, it appears that the rate of failed intubation is 3 times higher in the areas beyond the Cape Town metropolitan area.

Failed Intubation Related to Years Experience:

11 of the 13 failed intubations occurred with experienced paramedics. One failure occurred with a paramedic with 1-2 years experience, and one with a paramedic student.

Failed Intubation Related to Frequency of Intubation:

All failed intubations occurred with paramedics who claimed at least 2 to 4 intubations per month, 50% of whom claimed 4 to 8 intubations per month.

Table 23: Failed Intubation Related to Patient Resistance (Struggling):

For 3 of the 13 failed intubations, there was unfortunately incomplete data relating to degree of patient resistance. For the remaining 10 failed intubations:

Degree of struggling:	No. failed:
No struggling:	2
Minimal:	1
Considerable:	3
Maximal:	4

Table 24: Reasons Given for Difficult and Failed Intubation:

(Total of 76 difficult and failed intubations; percentages relate to this group.)

Reason:	No.	%
Patient struggling:	17	22
Obstructed view – secretions, vomitus, blood:	18	24
Obstructed view – trauma, oedema:	8	11
Obstructed view – normal but difficult anatomy:	23	30
Laryngospasm:	5	7
Difficult positioning of the patient:	6	8

Table 25: Drugs:

Number given:	No.	%
Midazolam:	61	44
Morphine:	10	7
Diazepam:	7	5
Etomidate*:	3	2
Other anaesthetic agent:	1	0.7
Suxemethonium*:	3	2

* Administration of suxemethonium, and etomidate were done in the presence of a doctor, in hospital.

Average dose of Midazolam: 6.8mg

The most common (or “usual”) dose of midazolam is 10 to 15mg.

45mg was given to 3 patients, and 30mg was given to 8 patients.

Table 26: Midazolam administration related to Ease of Intubation:

Degree of difficulty:	No.	%
Easy intubation:	16	26
Moderately difficult intubation:	22	36
Very difficult intubation:	14	23
Failed intubation:	8	13

Thus, for 44 patients out of 61 patients given midazolam (72%), difficult or failed intubation was experienced.

Of the 10 patients given morphine, all were also given midazolam concurrently.

Table 27: Patients with Recorded Oxygen Saturation:

No. of patients with recorded saturation:	No.	% of total study group
No. of patients with SpO ₂ recorded before intubation:	84	60%
No. of patients with SpO ₂ recorded after intubation:	90	64%
No. of patients with lowest SpO ₂ recorded during intubation:	87	62%

Table 28: Average Oxygen Saturation Readings:

Average SpO ₂ recorded before intubation:	88%
Average SpO ₂ recorded after intubation:	96%
Average lowest SPO ₂ recorded during intubation:	73%
Absolute lowest recorded SPO ₂ recorded	24%

Of those 87 patients with recorded “during intubation” oxygen saturation:

	No.	%
No. of “during intubation” SPO ₂ readings below 80%:	19	22

Table 29: Pre-oxygenation:

	No.	%
Pre-oxygenation was carried out in	105	75
Of the total study group:	107	76
Pre-oxygenation not carried out:	35	25

Of the patients not pre-oxygenated, 14 (40%) had ‘pre-intubation’ SPO₂ readings below 80%.

Suspected ‘likely desaturation’ occurred in another 39 patients (in whom SPO₂ was not measured), or 28% of the total study cohort, and of which 30 (21%) became clinically cyanosed.

8 of the 87 patients in whom ‘lowest SPO₂’ was recorded, had SPO₂ values below 80%, and were considered ‘easy’ intubations.

Oxygen desaturation was clinically suspected in a further 9 patients in whom SPO₂ was not measured.

There were thus a total of 17 desaturations to below 80% in the ‘easy intubation’ cohort of 64 patients, or otherwise stated, there was at least a 26.5% rate of desaturation in patients considered to be easy to intubate.

Table 30: Laryngoscopy and Intubation:

	No.	%
Cricoid pressure applied in:	43	31
In-line neck stabilisation applied in:	45	80
Ave. no. of attempts at laryngoscopy:	1.8	--
Ave. no. of attempts at intubation:	1.6	--
Max. no. of attempts at laryngoscopy and intubation:	8	
Recognised oesophageal intubations:	20	14

Table 31: Time to intubation:

Time:	No.	%
< 1 minute:	81	57
< 2 minutes:	90	64
< 3 minutes:	119	85
> 5 minutes:	3	2
> 10 minutes:	8	6

Average time to intubation: 2.9 mins (with a maximum of 40 minutes)

Table 32: Aspiration:

Aspiration:	No.	%
Suspected or detected before intubation:	73	52
Occurred during intubation:	10	7
Suction apparatus ready and available:	125	89
Suction apparatus actually used:	79	56

Cricoid pressure was applied in 50% of patients suspected of aspirating.

10% of aspirations occurred during the intubation attempt, while 2 of the 10 aspirations occurring during intubation occurred with ‘easy’ intubations. Neither of these 2 easy intubations with aspiration had cricoid pressure applied.

7 of the 10 aspirations that occurred during intubation occurred in patients’ whose primary indication for intubation was a ‘low GCS, intubated for airway protection’.

A ‘low GCS, intubated for airway protection’ was cited as the indication for intubation in 38 patients. Of these, 7 suffered aspiration events during intubation. This represents an 18% failure rate for airway protection manoeuvres.

Of those in whom intubation failed, 12 were managed with bag-valve-mask ventilation, and aspiration en route to hospital was detected in only 1 patient (8%).

80% of aspirations that occurred during intubation were associated with difficult intubation.

Table 33: Oropharangeal Bleeding Associated with Intubation:

	No.	%
Bleeding occurring before intubation:	44	31
Bleeding occurring after intubation:	24	17

Table 34: Post-intubation Bleeding Associated with Degree of Difficulty:

Degree of difficulty:	No./Total	%
Easy intubation:	4/64	6
Moderately difficult intubation:	8/41	20
Very difficult intubation:	7/22	31
Failed intubation:	3/13	23

Table 35: Post-intubation bleeding related to no. of attempts at laryngoscopy:

Bleeding was associated with:	10 single intubation attempts 14 multiple intubation attempts
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Table 36: Post-intubation bleeding related to difficulty of intubation:

Bleeding occurred in:	7 of 22 difficult intubations 2 of 13 failed intubations
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Table 38: Patient Outcome:

Outcome:	No.	%
Successful intubation and ventilation:	127	90
Failed intubation:	13	10
Successful BVM management:	9	6
Poorly-controlled BVM management:	3	2
Emergency tracheostomy:	1	0.7
Aspiration detected en route:	1	0.7
Patient died due to poor airway control:	3	2
Patient died for other reasons:	16	11
CPR terminated en-route/in hospital:	27	19
CPR successful:	15	11

Table 39: Equipment Availability:

Equipment:	No.	%
Pulse oximetry:	126	90
End-tidal CO ₂ detection:	7	5
Portable oxygen cylinder:	137	98
BVM oxygen reservoir bag:	137	98
Suction apparatus:	135	96
Cardiac monitor:	136	97
Ventilator:	85	61
Endotracheal tube introducers:	109	78
Range of endotracheal tube sizes:	135	96
Laryngeal mask airways:	25	18
Oesophageal Combitube:	5	4
Trans-tracheal jet ventilation device:	36	26
Emergency tracheostomy kit:	68	49

DISCUSSION OF RESULTS:

Questionnaires:

140 completed questionnaires were received, one for each intubation documented. Whilst being a relatively small number, 71% were received from within the Cape Town metropole, and 29% from beyond the greater Cape Town area. This mirrors the population distribution of the Western Cape, being essentially a 70:30 urban to rural ratio.

There are 69 operational paramedics spread through the Western Cape. We received questionnaires from 20 paramedics, representing a return rate of 28%. The true return rate is probably higher than this, but we have no way of accounting for outlying rural areas where paramedics were compliant with respect to the study, but where there were no opportunities for paramedics to intubate. During informal follow-up I ascertained this to be the case indeed.

Hence, we do not know which areas yielded a zero-return rate because of non-compliance, and which areas yielded a zero-return rate because of an absence of critically ill patients presenting opportunities for intubation. This is a design failure which unwittingly came about as a result of a conscious intention not to compromise the nature and confidentiality of the study, by pressurising paramedics to return data against their will.

Frequency of Intubation by Western Cape Paramedics:

More than 97% of returns were submitted by paramedics who do a minimum of 2 intubations per month. This is considerably in excess of the international norm, and may be attributed to the relative shortage of paramedics in the Western Cape (and therefore a very high caseload per paramedic), as well as the regrettable endemic high levels of interpersonal violence, gunshot injuries and motor vehicle accidents observed in the province.

If we compare the Cape Town metropolitan area to the San Diego County, both areas accommodate approximately 3 million people. The San Diego EMS system dispatches at least 2 paramedics to every call, whereas in Cape Town, we have an average of 26 ambulances per shift supported by 6 paramedics, each working *alone* on rapid response vehicles. Our service responds to an average of 320 emergency calls per day, of which half are received as urgent, life-threatening emergencies.

Considering the relatively high frequency of intubation by our paramedics (more than 65% of paramedics report an intubation frequency of at least 4 to 8 intubations per month), the Western Cape would indeed provide fertile ground for future studies, or for any multi-centred international trials. This high frequency of intubation also assists our paramedics in maintaining a high level of skill.

As mentioned, our paramedics' frequency of intubation is many-fold that of paramedics working in large centres in the United States. For example, in a recent study by the University of Pittsburgh School of Medicine³, the authors found that two-thirds of Pennsylvania paramedics perform endotracheal intubation less than 3 times per year, and 40% perform no intubations at all! This is due to the large number of paramedics within the Pennsylvania EMS system, and the low caseload per paramedic. In a previous study by the same authors⁴, they observed that since only a proportion of all intubations are performed as a "rapid-sequence intubation" (RSI) technique, that the average paramedic in their system will only perform RSI intubation *once every 4 years!*

In a study comparing paramedic experience to successful intubation, Garza et al⁵ analysed 909 intubations performed by a group of 98 paramedics, who had a success rate of 85%. Where 'months of experience' bore no correlation to intubation success rate, 'frequency of intubation' per paramedic yielded a significant difference. In our study however, there was no correlation between either 'years of experience' or 'frequency of intubation', on intubation success rates. This is further discussed under 'Difficult and Failed Intubation'.

Notwithstanding the high frequency of intubation amongst most of our paramedics, there are still some paramedics in outlying areas who receive very little to no opportunity to intubate. We detected a correlation between geographical area and failed intubation, with a 3 times greater rate of failed intubation occurring in the outlying areas. This would imply a correlation between frequency of intubation and success rate, despite this not being evident on direct scrutiny.

Unfortunately, our study cohort of failed intubations is small, which requires cautious interpretation. However, there still exists real cause for concern with regard to the maintenance of the technical skills of paramedics outside the large metropolitan areas, and this certainly requires remediation.

We also do not know whether there are paramedics who do not have the confidence, motivation or skill to attempt intubation when clinically indicated, or indeed what the failure and complication rates are of those paramedics (the majority) not participating in the study.

Furthermore, owing to the voluntary nature of the returns, there are a vast number of intubations that paramedics have elected not to enter into the study. The reasons for this may be varied. When considering the frequency of intubation claimed by paramedics, the number of paramedics who have entered themselves into the study, and the number of actual returns, this is certainly the case. This naturally raises the concerns of selection bias on multiple fronts.

Patient Profiles:

The majority of patients (57%) fall into the 18 to 50 year-old group, while 17% fall into the 0 to 10 year-old group, and a surprisingly high percentage (10%) fall into the age group of less than 1 year-old. It would certainly be interesting to examine this age group in further detail, and could be the subject of a further study.

Cardiac arrest accounts for a high percentage of intubations (25%), as does head injury (28%). An unfortunate oversight of the study was not to differentiate between the medical and trauma cardiac arrest subgroups. Non-cardiac arrest polytrauma accounted for 17% of patients, and medical 'non-cardiac arrest' (drowning, stroke, smoke inhalation, etc.) accounted for a surprisingly high percentage (32%). This obviously contributes to a high percentage of difficult and failed intubation, owing to the combative nature of these patients. This is discussed further under 'difficult intubation'.

Indications for Intubation:

Cardiopulmonary resuscitation is cited as the indication for intubation in 34% of patients.

This underscores a discrepancy in 'patient category' of 25% for cardiac arrest. This observation could be the result of the unintentional "double-scoring" of patients into, for example, the head injury *and* cardiac arrest groups.

A surprising number of patients were intubated for airway protection only, owing to depressed levels of consciousness (GCS less than 8), who were otherwise maintaining an adequate airway and ventilation. The wisdom of this practice is called into question when considering the incidence of aspiration occurring during intubation, and is further discussed under the category of 'aspiration'.

Inadequate airway maintenance, and inadequate ventilation accounted for 37% of intubations, whereas 'inadequate ventilation only' accounted for only 5%. This is not surprising, as inadequate ventilation can justifiably be supplemented with bag-valve-mask ventilation, without the need for intubation.

Place Where Patient Intubated:

Very interestingly, 22% of patients were intubated in hospitals or clinics (probably 'day hospitals', otherwise known as Community Health Centres), where a doctor was present

in 19% of cases. This confirms anecdotal reports where paramedics are called upon, by general practitioners working in these satellite Accident & Emergency departments, to intubate patients in these facilities. This is a very serious indictment against the training and skill of these 'emergency department' doctors, and needs to be addressed by the appropriate authorities.

Time Spent in Paramedics' Care:

The mean time that each patient spent in the paramedics' care was 60 minutes, with a maximum time of 5 hours and a minimum time of 20 minutes.

This has an important bearing on patient care with respect to the advanced life support equipment that paramedics have at their disposal. Paramedics are required to provide a high level of critical care for protracted lengths of time whilst in transit, and often without adequate equipment.

It is also important to note that, in comparison to their North American and European counterparts, South African paramedics have considerably longer prehospital times (from arrival on scene to arrival at hospital). Prehospital times in the United States and United Kingdom are commonly in the order of 15 to 20 minutes⁶, whereas our *mean* prehospital time is 60 minutes.

The reasons for the prolonged South African prehospital times are largely due to considerable geographic distances from scene to hospital, the historical disparity between the location of residential areas and hospitals, and the unfavourable relationship between paramedic supply and demand. Longer on-scene times are sometimes the result of additional time spent preparing patients for longer transits to more distant hospitals. Thus, "load and go" or "scoop and run" is a luxury not always accorded paramedics in the Western Cape.

This is all the more reason that paramedics require adequate provision of sophisticated advanced life support equipment. The problem in the supply of this equipment lies in

the enormous expense of importation from abroad, and the budgetary constraints imposed by the relative weakness of the South African Rand compared to foreign currencies.

Difficult Intubation:

In a study by Tayal et al ⁷, the incidence of failed intubation amongst U.S. anaesthesiologists in the controlled environment of the operating theatre is reported to be 0.05 to 0.35% (or 1: 285-2000).

The incidence of failed intubation in the prehospital setting is routinely reported in the order of at least 10%, and very often higher. This translates into a difficult intubation rate at least 20 times higher than in the hospital setting ^{4,8,9,10}.

Difficulty of Intubation:

The results of this study show very high rates of difficult and failed intubation, when compared to in-theatre endotracheal intubation. The reasons for this have been laid out in the introduction, and in the discussion up to this point.

We demonstrated a rate of 'easy' intubation of 45%. 'Moderately difficult' intubation was reported at 29%, and 'very difficult' intubation at 16%. Failed intubation was reported at 9%, which is within the norms reported in the international literature for prehospital intubation by paramedics, but is (not surprisingly) very much higher than similar data reported on in-theatre intubation.

Difficulty of Intubation related to Patient Effort and Cormack & Lehane Grading:

Our figures show that degree of difficulty of intubation, Cormack & Lehane grading and patient effort are *directly* related to each other.

This would suggest that the more a patient resists efforts to intubate, the more difficult it is to achieve adequate laryngoscopy, and therefore intubation.

Difficulty of Intubation Related to Patient Group and Patient Resistance:

All groups had a high percentage of difficult intubation, with the cardiac arrest group (those patients likely to present the least resistance) yielding a surprisingly high rate of difficult intubation at 37%, yet the lowest rate of failed intubation, at 3%. This group also had the lowest mean Glasgow Coma Scale (GCS) of 3.2, suggesting that these patients were the most flaccid.

When examining the cardiac arrest group more closely, 83% of patients were flaccid, offering no resistance to intubation. A further 9% offered 'minimal resistance', with no patients falling into the categories of 'considerable' or 'maximal' struggling. (Degree of struggling was not recorded in a further 9% of this group).

This suggests factors beyond patient effort accounting for the high incidence of difficult intubation, which perhaps requires further study.

These findings are borne out in a study by Wang et al ¹¹, which examined a series where 49% of failed prehospital intubations were attributed to inadequate relaxation, and where 41% of these failed prehospital intubations were intubated in the hospital Emergency Department. Thus, 59% of failed prehospital intubations were unable to be intubated in the relatively 'ideal' surroundings of the emergency department. *This once again suggests factors beyond inadequate relaxation contributing to difficult intubation.*

The head injury and polytrauma groups represented the highest rate of difficult intubation, with the corresponding highest rates in patient struggling (38% and 24% respectively), and mean GCS (5.1 and 4.6 respectively). The polytrauma and other medical groups represented the highest rates of failed intubation. Unfortunately, the numbers of patients in these groups are very small, and therefore the accuracy of extrapolated data must again be interpreted with caution.

The high incidence of difficult and failed intubation in the 'Other medical non-cardiac arrest' group can be similarly explained.

It is worthy of note that of the failed intubations, 2 were associated with no struggling, 1 with minimal struggling, 3 with considerable struggling and 4 with maximal struggling. (3 of the failed intubations unfortunately had insufficient data on patient effort).

The common theme of a combative patient with a higher mean GCS struggling against intubation efforts is the likely explanation for the phenomenon of difficult and failed intubation. However, as our study has demonstrated, and as is borne out by the literature, this is certainly not the whole picture.

Difficult Intubation Related to Glasgow Coma Scale:

Mean GCS for easy intubations was 4, and for very difficult intubations 5.8. Also of note, the mean GCS in the failed intubation group was 5.5.

A GCS of 3 was noted in 76% of easy intubations, and in only 25% of very difficult intubations.

6 of the 13 (46%) failed intubations were associated with a GCS of 3, suggesting other factors associated with difficult and failed intubation, as discussed above under 'difficulty of intubation related to patient group'.

These findings yet again underscore the importance of addressing factors beyond GCS and degree of patient resistance in addressing factors contributing to difficult prehospital intubation.

Difficult Intubation Related to Cricoid Pressure:

In the category 'very difficult' intubation, cricoid pressure was only applied in 6 of 20 patients, or in 30% of cases. Similarly, cricoid pressure was only applied in 4 out of the 13 failed intubations, or in 31%. This would suggest that paramedics do not utilise

cricoid pressure for ‘optimal external laryngeal manipulation’, in order to increase visualisation of the vocal cords.

Difficult Intubation Related to Cormack & Lehane Grading:

When examining Cormack & Lehane grading specifically, the results mirror the above results exactly. Namely, cricoid pressure was applied in only 6 out of 20 patients, or 30% of patients with Grade III visualisation, and in 4 out of 13 patients, or 31% of patients with Grade IV visualisation.

This suggests that paramedics are either not aware of, or do not place emphasis and value on the application of cricoid pressure for ‘optimal external laryngeal manipulation’, in order to optimise visualisation of the vocal cords. This is an area that needs to be addressed through simple ‘Continuing Medical Education’ (CME) follow-up.

In-line Neck Stabilisation:

In-line neck stabilisation was applied to 45 trauma patients. Unfortunately, a design failure of the study was not to differentiate between traumatic and medical cardiac arrest. We thus cannot accurately quantify the number of trauma patients, and therefore the percentage of patients in whom in-line neck stabilisation was applied. However, the number of known (non-cardiac arrest) trauma patients is 56. Thus, application of in-line neck stabilisation in 45 patients represents a maximum of 80% application of in-line neck stabilisation (presuming none of the cardiac arrests were of traumatic origin). This translates into at least 1 in 5 patients not receiving neck stabilisation procedures during the intubation attempt. Once again, this can be easily remediated through ongoing CME.

Number of Attempts at Laryngoscopy and Intubation:

The average number of attempts at laryngoscopy was 1.8, and average number of attempts at intubation (passing the endotracheal tube through the vocal cords) was 1.6. The maximum number of attempts in each group was 8. This indicates considerable difficulty at intubation. In fact, it is probable that the definition of “difficult intubation” for a paramedic on the road might not be the same as for a theatre-based specialist anaesthetist.

Time to Intubation:

The average time to intubation was 2.9 minutes, with 57% of patients intubated in less than 1 minute. 64% of all patients were intubated within 2 minutes, and 85% of patients intubated within 3 minutes. Only 2% of patients took longer than 5 minutes to intubate, and 6% took longer than 10 minutes to intubate.

Recognised Oesophageal Intubation:

Of the 140 patients in the study, there were 20 recognised oesophageal intubations (14%) that required re-intubation. In only 6% of intubations was end-tidal capnography used; it is thus not possible to say if this aided in the recognition of misplaced tubes.

Unrecognised Oesophageal Intubation:

Unfortunately, the self-reporting nature of this study precluded the detection of unrecognised oesophageal intubations arriving at hospital. This aspect is fully discussed in the literature review section of this document.

Failed Intubation related to Patient Age:

There is no specific relationship between failed intubation and patient age.

Failed Intubation related to Paramedic Experience and Frequency of Intubation:

There is no specific relationship between years of experience of the paramedic, or frequency with which paramedics intubate. This contrasts with results published in the literature, where a clear relationship between frequency of intubation and rate of successful intubation has been demonstrated⁵. In fact, 11 of the 13 failed intubations occurred with experienced paramedics. One failure occurred with a paramedic with 1 to 2 years experience, and one with a paramedic student. The remainder of failed intubations occurred with paramedics who claimed at least 2 to 4 intubations per month, and 50% of whom claimed 4 to 8 intubations per month.

One would expect difficult and failed intubation to occur more commonly amongst paramedics who intubate infrequently. However, it might be that those paramedics who have a lower threshold for intubation are more likely to encounter difficult and failed intubation for two reasons: Firstly, the more intubations that a paramedic attempts, the greater the statistical inevitability of encountering difficulties. Secondly, it is possible that the more enthusiastic a paramedic, the lower the paramedic's threshold for attempting intubation, and the greater likelihood that he or she will attempt intubation in poorly selected candidates – patients that could perhaps be more appropriately managed with less invasive airway techniques.

Failed Intubation related to Geographic Area:

Having said the above, there does appear to be a difference in failed intubation between geographic areas. 6 of 102 intubations in the greater Cape Town metropolitan area failed (6%), while 6 of 38 intubations beyond the Cape Town metropolitan area failed (16%). This suggests an almost three-fold failure rate beyond the metropole, which could perhaps be explained by discrepancies in frequency of intubation. Once again, these figures might be difficult to interpret with accuracy, since the numbers are relatively small, and the number of respondees is also relatively small. This topic has been discussed above under the heading of 'Frequency of Intubation'.

It has also previously been mentioned that many outlying rural areas did not submit any questionnaires. On follow-up, it turned out that this non-return was not due to non-compliance on the part of the paramedics in these areas, but rather due to the fact that there were no opportunities to intubate in these areas, during the study period.

Failed Intubation Related to Patient Struggling:

As already mentioned, patient resistance (struggling) is a significant contributor to difficult and failed intubation. Of the 13 failed intubations, no struggling was reported in 2, minimal struggling in 1, considerable struggling in 3 and maximal struggling in 4. There was unfortunately incomplete data for the remaining 3 failed intubations.

Reasons given for difficult and failed intubation:

Patient struggling accounted for 22% of difficult and failed intubations. One would have expected a higher percentage for this category, and this once again underscores the over-emphasis on lack of relaxation in relation to difficult and failed intubation. Obstructed view owing to secretions, vomitus and blood, accounted for the high percentage of 24%. Obstructed view due to trauma and oedema accounted for 11%. Laryngospasm accounted for 7% and difficult positioning of the patient for 8%.

Very significantly, obstructed view due to “normal but difficult anatomy” (ie. Cormack & Lehane grading of III and IV) accounted for a very high 30% of difficult and failed intubations. This prevalence of Cormack & Lehane III & IV is exceptionally high when compared to in-theatre intubation, and may be explained by poor technique, or by sub-optimal positioning of both the paramedic and the patient (for example, a patient on the floor, and a paramedic on his or her knees). This once again emphasises the importance of optimal external laryngeal manipulation.

Midazolam Administration in Difficult and Failed Intubation:

The number of patients to whom Midazolam was administered is 61 (or 44% of the study cohort). A further 7 (5%) were given Diazepam. 10 patients (7%) were given morphine concurrently. It has been reported anecdotally that morphine is often given simultaneously with a benzodiazepine for its synergistic effects, in achieving increased sedation and ablation of airway reflexes, although it is not licensed for this indication in terms of the Health Professions Council of S.A. paramedic drug protocol. Not all Metro paramedics had access to morphine during the study period.

Administration of Etomidate and Suxemethonium were given in hospital with a doctor present, in 3 cases.

The average dose of Midazolam was 6.8mg, although the most common or 'usual' dose was 10 to 15mg. 45mg was given to 3 patients, and 30mg was given to 8 patients.

Of the patients given Midazolam, 16 (26%) were considered 'easy', 22 (36%) were 'moderately difficult', 14 (23%) were 'very difficult' and 8 (13%) were failed. Thus, for 44 out of 61 patients given Midazolam (72%), difficult or failed intubation was experienced. This is a serious indictment against the efficacy of Midazolam as a drug used to facilitate endotracheal intubation. These findings are confirmed by published studies^{10,12}, discussed under the heading 'Sedative/hypnotic drugs'.

Complications:**Oxygen Saturation:**

Approximately 60% of patients had transcutaneous oxygen saturation measured before, during and after intubation.

The mean SpO₂ measured before intubation was 88%. Mean SpO₂ after intubation was 96%. The mean 'lowest SpO₂' recorded during intubation was 73%, with a lowest recorded SpO₂ of 24%.

19 of the 87 patients with recorded 'lowest SpO₂ during intubation' (22% of patients) had SpO₂ readings below 80%.

Of the total study group of 140 patients, pre-oxygenation was only carried out in 75% of patients, and ventilation was assisted prior to intubation in only 76% of patients. Of the patients with recorded SpO₂ values who were not pre-oxygenated, 14 (or 40%) had pre-intubation SpO₂ readings below 80%.

It is very significant that, according to the returned questionnaires, 25% of patients received no pre-oxygenation or assisted ventilation.

Suspected likely desaturation (during intubation) occurred in another 39 patients in whom SpO₂ was not recorded, or 20% of the total study group, and of which 30 (20% of the total study group) became clinically cyanosed.

8 of the 87 patients in whom 'lowest SpO₂' values were recorded, had SpO₂ values below 80%, and were considered 'easy' intubations. Desaturation was clinically suspected in a further 9 patients in whom SpO₂ values were not recorded.

Thus, for the 'easy' intubation group in whom we have recorded SpO₂ values, there were a total of 17 desaturations to below 80%. Or, otherwise stated, there was at least a 26.5% rate of desaturation in patients who were considered to be easy to intubate. This apparent lack of awareness, with respect to desaturation, is a cause for grave concern.

These findings are mirrored in the USA, where Davis noted in the San Diego trial¹³, that in 84% of intubations where the patient desaturated and became bradycardic, the intubation was described as 'easy' by the paramedic.

Aspiration:

Aspiration is briefly discussed above under the heading 'Indications for intubation'. It is discussed in further detail here.

In our study, aspiration *before* intubation was suspected or detected in 52% of all patients. Aspiration occurred *during* the intubation attempt in 10 patients, or in 7% of the total study group. Cricoid pressure was applied in only half of those suspected of aspirating, while 2 of the 10 aspirations that occurred during intubation, occurred with 'easy' intubations. Neither of these two patients had cricoid pressure applied pre-emptively. It is worthy of note that 80% of the aspiration events that occurred during intubation, occurred during difficult intubation.

For 7 of the 10 aspirations that occurred during intubation, the primary indication for intubation was a 'low GCS, intubated for airway protection only'. The indication of 'low GCS, intubated for airway protection only', was cited as the primary indication for airway protection in a total 38 patients. Of these 38 patients, 7 suffered aspiration events during the intubation attempt, representing an 18% failure rate for airway protection manoeuvres.

Of those in whom intubation failed, 12 were managed with oropharyngeal (Guedel) airway and bag-valve-mask ventilation. Of these 12 patients, only 1 was suspected of suffering aspiration en route to hospital. It is not known whether or not this patient was managed in a left-lateral head-down position, which further serves to minimise the risk of aspiration of gastric contents.

Morgan and Mikhail¹⁴ report the incidence of pulmonary aspiration of gastric contents in the operating theatre at 1:2000, or in 0.05% of patients. Wayne and Friedland¹⁵ reported an aspiration incidence of 13% in their series of over 1600 patients. More than 90% of these aspiration events occurred before paramedic intervention, with the balance occurring during the intubation procedure itself. These figures are very similar to those that we report.

The above data suggest that we need to revisit the concept of endotracheal intubation as a purely airway protective strategy in semi-conscious non-paralysed patients. It seems probable that we are doing more harm than good.

Oropharangeal Bleeding Associated with Intubation:

Bleeding before intubation occurred in 31% of patients, while bleeding noticed after intubation occurred in 24 patients, or in 17% of the total study group. If it can be assumed that post-intubation bleeding is associated with traumatic intubation, then this 17% represents a high percentage of traumatic intubation.

Post-intubation bleeding was associated with 6% of 'easy' intubations, and with 24% of difficult and failed intubations (the full breakdown in the results table). Post-intubation bleeding occurred in 10 single intubation attempts and in 14 multiple intubation attempts.

Therefore, difficult intubation (not surprisingly) seems to have a direct association with post-intubation bleeding, whereas multiple attempts at laryngoscopy and intubation do not.

It is significant to note that 31% of all intubation attempts are associated with blood in the airway before attempting intubation. This must certainly contribute to the high rate of difficult and failed prehospital intubation, and is corroborated elsewhere in this study.

Patient Outcome:

90% of patients were successfully intubated and ventilated, and 10% of intubations failed. Of the 13 failed intubations, 9 were successfully managed with bag-valve-mask ventilation, 3 were poorly managed with bag-valve-mask ventilation (who subsequently died before reaching hospital), and one required a (successful) emergency tracheostomy.

These figures are very much in accordance with the data coming from the USA^{4,8,10,16}, but in terms of in-theatre statistics, we have documented an extremely high rate of difficult and failed intubation, pulmonary aspiration, Cormack & Lehane grading, oesophageal intubation, and emergency tracheostomy rate. We thus need to look afresh at our philosophy towards prehospital endotracheal intubation, reassess its benefits, and examine techniques by which to improve our success and complication rates.

CPR was successful in 15 of the 48 CPR patients (31%). “Success” is injudiciously defined here as a ‘spontaneous circulation detectable on arrival at hospital’, rather than the more appropriate ‘neurologically intact at discharge from hospital’.

Equipment Availability:

Pulse oximetry was available for 90% of intubations. End-tidal capnography was only available in 5% of cases (these probably being due to a private service operating under the provincial ambulance control room in the Cape Town metropolitan area). The provincial ambulance service does not have any access to capnography.

Of note, endotracheal tube introducers (stylets or gum elastic bougies) were only available in 78% of intubations. There is also a remarkable paucity of alternative or “rescue” airway devices, in an environment where difficult and failed intubation is endemic. Namely, laryngeal mask airways (LMAs) were available in only 18% of cases, Combitubes were available in only 4% of cases, and trans-tracheal jet ventilation devices in only 26% of cases. Once again, some of these statistics may be due to the private service operating under ambulance control, as the prevalence for these devices within the provincial ambulance service is probably close to zero.

Of concern is that emergency tracheostomy kits were present in 49% of intubations. While not suggesting that this is a bad thing (100% prevalence would be better), it is worrying to note the relatively high prevalence of these devices over the low prevalence (to non-existence) of far safer and less invasive devices such as the LMA and

Combitube. This is further discussed in the literature review section under the heading 'Emergency tracheostomy'.

Also of concern is that there was not a 100% presence of such basic emergency medical equipment as portable oxygen cylinders, suction apparatus and bag-valve-mask reservoir bags. It is also worthy to mention that there is not a 100% presence of pulse oximeters and cardiac monitor-defibrillator units, and a virtual absence of end-tidal capnography.

If we compare the Western Cape to a First World country like the United Kingdom, a postal survey of 38 ambulance services in the United Kingdom¹⁷ revealed that 14 services (37%) provided neither stylet nor bougie to facilitate difficult intubation; the laryngeal mask airway was available to only 15 services (40%); needle cricothyroidotomy sets were available to 17 services (45%); and 29 services (76%) had nothing but a stethoscope to confirm endotracheal tube placement. There is no doubt that we are not alone in our state of need.

SUMMARY OF THE RELEVANT FINDINGS OF THIS STUDY:

1. We have a very high frequency of intubation amongst our paramedics, when compared to North American statistics, as referenced above.
2. We have a very favourable success rate of 90%, which mirrors the best rates published in the USA, and is certainly better than their norm.
3. We have documented an extremely high rate of difficult and failed intubation (in comparison to the operating theatre environment).
4. Pulmonary aspiration of gastric contents occurs in more than 50% of patients before the first attempt at intubation.
5. There is a very high incidence of pulmonary aspiration occurring during the intubation procedure itself.
6. Difficult intubation carries an especially high risk of aspiration.
7. Accordingly, it has become clear that the wisdom of intubating non-paralysed patients with depressed levels of consciousness, in an attempt to secure the airway against aspiration, is a dubious practice, as this may lead to an increased incidence of aspiration. This indication for intubation needs to be revisited. We also need to emphasise the role of cricoid pressure in this regard.
8. We have shown in our study, which is supported by the international literature, that the single-most important factor relating to difficult intubation is patient effort.

9. However, not all difficult and failed intubations are related to combativeness. Accordingly, we must look beyond this single parameter to improve prehospital intubation success rates in a significant proportion of patients.
10. We have detected a disproportionately high incidence of Cormack & Lehane grade III and IV laryngoscopic views.
11. One technique at improving visualisation of the vocal cords, which is sorely overlooked by paramedics, is the application of cricoid pressure, as “optimal external laryngeal manipulation”.
12. Cricoid pressure is also overlooked in terms of attempting to minimise aspiration.
13. In-line neck stabilisation is overlooked in a large percentage of patients who would benefit from this precaution.
14. The only drugs that paramedics have at their disposal, to ablate the intubation response, are morphine and midazolam. The efficacy of midazolam for this purpose must be seriously questioned. So, too, must the injudicious use of morphine in a cardiovascularly unstable head-injured patient. We need to look towards more efficacious and judicious approaches to ablating airway reflexes, and to teaching paramedics which patients *not* to intubate.
15. Our somewhat startling revelations on oxygen saturation have revealed that pre-oxygenation, assisted ventilation and the management of ‘peri-intubation’ oxygen saturation are matters that require urgent attention amongst those performing field intubation.

16. We have demonstrated a high incidence of pharyngeal trauma post-intubation. It is highly likely that this is due to patient effort, and is a matter that needs to be addressed under the heading of ‘reducing patient struggling’.
17. We have revealed a relatively high rate of emergency tracheostomy (in comparison to hospital statistics, and not the prehospital environment).
18. Paramedic experience and frequency of intubation do not appear to be important factors relating to failed intubation in our study, but geographic area certainly does – with a three times higher rate of failed intubation coming from beyond the greater Cape Town metropolitan area, ie. the more outlying or rural areas.
19. There is real cause for concern regarding erosion of skills for our paramedics working in outlying areas, some of whom have very little exposure to endotracheal intubation.
20. We have documented the very important finding that “day hospital” doctors, or more correctly, doctors working in clinics and the satellite emergency (casualty) departments of Community Health Centres on the Cape Flats, are calling upon paramedics to intubate patients in their departments, before interhospital transfer to referral institutions.
21. Paramedics are managing critically ill and unconscious patients for lengthy periods (a mean of 60 minutes and a maximum of 5 hours, in our study), without having the necessary equipment to maintain an acceptable level of Advanced Life Support care. As evidenced from the U.S. data, pulse oximetry and capnography have become mandatory essential equipment, and not “luxurious extravagances”. In terms of patient safety, this aspect of equipment provision requires urgent attention by the authorities.

22. We have highlighted some glaring deficiencies in essential equipment. In a small percentage of cases there was an absence of some items as fundamentally basic as oxygen and suction apparatus. But far more commonly, there was an absence of the more advanced equipment required for adequate and safe monitoring of patients, for adjuncts to assist with difficult intubation, and alternative airway devices for the management of difficult airways following failed intubation. Continuous waveform capnography, universally absent in the Western Cape government's EMS system, has become recognised internationally as an *essential* monitoring device for the intubated, ventilated patient.

University of Cape Town

LIMITATIONS AND FAILINGS OF THIS STUDY

1. The nature of this study, being a voluntary enrolment study, and the utilisation of multiple subjective forms of measurement, brings with it its own problems. Firstly, we might have unwittingly ‘selected out’ the more enthusiastic, more clinically competent paramedics who by their very nature would voluntarily enrol in such a project. It is possible that there could be a cohort of less enthusiastic, less clinically-grounded paramedics who would elect not to draw attention to their deficiencies, whether anonymously so or not. It is thus possible that we have obtained skewed results returned from the echelons of the more intellectually astute and clinically accomplished.
2. It is also possible that we have obtained skewed results from a cohort of paramedics who wish to present the situation in the field as more difficult than it actually is, for the purpose of campaigning for the use of intravenous anaesthetic agents and muscle relaxant drugs.

However, our results fall well within the norms of those reported internationally, and so it appears that this scenario is unlikely. There is no evidence to suggest any dishonesty on the part of the group of paramedics that participated in this study, and I can only commend them on what appears to be their blatant honesty in revealing “warts and all”.

3. Furthermore, and once again because of the voluntary nature of the study, we had no means of ascertaining which paramedics were non-compliant with respect to enrolment, and which were fully compliant, but simply had no opportunity to enter intubated patients into the study, because of their geographic remoteness.

It is thus a shortfall of the study that we did not accommodate for “blank returns”, which would mean that our ‘actual’ return rate was higher than

reported. This is almost certain to be the case, as I personally followed up certain areas where there were indeed no intubations performed during the study period, despite there being willing paramedics to yield returned questionnaires. For obvious reasons, it is important to identify this group of paramedics, which our study unfortunately did not accommodate.

4. It is certain that we have not ‘captured’ all endotracheal intubations in the Western Cape, for the period of the study. It is also almost certain, that even for those participating paramedics, not all intubations have been captured. We thus have no idea what the true intubation incidence is for the Western Cape, and thus we have no idea what the true difficult and failed intubation rates are, either.
5. An attempt was made to include the two large private ambulance services in the Western Cape, but owing to logistical difficulties (and not lack of effort), it was decided to limit the study to the provincial government’s Metro Ambulance and Rescue EMS system.
6. We have a very small number of failed intubations (13), which precludes an adequate analysis of this group. To accurately study ‘failed intubation’ per se would require a much larger study, which could hopefully include data returned from *all* paramedics in Metro’s employ, as well as from the private ambulance services in the Western Cape.
7. It is regrettable that we did not differentiate between medical and trauma aetiology with respect to the ‘cardiac arrest’ group, as this would have helped to clarify some of our data, such as the true percentage of trauma patients in whom in-line neck stabilisation was applied.
8. Because of the small number of paramedics that participated in this study (20), and the relatively small number of questionnaires returned (140), it is possible

that the data could be skewed by the individual practices of one or two paramedics.

9. Because self-reporting must rely on the subjective observation and opinion of paramedics, the fallibility of some of the data must be borne in mind. For example, it is entirely the opinion of the paramedic whether or not a patient died as a direct result of failed intubation. It is possible that there were factors at play not considered by the paramedic, such as high cervical spine injury, or missed oesophageal intubation.
10. Once again, because of the self-reporting nature of this study, we have no data on missed oesophageal intubations, which in some U.S. studies are commonly reported as high as 1% to 2%, and even as high as 25%^{9,18,19,20,21}. This is discussed in detail in the literature review under 'Unrecognised oesophageal intubation'.
11. The definitions of difficult and failed intubation vary from study to study. We had to rely on the subjective opinion of each paramedic in determining 'easy', 'moderately difficult' and 'extremely difficult' intubation. There would obviously be variations from one paramedic to another, in determining what constitutes a difficult intubation. Clearly, when one looks at time to confirmed placement of the tube, and the incidence of desaturation and aspiration, what is generally construed by a paramedic as an 'easy' intubation in the field would without question be regarded as a difficult intubation by an operating theatre-based anaesthetist. We must therefore be wary of comparing apples with oranges.
12. We did not undertake to measure the haemodynamic variables of heart rate and blood pressure before, during and after intubation, as it is extremely difficult to accurately record blood pressure measurements under the conditions of the prehospital environment. Bradycardia and hypotension are significant factors

that can exacerbate an already severe head injury, and have been reported to be common occurrences in a number of studies, the most important of which is the San Diego Rapid Sequence Intubation Trial^{13,22,23}.

13. We have limited ourselves to the practices and experiences of paramedics undertaking endotracheal intubation in the prehospital environment only. It was not the intention of this study to examine the longer term effects of intubation on patient outcome, with respect to in-hospital course following through to patient discharge.

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LITERATURE REVIEW:

Discussion of Paramedic RSI trials with adverse outcomes:

Those patients that underwent multiple intubation attempts in the San Diego¹⁰ trial paradoxically fared better than those who had single intubation attempts. This suggests that single intubation attempts were associated with worse injury (lower GCS), and possibly for this reason, with worse outcomes. Longer scene times might similarly suggest more catastrophic or multiply-injured, unstable patients.

Bulger, Copass et al²⁸ noted that in the San Diego study, GCS scores were not available for the hand-matched historical controls. The Abbreviated Injury Scale was used instead, yet AIS scores of 3 to 4 could be associated with GCS scores as high as 13 or 14. Thus, hand-matching of historical controls to AIS scores alone might have introduced significant bias against the study population, all of whom had GCS scores of less than 9.

It has been demonstrated in many studies that the lower the GCS, the more severe the injury, the more likely that the patient would be intubated – both because of the clinical decision to intubate, and because of the greater likelihood that intubation would be successfully accomplished in a more obtunded, less combative patient.

Thus, poorer outcomes in the intubated groups might be *associated* with successful intubation, but not necessarily *caused* by endotracheal intubation per se.

These poorer outcomes may be the result of any one or a combination of factors:

- Selection bias due to injury severity - the more severely injured a patient, the more likely that intubation in the field will be attempted, and the more likely it will succeed.
- “Secondary insult” - decreased cerebral perfusion consequent upon circulatory shock, hypoxaemic brain injury, and raised intracranial pressure as a result of hypoventilation and hypercapnia (before paramedic arrival).
- Poor methodology by inappropriate matching of historical controls;
- An increased incidence of pulmonary aspiration in severely obtunded patients with decreased protective airway reflexes.

- A constellation of adverse physiological effects of the intubation procedure itself, and consequent inadvertent hyperventilation (hypoxia, bradycardia, hypotension, hypocapnia).
- The nature of the injuries – if a certain cohort shows a preponderance towards penetrating gunshot head-injuries, or high-speed motor-vehicle collisions, one can expect a higher morbidity and mortality (as has been the case).
- The effects of positive pressure ventilation and/or hyperventilation on intrathoracic pressure and therefore on haemodynamic parameters (reduced cardiac output, especially in the face of hypocapnia and vasoconstriction).

The major lessons to be learned from the San Diego trial are:

- The importance of pre-oxygenation, oxygen saturation monitoring and the avoidance of hypoxia.
- The importance of end-tidal carbon dioxide monitoring, and the avoidance of hypocarbia.
- Avoidance of bradycardia and hypotension, and the importance of monitoring heart rate and blood pressure.

Despite the reasonable expectation that definitive airway management should minimise secondary brain injury, decrease morbidity and increase survival, there is much confounding data that contradicts this notion.

Could it be that field intubation is simply a high-risk and dangerous procedure? Or are we seeing the additional inputs of selection bias, severe primary injury secondary brain injury?

We must be careful not to abandon a potentially life-saving treatment on spurious grounds. There are without doubt serious problems associated with prehospital intubation. It is vitally important not to throw the baby out with the bathwater, in that our approach to paramedic intubation might require revisitation and refinement rather than abandonment. This might be especially valid in a country such as South Africa, where such invasive lifesaving procedures might be appropriate in a society with exceptionally high levels of endemic trauma, and where transit times to hospital, in comparison to many First World countries, are exceptionally long. As

the time-honoured adage states, “absence of evidence is not necessarily evidence for absence”.

Bag-valve-mask ventilation:

Paramedic RSI studies have almost consistently attracted ‘bad press’. There are many confounding variables creating volumes of controversy, not least of which is the single factor of injury severity and the bias this places on results.

It is almost impossible to refute the undeniably strong body of evidence advocating the success of such timeless airway manoeuvres as head-tilt, jaw-thrust and chin-lift, in conjunction with the head-down left-lateral position. The simplicity of oropharyngeal airway insertion, the maintenance of an adequate face-mask seal and effective bag-valve-mask ventilation becomes an extremely attractive argument.

This argument becomes especially powerful when one considers the unacceptably high incidence of missed oesophageal intubation reported in the international literature (discussed below). Add to this the high incidence of peri-intubation pulmonary aspiration, hypoxia and bradycardia, and the case becomes almost closed.

As attractive as it seems to close the argument here, this is unfortunately not the entire picture. If we could optimise the practice of intubation by learning from the international literature, would the retention of endotracheal intubation in the paramedic protocol not offer more benefit than harm?

We need to ask this question in the South African context, where unlike in North America and Europe, we commonly see transit times to hospital measured in hours rather than minutes. Clearly, this question begs further *home-grown* research.

In addition to the above, after having championed the cause of the “simplicity” of bag-valve-mask ventilation, it is necessary to sound a word of caution:

It is my anecdotal experience in training paramedic students in the operating theatre, that utilization of a collapsible anaesthetic breathing bag (as opposed to a self-inflating BVM resuscitator) unmask how surprisingly inadequate some

'experienced' ambulance personnel are at maintaining a good face-mask seal, and therefore adequate ventilation, and is attested to by Kurola et al ⁵⁰.

The uncomfortable truth is that these skills are rarely tested or exposed as being inadequate, since bag-valve-mask ventilation is almost universally carried out on cardiac arrest victims. Because of the dismal survival rates following CPR ^{16,29,30} – the vast majority of whom die regardless of whether or not they are adequately ventilated – poor technique by an unwitting practitioner might never be discovered.

Pre-oxygenation:

The U.S. National Association of EMS Physicians ³⁶ recommends that “pre-oxygenation should preferably be performed by permitting the patient to breathe using a non-rebreather mask until oxygen saturation is 100%”. They make no mention of assessing adequacy of ventilation. Similar protocols are followed in numerous other studies, not least of which is the San Diego trial ¹³. I am surprised at this (what I consider to be a seriously flawed) recommendation, since hypoventilation is extremely common in head-injured patients, and would almost certainly be masked by the administration of high concentration supplemental oxygen. The detrimental consequences of hypercapnia would not be addressed ^{8,37}.

It is my belief that high concentration oxygen can be more effectively administered via a BVM resuscitator with reservoir bag. The patient would still be able to breathe spontaneously, and if ventilation was at any time judged to be inadequate, ventilation could easily be assisted without having to exchange oxygen delivery devices. Utilization of a BVM resuscitator should be a mandatory prerequisite for any paramedic intubation protocol.

Success rates for prehospital endotracheal intubation:

Numerous studies have reported field intubation success rates between 85 and 97%, including those of Wang ^{4,10,40,41}, Davis ⁸, Slagt ¹⁶, Colwell ³⁶, Burton ³⁹ and Garza ⁴².

Many of these authors have somewhat worryingly hailed intubation success rates of 85% as “*successful*”, and “*safe*”, and many have reported a 1 to 2% incidence of unrecognised oesophageal intubation as “*acceptable*”. In any hospital-based system, these results would be considered “catastrophic” and highly litigious.

Wang and Yealy⁴ have suggested that a 15% need for alternative methods of establishing airway control in a rapid-sequence intubation setting does not constitute success, but rather failure; and deem this borderline ‘*success*’ to be the result of placing RSI in the hands of relative beginners in airway management.

They further bring to the fore a shocking study by Katz and Falk⁹, which revealed that a staggering 25% of intubations in their EMS system were indeed unrecognised oesophageal intubations. They allege this to be the consequence of inadequate medical oversight, and emphasize the fundamental importance of close medical supervision and clinical governance by an experienced specialist in airway management.

RSI is not a simple procedure, and can result in significant morbidity, as evidenced by the San Diego and other trials. RSI is a specialised technique applied to a small subset of patients, and is not the complete answer to difficult intubation, as up to 40% of failed intubations are not attributable to inadequate relaxation⁴. (This observation is certainly borne out in our study).

From the above studies, it can be seen that our intubation success rate of 90% in non-paralysed patients falls well within internationally published norms.

Nasotracheal Intubation:

When comparing oral to nasotracheal intubation in non-cardiac arrest patients, Wang¹⁰, Colwell¹⁸ and Brown³⁶ reported significantly higher success rates, shorter times to intubation, lower complication rates and lower incidences of unrecognised oesophageal intubation in the orotracheal group. Considering the results of these studies, blind nasal intubation cannot be recommended in the prehospital environment.

Aspiration:

Wayne and Friedland¹⁵ reported an overall aspiration rate of 13%, with more than 90% of these aspiration events occurring *prior* to suxemethonium administration. These results mirror our findings. In contrast, Morgan and Mikhail¹⁴ report the incidence of pulmonary aspiration of gastric contents at 0.05% in the fasted operating theatre population.

Unrecognised oesophageal intubation:

In the now notorious study by Katz and Falk⁹, in which 25% of endotracheal tubes were found to be misplaced on arrival at hospital, a mortality of almost 50% was demonstrated in the group with misplaced tubes, and a mortality rate of 12% was seen in the total study group, due to misplaced endotracheal tubes.

This paper cites numerous studies reporting dismal missed oesophageal intubation rates of 1% to 2%, with two reported as high as 5.8%⁹ and 9%¹⁹. Many of these authors have inappropriately prefixed their alarming percentage-proclamations with the disarming adverb ‘*only*’^{18,19,20,36}, and some have even described these complication rates as “*reasonable*”³² and “*small but important*”²⁰.

Silvestri et al⁴⁵ examined a series in which paramedics monitored end-tidal capnography at their own discretion. The overall incidence of unrecognised misplaced endotracheal tubes was an unbelievable 9%, *all of which occurred in the group without ET_{CO}₂ monitoring*. In the group undergoing continuous ET_{CO}₂ monitoring, there was an unrecognised oesophageal intubation rate of zero percent. A mortality rate of 100% applied to patients who presented to the Emergency Department with unrecognised misplaced tubes.

Clearly, the acceptance of unrecognised oesophageal intubation by the (U.S.) EMS fraternity is very different to the zero percent accepted by theatre-based anaesthetists.

It is patently obvious that the injudicious introduction of endotracheal intubation into any EMS system has the potential to negatively affect overall morbidity and mortality. This is especially relevant when bag-valve-mask ventilation has been

proven to be a vastly safer practice, with no deaths attributed to complications of face-mask ventilation in any of the studies cited in this review^{30,32,33,34,35}. This serves as a warning to services such as our own where there is very little in the way of medical direction, clinical audit and quality assurance.

The North American anaesthetic mortality rate is believed to be between 3.3 to 5 deaths per million anaesthetics, or at worst 1 death per 200 000 anaesthetics⁴⁶.

If we were to accept an unrecognized oesophageal intubation rate of “*only*” 1 percent, and presuming that the patient died from this oversight, this would translate into 2000 deaths per 200 000 prehospital intubations. Or otherwise stated, paramedic field intubations are 2000 times more lethal than theatre-based anaesthesiologist intubations!

If we extrapolate these “success” rates to the airline industry, a failure rate of “*only*” 1%, would translate into no less than 27 airline crashes at London’s Heathrow Airport alone, every single day!

Thus, a missed oesophageal intubation rate of “*only* 1%” should invoke a state of abject horror in the minds of paramedics and administrators alike, and should not be fobbed off with the idle complacency of, “a small but important experience with failed prehospital airway management”²⁰ which “remains to be addressed”⁴³. The EMS community needs to take full ownership for this highly lethal epidemic, and needs to introduce every measure to urgently intervene in this inexcusable cause of utter shame.

Capnography:

The San Diego study¹³, Poste’s aeromedical study²², Davis’ study of capnometry²³ and hyperventilation, and Silvestri’s very convincing study⁴⁵, all attest to the value of end-tidal capnography in the avoidance of both unrecognized misplaced endotracheal tubes and the avoidance of inadvertent hyperventilation. These studies demonstrated that patients undergoing ET CO_2 monitoring had significantly higher P_iCO_2 values on arrival at hospital, and a statistically significant decrease in mortality associated with the avoidance of inadvertent hyperventilation.

Emergency Tracheostomy:

We noted with concern the relatively high prevalence of emergency tracheostomy kits in 49% of the intubations undertaken in our study, over the low prevalence (to non-existence) of far safer and less invasive devices such as the LMA and Combitube, with their proven record of reliability and safety.

It would seem that paramedics have a much lower threshold for proceeding to tracheostomy than theatre-based anaesthetists, as borne out in both our statistics (1 tracheostomy in 140 patients) and in the international literature^{36,47}. Emergency tracheostomy is a highly invasive, often dangerous procedure with potentially catastrophic consequences, and is not without delayed complications such as oesophageal perforation, pneumomediastinum, tracheo-oesophageal fistula, tracheal stricture and infection. In contrast, the LMA and Combitube have a proven record of reliability and safety (discussed under ‘Alternative airway devices’).

Could it be that these prehospital airway emergencies do not survive to hospital without surgical intervention, and are therefore not reflected in hospital-based statistics? Or could these results be due to a combination of extremely difficult prehospital conditions, the difficulties imposed by combative patients, and/or the results of lesser skill and experience in advanced airway management, and perhaps most importantly, a lack of training in the use of, and availability of these alternative devices? Emergency tracheostomy should always be the very last resort in any difficult airway algorithm, and should always be preceded by non-surgical alternative ‘rescue’ airway devices⁴⁸.

Alternative Airway Devices:

The LMA and Combitube have become well-established, safe and effective first-line rescue ventilation devices in response to “can’t intubate-can’t ventilate” (CICV) situations. These devices can be inserted blindly, quickly, with a low level of skill, and have a low incidence of complications.

Parment et al⁴⁹ showed that the LMA had a 94% success rate as a first-line rescue airway device. Similarly, Kurola et al⁵⁰, Rumball et al⁵², Deakin et al⁵³, Rabitsch

⁵⁶ and Blostein ⁵⁵ have reported extremely favourable results for ease of placement and ability to ventilate with the LMA and Combitube, both as primary airway devices and as rescue devices in failed intubation scenarios.

The risk of aspiration with the LMA in situ is small ⁵¹. However, one must be mindful in that most studies of the LMA have been undertaken in fasted elective surgical patients. Aspiration associated with the LMA might be considerable in the non-fasted trauma patient with a potentially full stomach. A correctly placed LMA does not guarantee against aspiration, but neither does ventilation by face-mask.

The Combitube, although used very successfully in many trials, is not entirely without complications. There is one report in the literature of severe tongue engorgement (requiring tracheostomy) after prolonged placement of the Combitube in a morbidly obese patient ⁵⁷. Compression of lingual vessels was thought to be the most likely cause, and the authors consequently warn against the prolonged use of the Combitube.

Stoppacher ⁵⁸ reported 3 cases of oesophageal laceration and a single case of perforation of the hypopharynx in association with the use of the Combitube. Asamura ⁵⁹ reported on 2 cases involving hepatic portal venous gas imaging by CT scan performed shortly after death. The cause of the above finding was found to be due to gastro-intestinal distention as a result of bag-valve-mask ventilation or the use of the Combitube.

It must be remembered that the LMA and Combitube are supraglottic devices and therefore cannot solve truly glottic or subglottic obstruction – eg. laryngospasm, massive oedema, tumour, abscess, haematoma, etc. Glottic or subglottic problems will require the intervention of trans-tracheal jet ventilation, endotracheal intubation or a surgical airway.

Trans-tracheal jet ventilation can also be rapidly instituted, and is a subglottic device, but carries a significant risk of barotrauma through inadvertently large tidal volumes and too-short exhalation periods ⁴⁸.

Muscle relaxant drugs:

Austin⁶⁰ reviewed the use of prehospital neuromuscular blocking drugs, and reported significant increases in success rates with the prehospital use of suxamethonium. There were no reported complications to the use of suxamethonium, but a retrospective review of this nature cannot preclude that there were indeed none. However, some reported intubation success rates of only 85% in paralysed patients are causes for concern.

Pace and Fuller⁶¹ reported a 92% intubation success rate with the prehospital use of suxamethonium. Three patients developed symptomatic bradycardia and four suffered bradysystolic cardiac arrest following suxamethonium administration. It is not clear whether or not these complications were directly due to suxamethonium administration, due to undetected and/or unrecorded hypoxia, or due to vagal stimulation.

Wayne and Friedland¹⁵ reported a 95.5% intubation success rate in a 20-year review of the prehospital use of suxamethonium. The remaining 4.5% were successfully managed by alternative means. There were at least 6 unrecognised oesophageal intubations (0.3%) detected on arrival at hospital or at autopsy, and 22 patients died en route, believed to be due to their primary pathology. Nonetheless, death due to the adverse effects of suxamethonium or unrecognised oesophageal intubation could not be ruled out.

Some studies reported the use of longer-acting non-depolarising muscle relaxants such as vecuronium and rocuronium. With an intubation failure rate between 10% and 15% commonly reported even in paralysed patients, and an undetected oesophageal intubation rate commonly reported between 1% and 2% (and often higher), the use of non-depolarising agents in the prehospital environment is simply courting disaster. This is especially so in a “can’t intubate-can’t ventilate” scenario.

Suxamethonium presents many problems in the field, not least of which are the logistical difficulties of maintaining refrigerated storage, especially in hot climates such as South Africa. Notwithstanding the multiple side-effects of, and contra-indications to, suxamethonium, perhaps one of its greatest problems is its misconceived short duration of action. Whilst suxamethonium’s duration of action

is indeed much shorter than that of any of the non-depolarising muscle relaxants, Benumof has demonstrated this recovery period to be *shorter* than the period to terminal desaturation in the average “moderately ill” adult.

Hence, a compromised patient subjected to a “can’t intubate can’t ventilate” catastrophe is just as likely to suffer a prolonged hypoxic episode or death following the administration of suxamethonium, as would occur following administration of a longer-acting non-depolarising muscle-relaxant ⁶².

Perhaps the modified gamma cyclodextrin Org 25969, offers a glimmer of hope on the horizon. This experimental compound causes rapid reversal of neuromuscular blockade induced by the non-depolarising muscle relaxant rocuronium. Rocuronium is encapsulated by Org 25969, and results in reversal from profound neuromuscular blockade within two minutes. Added to this, rocuronium is the only non-depolarising muscle relaxant that affords intubating conditions within 60 seconds. Rocuronium does not require refrigerated storage facilities. Furthermore, it is free from histamine release and therefore stable from a cardiovascular perspective ⁶³.

Woods and Allam ⁶⁴ reviewed the subject of tracheal intubation without the use of neuromuscular blocking drugs. The only technique in their description that could be deemed near appropriate in the prehospital setting would be the combined administration of propofol 2 to 3mg/kg and remifentanyl 2 to 4 mcg/kg, which in numerous studies provided ideal intubating conditions in 80 to 90% of ASA grade I and II patients. However, most authors conclude that this technique should not be used in elderly or haemodynamically compromised patients, as blood pressure and heart rate fall significantly at these doses. In addition, mean duration of apnoea is 3 to 4 minutes. These caveats obviously preclude the use of this technique in the prehospital environment by non-anaesthetists.

Sedative/hypnotic drugs: Midazolam and Etomidate

Midazolam is a widely used benzodiazepine used to facilitate endotracheal intubation in non-paralysed patients. The problems with midazolam are primarily its relatively slow and unpredictable onset of action, its relatively long duration of action in the

event of failed intubation, and its tendency to cause hypotension in haemodynamically compromised patients.

Davis, Tamaki, et al ⁶⁵ demonstrated a statistically significant relationship between midazolam dose and hypotension in high-risk patients, such as those with polytrauma and head injury. Wang, O'Connor et al ¹⁰ and Werman, Schwegman, et al ¹² both reported no significant differences between success rates in midazolam-mediated intubation groups vs. non-midazolam-mediated groups.

Etomidate is favoured for its positive side-effect profile with respect to cardiovascular stability in the haemodynamically compromised patient. It also has beneficial effects on intracranial pressure and cerebral blood flow, and for this reason has been investigated for its use in the prehospital setting of the unstable head-injured patient.

There is unfortunately a paucity of data on the efficacy of etomidate as a stand-alone agent. Studies on etomidate are usually incorporated into RSI studies where muscle relaxants are concomitantly used. Reed and Snyder et al ⁶⁶ demonstrated a 79% vs. 23% success rate in the etomidate and diazepam groups respectively. Werman and Schwegman, et al ¹² found similar results, but more importantly noted that etomidate as a stand-alone agent failed in 45% of cases. Swanson et al ^{67,68} compared etomidate to midazolam when used in conjunction with muscle relaxants, and found no significant differences in success rates and haemodynamic parameters.

The biggest single criticism levelled against etomidate is its propensity to cause adrenocortical suppression through inhibition of the 11-beta hydroxylase enzyme system. While this inhibition has previously not been thought to be significant in single induction-dose boluses, a recent editorial in the journal "Anaesthesia" ⁶⁷ has prompted a sobering revisitation of the subject:

The authors postulate that etomidate has escaped scrutiny as a contributory factor in mortality following emergency surgery in the United Kingdom. The authors point to the moratorium placed on etomidate infusions in the ICU setting, where its use increased mortality from 28% to 77% in polytraumatised patients. A clear

relationship between etomidate use and cortisol level has been demonstrated, as was a four-fold increase in inotrope requirements in the ICU setting.

Etomidate has been clearly associated with depressed cortisol levels in elective surgery for well beyond 24 hours. The authors thus question the allegedly benign effect of adrenocortical suppression following induction-dose etomidate administration in the context of critical illness, emergency surgery and septic shock.

Considering that etomidate has been withdrawn in the United States, Australia, Canada, and the Republic of Ireland, the authors caution against the blind administration of this drug, and urge the consideration of safer alternatives such as ketamine or sodium thiopentone⁶⁹.

Thus, the fact that the potentially lethal complications of etomidate are currently being debated in the international literature, and the fact that etomidate offers at best a 55% successful intubation rate in the combative patient, forces one to look elsewhere for an acceptable stand-alone alternative.

SUMMARY OF LESSONS LEARNED FROM THE LITERATURE:

1. The intubation success rate of 90% amongst Western Cape paramedics generally far exceeds the success rates published in the international literature, and at worst is comparable to the best published studies.
2. Frequency of intubation by Western Cape paramedics vastly exceeds that reported in the USA and UK.
3. Patients in the Western Cape undergo much longer transit times to hospital than occurs in the USA and UK.
4. There exists a high incidence of unrecognised peri-intubation oxygen desaturation and bradycardia reported in the literature. Pre-oxygenation is thus critical.
5. A very high incidence of inadvertent hyperventilation has been consistently reported in the literature.
6. This hyperventilation and hypocarbia is strongly associated with poor outcomes in head-injured patients.
7. A very high incidence of hypotension has been reported in the literature. Monitoring of blood pressure during the peri-intubation period should be mandatory.
8. There is a high incidence of emergency tracheostomy in the prehospital environment in comparison with the operating-theatre environment. This practice often precedes other less invasive airway rescue procedures such as LMA or Combitube placement.
9. There is an extremely high incidence of unrecognised oesophageal intubation, misplaced or dislodged endotracheal tubes, and there exists an unacceptable level of complacency towards this problem.
10. A high incidence of pulmonary aspiration is reported in the literature, occurring both before intubation, and during the intubation attempt.
11. Non-pharmacologically-facilitated intubation is associated with a dismal, almost imperceptible success rate. We should be directing our efforts elsewhere.
12. Inadequate relaxation accounts for only 20 to 40% of difficult and failed intubations. Consequently, paralysing drugs are not a panacea to the problems faced with difficult intubation in the prehospital setting.

13. Basic airway management is not to be under-estimated. There is no substitute for a good face-mask seal and adequate bag-valve-mask ventilation.
14. Blind nasotracheal intubation is associated with prolonged intubation times, low success rates, an increased incidence of oesophageal intubation, and high complication rates. It is not to be encouraged in the prehospital setting.
15. There exists a general paucity of 'difficult airway' equipment amongst paramedic personnel, which includes alternative airway devices.
16. Failed intubation algorithms and protocols need to be developed and implemented.
17. Suxemethonium is associated with potentially lethal complications in the prehospital environment, as yet to be fully quantified.
18. Suxemethonium's relative short duration of action cannot be relied upon to restore ventilation before terminal desaturation, in a "can't intubate, can't ventilate" scenario.
19. The still experimental reversal agent Org 25969 might yield rocuronium a safe alternative to suxemethonium in the future. Its appropriateness in the field will have to be established.
20. Neither midazolam nor etomidate are ideal stand-alone agents for the facilitation of intubation. There are currently serious questions that have been raised about the safety and efficacy of etomidate, since its withdrawal from use in a number of countries.

WHERE TO FROM HERE? THE WAY FORWARD...

Following the publication of the San Diego and numerous other paramedic RSI trials, the NAEMSP stated in proceedings from their 2004 Annual Meeting³⁸, “These results force us to ask whether early ETI is beneficial *at all* in *any* patient subsets”.

The facts are that there are many confounding variables in determining outcome at discharge from hospital, and we are far from resolving these issues. There is absolutely no doubt that poorly-performed prehospital intubation carries a high morbidity and mortality. But what of the well-executed prehospital RSI programmes, such as that of the City of Bellingham, Whatcom County, Washington, which demonstrate a 96.6% success rate, the remainder of patients being successfully managed with alternative airway devices and BVM ventilation?

The importance of such basic manoeuvres as chin lift, jaw thrust, and placement of an oropharyngeal airway are undisputed. This, in conjunction with a good face-mask seal and adequate bag-valve-mask ventilation cannot be over-emphasized. Patients seldom die because they cannot be intubated. They die because basic airway management and ventilation are either overlooked or inadequately managed, or because advanced airway management goes horribly wrong.

In two studies examining trauma deaths in the United Kingdom, Hussain and Redmond concluded that up to 85% of patients with survivable injuries who died before reaching hospital, died from airway obstruction⁷⁰. In another study by Nicholl et al⁷¹, death due to airway obstruction in patients treated by ambulance crews was estimated at 28%.

In our society with its endemic trauma load and prolonged transit times to hospital, a strong argument can be made for retaining endotracheal intubation within the paramedic protocol, notwithstanding the current controversies. However, we need to learn from our own mistakes and from those from abroad, and improve the manner in which we perform endotracheal intubation in the field. We need to implement strong medical direction, clinical audit and quality assurance, and must embark upon a programme of active home-grown research if we are to undertake such a venture, always bearing in mind the adage, “Complex systems fail in complex ways”.

The ambulance service management and the paramedic body corporate would have to wholeheartedly embrace such an approach, if we were to meet with any level of success in retaining and expanding paramedic advanced airway management protocols.

We would have to start by immediately addressing those shortcomings exposed by our data and an examination of the international literature, namely:

- Paramedics working in outlying areas, and those intubating infrequently, would need to receive regular updating of their practical skills.
- We need to revise ‘protection against aspiration’ as an indication for intubating the non-paralysed patient, as there is a high rate of aspiration associated with this procedure.
- Pre-oxygenation and assisted ventilation prior to intubation needs to be emphasised through CME training programmes.
- The application of ‘external optimal laryngeal pressure’ needs to be taught as a basic method of improving visualisation of the vocal cords, as does the application of cricoid pressure to reduce the incidence of peri-intubation aspiration.
- In-line neck stabilisation needs to be emphasised in *all* trauma patients.
- Deficiencies in basic essential equipment need to be addressed.
- Deficiencies in pulse oximetry and capnography also need to be addressed.
- We need to be extremely aware of the possibilities of unrecognised oesophageal intubation, inadvertent hyperventilation and hypotension associated with endotracheal intubation, until such time as we can more accurately assess and manage these complications.
- The re-implementation of paramedic ‘partners’ needs to be addressed, in keeping with internationally published practices and recommendations.

Prerequisites for further development and enhancement of the existing Advanced Life Support airway management protocols would include the following:

- A comprehensive re-designed patient report form, with accurate record-keeping.

- Central storage and retrieval system for all records.
- Preferably a computerised database generated from all patient report forms.
- Re-evaluation of training methods and emphases.
- Continuing medical education and maintenance of practical skills.
- Close medical direction and leadership, and medical follow-up of every patient intubated in the field.
- Standardised algorithm-based protocols for basic and advanced airway management, such as an adaptation of the American Society of Anaesthesiologists' Difficult Airway Algorithm, or the adoption of Wang et al's Prehospital Airway Management Algorithm⁷². Such protocols would include a decision tree, confirmation of tube placement, failed intubation drills, 'rescue' techniques and devices.
- Universal availability of alternative airway devices, such as the LMA and Combitube as standard equipment, including such assist-devices as gum-elastic bougies and stylets, amongst others.
- Continuous waveform capnography should be *mandatory* for all paramedics practicing endotracheal intubation.
- Monitoring of ECG, SPO₂, ETCO₂ and blood pressure should be mandatory, before, during and after intubation.
- At least two members per "intubation team" – a paramedic and dedicated paramedic 'partner'.
- An open culture of communication between members of the 'intubation team' would need to be established – if an adverse event such as oxygen desaturation or an absence of CO₂ return on capnography occurred, members of the team would have the freedom to openly communicate this to each other³⁸.
- Any doubt about tube placement and/or an absence of CO₂ detection on capnography would mandate tube removal and reversion to BVM ventilation.

The above is in accordance with the 2001 National Association of EMS Physicians Position Paper³⁶ on Prehospital Rapid-sequence Intubation, by Wang, O'Connor, et al, which states thus:

- That modern prehospital medicine *may* include the use of RSI, and the use of neuromuscular blocking drugs *in selected patients*.

- That prehospital RSI is an advanced procedure that may *not* be appropriate to every prehospital system.
- That the following are minimum requirements of such a programme:
 - An ability to provide adequate medical direction, supervision and training, “*from physicians who have substantial clinical experience with RSI*”.
 - Training and continuing medical education (including hands-on operating theatre experience).
 - Availability of required monitors and equipment.
 - Adequate resources for drug storage and delivery.
 - Standardised RSI protocols.
 - Availability of back-up rescue airway devices.
 - All providers should be trained in at least one of needle cricothyroidotomy (trans-tracheal jet ventilation) or surgical crycothyroidotomy.
 - Continuing quality control, quality assurance and performance review.
 - A minimum of *two* care-givers is required to perform RSI, and in patients with possible cervical spine injuries, a minimum of *three* care-givers (“since RSI requires multiple tasks and the administration of multiple drugs”).
- That training requirements should cover:
 - Instruction on technique and application of RSI.
 - Instruction on RSI pharmacology.
 - Instruction on recognition of the potentially difficult airway, and where RSI may not be appropriate.
 - Instruction on alternative rescue airway techniques.
- That providers must maintain proficiency through adequate clinical experience or supplemental training in the operating theatre.
- That a *minimum* of continuous ECG monitoring, blood pressure monitoring, and pulse oximetry be used, and that end-tidal capnography, preferably with continuous waveform display, *must* be used.

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ACKNOWLEDGEMENTS:

I would like to thank Professor Michael James for his invaluable support and advice in helping to formulate the concept of this study, for assisting in the study design, and for his time, effort and suggestions in the final preparation of this document.

I would also like to thank Doctors Cleeve Robertson and Wayne Smith (Director and Deputy-Director respectively), of the Western Cape government's Emergency Medical Services, "Metro Ambulance and Rescue" for granting their permission for this study, and for their wholehearted support through the process of data-collection.

I am especially indebted to Dr Shaheen De Vries, also of Metro Ambulance and Rescue, who played a pivotal role in the dissemination and retrieval of questionnaires, and without whose friendship, enthusiasm and spirit of enquiry this study would not have been possible.

I would like to thank Maggi Gargan for her assistance with almost all the administrative aspects of this study. I am especially grateful to her for her general enthusiasm and encouragement, her information technology skills, her assistance with statistical analysis, proof-reading of the final document, and the many positive suggestions that she contributed throughout the process from inception to completion of this study.

Lastly and most importantly, I owe a huge debt of gratitude to all the paramedics of the Western Cape's Emergency Medical Services, who so willingly took part in the study. I would like to thank them for the enthusiastic manner in which they embraced the study, and the support that they demonstrated by their willingness to complete copious detailed questionnaires at all hours of the day and night. I respect and admire them for their integrity and the blatant honesty in the manner in which they returned the data to me.

ADDENDA

1. Recommended mandatory equipment as standard issue.
2. Advantages of continuous waveform end-tidal capnography.
3. Optimal external laryngeal manipulation.
4. Covering letter explaining research project.
5. Instructions for participants in the paramedic intubation research project.
6. Paramedic intubation research questionnaire.

University of Cape Town

RECOMMENDED MANDATORY EQUIPMENT AS STANDARD ISSUE:

1. BVM resuscitator, with reservoir bag and range of face mask sizes.
2. Oropharangeal (Guedel) airways – range of sizes.
3. Endotracheal tubes – range of sizes.
4. Portable suction unit with range of suction catheters.
5. Portable oxygen cylinder.
6. Laryngoscope with range of blades, spare bulbs and batteries.
7. Gum elastic bougies, stylets.
8. LMA range of sizes, Combitube, needle cricothyroidotomy and/or surgical cricothyroidotomy (“Mini-Trach”) sets.
9. Appropriate drugs including: Atropine, Adrenalin, Midazolam, Flumazenil (to be expanded upon as per protocol development).
10. ECG, pulse oximetry and end-tidal capnography.
11. Acceptable method of securing endotracheal tube.

A trained assistant would need to be available to assist the paramedic with all aspects of patient management, but especially with advanced airway care.

ADVANTAGES OF CONTINUOUS WAVEFORM END-TIDAL CAPNOGRAPHY:

1. The gold standard in confirming endotracheal tube placement.
2. Continuous breath-by-breath monitor of tube placement/dislodgement.
3. Ventilator or circuit disconnect/obstruction alarm; apnoea alarm.
4. Monitors adequacy of ventilation (hyper- and hypoventilation).
5. Fresh gas flow/rebreathing monitor.
6. Monitor of bronchospasm/expiratory obstruction (slope of expiratory phase).
7. Indirect monitor of sedation/paralysis/patient fighting ventilator.
8. Indirect (crude) monitor of metabolic rate (malignant hyperthermia, thyroid crisis, sepsis).
9. Crude monitor of cardiac output (gradually diminishing expired CO₂ level predicts imminent cardiovascular collapse).

OPTIMAL EXTERNAL LARYNGEAL MANIPULATION:

OELM is taught as the BURP technique⁷⁷. This is when cricoid pressure is applied Backwards, Upwards, to the Right, and with Pressure.

As most assistants applying cricoid pressure will be positioned on the right of the patient, they have the tendency to push to the left, which also distorts the pharyngeal and laryngeal anatomy to the left.

**DEPARTMENT OF ANAESTHESIA
FACULTY OF HEALTH SCIENCES
UNIVERSITY OF CAPE TOWN
GROOTE SCHUUR HOSPITAL**

**PARAMEDIC INTUBATION RESEARCH PROJECT
INTRODUCTION**

Dear Paramedic,

The incidence of failed endotracheal intubation, intubation-related complications and adverse outcomes, and the factors predicting difficult intubation, have been thoroughly studied in the hospital environment, amongst hospital-based doctors.

As a consequence, we have a wealth of information at our disposal, which has enabled us to identify factors that predict and contribute to difficult intubation. This knowledge has helped anaesthetists to refine their practices and techniques, which has greatly improved in-hospital practice, and which has in turn had a considerable impact on patient care.

Second to anaesthetists, paramedics are probably the group most often undertaking endotracheal intubation. However, paramedics function under extremely adverse working conditions, and with a limited drug protocol. We thus suspect that they experience much greater difficulties than theatre-based anaesthetists.

Remarkably, there have been no South African studies documenting the difficulties under which paramedics practice, studies that quantify difficult and failed intubation in the pre-hospital setting, or studies that assess the consequences of successful, difficult or failed intubation on patient outcome under such circumstances.

Thus, we have designed a study in the form of an anonymous questionnaire, the aim of which is to do exactly as stated above. The aim of this study is to identify and document factors contributing to difficult intubation and if possible, to identify ways in which to improve the ease and safety of intubation in the field, and to improve the frequency of successful intubation in the pre-hospital setting.

We therefore urge you to participate in this study, as it may ultimately have direct and profound benefits for both your practice, and for the patients that you manage in the field.

Specifically, the aims of this study are to:

1. Document intubation practices amongst paramedics.
2. Assess the unique difficulties and challenges faced in terms of endotracheal intubation, as experienced by paramedics in the field.
3. Determine the incidence of difficult and failed intubation in the field.
4. Assess the complications and adverse effects of difficult intubation in the field.
5. Assess compounding factors that influence the success or failure of intubation in the prehospital setting.
6. Assess the impact of early pre-hospital intubation on the critically ill or injured patient in terms of patient outcome.
7. Assess the influence of experience on success of intubation amongst paramedics.
8. Depending on the data gathered, make recommendations on intubation practices, training and drug protocols for paramedics.

Please feel free to contact Dr John Roos at any time if you have any queries, need to return completed questionnaires, or request extra blank forms. Contact can be made by telephone at 021 762 8652, sms 082 829 9979 or email dr.j.roos@iafrica.com.

We look forward to your co-operation, and wish to thank you in advance for your assistance with this anonymous and confidential study.

Yours faithfully,

**PROF. MFM JAMES
DR JOHN ROOS**

November 2004

**DEPARTMENT OF ANAESTHESIA
FACULTY OF HEALTH SCIENCES
UNIVERSITY OF CAPE TOWN
GROOTE SCHUUR HOSPITAL**

**INSTRUCTIONS FOR PARTICIPANTS IN THE PARAMEDIC
INTUBATION RESEARCH PROJECT**

INTRODUCTION:

Please understand that regardless of experience, qualification or station in life, we all have adverse outcomes at some point in our practice. The purpose of this study is to document both perfect and imperfect practice, and for this we require your objective reporting.

The unique difficulties of the pre-hospital environment present enormous challenges to our clinical skill. Even under the most ideal working conditions, we are all faced with difficult or failed procedures from time to time. Less-than-perfect practice is not necessarily a reflection on any individual, but is a fact of life and a statistical inevitability for us all.

Thus, we ask you to complete our questionnaires honestly, reflecting actual practice on the road, and not as we expect things should happen according to medical text books, protocol manuals, or institutional policies. Our study will be meaningless if your returned questionnaires reflect anything other than life as it really happens, warts and all.

CONFIDENTIALITY:

This is an anonymous and confidential survey. Returned questionnaires will not reflect the names of either paramedics or their patients, and will be returned in sealed, unlabelled envelopes. Note that individual follow-up will therefore not be possible. All information gathered will be treated with the utmost confidence and respect, in accordance with the principles of any other university research project.

Results of the study will be of a statistical nature only, and will bear no reference to individual paramedics, their patients, their employers or the organisations from which they hail.

INSTRUCTIONS:

We request that you submit the self-assessment questionnaire once only, and complete it at the same time as you do your first intubation questionnaire. Unfortunately there is some unavoidable duplication.

In addition, we request that you complete one intubation questionnaire for each patient upon whom you attempt intubation, whether the patient is successfully intubated or not.

We request that you (or your partner) run a stopwatch to time your intubations, but we understand that this will not always be possible, and that you may need to leave some spaces blank. This is preferable to estimated information, which might ultimately lead to incorrect conclusions.

We request that you start the stopwatch at the time that you administer drugs for intubation, and stop the watch on confirmation of correct placement of the endotracheal tube.

If you have a pulse-oximeter - and if conditions allow - we request that you document oxygen saturation immediately before intubation, immediately after intubation, and record the lowest saturation reading during your intubation attempt.

If you decide to pre-oxygenate your patient, please do not withhold pre-oxygenation for the sake of a 'pre-intubation' oxygen saturation reading -- rather let the pulse-oximeter reflect pre-oxygenation, as would be your normal practice. If you are unable to provide pre-oxygenation for whatever reason, then let the pulse-oximeter reflect that, too.

If you do not have a pulse-oximeter, or if conditions do not allow for monitoring of oxygen saturation, then we request that you leave the relevant spaces blank.

Please do not allow either timing of intubation, or measurement of oxygen saturation, to adversely affect your patients' management. It is of the utmost importance that you do not alter your practice for the sake of this study; but rather that this study accurately reflects your day to day practice as it occurs.

FEEDBACK:

If you would like to receive feedback, or the final results of this study, please let us have your name, phone number and email address. Your personal contact details will not be correlated with your returned questionnaires. Please address your correspondence to dr.j.roos@iafrica.com, phone me on 021 7628652, or phone or sms me on 0828299979.

THANKYOU:

We thank you for participating in this "first of its kind" South African study into the impact of pre-hospital endotracheal intubation practices undertaken by paramedics in the field. The more returned questionnaires we receive, the greater will be the database of information available to us, and thus the greater the accuracy of our research. More importantly, the greater the accuracy of our data, the more appropriate will be our conclusions, and the more relevant our recommendations. We thus urge you to return as many questionnaires as possible!

**PROF. MFM JAMES
DR. J. ROOS**

November 2004

**DEPARTMENT OF ANAESTHESIA
FACULTY OF HEALTH SCIENCES
UNIVERSITY OF CAPE TOWN
GROOTE SCHUUR HOSPITAL**

PARAMEDIC INTUBATION RESEARCH QUESTIONNAIRE

[Please complete and submit this questionnaire each time that you intubate or attempt to intubate a patient]

Please tick boxes only if answers are positive.

1. Private sector:
2. Government sector:
3. Within the greater Cape Town metropolitan area:
4. Outside of the greater Cape Town metropolitan area:
5. Conventional (road) ambulance service:
6. Aero-medical service:
7. Full-time employment:
8. Part-time or volunteer:

YEARS OF EXPERIENCE:

9. Paramedic Student (not yet qualified):
10. Qualified less than one year:
11. Between one and two years:
12. Between two and three years:
13. Between three and four years:
14. More than four years:

AVERAGE NUMBER OF INTUBATIONS PER MONTH:

[How many intubations per month would you estimate that you have done, on average, over the past three months?]

15. None (except for this one that you are documenting):
16. Less than 2:
17. 2 to 4:
18. 4 to 8:
19. More than 8 (ie. average at least two per week):

PATIENT DETAILS:

PATIENT AGE (ACTUAL OR ESTIMATED).

[Select most appropriate category only]

- 20. > 70 years
- 21. 50 - 70 years
- 22. 18 - 50 years
- 23. 10 -18 years
- 24. 5 - 10 years
- 25. 2 - 5 years
- 26. 0 - 1 years

[Select most appropriate category only]

- 27. Cardiac arrest (medical or trauma):
- 28. Head Injury:
- 29. Polytrauma:
- 30. Other Medical non-cardiac arrest (eg. drowning, asthmatic, stroke, etc.):

TIMING:

- 31. Time arrived on scene [(a) time]:
- 32. Time arrived at hospital [(b) time]:
- 33. Time in hours and minutes that the patient was in your care:

INDICATIONS FOR INTUBATION:

- 34. Cardiopulmonary resuscitation (CPR) before intubation:
- 35. Glasgow Coma Scale less than 8, intubated for airway protection only (to prevent aspiration) in a patient maintaining their own airway, breathing spontaneously and adequately:
- 36. Inadequate airway maintenance and inadequate ventilation:
- 37. Adequate airway maintenance BUT inadequate ventilation:
- 38. Other: Specify:

PLACE INTUBATED:

- 39. Hospital, clinic or other medical facility:
- 40. Ambulance or aircraft:
- 41. Roadside or casualty scene:
- 42. Residence or place of work:
- 43. Other: (Specify):
- 44. Glasgow Coma Scale: Total:
- 45. Doctor present?

DRUGS:

[Given immediately prior to intubation, for purpose of intubation]

- 46. Dose of midazolam (mg):
- 47. Dose of morphine (mg):
- 48. Dose of Etomidate (mg):
- 49. Propofol, Thiopentone or Ketamine:
- 50. Suxemethonium (Scoline):
- 51. Other muscle relaxant (paralyzing drug):
- 52. Other drug: Specify:

OXYGEN SATURATION:

If oxygen saturation was monitored:

- 53. SpO2 before intubation:
- 54. SpO2 after intubation:
- 55. Lowest SpO2 recorded during intubation attempt:
- 56. Did conditions or urgency allow for pre-oxygenation.?
- 57. Was ventilation assisted before intubation attempt?

If oxygen saturation was not monitored:

- 58. Do you suspect, or do you think it likely, that the patient desaturated during the intubation attempt?
- 59. Did the patient become clinically cyanosed at any time?

LARYNGOSCOPY AND INTUBATION:

- 60. Was cricoid pressure maintained WITHOUT INTERRUPTION from the time of administration of drugs (if no drugs given, then from the start of laryngoscopy) until CONFIRMED correct placement of the endotracheal tube:
- 61. Did conditions allow for in-line neck stabilization (for trauma patients):
[Leave blank if not a trauma patient]:
- 62. Number of attempts at laryngoscopy:
- 63. Number of attempts at intubation:
- 64. Number of times oesophagus intubated inadvertently:
- 65. Time from first laryngoscopy to confirmed correct placement of endotracheal tube: _____ . minutes: _____ seconds:

EASE OF INTUBATION:

- 66. Intubation was easy:
- 67. Intubation was moderately difficult:
- 68. Intubation was very difficult:
- 69. Intubation failed:
- 70. Cormack & Lehane grade I
- 71. Cormack & Lehane grade II
- 72. Cormack & Lehane grade III
- 73. Cormack & Lehane grade IV

PATIENT GAGGING or COUGHING or SWALLOWING or BITING or STRUGGLING AGAINST LARYNGOSCOPY:

- 74. None (patient flaccid):
- 75. Minimal (little effect on intubation and laryngoscopy):
- 76. Considerable (making laryngoscopy and intubation difficult):
- 77. Maximal (making laryngoscopy and intubation exceedingly difficult or impossible):

ASPIRATION:

- 78. Aspiration clinically suspected or detected BEFORE intubation attempt:
- 79. Aspiration occurred DURING intubation attempt:
- 80. Suction apparatus ready at hand for use before intubation attempted:
- 81. Conditions prior to intubation precluded ready availability of suction apparatus:
- 82. Suction apparatus actually used during intubation attempt:

BLEEDING:

83. Bleeding from mouth, nose or pharynx BEFORE intubation attempt:
84. Bleeding from mouth, nose or pharynx AFTER attempt:

REASON FOR FAILED INTUBATION:

85. Inadequate sedation/paralysis (patient gagging, biting, struggling, coughing against laryngoscopy):
86. Obstructed view (secretions, vomitus, blood):
87. Obstructed view (trauma, oedema):
88. Cords poorly visible due to normal but difficult anatomy (Cormack & Lehane grade III or IV):
89. Laryngospasm:
90. Awkward or difficult positioning of patient:
91. Other reasons (eg. obesity, bright sunlight, etc.):
92. Specify in (91) above:

PATIENT OUTCOME:

93. Successful intubation and ventilation:
94. Failed intubation:
95. Well-controlled airway management and ventilation by oropharangeal airway and bag-valve-mask resuscitator:
96. Poorly-controlled airway management and ventilation by oropharangeal airway and bag-valve-mask resuscitator:
97. Aspiration suspected or detected after failed intubation, or en route to hospital:
98. Patient died before reaching hospital, as a DIRECT result of inability to maintain airway and/or ventilation:
99. Patient died before reaching hospital for reasons UNRELATED to airway management (and excluding terminated CPR):
100. Cardiopulmonary resuscitation, (CPR) terminated or unsuccessful before, or on arrival at hospital:
101. Successful CPR (patient arrived at hospital with spontaneous heart beat and detectable cardiac output):

EQUIPMENT:

Did you, for this particular intubation, have the following equipment immediately available to you?

102. Pulse oximeter:
103. Capnograph:
104. Portable oxygen cylinder:
105. Reservoir bag (for bag-valve-mask resuscitator):
106. Fully functional portable suction unit:
107. Cardiac monitor/defibrillator:
108. Mechanical (automatic) ventilator:
109. Endotracheal tube introducers (bougie or stylet):
110. Range of endotracheal tube sizes appropriate to the patient:
111. Laryngeal mask airway (size appropriate for patient):
112. Combitube:

- 113. Trans-tracheal jet insufflation device:
- 114. Emergency tracheostomy kit:

University of Cape Town