Received Date : 08-Jul-2016
Revised Date : 21-Nov-2016
Accepted Date : 29-Nov-2016
Article type : Research Methods & Statistics

Title of Manuscript:

Studying the Safety and Performance of Rapid Sequence Intubation: Data Collection Method Matters

Author List:

Andrea S Rinderknecht, MD[a,b], Jenna R Dyas[a], Benjamin T Kerrey, MD, MS[a,b], Gary L Geis, MD[a,b], Mona H Ho MS[a], Matthew R Mittiga, MD[a,b]

Affiliations:

[a] Department of Pediatrics, Division of Emergency Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA, and [b] University of Cincinnati College of Medicine, Cincinnati, OH, USA

Corresponding Author:

Andrea S Rinderknecht, MD

Running Title:

Studying RSI: Chart vs. Video Review

Key Words:

Rapid Sequence Intubation, Chart Review, Video Review, Data Collection, Pediatric, Resuscitation, Oxyhemoglobin Desaturation, Research

Prior Presentations:

We previously presented the results of this study as a platform presentation at the annual meeting of the Pediatric Academic Societies (PAS) in San Diego, April 2015.

Grant or other financial support: N/A

Conflicts of Interest/Disclosures:

None of the authors have any conflicts of interest or financial disclosures.

Acknowledgements:

The authors thank Terri Byczkowski, PhD for her time and statistical support for this study.

Corresponding author email id : andrea.rinderknecht@cchmc.org

Abstract:

Objective:

We sought to describe and compare chart and video review as data collection sources for the study of Emergency Department (ED) Rapid Sequence Intubation (RSI).

Methods:

This retrospective cohort study compares the availability and content of key RSI outcome and process data from two sources: chart and video data from 12 months of pediatric ED RSI. Key outcomes included adverse effects (oxyhemoglobin desaturation, physiologic changes, inadequate paralysis, vomiting), process components (number of laryngoscopy attempts, end-tidal CO2 detection), and timing data (duration of pre-oxygenation and laryngoscopy attempts).

Results:

We reviewed 566 documents from 114 cases with video data. Video review detected higher rates of adverse effects (67%) than did chart review (46%, $p<0.0001$), identifying almost twice the rate of desaturation noted in the chart (34%, vs 18%, $p=0.0002$). The performance and timing of key RSI processes were significantly more reliably available via video review (timing and duration of pre-oxygenation, as well as timing, duration, and number of laryngoscopy attempts, all $p<0.05$). Video review identified 221 laryngoscopy attempts, whereas chart review only identified 187.

Conclusions:

When compared with video review for retrospective study of RSI in a pediatric ED, chart review significantly underestimated adverse effects, inconsistently contained data on important RSI process elements, rarely provided time data, and often conflicted with observations made on video review. Interpretation of and design of future studies of RSI should take into consideration the quality of the data source.

Manuscript:

INTRODUCTION:

As emergency medicine providers expected to competently lead resuscitations and perform critical procedures, we have a responsibility to honestly evaluate our performance and outcomes. The conclusions drawn from the study of resuscitation and critical procedures, such as rapid sequence intubation (RSI), rely on the fidelity of the data collected. Resuscitation and critical procedure performance present unique challenges with regard to data collection: events may be sudden, unexpected, and chaotic with multiple rapidly developing and co-occurring components. The sequence and timing of process elements are important, and with multiple providers participating in

different aspects of care, task fixation and loss of global situation awareness may occur with subsequent downstream effects on the accuracy of documentation.

Chart review is a common method of research data collection.[1] Although it is readily available, clinical documentation is not designed for research and is essentially a form of self-report, with inherent reporting and recall biases that are difficult to mitigate. Although efforts have been made to improve the quality of studies based on chart review[1,2], many studies continue to question the ability of clinical documentation to completely, reliably, and accurately reflect what occurred, especially during resuscitative care or procedural performance.[3,4]

Video review of emergency department (ED) care has been established as an effective modality for peer/performance review, education, and quality assurance, especially around critical procedures, trauma care, and resuscitation.[5-13] It provides audio and visual data, can capture simultaneously occurring data points, makes repeated viewing possible, and is objective in its capture of data.[10] We published a study utilizing video review to examine the performance of RSI in our pediatric ED. Compared to peer-reviewed literature at the time, most of which employed self-report, chart, or registry review methodologies,[14-16] we reported higher adverse effects and lower first laryngoscopy attempt success rates. A limited comparison of the data obtained from video review with that found in the corresponding medical records of our study population revealed notable differences in the documented rates of laryngoscopy success, oxyhemoglobin desaturation, and cardio-pulmonary resuscitation (CPR).[16] We speculated that these differences may have been the result of higher fidelity data capture using video review. To our knowledge, there are no studies directly comparing chart review to video review for data collection around a critical procedure in the ED.

In high-risk, dynamic clinical environments, such as an ED resuscitation area, there is a high likelihood that the written record and other self-report data may not completely or accurately reflect the patient status and resuscitative care provided. If data collection with video review is more thorough and accurate it may better inform research findings and conclusions than these traditional methods of data collection.

The purpose of this work is to identify the capacity of different data collection methods to accurately inform studies of critical procedures and resuscitative care. The objective of the current study was to describe and compare the availability and content of RSI outcome measures from chart review and video review. We hypothesized that video review would more reliably provide access to key RSI data, improving detection of adverse effects and allowing description of the performance and timing of process components vital to the study of RSI.

METHODS:

Study design

This is a retrospective cohort study comparing the availability and content of data from two sources: chart and video review. Our institutional review board approved the protocol prior to study commencement.

Study Setting and Population

This study was conducted in a high volume (90,000 annual visits) quaternary-care, academic pediatric ED. In this ED, critically ill or injured patients are managed in one of four resuscitation bays by an inter-professional team of nurses, physicians, paramedics, and respiratory therapists. During the study period, the nursing team leader co-leading the resuscitation with the responsible physician was primarily responsible for documenting the events of resuscitations on a paper form. Physicians documented history, exam, interventions, and medical decision making electronically. Each of the ED resuscitation bays has a ceiling-mounted digital video camera, which continuously records audio and video. Video recording was originally instituted for peer review and quality assurance activities related to the care of critically ill and injured patients, and consent for video review is included in the ED consent to treat.

We included the chart and video records of all children undergoing RSI in our ED between April 1, 2009 and March 31, 2010 who had complete video review data from our previous investigation[16] as well as all corresponding written and electronic medical records (EMRs). This study represents an unplanned use of this existing video review dataset for the purpose of direct comparison with the chart review data collected de novo for the current study.

Study Protocol

For this study, a trained research assistant with significant experience in RSI data collection reviewed all documentation in each subject's chart as well as the corresponding video review data collection sheet. Study data were collected and managed using a Research Electronic Data Capture (REDCap) database hosted at our institution.[17]

For chart review, we used the EMR, which includes both discreet data fields and free text electronic documentation, as well as a scanned copy of the hand-written nursing resuscitation record (Figure 1a) available in ChartMaxx (ArcGIS, Redlands, CA). Source documents included the handwritten resuscitation record completed by the nursing team leader (primarily designed for clinical documentation), as well as provider notes, procedure notes, and other EMR documentation. These were available in EmStat™ (Allscripts- Misys Healthcare Solutions, Chicago, IL) from the beginning of the study period until November 10, 2009, and in Epic (Epic Systems Corporation, Verona, WI) from Nov 11, 2009 through the end of the study period. During the study period, the hand-written nursing resuscitation record form was updated, for reasons unrelated to the study, to include a dedicated space to document the number of laryngoscopy attempts during RSI.

Each chart contained multiple source documents. Employing a standardized data collection form and well-defined rules and hierarchies developed a priori we developed a summary, or aggregate, record for each chart. Documentation of the occurrence of an event in any source document was interpreted as that event having occurred, even if two source documents were conflicting with regard to the occurrence/nonoccurrence of the event. For example, if there was only one procedure note, and that writer only identified themselves as performing a single attempt, but the resuscitation record identified another person performing an attempt, the aggregate would reflect two attempts performed by two unique providers. Similarly, if one source document reported "the patient tolerated the procedure well without complications" and another source document reported an oxy-hemoglobin saturation (SpO_2) of 76% during RSI, the aggregate would indicate that

desaturation had occurred. When a conflict was present within a chart, we followed our pre-determined hierarchy to determine the aggregate, favoring detection of adverse effects and detection of worst case values (e.g. highest number of laryngoscopy attempts, lowest documented SpO_2, etc.).

The original data source for video review was footage (video and audio) of care provided from the single, ceiling mounted camera (Figure 1b). Each video was reviewed by one of three pediatric emergency medicine physicians using a standardized data collection form as described in the previous study.[16] Continuously video recorded vital sign monitoring data were unavailable for review during this study. In order to assess inter-rater reliability, a second reviewer collected video review data (during the previously published study) for 14 subjects (12% of the sample) and chart review data (for the current study) for 11 subjects (10%) selected by random number generator[16].

As the videos were no longer available for review during this study, we used the original, securely stored video review data collection forms. The research assistant abstracted data from the video review data collection forms and entered it into the REDCap database. In order to mitigate abstractor bias affecting the interpretation of missing or conflicting chart data, the video review data for each patient was entered into REDCap after all chart data entry was complete.

Measures:

Appendices 1B-D list the definitions of each outcome, for both chart and video review. The primary outcome was the detection of adverse effects during RSI (defined as the interval from the administration of the RSI sedative to the placement of the final endotracheal tube (ETT)). Adverse effects included physiologic changes (desaturation, bradycardia, hypotension, or pulseless arrest requiring CPR), inadequate paralysis, vomiting, non-airway/esophageal intubation, unplanned extubation, and right mainstem intubation (RMI). Since continuously recorded vital signs were not available for this study, desaturation was defined on video as verbalization by the team of desaturation or SpO_2 dropping to <90% or an obvious corrective action initiated to reverse desaturation, hypoxia, or dropping SpO2, and from chart review as documentation of SpO_2 dropping to <90% or reference to desaturation, hypoxia, or cyanosis. Additional outcomes included the presence/absence of data from chart and video review regarding the performance of important RSI process characteristics and the timing or duration of key steps. These included any data points which we felt might be a focus of future studies of the process, safety, or evidence-based practice of RSI; most importantly including method and duration of pre-oxygenation, identity of the provider performing laryngoscopy, total number and duration of laryngoscopy attempts performed, and use of capnography ($ETCO_2$) for confirmation of airway location of the ETT. Select data points, including ETT size, identity of administered RSI medications, and patient age and sex, were not amenable for comparison between chart and video because the original data for these elements was gathered with the assistance of the EMR. Definitions for all data points were developed a priori after review of the literature as well as group review of multiple cases, and recorded in a coding guide for abstraction (Appendix 1).

Missing data

As this study aimed to evaluate the availability of data from different sources, we defined data as truly missing only if could not have been obtained from the source. For example, for data collected by video review, occasional missing (undetectable) data points resulted from an obstructed camera view or corrupted audio during a segment of video. Missing data from the chart included source documents which would have been expected to be present (resuscitation record and attending documentation). Data which in traditional studies may have been coded as missing were described in this study by their availability (our ability to detect them) from the sources which were present for evaluation. Due to the inherent differences in the source types, definitions varied for video and chart review (see Appendix 1B-D).

For video review, a source which allows for continuous observation of everything that happened during a case, a determination was made by the study team for each data point as to whether that data point should be detectable (available for data collection) on video. Data points determined to be detectable (available) but not observed to be performed (or heard to be verbalized) were coded as available but "did not occur" (not performed) (e.g., for a video during which there was continuous unobstructed view of the patient's head and neck, the performance of suctioning or application of cricoid pressure would have been "detectable" (that data point was available for collection from video review), but if it was not observed to have occurred, it was coded as "did not occur" (not performed)). Specifically for depth of oxyhemoglobin desaturation, the team may have verbalized the occurrence of desaturation ("available", and "detected/occurred") but not the severity (SpO_2 nadir) ("not available").

For data collected by chart review, the absence of documentation of adverse effects was interpreted as nonoccurrence. For example, if there was no documented evidence of desaturation ("hypoxia", "desaturation", etc) and all recorded SpO_2 values were ≥90% during the RSI interval, it was interpreted as not having occurred. If there was no documentation of a process component or time data in the chart, we coded it as "not available" from the chart. We acknowledge that the clinical team may not document the non-performance of process elements, but felt it was important to measure the ability of each data source to confirm the presence or absence of each data point for comparison (especially those critical to safe performance of the procedure, such as ETCO2 use for confirmation of correct ETT placement).

Data Analysis

Descriptive statistics including frequencies and means were reported for the availability and content of adverse effects and process/timing data. McNemar's, paired t-tests, and Wilcoxon Signed Rank tests were used to detect differences in reported events between chart and video review for categorical and continuous data, respectively. Interrater reliability was measured using Cohen's Kappa for dichotomous data. SAS software version 9.3 (SAS institute, Inc., Cary, NC) was used for all analyses.

RESULTS:

Characteristics of study subjects

One hundred twenty three patients underwent RSI during the 12 month study period, of which 114 (93%) had video review data available. Nine patients did not have videos available for review due to automated deletion from the secure server prior to review by the responsible investigator.

We reviewed 566 source documents available from the 114 charts (Table 1), and developed aggregate summaries for each.

Main Results

Detection of Adverse Effects

Table 2 describes the significantly higher rates of adverse effects detected by video review. 18 cases of desaturation were detected by both chart and video review. Video review identified 21 cases with desaturation, 2 with bradycardia, and 3 with hypotension not detected by chart review. For one patient, although the development of bradycardia and hypoxia requiring epinephrine and atropine were acknowledged, not one of the 4 source documents available in the chart mentioned that the chest compressions observed on video review were performed. Chart review identified 3 cases of desaturation and 4 of hypotension not detected by video review.

Availability of Process Component Data

Table 3 describes the ability to determine presence/absence of RSI process characteristics in each case via chart and video review. The majority of RSI process characteristic data elements (most importantly, the method of pre-oxygenation, the use of ETCO2 detection to confirm ETT position, and the total number of laryngoscopy attempts performed) were significantly more reliably available through video review. We identified 160 providers performing laryngoscopy via video review, but only 145 through chart review, of which 128 (88%) could be linked to a specific laryngoscopy attempt (compared with 100% via video review).

Availability of Time Data

Table 4 lists the availability of time data required to calculate the duration of key steps during RSI. Determination of the length of individual laryngoscopy attempts was rarely possible through chart review. We were able to calculate the duration of pre-oxygenation for 74 (65%) chart review cases, compared to 111(97%) of video review cases. Using charted time data for sedative administration and time of ETT placement, we were able to calculate an RSI duration interval for 97 of the chart review cases (85%) compared with 99% of video review cases. For the 97 cases where an RSI duration was available from both, it was significantly shorter via video review (median duration 3.0

minutes, IQR 2-8, range 0-31) than via chart review (median duration 4.0 minutes, IQR 3-9, range 0-34) ($p<0.0001$).

Comparison of Data Content

Of the 21 patients with desaturation identified by chart review, 19 (90%) had a corresponding SpO_2 value documented. Twenty four (62%) of the 39 identified by video review had a verbalized SpO_2 value documented on the data collection forms. The depth of desaturation noted was not significantly different between chart and video review for the 9 patients who had values from both for comparison (mean difference in lowest SpO_2 was 3.6%, $p=0.69$). The number of laryngoscopy attempts performed was identifiable for all 114 patients via video review, and for 108 (95%) patients via chart review (six charts did not have sufficient data to definitively determine whether a single or multiple attempts occurred). Video review identified a total of 221 laryngoscopy attempts, whereas chart review only identified 187. For the 108 patients for whom a definitive number of laryngoscopy attempts was available from both methodologies, the Wilcoxon Signed Rank test showed the number of attempts identified by video (median of 1, IQR 1-3, range 1-9) to be significantly higher than the number identified by chart review (median of 1, IQR 1-2, range 1-6) ($p<0.0001$). In addition, disagreement between video and chart review on the number of attempts identified occurred in 22 (20%) of these patients.

Source Document Characteristics

The hand-written resuscitation record documented the presence/absence of desaturation 99 of 112 times (88.4%), where oxygen saturation levels were included among vital signs documented during RSI. All 3 cases of desaturation and 4 of hypotension detected by chart review (and not by video review) were identified solely through vital signs documented in this record. Thirteen (11.6%) did not have recorded vital signs during the RSI interval. By comparison, the source that was next most likely to document presence/absence of desaturation was the PEM attending's note (20 out of 64 [31%]). Only 2 of 40 (5%) resident notes addressed the presence/absence of desaturation.

The resuscitation record reported a summary count of laryngoscopy attempts for 83/112 cases (74%), identifying 129 total attempts. By comparison, 44/111 (40%) attending notes, 14/41 (34%) fellow notes, 6/105 (6%) resident notes, 22/23 (96%) attending procedure notes, 16/16 (100%) fellow procedure notes, and 31/31 (100%) resident procedure notes reported a count of laryngoscopy attempts. When a dedicated space for documenting attempts existed on the resuscitation record form (89 of the 112 records), an attempt count was documented 81 times (91%). When there was no dedicated space (23 of the 112 records), an attempt count was only documented twice (8.7%).

Conflicting data

Adverse effects or process characteristics documented in more than one source document within a patient's chart were often conflicting. In 27/114 (24%) charts more than one source document detailed the presence/absence of desaturation allowing for comparison for consistency. In 5 (18.5%) the source documents disagreed about whether desaturation occurred. More than one source document indicated the total number of laryngoscopy attempts in 75 charts, 16 (21.3%) of which disagreed. Appendix 2 shows an example of conflicting documentation around post-intubation ETT location.

Missing Data

For video review, 1 patient had missing data (performance of airway assessment, mist in the tube for confirmation and $ETCO_2$ detection for confirmation) due to corrupted audio, 2 patients had missing data (suctioning, start time of pre-oxygenation and time of final endotracheal tube placement) due to obstruction of the camera view, and the following data were missing from the original study data collection forms for unknown reasons: application of cricoid pressure (once), start time of pre-oxygenation (twice), and time of endotracheal tube placement (once). For chart review, 2 patients had no resuscitation records and 3 had no attending documentation. Only 73 (64%) of 114 charts contained at least one RSI procedure note.

Inter-rater Reliability

For the original video review data collection, abstractor agreement was good for the occurrence of adverse effects such as desaturation and bradycardia during RSI ($\kappa = 0.85$). For chart review, abstractor agreement was good for the identification of documentation around adverse effects ($\kappa = 0.86$) and for the specific documentation and occurrence of desaturation ($\kappa = 0.71$ and 0.64, respectively). For both video and chart review, abstractor agreement was good for the identification of laryngoscopy attempts, performing providers, and key time data around administration of medications and timing/duration of laryngoscopy ($\kappa = 0.81$-1.0).

DISCUSSION:

In order for observational studies to arrive at sound conclusions, the data upon which they are based must be available and accurate. To our knowledge, this is the first study to directly compare chart review to video review for data collection around ED RSI. Video review allowed for detection of significantly higher rates of adverse effects (67%) than did chart review (46%), identifying almost twice the number of desaturation episodes noted in the chart. Chart review significantly under-reported inadequate paralysis, vomiting, and non-airway/esophageal intubation, and detected only 1 of the 2 cases where chest compressions were initiated during the RSI interval. Video review more reliably allowed assessment of key RSI process components, identified higher numbers of laryngoscopy attempts, and allowed evaluation of the timing and duration of key components. We

feel this study underscores the limitations of chart review in informing accurate conclusions about procedural performance and establishes video review as a superior method of data collection for this type of study.

Conclusions regarding the safety and expected outcomes of pediatric RSI in the peer-review literature are largely based on studies that collected data utilizing chart review and/or self-report. The inherent limitations and biases of chart review are compounded when the chart review methodology is inadequately described or of suboptimal quality.[1,2,18,19] Consumers of peer-reviewed literature based on chart review and/or self-report may acquire a false sense of security regarding the performance of RSI for pediatric patients, wrongly assuming that the risk of complications and significant adverse physiologic effects is negligible. For example, a retrospective chart review of 143 children intubated in a pediatric ED reported bradycardia in 4% of patients and hypoxemia in 22%.[20] A study of prospectively collected self-report airway data from the National Emergency Airway Registry (NEAR) described 127 children who underwent RSI, with only 16% experiencing at least 1 adverse effect (2% with desaturation, 7% with mainstem intubation, and 4% with esophageal intubation).[15] We believe these low adverse effect rates may reflect the limitations of these data collection methods, which are susceptible to recall and reporting bias, as well as impacted by task fixation and loss of global situational awareness of providers performing the procedure.

Contemporary studies using data collection methods other than self-report and chart review support our suspicion that adverse effects are underreported by those methods. An ED study using continuously recorded vital signs reported desaturation (SpO_2<90%) in 35.5% of adult patients undergoing RSI.[21] This rate is nearly identical to the rate that we observed through video review and higher than rates previously published for adult patients undergoing RSI in the ED. Su et al, comparing paper documentation during CPR with monitor waveform data and video recording (no audio), showed that critical events, including the presence of shockable rhythms and the occurrence of prolonged states of inadequate blood flow, were not detailed by paper documentation[5].

Video review also illuminates RSI process characteristics and failures that may not be identified through chart review. Had we used resuscitation documentation alone, our reported rate of first laryngoscopy attempt success (64%)[16] would have been more comparable to rates reported in previous studies utilizing chart review or self-report (78-83%)[3,14,15]. The significantly higher number of attempts and lower first attempt success rate (52%) identified for the same patients using video review highlight the overestimation of success suggested by chart review data. We acknowledge that there may be variation in success and safety among centers, but hypothesize that a proportion of the discrepancies in reported laryngoscopy attempt numbers and success rates may reflect differences in data collection methodology rather than significant differences in performance.

Conclusions regarding the contribution of RSI process elements to risk of adverse effects are hard to draw without complete and accurate data. Data obtained from video review suggests the duration of laryngoscopy attempts may be more important in determining the risk of adverse effects than the total number of attempts, as suggested by previous studies.[22-25] Bodily et al, in a study of desaturation during RSI, found that the times of paralytic administration and ETT placement confirmation were frequently missing from the nursing documentation, making the identification of the RSI interval for the assessment of desaturation impossible in 26 of 99 cases.[21] We were not reliably able to calculate an RSI duration interval, the duration of laryngoscopy attempts, or the

duration of pre-oxygenation from chart data, all of which were possible in at least 97% of video review cases. A study by Kaye et al described the inaccuracy of time documentation during in-hospital resuscitation: 14.9% of time intervals were not usable because of missing time data, negative calculated intervals, and unlikely intervals of zero minutes.[4] These data bring into question the capacity of chart documentation to provide time data for the study of resuscitation or procedures, making it impossible to assess the contributions of certain process characteristics to procedural risks.

Table 5 outlines the pros and cons of video and chart review for data collection. Although we believe it to be superior for studying RSI and other critical, time-dependent procedures, video review has disadvantages. Without the integration of continuous vital sign data, physiologic data or changes may not be detectable unless verbalized by providers. In addition to capital investment required for cameras, microphones, servers, and secure data storage, video review is time-intensive. We estimate that for every minute of video from which data is abstracted, 2-4 minutes of reviewer time is required. Other potential barriers to video review include privacy issues (patient and provider) and medico-legal concerns which may vary depending on institutional culture or state regulations. The implementation and use of video review requires strict data security plans, discretion, sensitivity, and responsibility.

LIMITATIONS:

This study represents data from a single center and thus may not be generalizable. Other institutions may have different documentation practices and care teams (with varying levels of experience and numbers of providers contributing to documentation). These factors may increase or decrease the availability of data and detection of adverse effects. However, we have no reason to suspect that the biases and inherent limitations of chart documentation would be categorically different in another setting for this critical, time-dependent procedure.

Data abstractors were not blinded to the hypothesis of the study during the chart review portion of the study. The investigators' bias toward video review based on prior experience studying RSI and the lack of blinding to the study hypothesis could have introduced bias, affecting data detection from chart review. However, we chose data points based on their relevance to RSI research and developed a priori definitions for the presence of data in the chart that were liberal and inclusive in an attempt to maximize event detection. This ultimately may have skewed our results toward making chart review look more effective than it is. Additionally, the aggregate chart review data was entered into REDCap prior to the video review data to limit the influence of the video data. The original video review data was collected prior to knowing the differences in desaturation rates from chart and video, and no specific hypotheses relating to potential differences were present at the time of video review.

Due to the lack of access to continuously recorded vital sign monitoring data to provide a gold standard for comparison for both chart and video review we likely underestimated rates of physiologic adverse effects, such as desaturation, using both methods of data collection.

CONCLUSIONS:

When compared with video review for retrospective study of RSI in a pediatric ED, chart review significantly underestimated adverse effects, inconsistently contained data on important RSI process elements, rarely provided reliable time data, and often conflicted with observations made on video review. For those who plan to study the performance and outcomes of resuscitation or critical procedures such as RSI, we suggest the following: 1) existing peer review literature studying RSI and other aspects of resuscitation based on chart review or self-report methodologies should be interpreted and applied with caution; and 2) if feasible, strong consideration should be given to making video review with access to continuously recorded vital sign data the gold standard.

REFERENCES:

1. Gilbert EH, Lowenstein SR, Koziol-McLain J, Barta DC, Steiner J. Chart reviews in emergency medicine research: Where are the methods? *Ann Emerg Med.* Mar 1996;27(3):305-308.

2. Kaji AH, Schriger D, Green S. Looking through the retrospectoscope: reducing bias in emergency medicine chart review studies. *Ann Emerg Med.* 2014;64(3):292-298.

3. Guilfoyle FJ, Milner R, Kissoon N. Resuscitation interventions in a tertiary level pediatric emergency department: implications for maintenance of skills. *CJEM.* Mar 2011;13(2):90-95.

4. Kaye W, Mancini ME, Truitt TL. When minutes count--the fallacy of accurate time documentation during in-hospital resuscitation. *Resuscitation.* Jun 2005;65(3):285-290.

5. Su L, Waller M, Kaplan S, Watson A, Jones M, Wessel DL. Cardiac resuscitation events: one eyewitness is not enough. *Pediatr Crit Care Med.* May 2015;16(4):335-342.

6. Gelbart B, Hiscock R, Barfield C. Assessment of neonatal resuscitation performance using video recording in a perinatal centre. *J Paediatr Child Health.* Jul 2010;46(7-8):378-383.

7. Carbine D, Finer N, Knodel E, Rich W. Video recording as a means of evaluating neonatal resuscitation performance. *Pediatrics.* Oct 2000;106(4):654-658.

8. Upperman JS. Trauma Video Review: A Valuable Resource. *Pediatrics.* 2006;118(2):839-839.

9. Oakley E, Stocker S, Staubli G, Young S. Using video recording to identify management errors in pediatric trauma resuscitation. *Pediatrics.* Mar 2006;117(3):658-664.

10. Mackenzie CF, Xiao Y. Video techniques and data compared with observation in emergency trauma care. *Qual Saf Health Care.* Dec 2003;12 Suppl 2:ii51-57.

11. Rogers SC, Dudley NC, McDonnell W, Scaife E, Morris S, Nelson D. Lights, camera, action... spotlight on trauma video review: an underutilized means of quality improvement and education. *Pediatr Emerg Care.* Nov 2010;26(11):803-807.

12. Kerrey BT, Mittiga MR, Rinderknecht AS, et al. Reducing the incidence of oxyhaemoglobin desaturation during rapid sequence intubation in a paediatric emergency department. *BMJ Qual Saf.* Nov 2015;24(11):709-717.

13. Fitzgerald M, Gocentas R, Dziukas L, Cameron P, Mackenzie C, Farrow N. Using video audit to improve trauma resuscitation--time for a new approach. *Can J Surg.* Jun 2006;49(3):208-211.

14. Sagarin MJ, Barton ED, Chng YM, Walls RM. Airway management by US and Canadian emergency medicine residents: a multicenter analysis of more than 6,000 endotracheal intubation attempts. *Ann Emerg Med.* Oct 2005;46(4):328-336.

15. Sagarin MJ, Chiang V, Sakles JC, et al. Rapid sequence intubation for pediatric emergency airway management. *Pediatr Emerg Care.* Dec 2002;18(6):417-423.

16. Kerrey BT, Rinderknecht AS, Geis GL, Nigrovic LE, Mittiga MR. Rapid sequence intubation for pediatric emergency patients: higher frequency of failed attempts and adverse effects found by video review. *Ann Emerg Med.* Sep 2012;60(3):251-259.

17. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* Apr 2009;42(2):377-381.
18. Badcock D, Kelly AM, Kerr D, Reade T. The quality of medical record review studies in the international emergency medicine literature. *Ann Emerg Med.* Apr 2005;45(4):444-447.
19. Worster A, Bledsoe RD, Cleve P, Fernandes CM, Upadhye S, Eva K. Reassessing the methods of medical record review studies in emergency medicine research. *Ann Emerg Med.* 2005;45(4):448-451.
20. Fastle RK, Roback MG. Pediatric rapid sequence intubation: incidence of reflex bradycardia and effects of pretreatment with atropine. *Pediatr Emerg Care.* Oct 2004;20(10):651-655.
21. Bodily JB, Webb HR, Weiss SJ, Braude DA. Incidence and Duration of Continuously Measured Oxygen Desaturation During Emergency Department Intubation. *Ann Emerg Med.* Mar 2016;67(3):389-95.
22. Sakles JC, Chiu S, Mosier J, Walker C, Stolz U. The importance of first pass success when performing orotracheal intubation in the emergency department. *Acad Emerg Med.* 2013;20(1):71-78.
23. Hasegawa K, Shigemitsu K, Hagiwara Y, et al. Association between repeated intubation attempts and adverse events in emergency departments: an analysis of a multicenter prospective observational study. *Ann Emerg Med.* Dec 2012;60(6):749-754.e742.
24. Mort TC. Emergency tracheal intubation: complications associated with repeated laryngoscopic attempts. *Anesth Analg.* Aug 2004;99(2):607-613.
25. Rinderknecht AS, Mittiga MR, Meinzen-Derr J, Geis GL, Kerrey BT. Factors Associated With Oxyhemoglobin Desaturation During Rapid Sequence Intubation in a Pediatric Emergency Department: Findings From Multivariable Analyses of Video Review Data. *Acad Emerg Med.* Mar 2015;22(4):431-40.

Video vs Chart Manuscript – Tables

Table 1: Availability of source documents in charts of 114 patients undergoing Rapid Sequence Intubation in a pediatric ED

n (%) shown

Type of source document	**Number available** (N=114 unless otherwise noted)
Hand-written resuscitation record	112 (98)
Attending note	111 (97)
Fellow note[1]	41 (77)
Resident note	105 (92)
Attending procedure note	23 (20)
Fellow procedure note[1]	16 (30)
Resident procedure note	31 (27)
Other procedure note[2]	8 (25)
Scanned RN documentation[3]	14 (13)
Other[4]	105 (92)

[1]N = 53 cases where a fellow participated in care.

[2]N = 32 cases where providers from outside the ED performed laryngoscopy attempt(s). Other procedure notes were written by critical care (PICU) fellows (8 out of 10 cases). Neither anesthesia (21 cases) nor otolaryngology (1 case) providers wrote procedure notes when they intubated in the ED (N=22).

[3]Handwritten nursing documentation, usually representing additional resuscitation documentation

[4]Other notes included triage notes, respiratory therapist documentation, or other electronic nursing documentation.

Table 2: Adverse effects detected during Rapid Sequence Intubation (RSI)[1] by chart and video review

n (%) shown

	Chart review (N=114)	Video review (N=114)	p value
Any (at least one) adverse effect	52 (46)	76 (67)	<0.001
Specific adverse effects			
Desaturation	21 (18)	39 (34)	0.0002
Inadequate paralysis or movement	5 (4)	30 (26)	<0.0001
Non-airway / esophageal intubation	5 (4)	20 (18)	0.0001
Vomiting	3 (3)	9 (8)	0.014
Right mainstem intubation	29 (25)	36 (32)	0.052
Bradycardia	3 (3)	5 (4)	0.16
Hypotension	4 (4)	3 (3)	0.71
CPR[2]	1 (1)	2 (2)	0.32
Unplanned extubation	4 (4)	3 (3)	0.56

[1]The RSI interval was defined as the time between the administration of the first RSI sedative and the securing of the final endotracheal tube

[2] Chest compressions initiated during the RSI interval, as defined above, in a patient with a perfusing rhythm prior to administration of the RSI medications

Table 3: Availability of data describing relevant Rapid Sequence Intubation process characteristics
n (%) shown

	Chart review (n=114)	Video review (n=114)	p value
Method of pre-oxygenation	98 (86)	114 (100)	<.0001
Suctioning	11 (10)	112 (98)	<.0001
Application of cricoid pressure	34 (30)	113 (99)	<.0001
ETCO2 detection confirmation	83 (73)	113 (99)	<.0001
Mist in tube for confirmation	23 (20)	113 (99)	<.0001
Auscultation for confirmation	69 (61)	114 (100)	<.0001
Total number of laryngoscopy attempts	108 (95)	114 (100)	0.03
Identity of laryngoscopist[1]	111 (97)	114 (100)	0.25
Airway assessment performed	112 (98)	113 (99)	0.56

[1] Identification of at least one laryngoscopist was possible

Table 4: Availability of data around timing of key Rapid Sequence Intubation (RSI) steps
n (%) shown

	Chart review (n=114)	Video review (n=114)	p value
Pre-oxygenation started	74 (65)	111 (97)	<.0001
Beginning / End of laryngoscopy attempt[1]	1 (1)	114 (100)	<.0001
Successful (final) endotracheal tube placement	101 (89)	113 (99)	0.0005
Sedative administration[2]	111 (97)	114 (100)	0.25
Neuromuscular blocker administration[2]	112 (98)	114 (100)	0.50

[1] Start or stop time of any RSI laryngoscopy attempt documented

[2] Administration time of the first dose of medication given as part of RSI

Table 5: Pros and Cons of Chart and Video Review

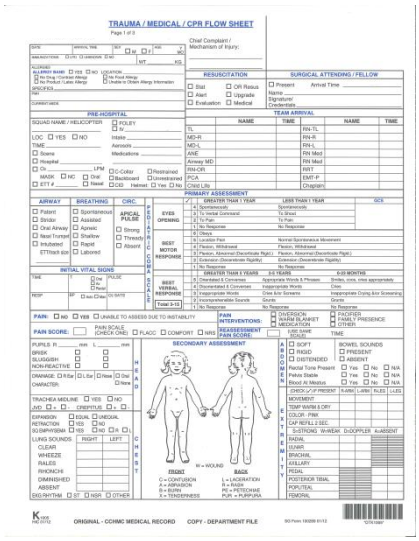
Method	Pros	Cons
Chart review	Inexpensive Readily available Vital sign availability Medication dosage available Chart documentation exists for every encounter Consent not required for documentation	Retrospective Incomplete /Missing data Labor intensive Limited / Inaccurate time data Conflicting data (multiple source documents) Interpretation may be required Bias (recall, reporting) Reliance on providers to document relevant data (first priority is care, not documentation) Lack of standard definitions (attempt, desaturation)
Video	Real time	Expensive

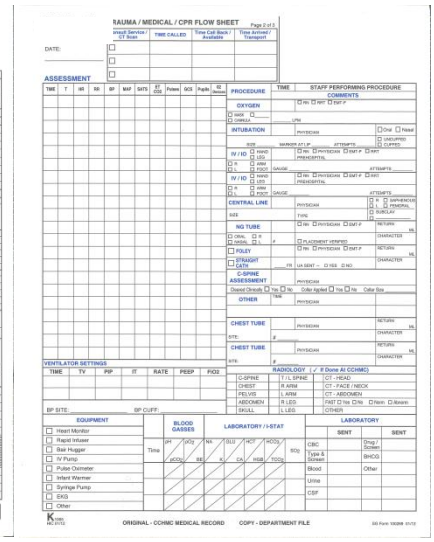
review	Captures both audio and video data Captures simultaneously occurring data Repeated viewing possible Objective Available / Accurate time data Single record	Limited availability Labor / Time intensive Relies on verbalization or clear action Fear of discovery (medico-legal concerns) Cultural barriers (perception of providers) Missing data (Human error or technical difficulties) Requires consent process (video-recording of care)

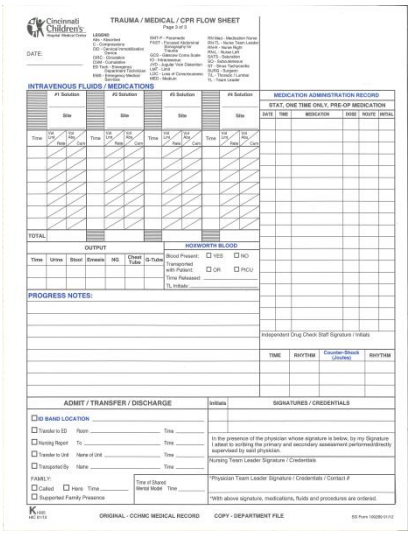
Video vs Chart Manuscript - Figures

Figure 1: Examples of Data Sources

A. Hand-Written Nursing Resuscitation Record (pages 1-3)







B. View from ceiling-mounted digital video camera