

Telemedicine to Reduce Medical Risk in Austere Medical Environments

The Virtual Critical Care Consultation (VC3) Service

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ABSTRACT

One of the core capabilities of prolonged field care is telemedicine. We developed the Virtual Critical Care Consult (VC3) Service to provide Special Operations Forces (SOF) medics with on-demand, virtual consultation with experienced critical care physicians to optimize management and improve outcomes of complicated, critically injured or ill patients. Intensive-care doctors staff VC3 continuously. SOF medics access this service via phone or e-mail. A single phone call reaches an intensivist immediately. An e-mail distribution list is used to share information such as casualty images, vital signs flowsheet data, and short video clips, and helps maintain situational awareness among the VC3 critical care providers and other key SOF medical leaders. This real-time support enables direct communication between the remote provider and the clinical subject matter expert, thus facilitating expert management from near the point of injury until definitive care can be administered. The VC3 pilot program has been extensively tested in field training exercises and validated in several real-world encounters. It is an immediately available capability that can reduce medical risk and is scalable to all Special Operations Command forces.

Introduction

SOF Medicine in the Gray Zone Environment

Throughout history, armed conflict has led to substantial medical innovation that improves outcomes for Combat casualties and civilians when innovations translate to civilian healthcare. The case-fatality rates during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) are the lowest in recorded conflict.¹ Multiple medical advances have contributed to this success,¹⁻⁴ but only Tactical Combat Casualty Care (TCCC)^{5,6} and, in many cases, pre-hospital damage control resuscitation (DCR),⁷ can be reliably implemented before casualties reach a surgical facility. Other important interventions, including damage control surgery, hemostatic (whole-blood or matched-component therapy) blood-product resuscitation, Joint Trauma System management guidelines, and critical care casualty transportation, all require advanced medical capabilities and significant logistical support. Constrained geography and recognition that outcomes improved when casualties received rapid, definitive, surgical resuscitative care led to the development of increasingly more robust medical evacuation capabilities in OIF and

OEF.⁸ As the military transitions from operating environments with mature medical and evacuation resources to more resource-limited operations, a shift in medical capabilities is necessary because advanced trauma care from combat support hospitals (CSHs) and forward surgical teams (FSTs) is unlikely to be available within the “golden hour,” if at all. The concept of prolonged field care (PFC), currently being trained and iteratively refined, addresses this operational constraint.^{9–11}

PFC: Tactical Solutions for Austere, Dispersed Operations

Of the medical advances most responsible for improving outcomes in OIF and OEF, TCCC and, in many cases, DCR are currently the only reliably available intervention to SOF in the gray-zone operational environment.^{12–14} During these missions, SOF medics are often the most advanced US or North Atlantic Treaty Organization medical provider, and mission constraints may prevent evacuation of critically ill or injured patients to definitive care for hours or days.

The PFC Working Group has identified 10 capabilities to train and mature that will optimize SOF medics’ ability to care for critical casualties for extended periods and enable successful evacuation to definitive care.¹¹ The PFC Working Group also identified four basic operational scenarios in which PFC is practiced: ruck, truck, house, and plane. Care in these scenarios is not sequential and not all casualties will receive care in all scenarios.¹⁰

The challenge PFC caregivers must address is how to optimize medical outcomes and mitigate medical risk in areas that lack traditional echelons of care or rapid evacuation.^{1,9} The solutions most readily available in the short term are (1) training to increase austere critical care and evacuation capabilities of SOF medics and (2) providing medics with access to expert consultation in real time to assist in the care of critically ill casualties. Real-time consultation between the medic and a specialty consultant can be broken down into synchronous (telephonic or video telecommunication) and asynchronous (texts, data, images, video, and so forth, sent via short message service or e-mail) forms of communication.

Development of a PFC Teleconsultation Solution: The Virtual Critical Care Consult (VC3) Service

In August 2015, the PFC Working Group began collaborating with a team of critical care physicians at the US Army Institute of Surgical Research (USAISR) to create a solution for the ninth PFC capability: obtain telemedicine consultation. A retrospective review of all consultations placed to the Army Medical Department’s e-mail teleconsultation program from January 2014 to December 2015 confirmed a need to continue with solution development, because 15% of consultations had potential for clinical deterioration or death. Crucial to the development of a solution was the involvement of SOF medics at every stage of conceptualization, testing, and refinement. The following initial criteria for an on-demand telemedicine service were identified by focus group

consensus:

1. Availability of expert consultation should be real time (i.e., synchronous), simple to obtain, and rapidly accessible (within minutes). Critically ill patients may decompensate rapidly and the need for decisive management is immediate.
2. Telephonic consultation is the primary mode of assistance, not video or data transfer. The rationale for this criterion was twofold. First, telephonic communication is nearly universally available, is very low bandwidth, and does not require additional equipment that may cause operators to stand out in the local operating environment. Second, telephonic consultation has a long history of successful implementation and is practiced every day in academic and remote medical centers where consulting physicians work; thus, the skillset for this type of consultation requires minimal training. Generations of clinicians have improved the care of patients by simply talking with more experienced providers with no visual data guiding the reporting or recommendations.
3. Telecommunications may be augmented by images sent via e-mail or text, given the ubiquity of transmitting visual data by these means from even the most austere settings. Images can assist remote consultants with providing consultation in context, and these can convey significant amounts of information more rapidly than voice alone. Data sent in this manner also require significantly less continuous bandwidth. If bandwidth is not available, they are not required.
4. Teleconsultation should be obtained via devices currently carried by SOF medics and include commercial cellular and satellite devices. Obtaining teleconsultation should not place a burden for acquiring, learning, carrying, and powering additional devices by medics already facing significant time, space, and weight constraints.
5. The initial consultants should be a critical care physician with experience in medical, trauma, surgical, and burn critical care. These physicians are specialty trained experts in the non-operative management of critically ill patients who may clinically decompensate in the time beyond the golden hour—a significant risk for casualties who cannot receive timely, definitive surgical or medical care.
6. PFC is defined as prehospital care. Prehospital care does not require documentation in an electronic medical record. This allows solutions to require less technology. Documentation can be handwritten. Because medics do not store personal health information and they do not need send personally identifiable information, transmission can be over media and networks not certified for these purposes. This enables more rapid development and use of a tele-consultation system.

The PFC Working Group began testing teleconsultation in October 2015. Initially, two methods were evaluated: a current commercially available telemedicine service for travelers and the USAISR burn phone line. The commercial service routed calls through a non-physician provider, usually a paramedic, during a “triage step.” Callers were dissatisfied with the time it took to get past triage to the expert consultant, with the delay in call transfer to the consultant or waiting for consultant to call back, and with having to provide duplicate information during the triage phase and subsequently to the consultant. Calls to the burn hotline suffered from inconsistent awareness from the large Burn ICU staff about how to route calls for a new category of critical

care consultation.

These problems ultimately led to a third model: calls direct to an on-call intensive care physician. A dedicated phone number was assigned to call forward to the mobile phone of an on-call critical care physician. An e-mail address was also created to send messages to a distribution list of VC3 providers and PFC telemedicine Working Group leaders as a mechanism for the team to maintain situational awareness of VC3 activity and as a potential back-up solution should the phone line fail. Medics consistently preferred this method for both its expediency and for the quality of advice obtained from the military critical care physicians.

Equally important to the development of the VC3 Service was the development of a format by which callers inexperienced in conveying information about complicated, critically ill patients could consistently communicate such information to a consultant in a compressed, high-yield format.^{15,16} VC3 revised this format multiple times based on feedback from testing until it reached the current operational “script” (Appendix B). An important element of the script is the “capabilities” section, which addresses a concern of SOF medics: that the consultant physician will not appreciate the austerity and limitations of the environment in which they are operating.

Finally, a process evolved to optimize the efficient exchange of information. In best case scenarios, medics send images to the VC3 e-mail consisting of the capabilities section of the script, the clinical flowsheet (Appendix A), and any relevant images of wounds, care environment, equipment, and any other important information shortly before calling the VC3 number (preferably 10- 15 minutes lead time). Images must not reveal patient identity, location, or compromise operational security. At the beginning of a call, medics and the consultant exchange call-back or text-back information to facilitate follow-up and reconnection if the call is interrupted. Importantly, if images cannot be sent or there is no time to delay calls, the service may still be engaged immediately using the phone call, and information will be exchanged as optimally as possible.

Results

Testing continued into the spring of 2016 and involved numerous SOF units from Army, Marines, and Joint Special Operations Command. Devices tested were most commonly commercial cell phones but also included satellite phone and tactical communications systems. No appreciable differences in call quality were noted, provided a good signal was available. Satellite phones were limited by the ability to perform voice-only communication.

Operationally, VC3 has been used in support of the Special Operations Command Africa and Special Operations Command Central since late 2015. Real-world VC3 cases involving threatened airway compromise secondary to cellulitis; threatened vision due to ophthalmitis; penetrating abdominal trauma; and fragment injury requiring wound-tract debridement, foreign body removal, complex wound closure, and wound care validate the need for this capability. The abdominal trauma and wound management cases are detailed in this edition of *Journal of Special Operations Medicine*. In all cases, real-time teleconsultation improved local

provider confidence, patient outcome and, in at least one case, increased partner force confidence and alliance with the embedded SOF element.

Discussion

Current Special Operations doctrine predicts prolonged gray-zone operations.^{12,13} In this environment, smaller elements will operate in more dispersed, austere environments with little health-service support, often in failed states, with little to no organic medical infrastructure. The nature of risk in these environments is shifting from penetrating and blast trauma, to include significant rates of blunt trauma, burns, and infectious disease. Low-frequency, higher-risk resuscitations are predicted to become a normal experience in the next decade's operational environment. Although operational medical risk remains moderate to high, wide geographic dispersion of small elements operating in areas with limited country clearance who incur low casualty rates make it difficult, if not impossible, to provide conventional medical support through conventional echelons of care and military medical evacuation.

The use of critical care teleconsultation services and a multidisciplinary team approach to the care of patients in the intensive care unit (ICU) have been demonstrated to improve mortality in civilian and military ICUs.^{17–21} Real-time teleconsultation can “bring the expert to the patient” in austere settings where the patient cannot be transported to the ICU for definitive care in a timely manner.¹⁹ It is expected that the widespread availability and use of critical care teleconsultation by SOF elements conducting gray-zone operations will result in a reduction of medical risk and an improvement in outcomes for critically injured and sick casualties. Ongoing research efforts are targeted to demonstrate this benefit.

VC3 is a solution that provides synchronous teleconsultation to deployed SOF. It has been developed with the close collaboration of SOF medics, SOF providers, and expert clinicians in the only military level 1 trauma and burn center. VC3 has been tested and refined in dozens of training exercises and validated in real-world scenarios.

The most important near-term challenges to SOF teleconsultation and VC3 are scalability, sustainability, and physician participation. Scaling VC3 to be available to all SOCOM forces operating in austere environments is one of the most high-yield, immediately available methods to reduce medical risk. The investment needed to achieve such scaling is small: call-forwarding software to ensure that a medic's call will be answered if the primary on-call provider is occupied or out of coverage range, a coordinator to manage a roster of critical care physicians who volunteer to take VC3 calls, and a research coordinator to collect data from the calls, thus helping to further refine the system and enable future enhancements in operational telemedicine.⁴

All branches of the military employ physicians with the required training and experience to be expert VC3

consultants. Establishing a cadre of VC3 providers requires selection, vetting, and training, as well as recognition of activities in support of operational teleconsultation by parent medical directorates. Regarding the former, the importance of a critical care provider (receiver) understanding the operational context of the SOF provider (sender) cannot be overstated. Introducing providers to VC3 via participation in training events ensures that physicians have a working knowledge of the equipment and capabilities of the SOF medic and develop rapport, both of which will optimize real-world interactions. VC3 providers should be afforded the opportunity to train in the field with the medics they may be supporting, to stay current with training levels and equipment used. In this context, traditional metrics of physician performance such as productivity or revenue generating units may be difficult to extrapolate from VC3 encounters and training. Modification of the VC3 service to fit current productivity and reimbursement standards would be detrimental, and would likely discourage SOF medic use, and thus negatively impact patient outcomes. Because the primary role of military medicine is the support of combat operations, metrics that account for the value of physician participation in programs that support operations and reduce operational risk, such as VC3, should be developed.

Future Directions

Current efforts are focused on expanding this pilot program to allow all deployed forces access to the consultation service. Additional effort is underway to create a unified military program that includes immediate access to multiple subspecialty services and guidelines regarding access to this system across the spectrum of illness (i.e., routine, non-urgent consultation through immediate/emergency consultation). Pursuit of technology must allow telemedicine services to remain flexible and scalable according to SOF mission needs and account for wide variation in technological capability at the point of need. Research efforts are ongoing to determine when or if more advanced technologies can provide better consultation and improve patient outcomes than the voice and e-mail consultation solutions described here.

Conclusion

VC3 is an immediately available method to reduce medical risk in gray-zone operating environments. It meets the SOCOM requirement for telemedicine support of decentralized operations. With minimal investment, VC3 can be sustained and scaled to all SOCOM forces. This is an essential first step before exploring additional capabilities or scaling to support conventional force operations.

Keypoints

- The VC3 service is a direct link between medics in austere environments and critical care subject matter experts that enables best possible care of critically injured and sick patients during PFC.
- VC3 provides effective consultation by telephone; meeting a core requirement voiced by SOF medics that telemedicine be accessible in a wide variety of environments without specialized communications equipment. The addition of images transmitted by e-mail can enhance communication but is not a requirement.
- The VC3 service has demonstrated success in multiple training and real-world scenarios.
- Access to this service is expanding and is available to US SOF units for training and operational use via unit

surgeon sections, Theater Special Operations Command Surgeon sections, and the Special Operations Medical Association (SOMA) PFC Working Group.

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The views expressed are those of the author(s) and do not reflect the official policy or position of the US Army Medical Department, Department of the Army, Department of Defense, or the US Government.

Disclosures

The authors have nothing to disclose.

**Appendix A:
The PFC Flowsheet.**

This document is intended to help medics (or other PFC providers) not only document care but identify important trends in data (e.g., declining urine output with steadily increasing heart rate and respiratory rate may suggest volume depletion), and not miss routine care that is vital during prolonged evacuation (e.g., repositioning casualties so they do not develop pressure ulcers, scheduled pulse checks, routine medication administration like acetaminophen every 4–6 hours). Images of this information sent ahead of consultation helps consultants make more informed and concise recommendations.

| Prolonged Field Care Casualty Card v.21 (24 Nov 2017) | | | | | | |
|---|-----------------|-----------------|--|----------------|-----------------------------------|--|
| Name: | Date: | Time: | Weight: | Blood type: | EVAAC Category: I D M E | |
| S: | | | M.I.S.T. Report: | | | |
| A: | | | MCI: | | | |
| M: | | | Stable or Unstable | | | |
| P: | | | Injuries / Illness / Problems | | | |
| T: | | | Treatments - Plans | | | |
| E: | | | 1 | | | |
| | | | 2 | | | |
| | | | 3 | | | |
| | | | 4 | | | |
| | | | 5 | | | |
| | 6 | | | | | |
| | 7 | | | | | |
| | 8 | | | | | |
| | 9 | | | | | |
| | 10 | | | | | |
| TQ 1 time on: | TQ 2 time on: | TQ 3 time on: | TQ 4 time on: | TXA Dose 1 on: | | |
| TQ 1 Converted: | TQ 2 Converted: | TQ 3 Converted: | TQ 4 Converted: | TXA Dose 2 on: | | |
| Notes: | | | Teleconsult Call Script and Patient Handover Info Time: This is _____, an _____ (Job Position) I have a patient with _____ who I think has _____ and I need _____ Chief Complaint _____ Brief History _____ Vitals HR _____ RR _____ BP _____ Temp _____ Pulse _____ Cx _____ UOP _____ AVPU _____ Exam _____ Findings: _____ Recommendations Fluids/Meds _____ Interventions _____ Red- Flags _____ | | | |

Newest version available at prolongedfieldcare.org

| Prolonged Field Care Casualty Card v.21 (24 Nov 2017) | | | | | | | | | |
|---|-------|--------|-------|-------|----------------------------------|--|--|--|--|
| Day | Hour | Minute | Other | D | Checklist | | | | |
| | | | | I | Resusc Tx | | | | |
| | | | | M | Exams | | | | |
| | | | | Other | Detailed Exam | | | | |
| Time Zone: | 200 | | | 200 | Send MIST Report | | | | |
| | 190 | | | 190 | Monitors | | | | |
| | 180 | | | 180 | 2nd NFD | | | | |
| | 170 | | | 170 | GCS/Neuro/RMACE | | | | |
| | 160 | | | 160 | Analgesia | | | | |
| | 150 | | | 150 | Sedation | | | | |
| | 140 | | | 140 | HR / Cx | | | | |
| | 130 | | | 130 | Upgrade Airway | | | | |
| | 120 | | | 120 | Post Cric Checklist | | | | |
| | 110 | | | 110 | Vent w/ PEEP | | | | |
| | 100 | | | 100 | Hypothermia Tx | | | | |
| | 95 | | | 95 | Recalc TISA and Fluids | | | | |
| | 90 | | | 90 | Ultrasound of ax | | | | |
| | 85 | | | 85 | Fluid Challenge | | | | |
| | 80 | | | 80 | 1st TXA dose (ASAP) | | | | |
| | 75 | | | 75 | Blood Type Card | | | | |
| | 70 | | | 70 | FWB Transfusion | | | | |
| | 65 | | | 65 | Convert TQ <4hrs | | | | |
| | 60 | | | 60 | Foley / Bladder Tap | | | | |
| | 55 | | | 55 | Adjust Vent Settings | | | | |
| | 50 | | | 50 | UA Dipstick | | | | |
| | 45 | | | 45 | Clear C-Spine | | | | |
| | 40 | | | 40 | Position Head Patient | | | | |
| | 35 | | | 35 | Peripheral Pulses | | | | |
| | 30 | | | 30 | Compartment Syndrome | | | | |
| | 25 | | | 25 | Echabotomy | | | | |
| | 20 | | | 20 | Reduce / Split Tx | | | | |
| | 15 | | | 15 | DVT Prophylaxis | | | | |
| | 10 | | | 10 | Antibiotic War Wound Tx | | | | |
| | 5 | | | 5 | Tetanus | | | | |
| | 0 | | | 0 | Teleconsult | | | | |
| | | | | | Lab | | | | |
| | | | | | X-Ray / Imaging | | | | |
| | | | | | PreOp Eval | | | | |
| | | | | | Debridement | | | | |
| Output | | | | | | | | | |
| Fluid Input | | | | | | | | | |
| Pain under/RMACE | | | | | | | | | |
| AVPU/Neuro/RMACE | | | | | | | | | |
| Eye response | 4 | | | | Nursing Care Reminders | | | | |
| Oral Response | 5 | | | | Vitals q1h | | | | |
| Motor Response | 6 | | | | Flush Saline Locks | | | | |
| GCS Total | 15 | | | | Secure IT Tube | | | | |
| Drug/Intervention: | Dose: | | | | Reposition q2hrs (30° Each side) | | | | |
| Drug/Intervention: | Dose: | | | | Change Blood Tube q4hrs | | | | |
| Drug/Intervention: | Dose: | | | | Oral Care / Hygiene q4hrs | | | | |
| Drug/Intervention: | Dose: | | | | Foley Care q4hrs | | | | |
| Drug/Intervention: | Dose: | | | | Sponge Bath q12hrs | | | | |
| Drug/Intervention: | Dose: | | | | Change IV Bag q24hrs | | | | |
| Drug/Intervention: | Dose: | | | | Change Foley Cath q2hrs | | | | |
| Drug/Intervention: | Dose: | | | | Change M Lines q2hrs | | | | |
| Drug/Intervention: | Dose: | | | | Change F/ME q2hrs | | | | |
| Drug/Intervention: | Dose: | | | | | | | | |
| Drug/Intervention: | Dose: | | | | | | | | |
| Drug/Intervention: | Dose: | | | | | | | | |
| Drug/Intervention: | Dose: | | | | | | | | |

**Appendix B:
The VC3 Call Script.**

Structured communication has been demonstrated to increase information transfer in both volume and content.¹⁶ The script is broken into five sections: Introductions & Call-Back, Clinical History and Problem, Vital Signs/Exam/Previous Interventions, Recommendations, Follow-up. At the end of each section, a “pause point” is designed to give the consultant or medic an opportunity to review information presented, via a read back, and to ask clarifying questions. The section on capabilities is intended to be sent ahead of the voice consultation as a form of background information; however, medics often send images of the entire script, which allows consultants to review the case before receiving the phone call and often reduces talk time and may facilitate more concise recommendations.

VIRTUAL CRITICAL CARE CONSULTATION (VC3) GUIDE – 8 July 2017 (v3)
To be used with Prolonged Field Care Card

1. Before calling, E-mail image of the casualty (wounds, environment, etc.), “capabilities” (back of page), & vital signs trends to dod.vc3@mail.mil
2. If call not answered: a) call ext number on FACE or call back in 5 – 10 min.
3. If unable to provide information due to operational security, state so.

P:
A:
C:
E:

This is _____ I am a (job/ position) _____
My best contact info is: _____
YOUR best contact info is (Consultant's number): _____ Alternate e-mail: _____
***** PAUSE POINT to CONFIRM CONTACT INFO *****

I have a _____ year-old (sex) _____ (active duty/foreign national/DOA, etc.), who has the following:
Mechanism of injury or known diagnosis(es): _____
The injury/start of care occurred _____ hours ago. Anticipated evacuation time is (hours from now): _____
Injuries/Problems/Symptoms: _____

Treatments: _____

He/she is currently (circle) stable/ unstable, getting better/ getting worse/ getting worse rapidly
Known Medication Allergies/Past medical/Surgical history: _____

I need help with (drugs/etc if possible, i.e. “I need help reading this ECG,” or “I need help stabilizing this patient,” etc.) _____

Other Consultants have recommended: _____

***** PAUSE POINT for Remote Consultant to ask clarification questions *****

| | | | | | | |
|--|----------------------------------|--------------|-----------|-------------|---------------------------|-------------|
| VITALS (current & trend as of _____): | HR: _____ | BP: _____ | RR: _____ | SpO2: _____ | EtCO ₂ : _____ | Temp: _____ |
| UOP (ml/hr) _____ over _____ (if hours) | Mental Status (GCS/ AVPU): _____ | | | | | |
| EXAM: Neuro _____ | (ext/ MSK) _____ | | | | | |
| Heart _____ | Pulses _____ | | | | | |
| Lungs _____ | Skin/ Wounds _____ | | | | | |
| Abd _____ | | | | | | |
| LABS: ABG: _____ | Lactate: _____ | Other: _____ | | | | |

***** PAUSE POINT for Remote Consultant to ask clarification questions *****

| Plans/Recommendations | |
|-----------------------|------------------------------------|
| PRIORITY | RECOMMENDATION |
| | Neuro or problem #1 |
| | CV or problem #2 |
| | Pain or problem #3 |
| | GI or problem #4 |
| | Renal or problem #5 |
| | Endocrine or problem #6 |
| | MSK/ Wound or problem #7 |
| | Tubes, lines, drains or problem #8 |
| | Prophylaxis/prevention or prob#9 |
| | Other _____ |

| TO-DO/ FOLLOW-UP/TO-STOP | NOTES |
|--------------------------|-------|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |
| 6. | |

***** PAUSE POINT, for Medic/Local Caregiver to ask clarification questions/HEADSACK *****
Available “Kit” contents, equipment, medications, etc. POSSIBLE PROBLEMS/ISSUES AND SIGNS AND SYMPTOMS, RE-DOING CALLS ETC.

| | |
|--------------------------|--|
| Comms: | Temp GI ID: _____ SAT/Local Cell# _____ |
| | Other (FaceTime, VSee, Skype, WhatsApp, etc.): _____ |
| W/Access: | IV Central line ID (location) Other: _____ |
| Monitor: | Propaq Tempac Foley Graduated urine Fulse only Exam Only |
| | Other: _____ |
| IV Fluids: | Fluoro-type LR Normal Saline 3% saline Other: _____ |
| Colloids: | Hesolarch Albumin Other: _____ |
| Blood products: | Whole blood PRBC Plasma FDP Platelets Other: _____ |
| Medications: | Antibiotic: (name/route/dose) _____ |
| | Morphine (IV/PO) Other opioid (name/ IV/PO): _____ |
| | Fentanyl (IV/PO) (mcg) Ketamine _____ |
| | Midazolam _____ Clonidine (IV/PO) _____ |
| | TBA _____ Other (S): _____ |
| Airway/Smoothing: | ETT Critch UVA BVM O2 Suction (type): _____ Vent (non/mode): _____ |
| Miscellaneous: | |

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