Final Progress Report

Brief, Risky, High-Benefit Procedures:
Best Practice Model

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Report Components

1. **ABSTRACT**

Purpose: To demonstrate the value of video-based task analysis in establishing and evaluating safety-enhancing best practices for brief, risky, but beneficial procedures, using a model of video recorded chest tube insertion (CTI).
Scope: Videos of CTI under emergency and elective levels of task urgency were analyzed before and after implementation of a video-based training program.
Methods: Subject matter experts (SMEs) were interviewed, and a task analysis of CTI was developed. CTI performance was video recorded, and 49 CTI videos were analyzed by SMEs using the task analyses template to extract qualitative and quantitative data. A best practice model of CTI was developed from the aggregated video reviews. Video clips from the original video recordings and from an 'idealized' CTI performed by a thoracic surgeon on a cadaver were used to develop a training compact disc that was distributed to staff performing CTI. Ergonomic analyses of CTI instrument trays were made. Fifty-three more CTIs were video recorded and analyzed after training.
Results: All 49 CTIs video recorded before training showed breaks in sterile technique, and there was a 15% incidence of empyema. Causes of contamination included inadequate surgical prep and drape, lack of universal precautions, instrument tray position and contents, and concurrent procedures. Two operator needle sticks and a knife cut were recorded. After training, the 53 CTIs had a 4% incidence of empyema. Thirty-seven percent of elective and 66%of emergency CTIs had sterile breaks. No operator injuries occurred with a redesigned instrument tray. DVD summarized key findings from the study. Keywords: video, task analysis, best practice model, chest tube insertion, training, ergonomics

2. **PURPOSE**

The objectives of this study are

1) To demonstrate the value of video-based task analysis in establishing and evaluating safety-enhancing best practices in brief, risky, but highly beneficial procedures.
2) To develop a set of video-based methods and techniques for studying performance of real, dynamic, time-critical, risky, and stressful tasks.
3) To use the methods and techniques to iteratively develop a best practice model of multi-person performance (surgeons, anesthesiologists, nurses) for such a risky, but highly beneficial, task as chest tube insertion (CTI) for hemothorax or pneumothorax in trauma patients.
4) To test implementation of the best practice model to determine its impact on morbidity, patient length of stay, disposition, and complications.

3. **SCOPE**

<u>Background</u>

CTI is associated with significant morbidity, ranging from 6-36% of all chest tube placements in trauma patients. Mortality is reported from unilateral pulmonary edema and from empyema. Major organ lacerations, including injury to the lung, stomach, spleen, left lobe of the liver, and diaphragm, have been reported following CTI. The morbidity is significant, including improperly placed chest tubes, repeated pneumothorax after chest tube removal (requiring re-insertion of another chest tube), and thoracotomy for lung decortication, rib resections, and lung laceration repair.

Complications of CTI in one study of 426 consecutive patients occurred in 21%. Undrained pneumothorax, hemothorax, or effusion despite CTI occurred in 35 patients. There were 16 incidents of undrained pneumothoraces, all of which required another chest tube for lung expansion. Sixteen patients had large undrained hemothoraces; of these, some required an additional chest tube, and three required open thoracostomy for clot evacuation. Three patients with undrained effusion required additional tube placement for drainage. Pneumothorax occurred after chest tube removal in 33 patients, 20 of whom required placement of another chest tube. Nineteen chest tubes, including tubes that were not in the thoracic cavity or were placed too superiorly to drain fluid, had to be replaced secondary to inadequate or improper initial placement.

There were fewer complications (6%) when CTI was performed by a surgical resident, compared with CTI performed by an emergency physician (13%) or performed prior to transfer to the author's hospital (38%). In addition, the presence of shock (systolic blood pressure less than 90 mmHg prior to or on admission), need for mechanical ventilation, and admission to the Intensive Care Unit were all positively correlated with complications of CTI.

Recommendations to reduced complications of CTI include improvements in the educational system to provide a better understanding of the indications for CTI and its potential complications as well as improved technical assistance for performing the procedure appropriately. Specific suggestions from other authors suggest animal laboratory practice, cadaver practice, and avoidance of breaks in aseptic technique. The objectives of CTI should include 1) complete evacuation of hemothorax; 2) close dead space by lung expansion; 3) meticulous sterile technique; 4) chest tube removal in less than 72 hours; and 5) prophylactic antibiotics only if the patient is immunocompromised due to diabetes, previous splenectomy, pregnancy, or end stage renal disease, or when the patient is injured by high-speed projectiles causing widespread tissue destruction. Other authors suggest that the recording and reporting of complications of CTI should be carried on concurrently with the use of chest tubes, and a standard technique must be used for insertion and removal of such chest tubes.

Context

At our own institution, the Shock Trauma Center, in a published report of CTI in 1984, 16% of trauma patients who had chest tubes placed for fluid in their pleural cavity subsequently developed empyema. All 31 patients with empyema were treated with antibiotics and continued drainage. Nine patients required thoracic operations, including rib resection (n=9 patients), and three patients had subsequent decortication. Three patients had recurrent empyema, and four patients died due to infection.

The authors suggest that some of the patients may have developed their empyema secondary to contamination at the time of CTI. Empyema accounted for 10% of all nosocomial infections in multiple trauma patients in the Shock Trauma Center. The recommendation was that nosocomial empyema requires aggressive therapy, as 40% of these patients died either secondary to the infectious process or because of an underlying disease state.

Settings

CTI was chosen as the model for our efforts for several reasons. It is a potentially life-saving procedure, though it is not without risk (see above), when pneumothorax or hemothorax is diagnosed and treated emergently. It is a commonly performed and taught procedure in trauma centers. From a data collection and analysis perspective, the activities involved in CTI are well defined, and CTI has a clear start and finishing point. Comparisons could be made across different types of emergency and nonemergent cases, as it is used in circumstances with variable time pressure. Last, the process of CTI is generally considered by clinicians to be stressful and high in workload, making it a good model for video task analysis.

Participants

Surgeons, including attending, fellows, and residents in trauma, participated in video recording of a performance of CTI. In addition, nursing staff, anesthesiologists, and trauma technicians were involved in the teamwork required for CTI. A cadre of 12 attending surgeons and anesthesiologists (named the Invasive Procedure Outcome [IPO] Group) acted as the SMEs for video review. The surgical fellow team leaders worked to ensure that the Best Practice for Chest Tube Insertion training material was reviewed by the residents inserting chest tubes.

Forty-nine CTIs were video recorded before development of the training material, and 53 were video recorded after the educational process was completed and the best practice information was disseminated.

4. METHODS

Study Design

The study was exploratory. No previous data were available on using video to analyze CTI. A task analysis methodology for extraction of research data from video was modified for CTI. The study first used a combination of interviews with SMEs and review of existing video recordings of CTI to develop a task analysis for CTI. The study recorded 49 CTIs to determine current practices in our institution. These CTIs were reviewed by multiple SMEs. A best practice model was developed by synthesis of their reviews and video clip review (see below). An 'idealized' CTI was performed by a thoracic surgeon using these best practices on a cadaver, and this was video recorded. The best practice model was disseminated by use of video clips from real and 'idealized' CTI copied onto multiple CDs. The CDs were distributed to those performing CTI. Following this training in the best practice model and a Grand Rounds presentation to the staff, another 53 CTIs were video recorded and analyzed in the same way as the first 49.The data were compared before and after best practice training. The key points from the study were summarized in an 8-minute video DVD. A flow diagram of the study is shown in Figure 1.

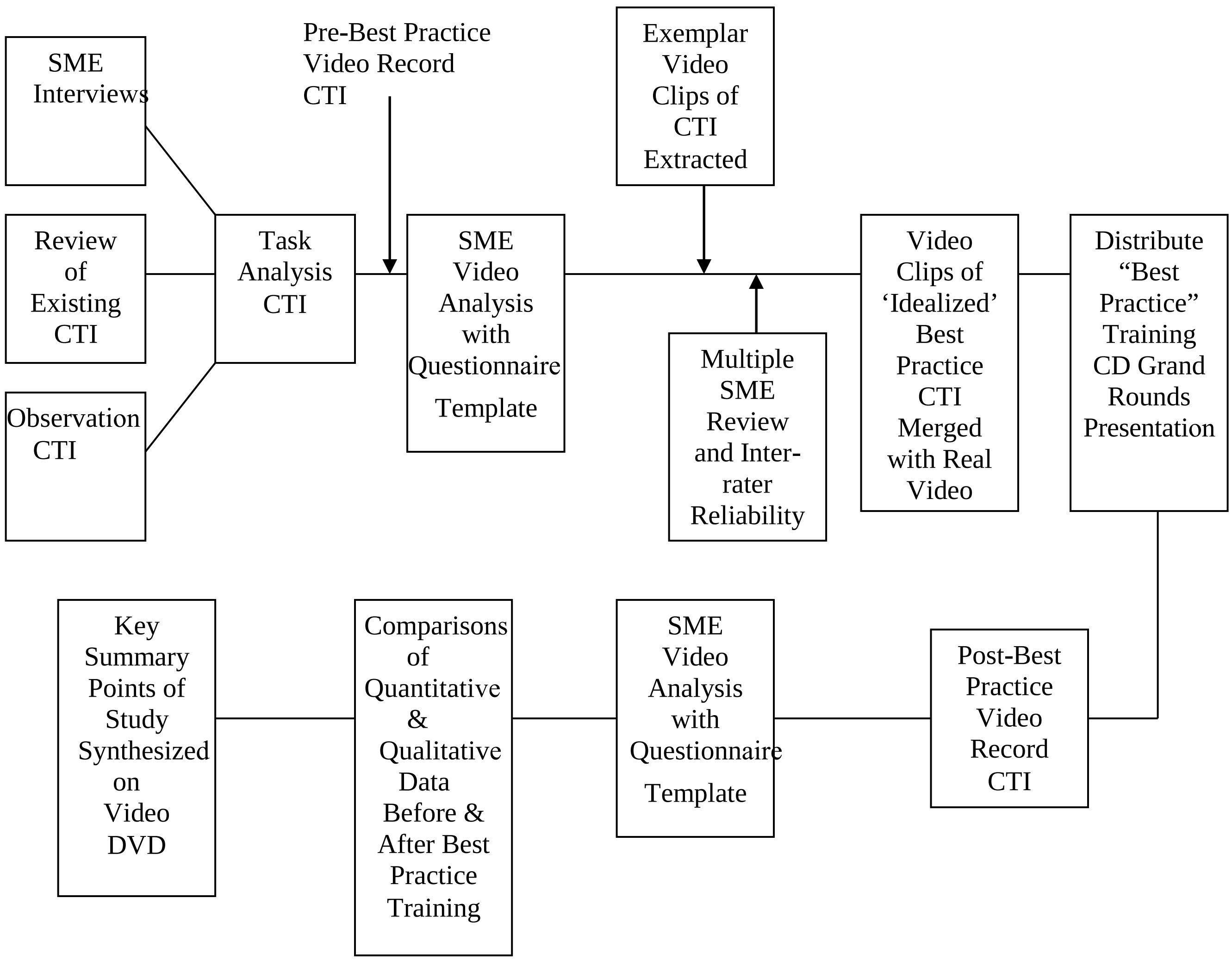

Fig. 1 Flow Diagram of Chest Tube Insertion Best Practice Study

Data Sources/Data Collection

Included in the data gathered for this study were the following:

1) Multidisciplinary (surgeons, anesthesiologists, nurses) SME interviews. These were audio recorded, and a summary was transcribed.
2) Video recordings of CTI with Template Task Analyses. The data collection questionnaire was a 70-item data collection form completed by the SME during review of a video recording of CTI. Quantitative data that were included in this research data extracted from the CTI video recordings included the following:
   a) Timing of steps in task of CTI and number of attempts made before successful insertion.
   b) Complete (or omission) of 17 specific subtasks identified by SMEs as essential for CTI. These became known as the “Rules” of CTI. The video of each CTI was examined for these subtasks as follows: Before CTI (n=6): Vital sign monitors in use, patient positioned correctly (e.g., ipsilateral hand above shoulder), analgesia/anesthesia given, skin prepped, surgical field draped, and universal precautions employed (sterile gloves, gown, and mask). During CTI (n=7): Correct incision site, lack of patient movement, operator supervised, clamp opened wide on entry into pleura, finger inserted into pleura and rotated 360 degrees, clamp placed on tip of chest tube to direct tube, surgical sterile technique. After (n=4): Chest tube cut (to ensure leak-proof connection). Drainage system connected with sterile technique and sterile suture, dressing applied.
3) Multiple SME reviews were obtained of video clips extracted from the complete video recordings of CTI. hese video clips illustrated good and bad examples of the 17 subtasks.
4) Discharge summaries from patients who had CTI identified the mechanism of hemothorax or penumothorax, how long the chest tube remained in position, any complications resulting from CTI, and hospital outcome. Afterward, hospital discharge complications were captured from outpatient clinic notes.

Data Collection

Video images were acquired from three sources: a wide-angle “environmental” camera showing a general overview of a resuscitation bay of the trauma center, a pan/tilt/zoom (PTZ) roof-mounted camera directed so as to minimize patient features and zoomed onto the anatomic area on which the task was to be performed (chest), and a head-mounted wireless video camera worn by the task operator. Sound was obtained from two roof-mounted microphones. In addition, a video interface with physiologic recordings of patient vital signs allowed assessment of the changes produced by the task onset until completion. Two video recordings were made for review of each case studied. One video recorded a composite four-image view from all video sources. The second video recorded the high-quality, close-up PTZ image. All data, including voice, video, and vital signs, were time stamped with a machine-readable time code at video acquisition. This time code was used to synchronize the multiple images. A software tool facilitated video analysis by enabling 01., 0.5, 1.0, 5.0 and 7.0 times real-speed playback and scrolling to specific time codes. A video task analysis data sheet that systematically extracted times, events, and recorded equipment that was used and other details of the task was completed using simultaneous display of both synchronized video recordings.

Interventions (See Fig. 1)

The primary intervention carried out in this study was training of those performing CTI in a Best Practice model to minimize patient safety and operator safety hazards.

Measures for CTI Best Practice Intervention

Timing of steps in CTI task
Number of attempts at CTI
Completion or omission of “Rules” of CTI
Injury Score and Physical Status of Patients undergoing CTI
Urgency Status (Emergent and Elective)
Clinical Information (Mechanism of Injury, Complications of CTI, Duration (Chest tube), length of hospital stay, other related patient morbidity and mortality, post-discharge complications of chest tube
Frequency and timing of breaks in sterile surgical technique during CTI

Limitations

1) The data were collected in a single trauma center, the RA Cowley Shock Trauma Center at the University of Maryland (STC). The STC is the primary adult resource center of the State of Maryland EMS. The outcomes from patients admitted, as measured by the Trauma and Injury Severity Score (TRISS) methodology in reduced injury-specific mortality, is 6 standard deviations better than national norms. The practices at STC for CTI may not reflect other trauma centers practices, and the severity of injury at STC may be greater than at other trauma centers. The high mortality among emergency CTI patients is linked to other significant injury severity. Such patients would not be seen as frequently in a typical Emergency Department. The practices for CTIs in community and many other hospitals do not employ the same surgical techniques; rather, CTI introduces a trochar, and a smaller bore catheter than is used for management of trauma. All CTIs at Shock Trauma were performed using 33-39 FG chest tubes; no trochars or needle placement was used for definitive care of hemothorax or pneumothorax.
2) The personnel who performed CTI before and after training in the Best Practice model were not the same operators. The trauma team resident-in-training composition changes monthly at STC. The Fellow leading a given team remains for 2 to 3 months in the Trauma Resuscitation Unit (TRU), where video recordings of CTIs were made. The Attending Surgeons who supervise all the team members were constant throughout the study.
3) A sustained effort was required by the principal investigator (PI) to obtain SME reviews and have continued acquisition of video recordings of CTI. When the PI was out of the clinical area for 1 month (meetings/vacations, etc.), the acquisition of video recordings of CTI was minimal.
4) Those CTIs that were video recorded were not all the CTIs that were performed during the study conduct period. There was not funding to obtain

technical support for 24x7 video acquisition of all CTIs during the funding period or allow recording of consecutive CTIs.

5. RESULTS

Pre-Best Practice Data

Forty-nine video recordings were acquired of chest tube insertion in 38 patients, of which 25 were emergency and 24 were elective insertions. The SME derived performance measures, obtained from interview and by questionnaire, were compared with the practices seen on video clips (Table 1).

Task	Statement with Video Clip	SMEs Response (n=11) (Agree=1, Disagree=10)	Actual Video n=38 CTs
Prep	I recommend this way to prep Squirting betadine better than gauze prep	9.1±0.7 7.2±2.6	EM Wider Prep would reduce contamination 14%
Drape	Sterile gown and drape prevent contamination Sterile gown and drape not necessary during CPR/CT	3.0±2.1 6.0±2.6	EM 66% no drape No gown EM 55%
Positioning	Arm must be secured for all CT insertions	2.6±1.6	10% arm contaminate
Monitor	EKG unnecessary during CT placement	8.1±1.6	5% no EKG
Universal Precautions	Masks and hats essential for every CT	1.3±2.0	EM 14% no mask, 30% no cap EL 5% no cap
CT insert	Patient always moves with CT insert Patient	6.9±2.3 2.0±1.5	EL 43% pt moved EM 0% move

	movement increases CT insert complications		
CT and CVP/FAST	Simultaneous elective procedures not best practice	2.2±1.7	EL 15% simultaneous procedures
Contamination	Acceptable to use non-sterile gloves for CT insert	7.0±2.9	EM 10% non-sterile gloves
Suturing	Suturing does not have to be sterile	8.2±1.3	EL 29% non-sterile EM 100% nonsterile

EM=Emergency Chest Tube insertion; EL=Elective Insertion; CT=Chest Tube CPR=cardiopulmonary resuscitation; FAST=Focused Abdominal Scan in Trauma; EKG=Electrocardiograph

Table 1

Eleven SMEs identified what they considered optimum performance from the video clips. Most of the best practices were not carried out, especially during the emergency chest tube placements. The SMEs themselves did not routinely place the chest tubes but supervised the junior staff or resident operators who performed the task. Whether the SMEs were physically present was noted; in all but a few instances, they were co-located with the operator. Why the SMEs did not correct nonoptimal performance is unclear, but there are several possible explanations: 1) The number of infringements of sterile procedure were two times higher in emergency (n=113) than elective (n=64) chest tube insertion, indicating that time pressure may have limited the abilities of the operator to perform optimally. 2) In patients who had emergency chest tube procedures, the patient was 'in extremis', and many required bilateral chest tube placement. Two operators worked on each side of the chest, in some instances using only one surgical instrument tray, increasing the opportunities for breeches in sterile technique as well as operator injury from knife cuts and needle injury. 3) Noncompliance with standard operating procedures that require the operator to wear a sterile gown and sterile gloves was a frequent performance failure (Table 1). Although wearing of nonsterile gloves only occurred in emergency CTIs, the failure to wear a sterile gown, (but use sterile gloves) indicates that this shortcut, while expediting the process of relieving a hemothorax or pneumothorax when performed by experts, in fact led to contamination of the sterile chest tube on clothing or nondraped areas of the patient or gurney when this approach was taken by less-expert operators. The residents generally took longer and had greater duration of chest tube manipulation before insertion than the more expert operators. 4) Preparatory tasks were cut short in some instances when the skin was only 'prepped' over a small area or the prep solution was not allowed to dry (only effective as a sterilizing solution when wiped dry), and the area around the point of insertion of the chest tube was not adequately covered by a large enough area of sterile drapes (to prevent contamination of the sterile tube during its manipulation and insertion).

Though all of these are short-term performance deficiencies, they have long-term (infectious) consequences. Of the 38 patients, 13 (34%) died within 24 hours due to the severity of their injuries and not in association with the chest tube placement. Of the remaining 25 patients, three (12%) developed empyema (an infection between the lung and chest wall) requiring surgery to remove the infected material, resulting in prolonged hospitalization.

Pre-Best Practice Training

The results of analysis of the first 49 chest tube insertions (25 in emergency and 24 in elective insertions) were quite revealing. All chest tubes, emergency and elective, were contaminated during the time from surgical prep of the chest to application of the dressing. There were 113 instances of contamination in the 25 emergency chest tube insertions and 50 instances of contamination in elective chest tube insertions. Timing of breaks in sterile technique in relation to the start of the surgical skin prep was less than 1 minute in all but one of the 25 emergency chest tube insertions. Duration before sterile breaks occurred was significantly more prolonged in elective chest tube insertion; one insertion remained sterile for 28 minutes, but all chest tube insertions were eventually contaminated (Fig. 2).

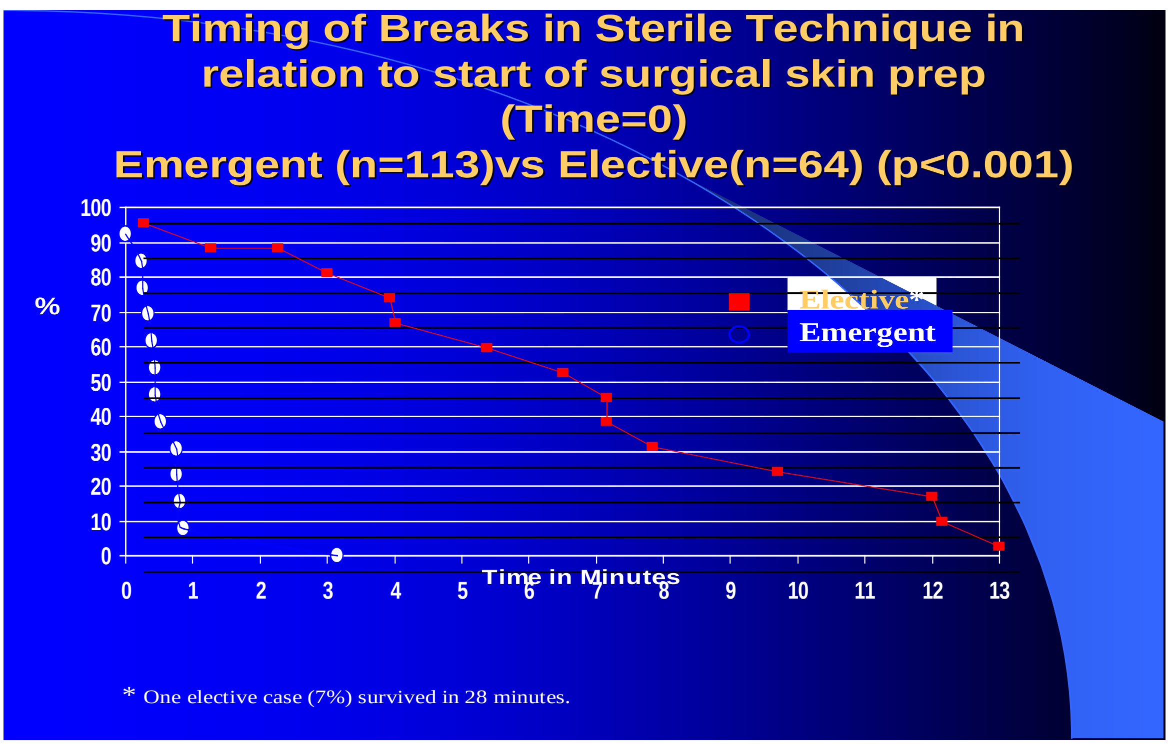

Fig. 2

Two needle sticks and one knife cut occurred among operators inserting the tubes, and these were recorded on videos of 49 chest tube insertions. Multiple factors were noted to potentially avoid these problems, including full gowning of the operator, wide area draping of the patient, improved skin prep, change in composition of instrument tray, better positioning of the instrument tray in respect to the operator, different position for application of CPR during chest tube insertion, and improved sterile technique for attachment of chest tube to drainage system. The measures that would have prevented contamination of chest tube placement are shown in Fig. 3. Precautions against contamination that were used are shown in Fig. 4. The lack of use of many standard techniques for infection control was identified on video review of the 49 chest tube insertions. There were more omissions of these precautions in emergency than in elective CTI.

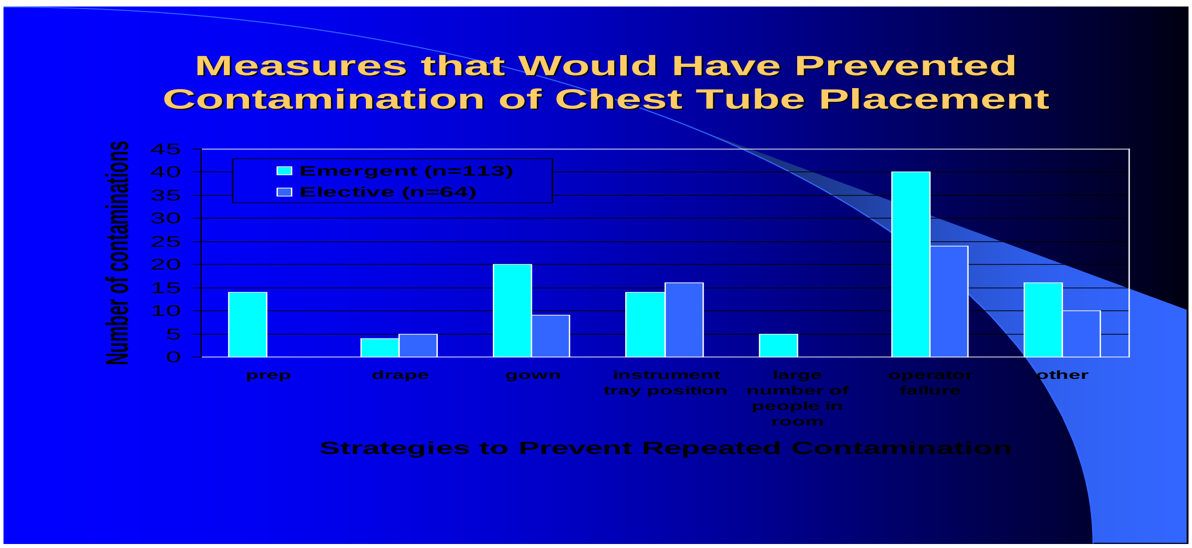

Fig. 3

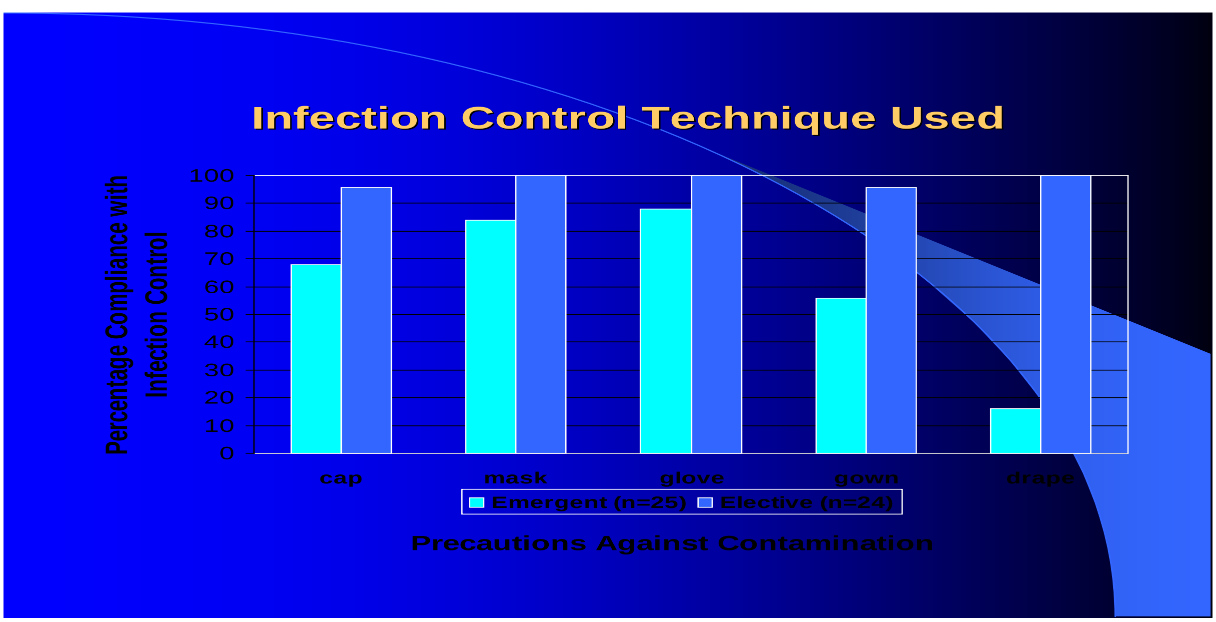

Fig. 4

Outcomes - The outcomes of Pre-Best Practice CTI were that 19 of these patients who were severely injured (all of whom were receiving CPR) died. Thirteen patients had bilateral CTI. None of these patients undergoing emergency CTI survived long enough to develop known complications or empyema. Of the surviving 19 patients, three developed empyema (15% incidence), requiring video-assisted thorascopic surgery (VATS) and prolonged hospital stays. In another three patients, multiple chest tubes were required, because the original tube did not drain the air and/or blood. One patient had the chest tube fall out. In two patients after removal of the chest tube, air re-accumulated, requiring repeat chest tube placement. In one of these patients, the air re-accumulation occurred after hospital discharge.

Post Best Practice Training

Fifty-three CTIs were video recorded after the Best Practce Training CDs were distributed and a Grand Rounds presentation was made to all the trauma center staff. Of these CTIs, 12 were inserted in emergency circumstances, and 11 were bilateral. Seven of the 53 patients died before hospital discharge; none of these deaths were related to CTI. Two patients developed empyema among the 46 survivors (4.3% incidence). Two of the CTIs were needed to correct pneumothoraces occuring as a result of subclavian central line insertion. Multiple chest tubes were required in seven patients. One of the patients developing empyema had five CTIs. A second patient required three CTIs within 3 hours, because the first two tubes were kinked on insertion and did not relieve the pneumothorax. In one CTI, the side holes of the chest tube were found to be outside the pleural space, causing air leaks and persistent pneumothorax. The single most frequent complication of CTI seen after Best Practice training was air leak or re-accumulation of a pneumothorax after chest tube removal. Nine patients had persistent pneumothorax after chest tube removal. In one patient, this occurred 5 days after hospital discharge (Fig. 5).

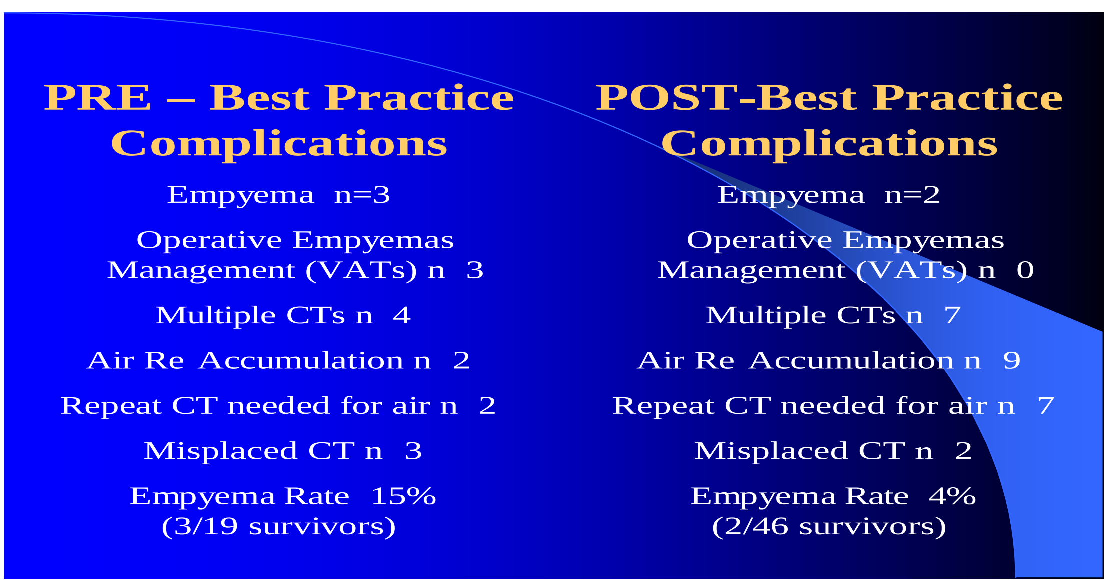

Fig. 5

The mechanism of injury among the pre and post best practice patients whose CTIs were video recorded were similar and are shown in Fig. 6.

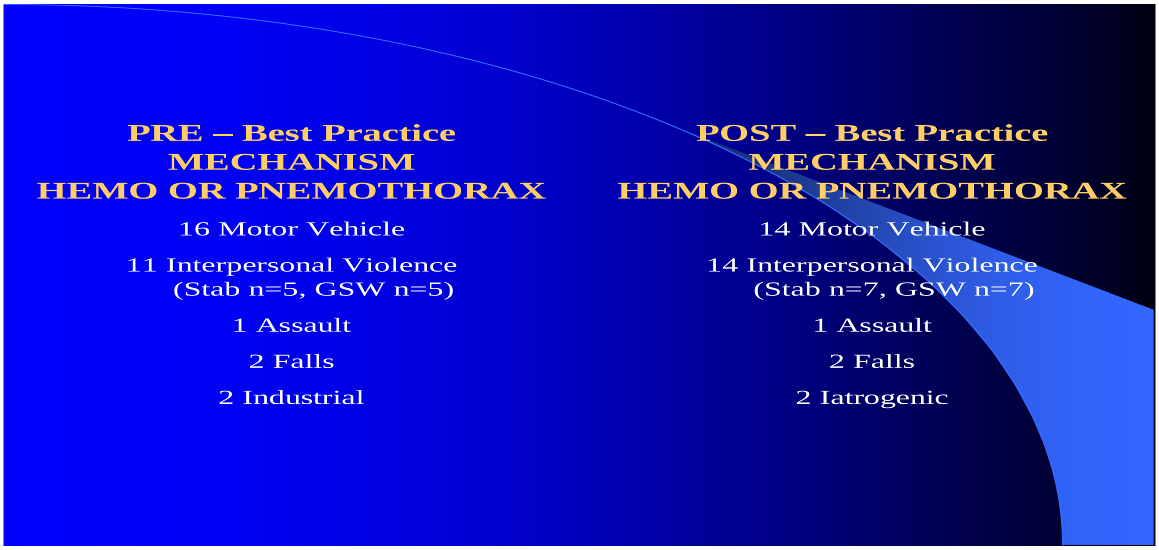

Fig. 6

COMPARISON OF PRE AND POST BEST PRACTICE TRAINING PERFORMANCE

Comparison of duration of performance of CTI (time from skin incision start to completion of suturing of chest tube in position) shows that, in both pre and post CTI, the duration was significantly shorter for emergency CTI (Fig. 7). Break in sterile technique occurred in all 49 CTIs before Best Practice training and in 37% (15/41) of elective CTIs and 66% (8/12) of emergency CTIs after training.

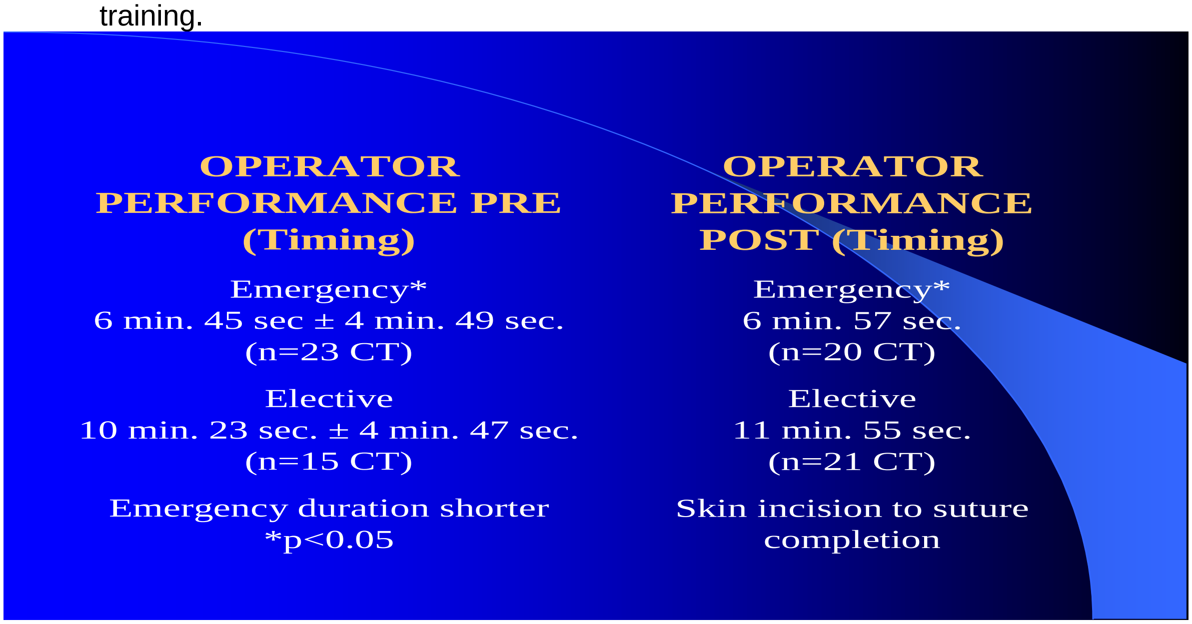

Fig. 7

The recurring problems seen despite Best Practice training included contamination of the surgical site by assistants or supervisors not using universal precautions (sterile gloves, gown, and mask). In six instances, the unrestrained hand of the patient contaminated the surgical site. Inadequate draping remained a problem in three CTIs. Contamination of the operators' sterile gloves during drainage system connection (nonsterile), which was then followed by suturing of the chest tube in position, occurred four times. Poor gowning and gloving technique was seen, with the ties of untied surgical masks contaminating the surgical site; the sterile gown not “turned” or tied, causing it to fall off the shoulders; and the cuffs of a sterile gown not inserted into the gloves, causing contamination. It was also noted that procedures carried out simultaneously with CTI – particularly central (subclavian or femoral) central line placement – increased the chance of contamination.

POST – Best Practice	Cause of Sterile Breaks	Other Noted Practices
Gowning/Gloves/Masks	n=9	Ungowned Assistants/ Supervisors cause contamination
Patient Arm not restrained	n=6	Simultaneous procedures increase chance of contamination
Inadequate Draping	n=3	
Drainage Connection	n=4	Untied surgical masks Gown not “turned” or tied Cuffs of gown not in gloves

Fig. 8

DISCUSSION

Data collection is a major challenge of studying real, complex, dynamic settings, yet such examination of real environments where experts perform is important to understand how risk, uncertainty, and team and ergonomic factors impact workplace performance. Although observational field studies are helpful and have made valuable contributions to the Human Factors literature (Rasmussen 1983, Xiao 1994, Vincente 1997), they lack detail and systematic feedback to participants. Video taping makes it possible for participants to review their activities and for analysts to extract quantitative data.

The advantage of video recording is that fine-grained analysis is possible to detect procedural omissions or nonoptimal performance practices. Video analysis can also identify means for prevention of such nonoptimal practices. Together with other data collection, they allow quantitation of the effects of these practices on outcome. Another advantage of video recording over other means of data collection is that video recording has been shown to detect quality assurance occurrences that are not identified by self-reports, because the participants frequently are unaware of their deficiencies in performance. Only after systematic task analysis video review by subject matter experts (SMEs) are such performance deficiencies revealed (Mackenzie et al 1996). Video as a data source to examine safety in the workspace has been used in several domains to examine remote collaboration (Nardi et al 1997), conformity to safety practices (Weick et al 1993), and performance of tasks (Mackenzie et al 1994) and as a training tool Townsend et al 1993). In this study of CTI, video clips of short duration (5-15 min) provided a rich source of material for targeted safety performance review while simplifying the participation consent, confidentiality, and data analysis problems associated with more comprehensive and longer duration video acquisition.

Video recording has a long history as a tool for Human Factors Research. Nardi et al (1997) showed how video was used to examine collaborative work in a hospital operating room, and they noted the central role of video as data in coordinating teamwork and educating medical personnel. Video has also been used to improve aviation accident research (Armstrong 1989) and user interface testing (Kennedy 1989) and as a feedback tool for computer-supported cooperative work (Harton, Elwart-Keys, and Kass 1989). Video is a powerful tool for empirical research (Neal 1989), functioning as a unbiased observer and recorder of events. The process and convenience of CD video clip review was well received. The complete task of chest tube insertion in elective and emergent circumstances was reviewed first to allow the video abstracts to be seen in context of a complete procedure.

Video recording of the task CTI revealed many safety issues; also, because the video recordings were collected in the context of expert team performance in a real workspace at two levels of task urgency, much more than the safety of the task under study was captured by video taping. The additional human factors identified include communication, team performance, systems factors, and ergonomic and other issues associated with small-team interactions. We found advantages of video recording over observation in that it minimized factual uncertainty and recreated the event so that participants SMEs were not dependent on memory. Video data can be used as a source for group discussions. Furthermore, events, commentary, warnings, and alarms that might not have been heard or noted at the time can be recalled by video review. Video acquisition allowed participants in the video taped event to reflect on their performance in great detail and to consider intervention or factors only identified in retrospect and not considered or attended to at the time. Reviewers provided comment on covert mental processes cued by viewing the video tapes. Video analysis can provide an explanation for task omission and information on the context of the event. Team performance, including division of labor, team adaptive behavior, coordination failures, and responsibilities of the leader, are captured, and so are the changing roles of team members and information flow in response to the urgency of the procedure. The detailed documentation available from review of the video recording can yield lessons difficult to learn from observation or retrospective reports, and the review can confirm error evolution.

Task-oriented video recording is successful for assessing performance, as it can be used to interpret and aggregate findings across multiple events. Video recording of the same event or task at two levels of task urgency was particularly revealing as a means of identifyin performance discrepancies from the expert-derived task analysis process model.

As a result of our 11-year experience with video recording in this trauma center, we can contrast and compare video to observation (Table 2).

Table 2

Contrasts and Comparisons between Video Data and Observation	
Video	Observation
Information acquired passively in a reusable record of data.	Active information gathering process with “a priori” intent.
Multiple domain experts can repeatedly review video data after event.	Domain expertise needed at time of observation. No repeat opportunities to review data.
Video taped subjects can review and provide comments on covert processes.	Subjects of real-world team events have hindsight bias and frequently remember what they think they did rather than what they actually did.
Fine-grained analysis can include nuances of contextual and systems factors.	Analysis involves paraphrasing and theorizing.
Second-by-second behavioral and verbal interactions are recorded that can be central to interpretation and hypothesis development.	Conceptual framework guides observation, but data parsing occurs at the time of observation, not after, as in video.
Events or tasks not associated with the original analysis may be detected and data extracted later.	Only events observed can be analyzed later.
Video allows expanded analysis of time- critical, brief, or uncertain events.	Fleeting events, simultaneous interventions, or brief communications are very difficult to observe and document accurately.
Video taping detects quality assurance occurrences not identified in self-reports.	Less likely to link QA issue to outcome, because original data are lacking.
Video is a powerful feedback and training tool.	Feedback and training are more difficult without video stimulus material.

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5. **List of Publications and Products** (Bibliography of Published Works and Electronic Resources from Study—Use AHRQ Citation Style for Reference Lists).

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PRESENTATIONS

1. Best Practice for Brief, Risky, Beneficial Procedures. Medicine Technology and Human Factors in Trauma Care, A Civilian/Military Perspective, Nov. 15-16, 2001.
2. Video-based Data to Develop Best Practices AHRQ Conference, Feb 2002, Bethesda, MD.
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6. Video as Research Data. Presentation at Video as Research Data Conference, Baltimore, Oct. 1, 2002.
7. Video and the pre-hospital data. Grand Rounds, Dept. of Anesthesiology, University of Maryland, Jan. 16, 2003.
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9. Research to practice – success stories. Plenary Presentation AHRQ 2nd Patient Safety Conference, Mar. 4, 2003, Arlington, VA.
10. Congressional delegation presentation on behalf of AHRQ, Mar. 4, 2003.
11. Video as research data for patient safety, 2003, Plenary Presentation, Annenberg IV National Patient Safety Foundation Conference, Mar. 2003.
12. Video on Research Data in Emergencies. Plenary Presentation National Health Information Infrastructure-Developing a National Action Agenda for NIH, Jun. 30, 2003.
13. Patient Safety. Class lecture to 3rd year (Junior) Medical Students, University of Maryland, School of Medicine, Jun. 30, 2003.
14. Implementing research to Improve Patient Safety. AHRQ, Jul. 22, 2003.
15. Review of best practices. AHRQ Conference, Sept. 4, 2003, Arlington, VA.
16. Video Clips as a Data Source for Safety Performance. Human Factors and Ergonomics Society Meeting, Denver, CO, Oct. 15, 2003.

17. Best Practices for Brief, Risky Procedures. Grand Rounds, Dept. of Anesthesiology, University of Maryland, Oct. 23, 2003.
18. Video as Research Data for Patient Safety. National Patient Safety Summit, Crystal City, VA, Nov. 7, 2003.
19. Chest Tube Insertion Video. Grand Rounds, Shock Trauma Center, University of Maryland, Mar. 2004.
20. Video for Patient Safety and Best Practices. Class lecture to 3rd year Medical Students. University of Maryland, School of Medicine, Jun. 30, 2004.
21. Video Data for Best Practices. Making the Health Care System Safe: 3rd Annual Patient Safety Research Conference, Postponed to Sept. 26-28, 2004.
22. Video Data for Patient Safety. Plenary presentation Trauma Care 2004, Sydney, Australia. To be presented Oct. 16, 2004.

MULTIMEDIA PRODUCTS

CD#1 – A CD with video of: 1) Elective Chest Tube (CT) Insertion; 2) Emergency Chest Tube Insertion; 3) A clip from the TV show “ER” showing a chest tube insertion.

CD#1 was used to show multiple reviewers what views to expect in the shorter clips used on CD#2. In addition to showing a complete CT Insertion from start to finish in elective and emergency circumstances, CD#1 also contained a TV representation of CT insertion. This clip was used to gauge the severity of the reviewer’s evaluation. The TV clip showed several obvious errors and breaks in sterile technique and performance deficiencies.

CD#2 contained more than 70 brief (10-90 sec) clips illustrating events that occurred in the first 50 chest tube insertions that were video recorded. CD#2 was distributed to 12 attending physicians working in the Shock Trauma Center and to four experienced trauma nurses who functioned exclusively in the Trauma Resuscitation Unit (TRU), where the video recordings were made. The multiple reviewers completed the same evaluation forms after viewing each of the video clips. Each viewed the same video but were not constrained by time or place when the evaluation was made. Inter-rater comparisons, therefore, were possible. We found this approach to be well received by clinicians, who were able to complete the reviews at their convenience, not that of the investigators.

CD#3 – Best practice training was used to train the clinicians in Best Practices for CT Insertions before starting on Phase II of video recording. The video shows clips from real CT insertions to illustrate nonideal and best practices. A cadaver and a thoracic surgeon were video recorded to illustrate subtleties of surgical technique and to obtain detailed close-up images of certain parts of the CT insertion procedure. CD#3 was distributed to Shock Trauma staff and was available at all times for viewing on a dedicated computer with a CD player located in the TRU.

DVD#1 – Best Practice DVD with sophisticated graphics and sound system to support the important Best Practices messages derived from this research on CT insertion. This DVD was placed on the web and can be viewed at www.hfrp.umm.edu and www.som.nsc.umaryland.edu.