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Effect of Intensive Physician Oversight on a Prehospital Rapid Sequence Induction Program

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Abstract

Objective—To examine the effects of adding close concurrent and retrospective physician oversight, consistent with NAEMSP recommendations, to an existing regional prehospital rapid sequence induction (RSI) program.

Methods—This study involved a retrospective cohort of patients receiving RSI between January 1st, 2004 and July 31st, 2008. On January 1st, 2007 an updated program including additional concurrent and retrospective physician oversight, increased RSI specific continuing medical education, and cadaver lab training was implemented. Study patients were divided into pre- (1) and post- (2) intervention groups based on date of medical care. Data regarding baseline characteristics, airway management, medication usage, and performance factors were compared between groups. A retrospective review by two EMS physicians assessed if the RSI was “clearly indicated” based on a predetermined set of criteria

Results—There were 109 RSIs performed in Group 1, and 54 in Group 2. Absolute increases in the use of both BLS (5%, $p=0.02$) and ALS (41%, $p=0.001$) airway techniques were observed. Increases in post-intubation administration of midazolam (30%, $p=0.001$) and morphine (24%, $p=0.001$), and decrease for vecuronium (–28%, $p=0.001$) were observed. The intubation success rate (92 vs. 94%) and frequency of recognized esophageal ETT placement (5 vs. 6%) were not statistically different. The number of unrecognized esophageal ETT placements remained zero. Physician chart review demonstrated an absolute increase in “clearly indicated” RSIs (17%, $p=0.013$).

Conclusions—Close concurrent and retrospective physician oversight consistent with recommendations from the National Association of EMS Physicians is associated with improved cognitive skills in paramedics, including appropriate patient selection for RSI. Further research is warranted to validate this model and optimize where resources are best used to enhance patient safety and improve clinical management for this controversial paramedic skill.

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Keywords

emergency medical services; prehospital care; rapid sequence intubation; paramedic

Introduction

Managing the patient's airway is held as an important priority of emergency medical services (EMS). Endotracheal intubation is considered by many to be the gold-standard for securing the airway in EMS patients with a compromised or potentially compromised airway and/or respiratory effort. However, intubation may not be possible with combative or semi-responsive patients without the use of rapid sequence induction (RSI), which includes administering a sedative and paralytic medication. The RSI procedure, required in only a very small subset of EMS patients, allows EMS providers to correct life threatening respiratory and/or airway compromise with the goal of improving patient outcome.

The process involved to perform prehospital RSI is complex and requires multiple cognitive steps and procedural skills. In 2001, the National Association of EMS Physicians (NAEMSP) authored an evidence-based position statement outlining the expected elements of an EMS system providing RSI services.¹ These elements can be placed into the broader categories of procedural and cognitive recommendations. Specific procedural areas include continuous endotracheal tube placement monitoring, standardized RSI protocols, and training in backup rescue airway techniques. Cognitive elements include medical direction and oversight, continuing RSI education, and quality assurance with performance review. These elements were further reinforced in 2007 by an expert panel looking at the role of RSI in severe traumatic brain injury.²

Although accepted without dispute in the hospital setting, research has continued to question the safety and effectiveness of EMS providers to perform endotracheal intubation (ETI) in the prehospital environment, including scrutiny over the use of chemical sedatives and paralytics.^{3,4} Most recently, a 2009 study described high levels of errors in prehospital ETI, although these had limited correlation with poor outcomes.⁵ In addition, consideration of the limited number of procedures performed⁶, even in training programs⁷, have led to discussion of setting minimum practice standards to utilize a smaller, but more experienced team of providers.⁸ Furthermore, after using cognitive psychology concepts to analyze prehospital ETI, Wang et al.⁹ concluded that greater emphasis should be placed on the process of ETI. This includes appropriate patient selection and the role of ETI, not just the procedural skill of endotracheal tube placement and administration of medications to facilitate airway management.

A qualitative study with paramedics and physicians found support for prehospital ETI as well as active involvement by medical directors.¹⁰ Additional research has examined the role of training in the success of an RSI program and have questioned the ability of paramedics to reliably and safely perform RSI due to a lack of sufficient cognitive and procedural training, experience, or physician oversight.^{11,12,13} In contrast, paramedics subjected to intense educational curricula and medical director-involved training have demonstrated improved RSI success rates and/or reduced rates of complications.^{14,15,16}

We sought to determine the effects of adding intense concurrent and retrospective physician oversight to an existing regional RSI program. We hypothesized that with intense oversight we would improve both the cognitive skills of performing RSI, such as patient selection, post-intubation sedation, and recognition of failed intubation, and the procedural skills, primarily success rate of the procedure itself.

Methods

Study Design

This was a retrospective medical record review of the cohort of patients on whom an RSI was performed by RSI-credentialed paramedics in the Monroe-Livingston EMS Region between January 1, 2004 and July 31, 2008. There were no exclusion criteria, although by protocol RSI could be performed only for patients older than 14 years of age or greater than 40kg and only paramedics specifically credentialed could perform RSI. Patients were considered to be part of the pre-intervention group (Group 1) if they received RSI between January 1, 2004 to December 31, 2006, the date on which the regional RSI program implemented close concurrent and retrospective medical director oversight (as described in Study Intervention). Patients cared for on or after January 1, 2007 were categorized as part of the post-intervention group (Group 2). Institutional Review Board approval was obtained.

Study Population and Setting

The EMS system examined in this study includes a two county area of nearly 800,000 persons spread over 1,291 square miles of urban, suburban, and rural areas. The region includes thirty different advanced life support agencies and sixty-one basic life support agencies with approximately 350 paramedics and nearly 3,000 other EMS providers (Certified First Responder through EMT-Critical Care). They respond to approximately 120,000 calls for service annually.

The EMS region operates under a common set of medical protocols approved by a physician-led oversight body. A RSI protocol had been available in the region since 2003. This protocol uses etomidate for sedation and succinylcholine for paralysis with lidocaine and atropine available for pretreatment if indicated. The use of sedatives alone, sometimes referred to as “facilitated intubation”, is not permissible under the protocol. Continuous waveform capnography was required throughout the study period. There were no clinically significant changes in the medical protocol or RSI equipment during the study period.

Under the original RSI program, a small group of paramedics (approximately 40) were selected based on experience (at least 4 years as a paramedic and no outstanding quality assurance concerns) and an agency medical director letter of recommendation. Each paramedic then had approximately 8 hours of initial didactic and procedural (manikin and simulator) RSI training supervised by an EMS physician. Feedback regarding RSI cases was given to the RSI paramedic for instances of clinical concern.

Study Intervention

On January 1st, 2007, the region implemented a redesigned RSI program policy consistent with NAEMSP recommendations. The RSI procedural protocol itself did not change. Prior to the implementation of the new program, RSI review consisted of an occasional retrospective review of medical records with provider feedback reserved for negative outcomes. The purpose of the new program was to provide intensive cognitive and procedural skills training and refinement on a continuous basis. Under the new program, RSI paramedics are required to participate in at least eight hours of RSI continuing education every year, including advanced airway (5 hours) and cadaver lab training (3 hours) with an emphasis on scenario and simulation techniques versus lecture based materials. All education and training is provided and overseen by one of four EMS physicians, who also immediately debrief the RSI paramedic upon transfer of patient care when RSI has been performed. Lastly, through an intensive quality improvement and performance review system, an EMS physician reviews every prehospital medical record in which a RSI paramedic was requested or provided a patient evaluation for RSI, regardless of whether the procedure was performed or not. The physician then provides constructive

feedback to the paramedic and uses this information to design system-wide training to address recurrent deficiencies or share “lessons learned” from these relatively infrequent events.

Study Protocol

The patient care episodes were divided into pre- and post-intervention groups, with Group 1 from January 1, 2004 through December 31, 2006, and Group 2 from January 1, 2007 through July 31, 2008. Data was abstracted using a standardized data collection instrument by a research assistant (AF). Categories of variables examined included: age, GCS, vital signs, procedures performed, medications used, and complications. The charts were additionally reviewed by two EMS physicians (JTC and AZF), blinded to each other's decision, to assess evidence of a clear indication for RSI. “No clear indication” for RSI was defined as one being performed in a patient who had an oxygen saturation greater than 92% (with supplemental oxygen if applied) and a documented Basic Life Support (BLS) maintainable airway, or a transport time of less than 10 minutes and a BLS maintainable airway. Both criteria required an absence of documentation suggesting imminent potential for airway loss. A 10 minute cut-off value was chosen by consensus of an EMS oversight group. Cases with missing, unclear or ambiguous results were discussed between the two physicians to reach consensus. In situations where a consensus could not be reached, a third EMS physician (MNS) gave a final decision. All data were placed in a Microsoft Access Database constructed for this study. Provider information was de-identified to ensure privacy.

Group 1 and 2 were compared using the Student's t-test for continuous variables and the Chi Square test / Fischer's exact test for categorical variables, using Minitab (Version 14). All analyses were performed with a p-value set a priori at 0.05 to determine significance between the two groups.

Results

There were 109 RSIs performed in Group 1, and 54 in Group 2. The documented demographics and pre-intubation characteristics of the two groups were similar (Table 1). Although there was no statistical ($p > 0.05$) change in the report of foreign materials in the airway (blood, teeth, or foreign bodies), there were increased secretions noted during RSI attempts in Group 2 (10 (9%) vs 19 (35%) $p < 0.001$).

The number and variety of airway interventions attempted prior to performing RSI increased after implementing the new program, including a statistically significant increase in documentation of any ALS airway techniques ($p = 0.001$) (Table 2). There was also a statistically significant increase in chin lift/jaw thrust ($p < 0.001$), use of high flow non-rebreather ($p = 0.001$), intubation attempts without paralytics ($p = 0.001$), and CPAP ($p = 0.01$).

Recorded indications for RSI showed a statistically significant decrease in performing the procedure due to “potential or actual airway compromise” ($p = 0.049$) and an increase due to “compromised ventilatory effort” ($p < 0.001$) (Table 3). There were no changes in the use of induction medications, however there was an increase in the use of the bougie (intubating stylet) ($p < 0.001$) during intubation.

The majority of post-RSI vital signs did not statistically change (Table 4). Statistical changes ($p < 0.001$) in post-intubation frequency of medication use consisted of an increase for midazolam and morphine, and decrease for vecuronium in Group 2. These percentages were based on any use during a call, making a patient receiving multiple doses equivalent to a patient receiving one dose of medication post-intubation for analysis purposes. There were statistically significantly increased rates of bradycardia ($p = 0.03$), hypotension ($p = 0.006$) and gastric

contents in the airway ($p = 0.044$) reported immediately following intubation in Group 2, however fewer missing measurements of oxygen saturation ($p = 0.001$).

There were statistically increased scene ($p = 0.002$) and transport ($p = 0.01$) times in Group 2 (Table 5). The success rates for intubations, first attempt success rates and frequency of esophageal ETT placements were not statistically different ($p > 0.05$). The number of unrecognized esophageal ETT placements remained zero. Indicated RSI intubations increased, from 72% to 89% ($p=0.01$) (Table 5).

Discussion

Despite its publication in 2001, in our experience the NAEMSP position statement on Rapid Sequence Intubation has not been embraced throughout the EMS community as evidenced by the wide variety of protocols, policies, selection, and training of paramedics who perform RSI throughout the country. We sought to demonstrate an association between the addition of concurrent and retrospective physician oversight (consistent with NAEMSP recommendations) and improvements in an existing regional prehospital RSI program. As no such analysis has previously been published, this provides an opportunity to demonstrate whether implementing the medical oversight, educational, and quality assurance recommendations set forth by the NAEMSP is associated with improved RSI performance.

Our data did not show a statistically significant change in procedural skills over time, with 92% and 94% intubation success rates for groups 1 and 2 respectively. This is not completely unexpected considering that our intervention was primarily cognitive in nature with increased amounts of conceptual/didactic training and provider feedback. There was not a clinically significant change to the procedural training that the paramedics underwent, although there was a greater emphasis placed on the use of certain procedures, such as ETCO₂ monitoring, baseline BLS techniques, and the use of alternative/additional airway techniques (King/Bougie). It is important to note that there were not enough subjects in the study to determine equivalence with regards to success rates in the two groups.

It is the gains in cognitive performance that are most notable in the results of this study, with improvements observed in patient selection, increased implementation of non-invasive management and ALS adjuncts, as well as improved post-intubation management. The most critical of these improvements is in the realm of patient selection, where we found an increase in the number of indicated RSIs from 72% to 89% ($p=0.016$). While there is no gold standard to retrospectively determine whether a RSI was clearly indicated based upon documentation, we applied two criteria to help further describe the decision-making of RSI paramedics. The lack of clear indication for RSI was defined as oxygen saturation greater than 92% and a BLS maintainable airway or a transport time of less than 10 minutes and a BLS maintainable airway. The latter defines the patient who may indeed need RSI, but transport to the nearest emergency department is likely more appropriate than delaying time on scene to perform RSI. It is possible that the latter criteria also lead to an increase in mean transport time for RSI patients (14.3 to 20.8, $p=0.002$), or that group 2 was geographically located further from the hospitals. Because of the methods of this study, it is impossible to ascertain whether this is truly better patient selection or due to improvements in documentation. In addition, both criteria rely heavily on the documentation quality of the provider and therefore may underestimate the actual “indications” for the procedure.

As mentioned above, there were additional improvements in non-invasive management and ALS adjuncts usage, suggesting a more aggressive use of alternatives instead of “jumping” to use RSI as a first line treatment. In addition, more providers indicated the use of RSI to restore compromised ventilatory effort rather than because of potential for airway compromise.

Together they may signify a greater understanding of the risks and benefits associated with RSI. Demographic data in Table 1 support that these documented differences are less likely due to differences in patient populations and more representative of improved paramedic cognitive skill and documentation as a result of the program.

Lastly, we must address the concern of whether elements of care are being performed, but not documented. This is highlighted in that only 43% of pre-intervention patients, and 69% of intervention patients, received 100% oxygen via a NRB. It is not clear if this is because it is not being documented, the patient is not getting high-flow oxygen, or they immediately started using a BVM. Unfortunately we are unable to make a conclusion based on the data collection methods. What we do notice is that there is an increased rate of hypotension, bradycardia, and gastric contents in the airway, despite the fact that initial RSI medications remained similar between groups. In addition, there were fewer missed measurements in the intervention group. These all suggest improved surveillance and documentation by the providers, although a greater frequency of complications or interaction with post-intubation medications can not be excluded.

Limitations and Future Research

This study is limited by its retrospective design and its reliance on prehospital medical records for procedural performance metrics and patient selection. Specifically, the serial design of the study limits our observed changes as associated with, and not directly caused by the interventions in question. This likely causes an under-reporting bias due to errors of omission, rather than fabrication of information. There is also a possible ceiling effect in regards to successful intubations. It is conceivable that regardless of how much more training or experience a provider has there is a percentage of patients that will be unable to be intubated in the prehospital setting due to the inherent differences in positioning, lighting, equipment and additional assistance often found in the hospital setting. These potential biases, as well as our model for proper patient selection, both require further investigation. However, the effects of recommendations such as the NAEMSP position statement on RSI may only be examined by retrospective or natural experiments such as this, for randomizing patients to care by providers with and without such oversight may be fraught with ethical challenges. Future research should examine if these effects are sustained, as well as the criteria for appropriate selection of patients for prehospital RSI and correlate this to outcomes data in order to gain a more accurate assessment of the quality of an RSI program and the impact of the procedure's performance on the outcome of a properly selected patient.

Conclusion

This study suggests that close concurrent and retrospective physician oversight consistent with recommendations from the National Association of EMS Physicians is associated with improvement of cognitive skills in paramedics, including appropriate patient selection for RSI. Further research is warranted to validate this model and optimize where resources are best used to enhance patient safety and improve clinical management for this controversial paramedic skill.

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Table 1

Demographic and Pre-Intubation Characteristics of Patients

	Pre-Intervention Group 1 (n=109)	Post-Intervention Group 2 (n=54)	p
<u>Patient Factors</u> (Group 1/2)			
Age (years) (104/54)	53	60	0.05
Glasgow Coma Score (105/53)	6.3	6.6	0.6
<u>Airway Difficulty</u>			
Cormack-Lehane Grade 1	46 (43%)	22 (45%)	0.9
Cormack-Lehane Grade 2	47 (44%)	20 (41%)	0.8
Cormack-Lehane Grade 3	11 (10%)	4 (8%)	0.4
Cormack-Lehane Grade 4	4 (4%)	3 (6%)	0.9
<u>Clinical Category</u>			
Medical	64 (59%)	37 (69%)	0.2
Trauma	45 (41%)	17 (31%)	0.2
<u>Vital Signs Pre-RSI</u> (Group 1/2)(Mean)			
Heart Rate (beats/min)(106/54)	107	105	0.8
Systolic BP (mmHg)(96/51)	153	149	0.6
Diastolic BP (mmHg)(79/46)	94	92	0.7
Respiratory Rate (breaths/min)(101/51)	18	22	0.2
O ₂ Saturation (%) (90/49)	89	88	0.4
EtCO ₂ (mmHg)(10/14)	52	44	0.4

Table 2**Interventions Attempted Prior to RSI**

	Pre-Intervention Group 1 (n=109)	Post-Intervention Group 2 (n=54)	p
BLS Airways Attempted			
Any BLS Airway Technique	104 (95%)	54 (100%)	0.2
Chin lift/jaw thrust	5 (5%)	15 (28%)	< 0.001
Naso-pharyngeal airway / Oro-pharyngeal airway	28 (26%)	17 (31%)	0.4
High Flow Non-Rebreather	47 (43%)	37 (69%)	0.001
Bag-Valve-Mask	79 (72%)	37 (69%)	0.6
ALS Airways Attempted			
Any ALS Airway Technique	16 (15%)	30 (56%)	0.001
Intubation (Non-RSI)	9 (8%)	21 (39%)	0.001
King Airway/Combitube	0 (0%)	1 (2%)	0.3
Continuous Positive Airway Pressure	5 (5%)	10 (19%)	0.01

Table 3

Indications for RSI, Medications, and Adjuncts Used

	Pre-Intervention Group 1 (n=109)	Post-Intervention Group 2 (n=54)	p
Indication for RSI			
Potential or Actual Airway Compromise	92 (84%)	38 (70%)	0.049
Ventilatory Effort Compromised	54 (50%)	42 (78%)	< 0.001
Combative/ness	39 (36%)	15 (28%)	0.3
Smoke Inhalation/burns	2 (2%)	2 (4%)	0.6
Decreased Mental Status	96 (88%)	41 (76%)	0.07
Induction Medications Used			
Atropine	2 (2%)	1 (2%)	1
Lidocaine	47 (43%)	18 (33%)	0.2
Etomidate	109 (100%)	54 (100%)	1
Succinylcholine	105 (96%)	52 (96%)	1
Airway Adjuncts Used			
Any Airway Adjunct Used	11 (10%)	17 (31%)*	0.002
Bougie (Intubating Stylet)	6 (6%)	16 (30%)	< 0.001
Combitube/King Airway	4 (4%)	2 (4%)	1

* One provider used both a Bougie and King Airway on one patient

Table 4**Post-Intubation Management**

	Pre-Intervention Group 1 (n=109)	Post-Intervention Group 2 (n=54)	p
Vital Signs Immediately Post-RSI (Group 1/2)			
Heart Rate (beats/min) (105/54)	102	104	0.7
Systolic BP (mmHg) (98/53)	143	147	0.6
Diastolic BP (mmHg) (85/51)	89	88	0.9
O ₂ Sat (%) (86/49)	97	96	0.2
EtCO ₂ (mm Hg) (87/52)	41	49	0.02
Post-Intubation Medications Used			
Etomidate	38 (35%)	12 (22%)	0.08
Midazolam	39 (35%)	35 (65%)	< 0.001
Morphine	4 (4%)	15 (28%)	< 0.001
Vecuronium	54 (50%)	12 (22%)	< 0.001
Post RSI Findings (Group 1/2)			
Lowest EtCO ₂ during transport (87/52)(Mean)	32	36	0.1
Lowest O ₂ Saturation during procedure (11/36)(Mean)	84	85	0.8
Lowest O ₂ Saturation measurement missing	98 (90%)	18 (33%)	0.001
Complete Relaxation Following Induction	104 (95%)	51 (94%)	0.3
Gastric Contents in Airway During Intubation	2 (2%)	5 (9%)	0.04
Bradycardia Following Procedure	5 (5%)	9 (17%)	0.03
Hypotension Following Procedure	8 (7%)	14 (26%)	0.006

Table 5

Performance Factors

Factor (Group 1/2)	Group 1	Group 2	p
Time (mean) from dispatch to patient's side (min) (104/54)	10.5	10.7	0.9
Time (mean) from patient's side to transport (min) (98/53)	17.3	23.3	0.02
Time (mean) from leave scene to ED arrival (min) (99/53)	14.3	20.8	0.002
Successful Intubation (108/54)	99 (92%)	51 (94%)	1
Number of intubation attempts			
1	90 (83%)	48 (89%)	0.5
2	11 (10%)	5 (9%)	0.2
3	7 (6%)	1 (2%)	0.03
Esophageal placement of ETT	5 (5%)	3 (6%)	1
Unrecognized esophageal ETT	0%	0%	1
Clear Indication for RSI	78 (72%)	48 (89%)	0.02
Reason for RSI was not clearly indicated			
Distance <10 min with BLS maintainable airway (31/6)	18 (42%)	3 (50%)	1
Oxygenation >92% with BLS maintainable airway (31/6)	13 (58%)	3 (50%)	0.9