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ABSTRACT

Prior attempts to use standard “self report” or interview protocols to extract After Action Review (AAR) descriptions of emergency event decision making and problem solving strategies generated by participants are problematical. Cognitive psychological studies suggest that the resulting information often contains significant errors and omissions (Glaser et al., 1985; Besnard, 2000). These errors are not often recognized by participants who solved important problems in emergency situations and wish to give accurate reports on their solutions because the knowledge they are describing is largely automated and unconscious (Wheatley & Wegner, 2001). The problem is further complicated by the fact that experienced medical personnel mistakenly believe that their reports are complete and accurate and that they solved the problems they are describing in a conscious, willful, deliberate manner (Wegner, 2002). These reporting errors most likely increase in number and severity under time-pressure battlefield situations (Hunt & Joslyn, 2000). This research attempts to improve medical AAR with a novel combination of Cognitive Task Analysis conducted while interviewees moulage simulators (Clark and Estes, 2002; Clark & Estes, 1996; Velmahos et al, 2002). Nine trauma surgeons who have used Argyle-type shunts to repair femoral artery damage have been interviewed separately and together. Data from these interviews are being analyzed for a report that will be written by 12/31/2006. It is hypothesized that our protocol which employed a novel combination of medical Cognitive Task Analysis combined with the moulage of instruments and depictions of the femoral artery will more accurately capture the mix of automated and conscious decisions used to solve critical medical problems faced in battlefield situations.. Each surgeon was interviewed separately and after reviewing the results, each surgeon was asked to correct and improve on the information gathered from the “other” surgeons. This process has been found to identify and eliminate reporting errors as well as provide accurate and efficient descriptions of surgical decisions and actions that solved battlefield problems.

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INTRODUCTION

This study was designed to test a novel approach to medical after action reviews (AAR) by employing a cognitive task analysis (CTA) interview protocol with surgeons who are asked to moulage a medical simulator while being interviewed. The research design calls for the interview of a minimum of eight to a maximum of ten trauma surgeons who were either deployed in a Forward Surgical Team (FST) in Iraq or in an urban trauma surgery service and used Argyle-type shunts to repair damaged femoral arteries. Each surgeon will be interviewed separately and asked to describe how to perform a routine medical procedure and how they employed Shunts under emergency conditions. Half of the surgeons will describe their surgical protocol as they manipulate the surgical instruments and view depictions of the anatomy surrounding the femoral artery. The accuracy and completeness of the interview data will be analyzed to determine the gain or loss of AAR fidelity due to CTA use with and without simulators.

BODY

In this part of our report we review our accomplishments during the past year in relation to the Statement of Work (SOW) approved in our proposal.

Section 1: SOW Progress

This section of the report is constructed around the five items on our approved SOW. After listing each SOW item, we report the progress we have made to complete the item.

1) Work with designated Army POC to identify and schedule interviews with three medical personnel who separately experienced and solved an important medical problem.

We determined that we could not limit our study to three surgeons because of analysis problems and so sought and received IRB permission to extend the number of subjects from three surgeons to a minimum of eight and a maximum of 10. At Dr. Pugh's suggestion and because of difficulty securing the participation of Army surgeons, we extended invitations to trauma surgeons in an urban ER that serves as a training center for military surgeons. During the IRB Continuing Review process in August, 2006, our study was re-categorized as "exempt" human subject research.

2) Develop an interview protocol based on Cognitive Task Analysis (CTA) and arrange for the use of medical simulators to be used during the interviews.

Starting at the beginning of the project, the research team developed a CTA interview protocol which was reviewed, tested in the interview with a benchmark Army trauma surgeon who had experience working in an early Forward Surgical Team (FST) in Iraq and

this protocol was analyzed by the research team. This version of the CTA interview protocol is attached as *Appendix A* at the end of this report.

Problems:

The Army surgeons we consulted initially advised us to focus our interviews on the use of Argyle-type shunts because of the number of traumatic leg injuries in Iraq. This novel use of the shunts has apparently saved many soldiers from amputation. Yet after we scheduled our interviews we learned that there is currently no available simulator that allows surgeons to moulage the area surrounding the femoral artery to demonstrate their technique with the shunts. Our COR Dr. Pugh advised us to substitute a tray of the surgical instruments used during the surgery and high resolution color images of exposed femoral arteries for the surgeons who are randomly assigned to that condition in our study.

3) Conduct the CTA interviews with each of the participants separately, keeping a video and audio record of the result as described in the methods section and in the approximate sequence listed in Figure 1 (in the proposal).

Seven interviews have been completed as of the date this report is being submitted. Video and audio records have been made of all interviews as specified in our SOW according to the sequence listed in our proposal. Two additional interviews will be conducted by Dr. Clark and will be completed by October 5, 2006.

Problems: During the course of this study we have experienced constant and significant difficulties securing the participation of trauma surgeons with battlefield experience. Most Army trauma surgeons are fully deployed and while most of those contacted were supportive and willing to participate, few had the time. Our COR Dr. Pugh advised us to extend our invitation to include urban trauma surgeons in the study. In the setting where we are recruiting the surgeons, USC County Hospital and the surgery department of the USC Keck School of Medicine, surgeons constantly handle injuries that are very similar to those that occur in battlefield situations. The delay caused by our initial difficulty recruiting surgeons led us to request a no cost extension in our study. We were originally scheduled to complete the study on 9/30/2006 and have secured an extension to 12/31/2006.

4) Summarize each interview as a procedure listing the types of information gathered.

Seven of the interviews collected in the past year have been completed, transcribed and each was formatted as a procedure for review as specified in our proposal and all have been sent to the participating trauma surgeons for correction. Three surgeons have completed their review and have returned their revised protocols. Four remaining surgeons are revising their protocols. Two additional interviews will be conducted on October 5, 2006 to end the interview process. One of the formatted and corrected protocols generated by an Army trauma surgeon who is on his second tour of duty in Iraq is attached as Appendix B to serve as an example of the outcome of this stage in the SOW.

5) Write and submit a final report at the end of the project that answers the following questions: a) what important medical event(s) was/were encountered? b) What aspects of their prior training helped prepare the medical experts for the event and what

additional preparation would help new medical personnel to deal more effectively with similar events?; c) What solution(s) were developed in the field that should be included in future training? d) A description of the CTA and simulator process overview and evaluation; and e) how can we leverage the field solutions for the development of new training that uses more advanced medical simulation technology?

When the interviews are completed, formatted and corrected and returned by all of the surgeons, we will analyze the data and complete the report required in SOW 5 by the required deadline.

KEY RESEARCH ACCOMPLISHMENTS

- The development of a surgical cognitive task analysis protocol (See Appendix A)
- Example of a corrected CTA for the use of Argyle-type Shunts by an Army Trauma Surgeon who has completed two duty tours in Iraq (See Appendix B)

REPORTABLE OUTCOMES

- The development of a surgical cognitive task analysis protocol (See Appendix A)
- The development of trauma surgeon CTA's for the use of Argyle Shunts (See example in Appendix B)
- Presentations at professional conferences related to this study:
 - Feldon, D. & Clark, R. E. (June 2006). Instructional implications of task analysis for improving experts self report. Presentation to the European Association for Learning and Instruction. Leuven, Belgium, June 21, 2006.
 - Pugh, C. & Clark, R. E. (April, 2006) Use of Cognitive Task Analysis and Simulators to Reduce Errors in Surgical Training. Paper presented in a symposium at the annual meeting of the American Educational Research Association in San Francisco, CA, April 10, 2006.
 - Clark, R.E. (September 2005). Assessment insights from the use of cognitive task analysis to study expertise development. Invited address to the 2005 CRESST conference. Los Angeles, California, September 8, 2005.
 - Clark, R. E. & Pugh, C. (July 2005). Use of cognitive task analysis in surgical simulations. Invited address to the Office of Naval Research Conference titled "Metrics for evaluating performance in simulations". Redondo Beach, California, July 12, 2005.
 - Clark, R. E. & Feldon, D. (February 2005). Cognitive task analysis and simulators for after action reviews of medical events. Invited address to the annual meeting of the Telemedicine and Advanced Technology Research Center (TATRC), Marina del Rey, California, February 15, 2005.

CONCLUSIONS

Our study is progressing satisfactorily, if slowly, and provided that the surgeons who have been interviewed correct and return the protocols they are analyzing on time, we expect to finish our study by the deadline. We cannot reach any reasonable conclusions about the hypotheses in the study until we have the opportunity to analyze our data and test our hypotheses.

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APPENDIX A: Surgical CTA Protocol

Developed for TATRC Grant Award # **W81XWH-04-C-0093**

Richard E. Clark, Ed.D.

1. Establish general context for use of procedure, general indications and contraindications for use and any relevant history (see “Questions to be asked...” below, items 1-3).
2. Ask for a sequential explanation of the process. Emphasize that instructions should be given as they would to an intermediate medical student, and request that steps be described as specifically and completely as possible, including decisions that must be made, cues that must be attended to, etc. Remind the subject to use ordinal descriptors as frequently as possible (e.g. “First, do step 1. Second do step 2. Next, do step 3...”). Questions/clarifications should only be asked of the subject if the words used or pronoun-antecedent relationships are not clear. Ask also about the decisions that must be made and the criteria for choosing between the various alternatives when decisions are made (see “Questions to be asked...”, below, items 4 and 5)
3. Recite the sequence back to the subject – that is, paraphrase what you hear them say. Ask for corrections and clarifications.
4. Ask the subject if the sequence after the corrections and clarifications is sufficient to allow someone to complete the task successfully (see “Questions to be asked...” below, items 6-7).
5. Take a break. Compile notes into a single, step by step, action and decision procedure.
6. Ask the subject to listen to you talk through the procedure as if someone was performing the procedure in a hypothetical situation. Instruct him to interrupt, clarify, or correct if anything said is inconsistent with how he/she would perform the procedure.
7. Review the corrected procedure with subject. At each identified decision point, ask for all relevant cues (see “Questions to be asked...” below, items 4-5). Verify by rephrasing as a question (e.g. “So, in order to make this decision, I only need to look at these two things?”).
8. In preparation for a follow-up meeting, compile the written CTA document and send to the subject. Ask him/her to make any changes that are necessary to correct the accuracy of the CTA using the “track changes” function in Microsoft Word or to print a copy and bring handwritten notes for changes to the follow-up meeting.
9. At follow-up meeting, discuss all changes and finalize the CTA description. Explain to subject that when he is asked to review others’ CTA documents, his role is to determine whether or not the task can be successfully completed using the steps presented. He should neither assume that something unstated is known nor that the CTA should exactly match his personal procedure. He should also edit any steps that are unnecessary. The

emphasis should be on whether or not the CTA document to be reviewed is viable and efficient to complete the task as written. Any changes that the subject wants to make should be made in the same manner as the edits to his own document.

Questions to be asked during the interview protocol

1) What happened? What were the problems being solved and the medical goal of this event?

The objective of this question is to collect the expert's overview description of the "what, where, when, who, why" the event happened. In addition, background information on the precursors, context, preparedness, important and unexpected aspects of the event are collected as well as the expert's view of the goal to be achieved.

2) What conditions must be present to start the task? Here the goal is to collect information about the medical "conditions" or "indications and counter indications" that would permit medical personnel who have not experienced this event to know when it has occurred and how to identify it unambiguously. Any tests, observations or measurements that must be made are collected and described.

3) What is the reason for the unique or unexpected nature of this event? The goal here is to collect background information on why this event was perceived as unexpected or important. The interviewer usually asks what aspect of prior training or education prepared the expert for this event –and what might prepare future surgeons more adequately to deal with it.

4) What actions and decisions must be implemented to complete the task? What alternatives must be considered and what criteria must be used to decide among the alternatives? This question is the core of a CTA interview. The expert is asked to describe, in a step-by-step fashion, everything that must be done to diagnose and treat the problem being investigated. This is often the second question that is asked (after #1, "what happened"). The answers to questions # 2 and 3 most often turn up as the expert describes the sequence they follow(ed) to diagnose and treat. As the sequence unfolds, the interviewer often interrupts with questions about the actions being described such as "Can you demonstrate on the simulator what you are describing?", or "Why did you do that?", or "What alternatives did you consider and what criteria did you use to make that decision?" and "What would lead you to make a different decision with another patient? Could you demonstrate a different set of constraints for that decision on the simulator?" The key issue in a CTA is to capture all of the many complex decisions that must be made, the alternatives that must be considered before a decision is reached and the essential criteria for choosing between the alternatives. It is knowing when and how to make decisions that are most often the source of errors in medical training since experts tend to automate their decision making. While experienced experts make very rapid and accurate decisions, they cannot observe what goes on in their mind as they decide and so often fail to report decisions or the range of alternatives they considered and rejected. This information contributes to training that is often very accurate when it depicts the observable actions that subject matter experts (SME) use to solve problems but unobservable decisions are often ignored or distorted. The goal of this aspect of the CTA is to produce an accurate, step by step description of the most efficient and effective way to reach the medical goal and sub-goals of the task.

5) *What concepts, processes or principle knowledge is required to adjust this task to fit novel conditions?* As the expert describes actions and decisions in response to question #4, the CTA interviewer occasionally interrupts and asks for details about three types of knowledge. A) Concepts -- An explanation of the special medical or scientific terms used by the expert. The interviewer asks for definitions and identifiable examples. Examples are collected (and scanned or otherwise stored on a computer for later use as illustrations in the CTA). Concepts are the type of knowledge that supports accurate classification of all aspects of the problem and solution. B) Processes -- An explanation of how something important to the goal works, stage by stage – such as a disease progression or an organ system. Processes support clear understanding of the wider context of the systems involved in the problem and solution and help experts generate more adequate solutions to problems; and C) Principles - Essentially the “science” of the phenomenon being described in the form of variable cause and effect statements. Principles help identify and explain causes, solutions and the adjustment of procedures to accommodate highly important incidents related to the problem being studied. These three types of knowledge will eventually be reorganized and presented as the body of conceptual and scientific knowledge that will support the diagnosing and treating of the problem and the editing of established treatments to accommodate unusual cases.

6) *What equipment and materials are required?* The objective with this question is to determine if any unusual medical equipment or supplies, not usually available in the context where this problem might occur, need to be provided in order to effectively diagnose and treat the problem effectively. Descriptions of equipment are collected and scanned or stored on a computer for later use in the CTA report.

7) *What performance standards must be achieved? (E.g. time, accuracy).* All essential quantity and quality standards for the diagnosis and treatment of the problem must be identified so that they can be described in assessment instruments and for eventual training media and materials.

APPENDIX B:

Cognitive Task Analysis: Surgical Use Of Argyle Shunt For Lower Extremity Vascular Disruption

Surgeon D
Procedure Description: Lines 39 - 91¹

Task Analyst: Richard Clark, Ed.D.
Rossier School of Education
University of Southern California, Los Angeles, CA

August 16, 2006
Final Draft

Objective: Restore viability of the femoral artery (85)

Conditions:

Indications:

- Temporary shunting for orthopedic procedures (79)
- Combined vascular orthopedic injuries (94)
- Temporary restoration of blood flow to stabilize Pt (112, 126))
- Unavailability of vascular expertise to repair the vessel (120)

Contraindications:

Equipment:

- Surgical tray (39)
- Vessel loops (42)
- Heparin saline (47) and systemic (55)
- Right angle (42) and other (e.g. bulldog) vascular clamps (48)
- Fogarty catheter (51) (Size 3 or 4) (134)
- Silk tie (e.g., 2-0, 3-0) (76)
- Doppler (83)

Standard:

An extremity that is: (85)

- Warm
- Perfused
- Capillary refill

¹ The first part of this appendix represents a reformatted version of the interview data provided by Surgeon D. The second part of the appendix is a copy of the exact interview transcript where all “lines” are numbered. References to “lines” in the first part of the appendix indicates the location in the transcript of the CTA interview where the information in that section can be found. The interview transcript is reformatted to reflect the correct sequence and rationale for each stage in the shunt protocol since surgeons tend to jump around as they narrate the procedure they use.

- Pink
- Has a flow detectable by Doppler

Task List:

1. Control proximal and distal blood flow (39)
2. Prepare the vessel for the shunt (45)
3. Place the shunt in the artery (57)
4. Secure the shunt (75) and evaluate distal perfusion (82)

Task 1: Control proximal and distal blood flow (39)

Goal: Control proximal and distal blood flow (39), remove obstructions to flow (50), and inhibit clotting locally (47, 54) and, if appropriate, systemically (55).

Step 1.1: Control hemorrhage digitally with compression of the finger or hand (39)

Step 1.2: Dissect down around the finger or hand and expose the proximal and distal femoral artery (40)

Step 1.3: Clamp the proximal artery with a vascular or bull dog clamp and place a vessel loop (42) on the artery

Step 1.4: Repeat Step 1.3 distally (43)

Step 1.5: Repeat Step 1.3 for other side branches (44)

Step 1.6: Pull up on proximal and distal vessel loops, remove finger, and examine (44)

Step 1.7A: Decide if blood flow from proximal and distal artery has stopped (45)

IF blood flow has stopped, THEN go to Task 2 (45)

IF blood flow has not stopped, THEN re-evaluate clamps and search for additional side branches

Task 2: Prepare the vessel for the shunt (45)

Goal: Confirm antegrade flow of the proximal artery (46) and back bleeding of the distal artery (49); remove any obstructions to blood flow (53); inhibit clotting in the vessel (47, 54)

Step 2.1A: Decide if there is brisk antegrade flow from the proximal artery (46)

IF there is brisk antegrade flow, THEN go to Step 2.2 (47)

IF the antegrade flow is less than brisk, THEN pass fogarty catheters.

Step 2.2 Flush the proximal artery with Heparin saline (47)

Step 2.3: Place a vascular clamp on the artery (48)

Step 2.4: Examine the distal artery for back bleeding (49)

Step 2.5: Pass a Fogarty catheter in the distal artery and reexamine for back bleeding (50)

Step 2.6A: Decide if there is adequate back bleeding distally (52)

IF there is adequate back bleed and no clot is returned (149), THEN go to Step 2.7

IF there is not adequate back bleed and/or clot is returned (149), THEN repeat Step 2.5 (149)

IF there is not adequate back bleed and no clot is returned (150), THEN go to Step 2.7

Step 2.7: Flush the distal artery with Heparin saline (54)

Step 2.8: Place a clamp on the distal artery (54)

Step 2.9A: Decide whether to give Heparin systemically (55)

IF it is an isolated injury, THEN give 5,000 units of Heparin systemically (55)

IF there are associated injuries, THEN do not give Heparin systemically (56)

Task 3: Place the shunt in the artery (57)

Step 3.1: Examine the ends of the artery (57)

Step 3.2: Without debriding (57) and leaving the edges ragged (58), place the shunt near the proximal artery (58)

Step 3.3: Take the clamp off (58) and place the shunt in the proximal artery (59) about 3 to 4 centimeters (62)

Step 3.4: Secure the shunt with the vessel loop (60) by pulling up

Step 3.5A: Decide if there is brisk bleeding out of the shunt (61)

IF there is brisk bleeding, THEN go to Step 3.6 (63)

IF there is not brisk bleeding, THEN re-evaluate the proximal artery (step 2.1)

Step 3.6: Clamp the shunt to stop the blood flow (63)

Step 3.7: Measure the length of the shunt in relation to the remaining artery (64)

Step 3.8A: Decide if the shunt needs cutting

IF the defect is huge, and the shunt just barely fits into both (64), THEN will need longer shunt or another type of shunt, or may not be able to shunt and may need immediate definitive repair.

IF there is little defect, THEN cut the shunt as necessary, so that it will fit 3 to 4 centimeters into the distal artery (66)

Standard: The ends must be cut square (176) with no sharp edges (178), to avoid internal disruption as it is placed in the distal artery (69)

Step 3.9: Back bleed the distal artery (71)

Step 3.10: Place the shunt in the distal artery (72)

Step 3.11: Secure the shunt with the vessel loop (72)

Task 4: Secure the shunt (75) and evaluate distal perfusion (82)

Step 4.1: Tie the vessel around the shunt (76) proximally and distally (75)

Step 4.2: Tie the shunt to the vessel (78) proximally and distally (80)

Step 4.3: Observe visual and tactile distal perfusion (82)

Step 4.4: Assess blood flow with Doppler (83)

End

1 Interview 10D May 17

2 RC=Richard Clark

3 S=Surgeon

4 K=Ken

5

6

7 RC: We've got an IRB form, did anybody show it to you? I don't remember if we sent it to you
8 are not. It's got a description of the study if you want to see it and I hope you take it away. You
9 keep one and I'll keep the one you sign. We're asking to videotape this but the videotape won't
10 be published; we're just going to use it for data collection. If we want to do anything else with it,
11 we will contact you to get a separate permission from you. I'm also audio taping because we
12 always want a backup.

13

14 What this study is about is the use of a., we're just trying to collect a protocol. Have you ever
15 done one? How many do you think you might have done?

16

17 S: Shunts period or shunts of the femoral artery?

18 RC: Shunts of the femoral artery. Let's start there and then just do shunts period.

19 S: Shunts of the artery, probably 2 or 3. Shunts total probably a dozen.

20 RC: In the 2 or 3, how long?

21 S: 4 years.

22 RC: The other shunts, what area?

23 S: About 50

24 RC: What we're trying to do, oh, the other areas you've done shunts?

25 S: Mesenteric arteries, iliac arteries, clavion artery, brachial artery, popliteal artery.

26 RC: Just about everything.

27 S: Bunch, yeah.

28 RC: I'm going to shut up after asking a few questions at least for the first part of this. I would
29 like for you to describe sir, from the beginning, step by step, how to put a shunt into a brachial or
30 into a femoral artery and describe it to me the way you'd describe it to somebody who was going
31 to learn how to do it. Somebody who had enough preparation that it would be reasonable for you
32 to tell them how to do it. It's not a common procedure as I understand it.

33 S: Right, correct.

34 RC: But it is something that a trauma surgeon would at some point. So if you'd do it in that
35 regard, try to do it step by step, what do I do first, second, third, fourth.

36 S: Okay. Does it matter what the mechanism, gunshot, stab wound, do you care?

37 RC: No, if it matters to you or it would determine when or where or how, then describe it, but
38 other than that, no.

39 S: I would control hemorrhage digitally with compression of the finger or hand, make an incision
40 over the femoral artery. Next I would dissect down around the finger for controlling the
41 hemorrhage and then expose the proximal and distal femoral artery. Once those were exposed I
42 would get proximal control with a right angle and a vessel loop to get proximal control of the
43 femoral artery. Do the same thing distally, right angle and a vessel loop, just to have those areas
44 controlled. I control it on the other side branches that might be feeding. At that point I would pull
45 up on both vessel loops and take my finger off to see if we had it controlled. If we had it
46 controlled, then I would see if I had antigrade flow from the proximal artery that bleeds briskly.
47 Then I would be done with the proximal artery. I would flush the proximal artery with Heparin
48 saline and place a vascular clamp on that proximal artery.

49 Next I would look at the distal artery so what the back bleeding is like from there. If it's brisk
50 back bleeding I would probably still pass a Fogarty catheter one time just to make sure there's no
51 obvious clot. And if there's no back bleeding I pass a Fogarty catheter to retrieve any clot and
52 see what kind of back bleeding I get.

53 At this point, if it was an isolated femoral artery injury, I'm sorry after I pass a Fogarty in the
54 distal artery I would flush that with Heparin saline as well and place a clamp on that. Now that
55 I've got proximal distal controls, if it's an isolated injury I would give 5,000 units of Heparin
56 systemically. If there associated injuries, I would skip that step, I won't Heparinize.

57 Now I look at the 2 ends of my artery. Since I'm going to shunt I would not debride the edges at
58 all. I would leave the edges ragged. I would place the shunt near the proximal artery. Take the
59 clamp off, place the shunt in the proximal artery and usually you can hold that shunt in place
60 temporarily with the vessel that you had before. You kind of pull up on the vessel loop, kind of
61 go down around the shunt. At that point, I should see pretty brisk bleeding out of the shunt. Your
62 plugged in proximizers come out pretty briskly. I would take it about 3 or 4 centimeters into the
63 proximal artery. If I get brisk bleeding, I would clamp the shunt so it stops bleeding. And then I
64 would measure my length of the shunt in relation to the remaining artery I have. If it has a huge
65 defect and just barely fit into both, and there's a little defect, you've got to put a lot of shunt in
66 there so at that point, I would cut the shunt if necessary to 3 to 4 centimeters in the distal artery
67 as well.

68 That's one step you've got to be careful of because the shunts come rounded on the ends and if
69 you cut it now, you may make a sharp end. So you've got to be very cautious that you don't
70 make it to sharp and you actually cause some internal disruption when putting in the distal artery.
71 If I put it in the distal artery, I'm sorry, I would back bleed this artery to give me brisk back
72 bleeding so I don't introduce any air to it and I'd put the shunt on into the distal artery and secure
73 that with my best vessel loop as well. So now I've got the shunt going from proximally to
74 distally across both vessels with vessel loops holding it in place and presumably no bleeding
75 around that. Then I would secure the shunt in place proximally and distally both. Again, ragged
76 edges on both ends just to save artery. I would take a silk tie, 2-0 or 3-0 silk tie, tie the vessel so

that the shunt's in the vessel, I would tie around the vessel down onto the shunt. And I'm going to take the same suture material and I would tie to the shunt itself just to prevent dislodgement. A lot of times we shunt for orthopedic procedures and they're moving the arm around or leg around. So I would tie to the vessel and then tie the shunt itself to secure it in place and do the same thing proximally and distally.

Once that shunt is in place I would evaluate distal perfusion, is the distal extremity warm and pink? Does it have at least a Doppler flow. I generally can't feel a pulse distal to a shunt in general. Occasionally you can right next to the shunt but down the distal hand or foot or whatever you can't usually feel a pulse. But I think obviously viability would be extremity warm, perfused, capillary refill, pink, with at least Doppler flow and I would have Doppler available throughout whatever process is going to happen next. If orthopedics is going to fix a bone, I'd have them check the Doppler sequentially. If I'm going to be doing something else, I take in vein from the other extremity, I would have somebody checking the Doppler or myself every 5-10 minutes to make sure that shunt doesn't go down.

And I think that's it as far as the shunt.

RC: Okay, let me slip back to the beginning. When you make, what would lead you to make the decision, at what point would you decide that you're going to use a shunt?

S: Combined vascular orthopedic injuries. Probably the most common situations. Orthopedics has to do some sort of complex bony repair but I also have to do vascular repair. Your options at that point are do your definitive vascular repair and then have orthopedics fix the bone. The pro you establish vascular continuity immediately and the con is when you put your saphenous vein or your PTFE [??] in, ortho then manipulates your extremity around and this may disrupt your repair. So the other option would be to shunt and then have them do their orthopedic repair and then come back afterwards do your definitive repair. So that's probably the most common situation for me, I've got a combined orthopedic vascular injury, I don't want to do my definitive repair first, so I shunt, let orthopedic do the repair and then I come back, take the shunt out and put a piece of vein or piece of Gortex in to fix the artery.

RC: Okay and the reason to do it and let the orthopedic repair go first is?

S: So they don't disrupt my definitive.

RC: I see so the obstruction would as they're moving ...

S: the bone around

RC: They might then block blood flow.

S: Yes because they're not paying attention to your vas repair, they're pretty much the bone and then they move very vigorously.

RC: Okay

112 S: So that'd be one reason, combine orthopedic vascular trauma. Second reason is a patient who
113 is dying on the table, actively dying, and the time it takes, even a pretty straight forward vascular
114 injury is going to take 20, 30 minutes if everything goes perfectly to reestablish flow and that
115 may not be time that the patient has. As a temporizing measure in a damage control operation
116 and the patient is dying, I would shunt the artery in order to establish flow temporarily, get
117 the patient off the table to the ICU, make him better, warm him up, correct [acidophilus] and
118 then come back to the operating room in a stage manner 6, 8, 12 hours later to remove the shunt
119 and then do the definitive repair.

120 I think another option to shunt would be if I wasn't a trauma surgeon and didn't have the
121 expertise to do a vascular repair, you know someone's out in a more rural area and they don't
122 feel comfortable fixing a femoral artery and they could shunt, which I think a general surgeon, a
123 basic trained general surgeon can do that shut and get the patient to a vascular surgeon or have a
124 vascular surgeon come in. We don't do that here but I think that another reason to do that.

125 RC: So they do the final repair, you'd shunt it to get the...or get him stabilized

126 S: Yes.

127 RC: When you use the balloon, you do use it, you flush with Heparin and saline, you do that first
128 before you use

129 S: No, I usually look and see what kind of flow I have first.

130 RC: And that's a Doppler decision?

131 S: No, proximally..

132 RC: Oh that's right, you said you just look at blood flow.

133 S: If it's proximal it should shoot across the room. If it doesn't shoot across the room, then I pass
134 a Fogarty catheter and I usually base the size, you know, size 3, 4 roughly down there. Probably I
135 don't know, I usually bring the Fogarties in the room and look at them. It's easier for me to kind
136 of look at both and see but usually it's a 3, 4.

137 So proximally it should shoot across the room. If it does that, then I flush and I'm done. If it
138 doesn't do that then I pass the Fogarty to get the clot out and again, I should be getting across
139 the room pulsating [flow] proximally.

140 Distally it's a little more difficult because if they've been ischemic for a while they may not have
141 a lot of back flow. I'd like to see some back flow and no matter what I see, I generally pass a
142 Fogarty catheter once to make sure I don't get a lot of clot out. If I see no flow then I pass until I
143 clear all the clot out. It's a balance because passing catheter gets clot out, but passing catheter
144 also puts the artery in spasm and make cause internal injury, make cause more problems. So I
145 don't get too crazy distally because I don't want to have, don't want to cause secondary injury.

146 RC: How do you know when you've done enough? Getting back flow?

147 S: I get clot, first of all I get clot back and some back flow.

148 RC: Okay, if you get no back flow?

149 S: I generally will pass a Fogarty a couple of times as long as I keep getting clot back. If I pass it
150 once or twice and get no clot back, then I probably won't do any more, I'll just do my repair and
151 then suture the injury.

152 RC: Okay, I think that's it for that one. When you're tying off the vessel on both sides of the
153 shunt, do you ever use any other equipment to tie it—do you ever use clamps or is that later?
154 There are also clamps that some people use.

155 S: Clamps I would use to control proximal to see what I'm doing in my repair.

156 RC: Later you clamp.

157 S: Yes, I mean you can use the vessel loops or the clamps to control. The clamps are a little bit
158 more secure, they're on, they're not going anywhere. Vessels can come loose or whatever, so the
159 vessels I use for initial control and then I use the clamps for definitive control. But when the
160 shunt is in, I don't usually use clamps in at all. I'll flush and then clamp and then when I put the
161 shunt the clamps will come off.

162 RC: What leads you to make the decision to trim, you actually trim it to fit.

163 S: Again, if I've got a bunch of shunt left, I don't want to ram that into a small vessel...

164 RC: without damaging the vessel

165 S: Right. So I usually like to have 3 or 4 centimeters of shunt in each side.

166 RC: Okay, but if there's not a lot of damage that you're dealing with, flow is restricted, then
167 you're going to be trimming the shunt to fit this.

168 S: Correct to fit whatever..

169 RC: Whatever centimeter is each side

170 S: Correct. And the shunts are pretty good. I mean you don't usually get huge defects, usually
171 you're talking about defects between 1 and 3 or 4 centimeters, so the shunt usually actually fits
172 pretty well. But it really depends on the individual patient. I like to have in 3 centimeters
173 proximally and distally.

174 RC: You said that when you trim the shunt, you have to be really careful about sharp edges when
175 you put them back in. Do you have a way to trim them that takes..

176 S: I just make sure I cut them square. The shunts come rounded, normally when you get an
177 argyle shunt, it's a straight shunt that comes rounded on the edges. If you cut it, it's no longer
178 rounded. But just make sure that resident cuts it square and there are no sharp edges and if there
179 is, kind of trim that up. But I don't have any technique to do that in particular.

180 RC: And you use Doppler obviously to detect flow. Have you every done this in a military
181 setting? Are you involved in that?

182 S: I'm military but have not been to Iraq.

183 RC: Are you going to?

184 S: Starting in August. In Iraq, it'll be the setting I told you about like probably it's something that
185 I won't do a definitive repair if I've got 8 casualties and I can't take the time to fix this guys arm,
186 I'll shunt him, send him to the Army hospital down the road and let them do the definitive repair.
187 Whereas if he was a single casualty and I had unlimited time, I might do the definitive repair. So
188 I have to balance who I would do shunts on. But generally that's one place where general
189 surgeons have applied it because the military sends general surgeons to do trauma and a lot of
190 them don't feel comfortable doing a femoral artery repair. And in the Navy there's no specialists
191 in theatres, no cardiothoracic, no vascular surgeons, in theatre, they're all Army and Air Force
192 hospitals. So Navy general surgeons do shunt an artery and/or vein to establish flow into the
193 extremity and then send the patient to a vascular surgeon at the next level of care.

194 RC: Let's see, equipment, I think I heard most of the equipment. We talked about clamps, you
195 wouldn't use clamps in this case but only when you did the final repair, so you've got to clamp
196 off the artery, that's clear. Anything else we didn't talk about in terms of the equipment?

197 S: You mean you need vessel loops, vascular clamps of some sort, obviously silk suture, Fogarty
198 catheters, Heparin salines, systemic Heparin if you make that decision to use that.

199 RC: That it? Ken?

200 K: In the very beginning, you seemed to imply that it made a difference...are there decisions to
201 be made when you first examined?

202 S: Yes, the difference is in the stab wound, it may be something, for a gunshot wound generally I
203 would not pull it, do a primary repair, I'm going to put something in between the injury, a piece
204 of saphenous vein or a piece of gortex because a gunshot wound would certainly cause enough
205 destruction to the, you know, either separation of vessel, destruction of the vessel, sometimes
206 there will be too much tension to pull together. However if it's a stab wound that just cleanly
207 cuts an artery in half, I would be able to pull it together as a primary repair and I wouldn't shunt
208 that patient at all. So the stab wound I just do a primary repair and even if it was damage control,
209 it's fast enough to do right away. If it's a combine orthopedic vascular, which is unlikely in a
210 stab wound, you can do that very quickly and I would feel pretty comfortable with that repair. So
211 generally it would be more of a decision as to how I'm going to fix the vessel definitively.

212 Now if someone, if I was doing a damage control and maybe I might shunt the stab wound but
213 in general I would probably just pull that together primarily. That's kind of the main reason.

214 RC: You'd pull the two ends together and do a temporary.

215 K: In a damage similar to a gunshot, how's this?

216 S: Worse if anything.

217 RC: How much of an artery has to be damaged for you to think about amputating? What makes
218 that decision?

219 S: Extremity amputation?

220 RC: Yes.

221 S: Not so much the damage to the artery as systemic condition of the patient.

222 RC: How long it's been since...

223 S: How long, how sick the patient is and how damaged the rest of the extremity is. The vessel
224 itself no matter how damaged that is, I try to fix that. But if he's got the vessel plus a venous
225 injury plus a destroyed extremity from a boney standpoint, nerve standpoint that would make my
226 decision to amputate. But the vessel itself doesn't matter how damaged it is, we can always do
227 something to fix that.

228 RC: All right.

229 K: In the tools area, you mentioned using clamps, is the kind of clamp important?

230 RC: He only uses clamps for, well at least, for control.

231 S: Usually we'll have either clamped or sometimes it just depends on how easy it is to get out. If
232 it's easy to get out, you may just hold it with a pick up and control it; sometimes we put a clamp
233 on but it just needs to be a vascular clamp, you know sort of non crushing clamp and the size fits
234 whatever, you know bulldog clamps work easily in your field because they're small. But you can
235 use an angled DeBakey clamp and any kind of vascular clamp is fine as long as it's vascular and
236 the right size.

237 K: The final question I have is that if the patient is going to be traveling, how's your decision to?

238 S: That's when tying it to the vessel and to the shunt, kind of like you would tie a chest tube
239 down or abdominal drain and you tie it to the vessel and the shunt, that way the shunt doesn't
240 move at all within the vessel.

241 K: Would you do it differently if you know that patient's going to be traveling?

242 S: I just do that way all the time. But I think some people would just tie to the vessel alone on
243 both ends and not tie it to the shunt. That would secure fine if you not moving any where, that
244 would be fine. But I've just gotten in the habit of tying it to both the vessel and the shunt just out
245 of habit.

246 RC: Okay, that's it. Now here's what we're going to do next. First of all, we're going to have the
247 interview typed up and then out of that we're going to create procedure, one, two, three, four and
248 organize some of your [??] we're doing now. We'll ask you to review it, we'll give to you on

249 paper, but we'll also give it to you [???]. We'll meet with you for the actual writing. Then we're
250 going to revise it, then we're going to actually show you one or two other protocols that other
251 surgeons have done. We're trying to arrive at one best protocol. It's an Army project by the way
252 and we're funded by the Army to do this. Obviously, maybe surgeons are doing this and some
253 surgeons aren't. But we're trying to get as many protocols as we can with the idea that we come
254 up with the best given the conditions. We're going to ask you to help us not only by revising
255 your own but by editing other people's work.

256 S: Sure, that's be great.

257 RC: Dynamite. And then we're going to have a publication when we're done and we hope you'll
258 join us in co-authoring.

259 S: Absolutely, great.

260 RC: Thank you.

261 S: It's so nice to meet you both.

262 RC: Thanks for your time.

263

264 STOP-END

265