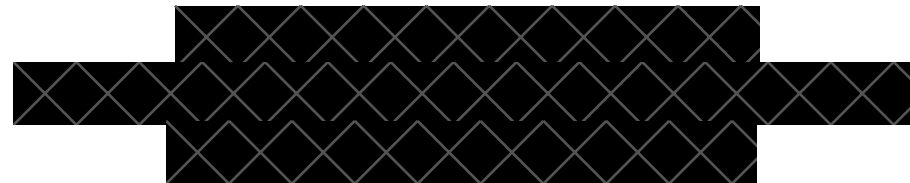
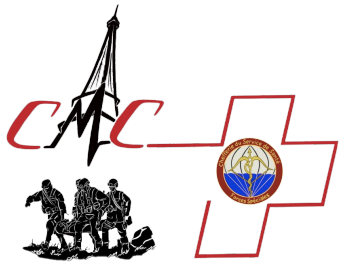


Paris Special Operation Forces
Combat Medical Care Conference

Oct 20/21 2022

In-flight Damage Control Surgery



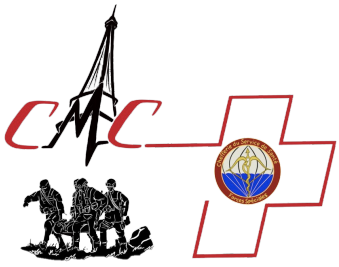


In-flight surgery: what for?



Hostage release, May 2019

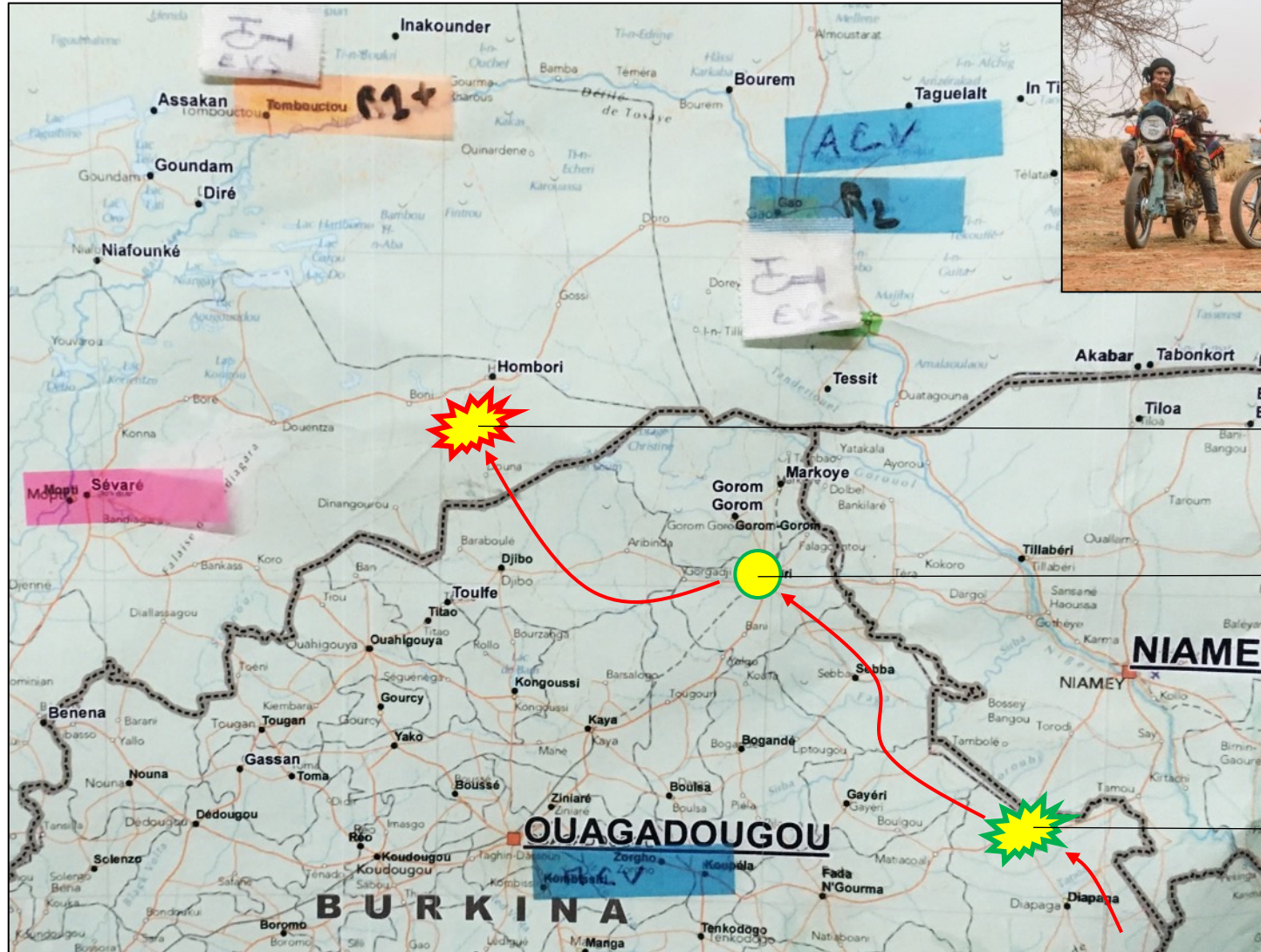
In-flight Damage Control Surgery



In-flight surgery: what for?



The hunt for
hostage takers

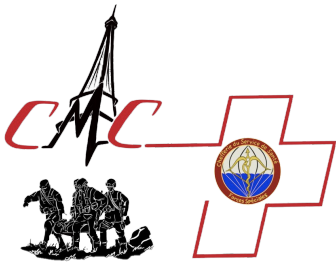


3rd Night

2nd Night

1st Night

In-flight Damage Control Surgery



In-flight surgery: what for?



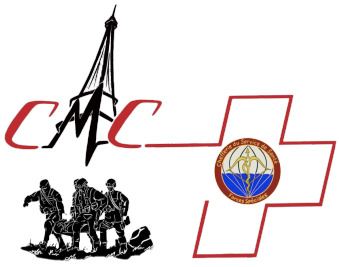
3rd Night

2nd Night

1st Night

Fr SOST

In-flight Damage Control Surgery



In-flight surgery: what for?

Fr SOST

- 20 min far from the action theater
- Air medevac, RW

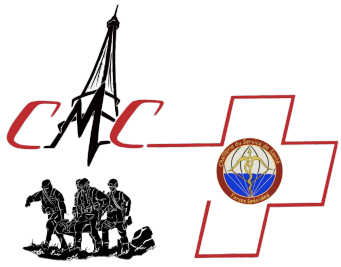


3rd Night

2nd Night

1st Night

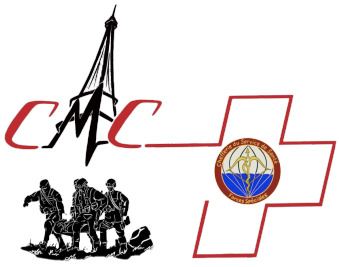
In-flight Damage Control Surgery



In-flight surgery: what for?



- 11 pm: Landing on Fr FOB
- 11.30 pm: Fr SOST Ready
- 2.30 am: 2 *Alpha* announced
- 2.50 am: OR Ready



In-flight surgery: what for?

Patient 1: Left thoracic GSW, cardiac arrest , ongoing CPR

Emergency thoracotomy

Clamping of the aorta

Pericardic opening

Exsanguinating cardiac wound

No recover of spontaneous cardiac activity

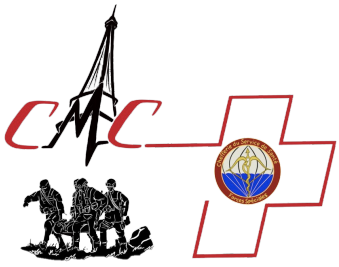
DOW

Patient 2: Left thoracic wound, Penetrating brain injury, no sign of life
KIA

Debriefing

- Patient 1: *evitable death* likely !
- Necessity to reduce the delay to surgery

In-flight Damage Control Surgery



In-flight surgery: for whom?

Injury

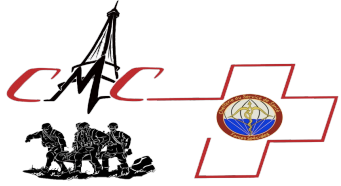
- Exsanguinating trauma
- **Non compressible hemorrhage**
- No efficacy of conventional resuscitative process (REBOA included)
- Limits of prolonged field care

Context

- No surgical facility
- Golden hours overtaken

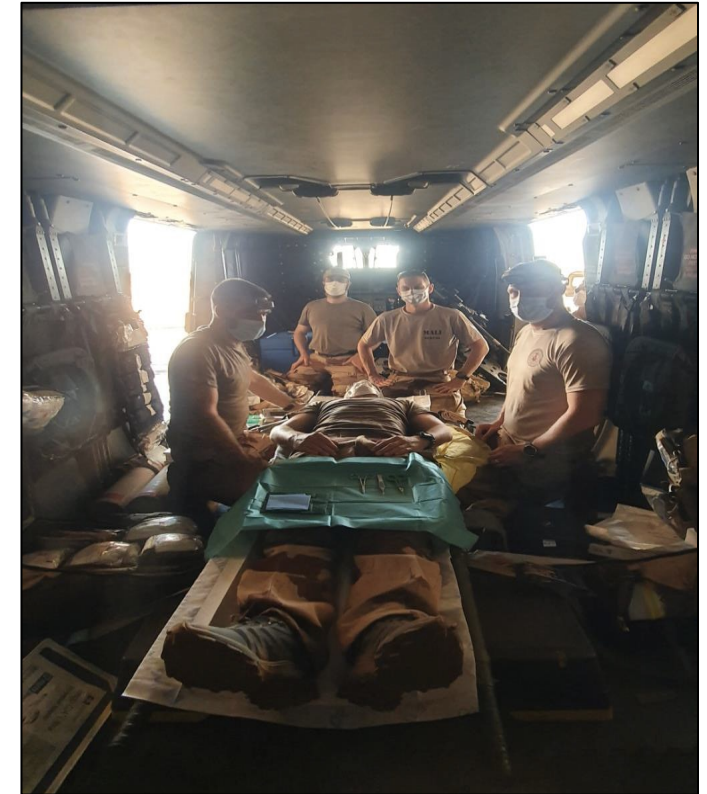


- High Risk of death during MEDEVAC
- Surgery during air MEDEVAC

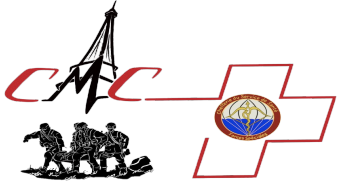


In-flight Damage Control Surgery

In-flight surgery: Specificity of Fr SOF's demand



- « Plug-and-play » surgical unit in SOF aircrafts
- Less than 90 kg
- No need for specific supply (energy, lightning, water, network...)
- Ready in 45 minutes



In-flight surgery: is it feasible? Is it foolish?



Life and Limb In-Flight Surgical Intervention *Fifteen Years of Experience by Joint Medical Augmentation Unit Surgical Resuscitation Teams*

J Dubose and al.

JSOM, 2020

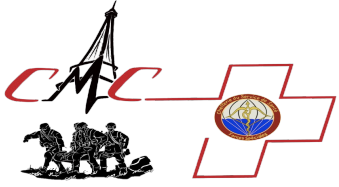
In-Flight Life and Limb Surgery Results

In-flight surgery was performed on both rotary wing and fixed wing evacuation platforms by the SRT for a total of nine patients, in roles including POI response (6/9; 66.7%), tail-to-tail transfer from other aeromedical evacuation platform (1/9; 11.1%) and CCT between MTF echelons (2/9; 22.2%).

2004-2019

n= 312

In-flight: 9 patients



In-flight surgery: is it feasible? Is it foolish?



Life and Limb In-Flight Surgical Intervention Fifteen Years of Experience by Joint Medical Augmentation Unit Surgical Resuscitation Teams

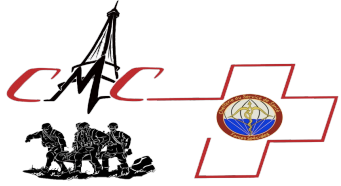
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JSOM, 2020

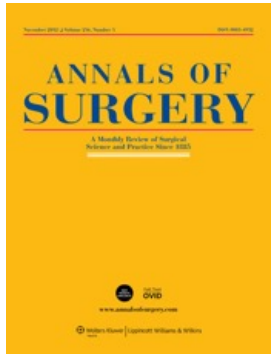
TABLE 3 Documented SRT Life and Limb Surgical Interventions During In-Flight Care Only (September 2004–May 2019)

	N = 9 casualties
Resuscitative thoracotomy	7 (77.8%)
Exploratory/damage control laparotomy	1 (11.1%)
Extremity fasciotomy	1 (11.1%)

- Resuscitative Thoracotomy (n=7)
- Survival:
 - With signs of Life: 77%
 - Without sign of life: 33%



Challenge 1: What surgery to perform for exsanguinating trauma?



Indications for Use of Damage Control Surgery in Civilian Trauma Patients

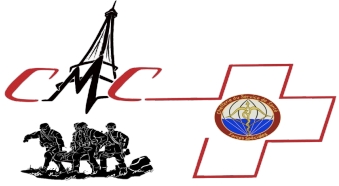
A Content Analysis and Expert Appropriateness Rating Study

Roberts et al

Annals of Surgery • Volume 263, Number 5, May 2016

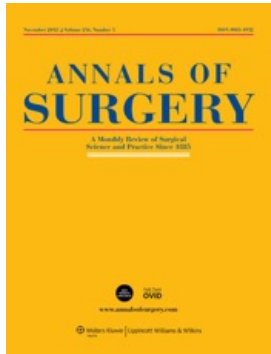
TABLE 2. Candidate Indications (n = 27) for Thoracic DC Interventions in Civilian Trauma Patients Who Are Currently Undergoing Thoracotomy

Indication Code(s) (Median Decision Threshold Value; IQR; No. Indications That Included a Decision Threshold)	No. Indications (%)	Expert Panel (n = 9) Evaluation*	
		Median RAM Scale Rating (IQR)	Verdict
Rapid lung-sparing surgery (pneumonorrhaphy, pulmonary tractotomy, and pulmonary wedge resection) (n = 1)			
Whenever possible when an emergent thoracotomy is indicated for thoracic trauma	1 (100)	9 (8–9)	Appropriate
Pulmonary tractotomy (n = 7)			
A parenchymal injury that is too big or deep to be handled by simple wedge resection	1 (14.3)	6 (3–8)	Uncertain
<i>Penetrating</i> through-and-through parenchymal injuries that do not involve the hilar structures	3 (42.9)	7 (6–8)	Appropriate



In-flight Damage Control Surgery

Challenge 1: What surgery to perform for exsanguinating trauma?



Indications for Use of Damage Control Surgery in Civilian Trauma Patients

A Content Analysis and Expert Appropriateness Rating Study

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THORAX

1. Thoracotomy
2. Sternotomy
3. Aorta clamping
4. Péricardotomy
5. intra-auricular veinous access
6. Cardioraphy
7. Hilum Clamping/stapling
8. Tractotomy

ABDOMEN

1. Laparotomy
2. Pringle Manoeuvre
3. Péri hépatic Packing
4. Splénectomy
5. Mesentery bleeding
6. Hollow viscus stapling
7. Néphrectomy
8. Pelvic Packing

NECK

1. Cervicotomy
2. Carotid contrôl
3. Trachéotomy

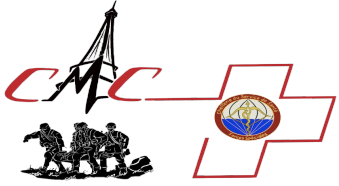
VASCULAR

1. Arterial shunting

NEUROSURGERY, ORTHOPEDY, ENT

0. None

→ About 20 hemostatic surgical procedures considered as 'appropriate'



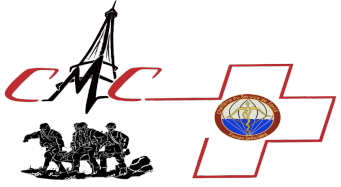
In-flight Damage Control Surgery

Challenge 2: Composing a light, rustic & autonomous surgical tool



- 4 people
- 1 surgeon+1 scrub nurse
- 1 anesthetist+1 anesthetist nurse
- *On the knee* installation!
- 4 backpacks, < 90 kg
- 1 casualty
- 3 hours autonomy
- **No electrocautery**
- **No surgical suction**



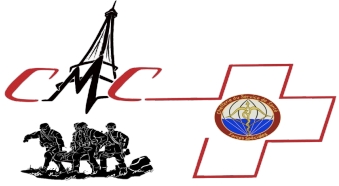


In-flight Damage Control Surgery

Challenge 2: Composing a light, rustic & autonomous surgical tool



PREFAB KIT for peritoneal packing
or peri hepatic packing

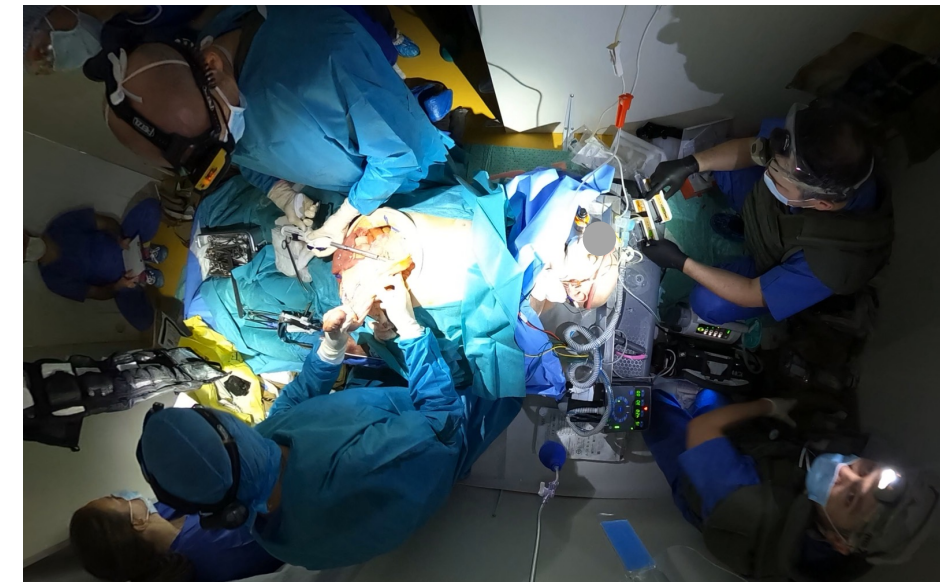


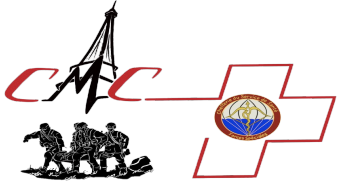
In-flight Damage Control Surgery

Challenge 3: Certification of the in-flight surgery tool

Is it possible to perform the 20 surgical procedures with limited resources ?

- Perfused cadavers Simlife®: *Breathing, circulating, bleeding!!*
- Faculty of medicine, Poitiers, France
- Model of a helicopter hold
- Real equipment and installation





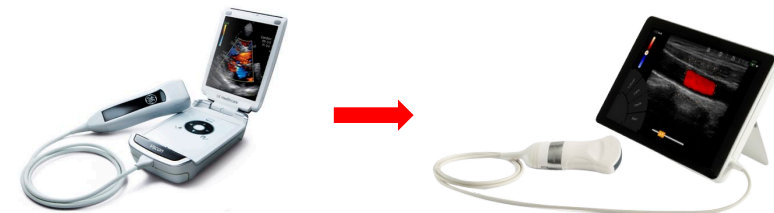
In-flight Damage Control Surgery

Challenge 3: Certification of the in-flight surgery tool

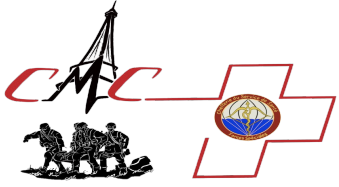
- Changes in surgical devices
- Changes in surgical procedures
 - No more arterial shunting: clamping is preferred to shunting
 - No more organ resection: clamping+ packing is preferred to resection



- Changes in anesthetist devices
- Changes in anesthetist procedures
 - Coniotomy is preferred to tracheotomy
 - 2 venous acces (Octopus) mandatory during field care



>>>> About 32 items have been changed at the end of the first test

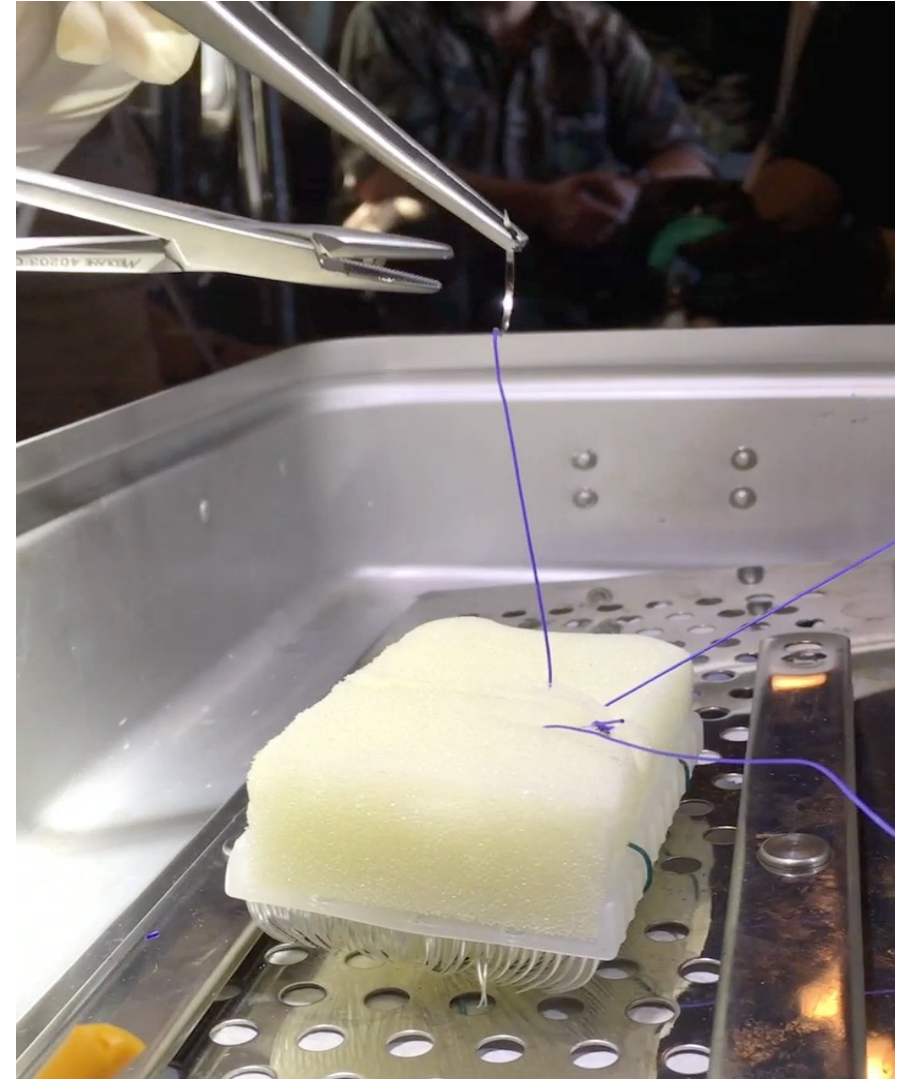


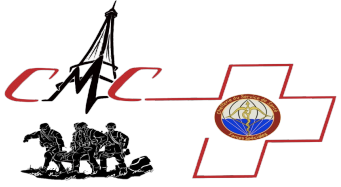
In-flight Damage Control Surgery

Challenge 4: Obstacles related to the aeronautical environment



- On exercises boxes
- Vibrations! → contraindicate the realization of fine surgical procedures
- Necessity to adapt the fly (even at war)!!





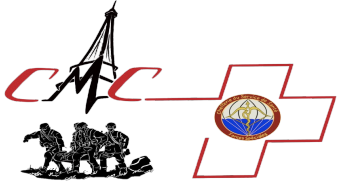
In-flight Damage Control Surgery

Challenge 4: Obstacles related to the aeronautical environment



- Air sickness
- Pre-habilitation mandatory
- Airsickness medication



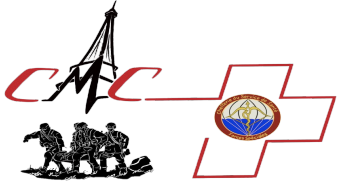


Challenge 4: Obstacles related to the aeronautical environment

Definition of a « War surgical MEDEVAC » paradigm

- How do you communicate with the helicopter crew?
- How and where do you do the « doc-to-doc » medical report?
- What weapons for the surgical team?
- Knowing the security rules on board
- ...





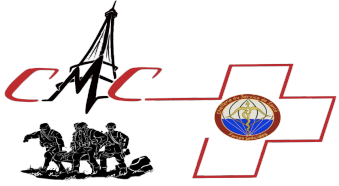
In-flight Damage Control Surgery

Final certification



- Porcine model protocol
- FMHS research lab (IRBA)
- Directive 2010/63/EU on the protection of animals used for scientific purposes
- Local Ethics committee approval
- Real conditions: Caracal helicopter, by night, standard team, complete autonomy
- Wound of the heart / sternotomy / Foley catheter/ cardiography
- The model survived

>>>> Successful final certification



Key points

- In flight surgery is working
- Necessity to change surgical paradigm s+++
- Education of the team members: the key point!
 - Time consuming
 - Resources intensive (aircraft, surgical mannikin ...)
 - Easier to operate a patient than to behave well in a helicopter at war
- Low occurrence of the event: 7 patients in 15 years for US armed forces
- Innovation in field management of non-compressible hemorrhages