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Impact of Forward Resuscitative Surgery to the War Fighter in Distributed Operations Deployment

75th MORSS (WG 23)

Sherry P Adlich, Teledyne Brown Engineering
Dr. Paula Konoske, Naval Health Research Center

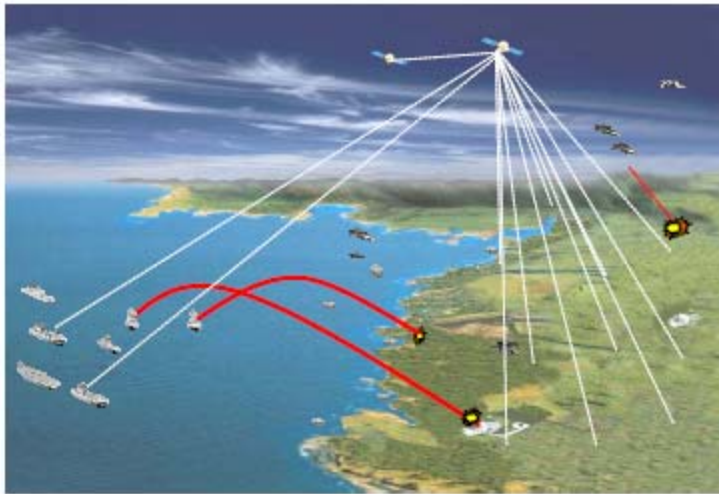
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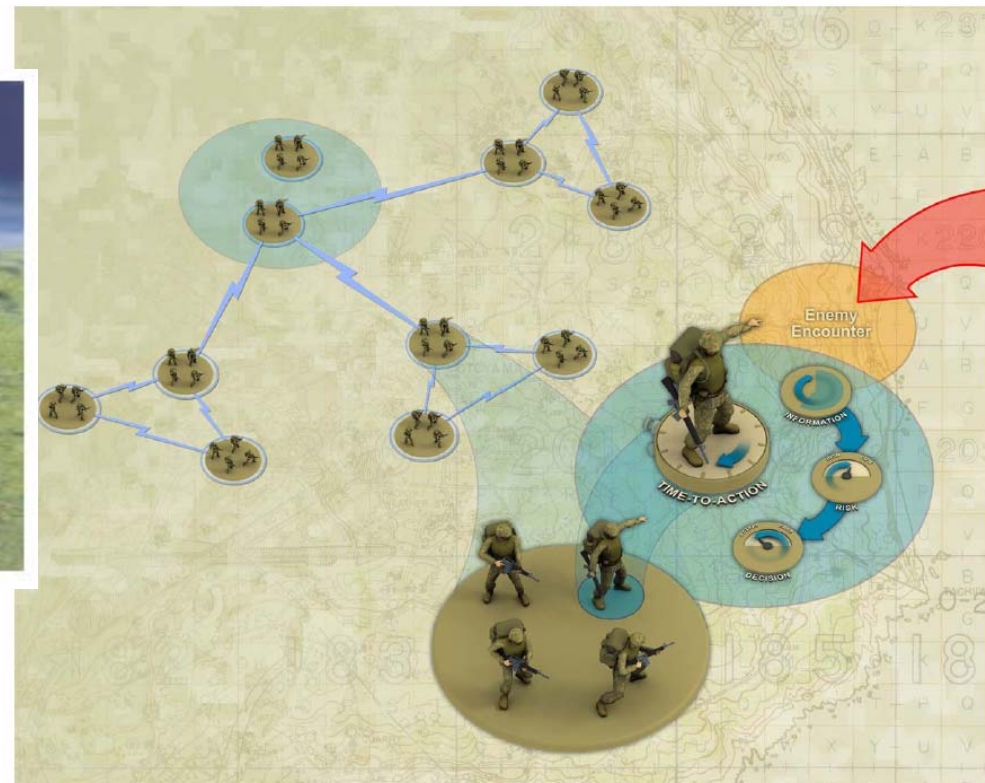
Distributed Operations

Distributed Operations Deployment

- Small teams deployed into different geographic locales.
- Maneuver warfare.
- Operate independently.
- Increased speed of command
- Treatment facilities can move with troops or be stationed at some distance away.
- Medical logistics issues



Distributed Operations Deployment



Overview

Problem

- Ensure effective of medical care to the war fighter in a Distributed Operations Deployment.

Objective

- Make an assessment of a Marine Expeditionary Unit in a complex and distributed environment both with and without a Forward Resuscitative Surgical System (FRSS), then conduct a comparative analysis in terms of patient outcomes and resource utilization.

Approach

- Use Tactical Medical Logistics Planning Tool (TML+)
- Use Sea Viking's DO CONOPS using a MEU and a FRSS
- Define cases, metrics, and assumptions
- Iterative Process
 - Develop Cases for 1x casualty stream
 - Run Cases in TML+
 - Analyze Results
 - Revise as necessary
- Repeat above with 2x, 3x, ... casualty streams until reach breaking point

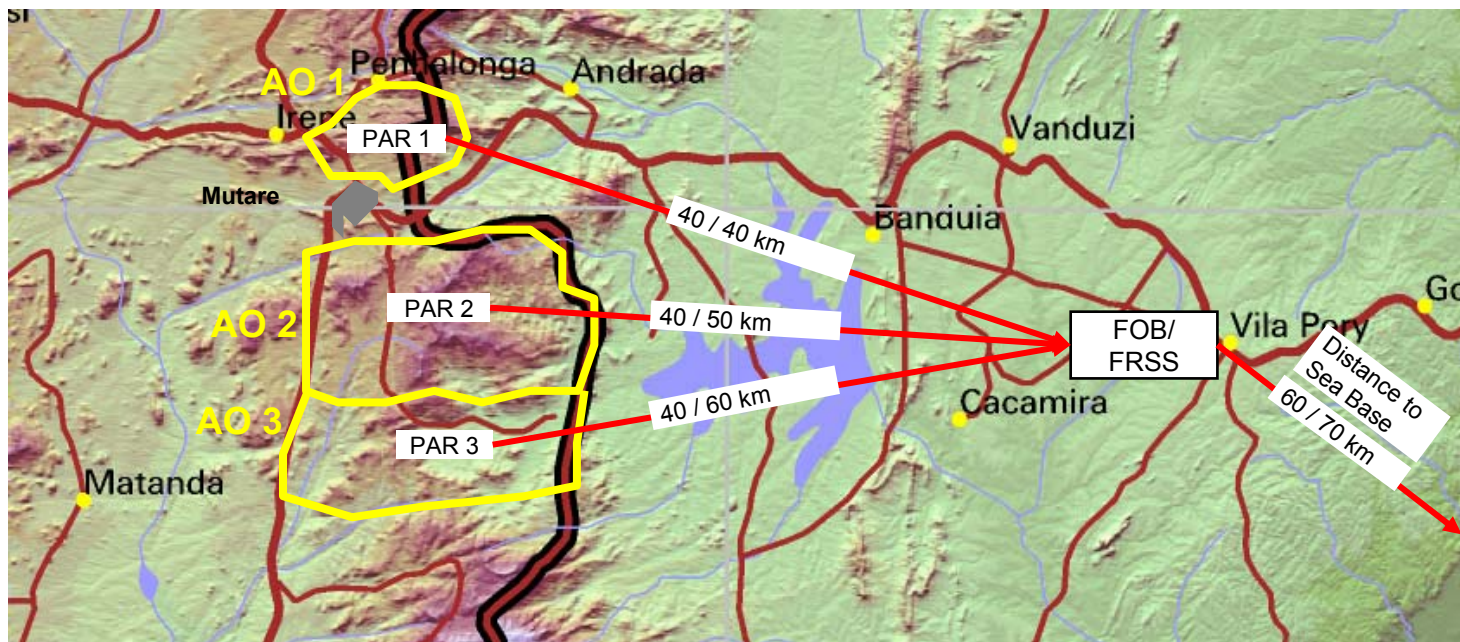
Results

- Analysis showed a direct relationship between the time a casualty reaches a facility for first surgery and the number of casualties who die of their wounds.

CONOPS

Use Sea Viking's Distributive Operation CONOPS using a MEU

- East Africa region in the year 2008
- Insurgents deploy in 30-45 man groups from a total population of 300-350
- USMC distributive operations deployment going against insurgents
- 3 Populations at Risk (PARs)
 - PAR 1 (228)
 - PAR 2 (222)
 - PAR 3 (287)
- Operate in 3 independent AOs
- A Forward Operating Base (FOB) has been established
- The scenario is of length 96 hours, but only a “slice of time” for overall operation



Casualty Estimation (1x)

AO	PAR	Total Days	Mean Number of			Mass Casualty Events WIA	Total
			WIA	DIS	NBI		
1	228	4	4.8	1.8	0.41	Mean of 3 casualties at 12 hrs Mean of 2 casualties at 56 hrs	12.0
2	222	3	3.7	1.3	0.30	4 at 80 hrs (mean of 1 casualty every 15 min)	9.4
3	287	2	3.2	1.1	0.26	Mean of 2 casualties at 56.2 hrs	6.6
Total			11.7	4.3	0.98	11.0	28.0

- All mass casualties will be life-threatening
- Rates based on the NHRC casualty estimation tool FORECAS
 - FORECAS projections are based on medical *admission* rates
 - Conversion formulas from admissions to occurrences based on OIF-1 data
 - Total WIAs = 1.18*WIA + WIA
 - Total DNBI = 2.5*DNBI + DNBI
- Patient condition (PC) code distribution determined from the NHRC tool PCOF

Baseline Case and Alternatives

	AO 100 km from ARG			AO 200 km from ARG		
	1X	2X	...	1X	2X	...
No FRSS	A1^x	A1^{2x}	A1...	B1^x	B1^{2x}	B1...
FRSS at FOB	A2^x	A2^{2x}	A2...	B2^x	B2^{2x}	B2...
FRSS near AO	A3^x	A3^{2x}	A3...	B3^x	B3^{2x}	B3...

All x cases use standard casualty rate

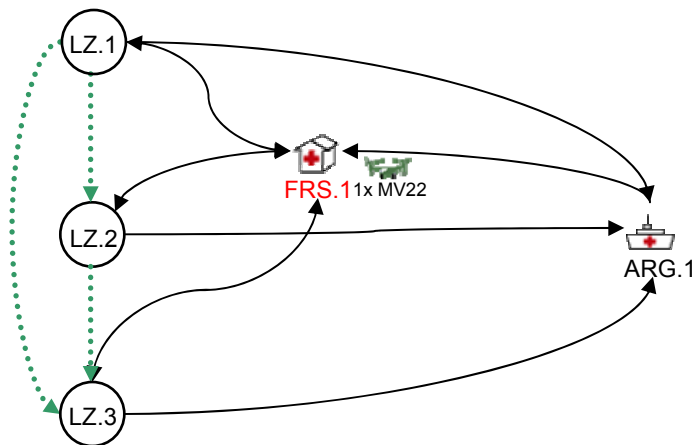
All 2x cases use a doubled casualty rate

Continue casualty multiplier until reach breaking point

A1^x will be the Baseline case.

Assumptions

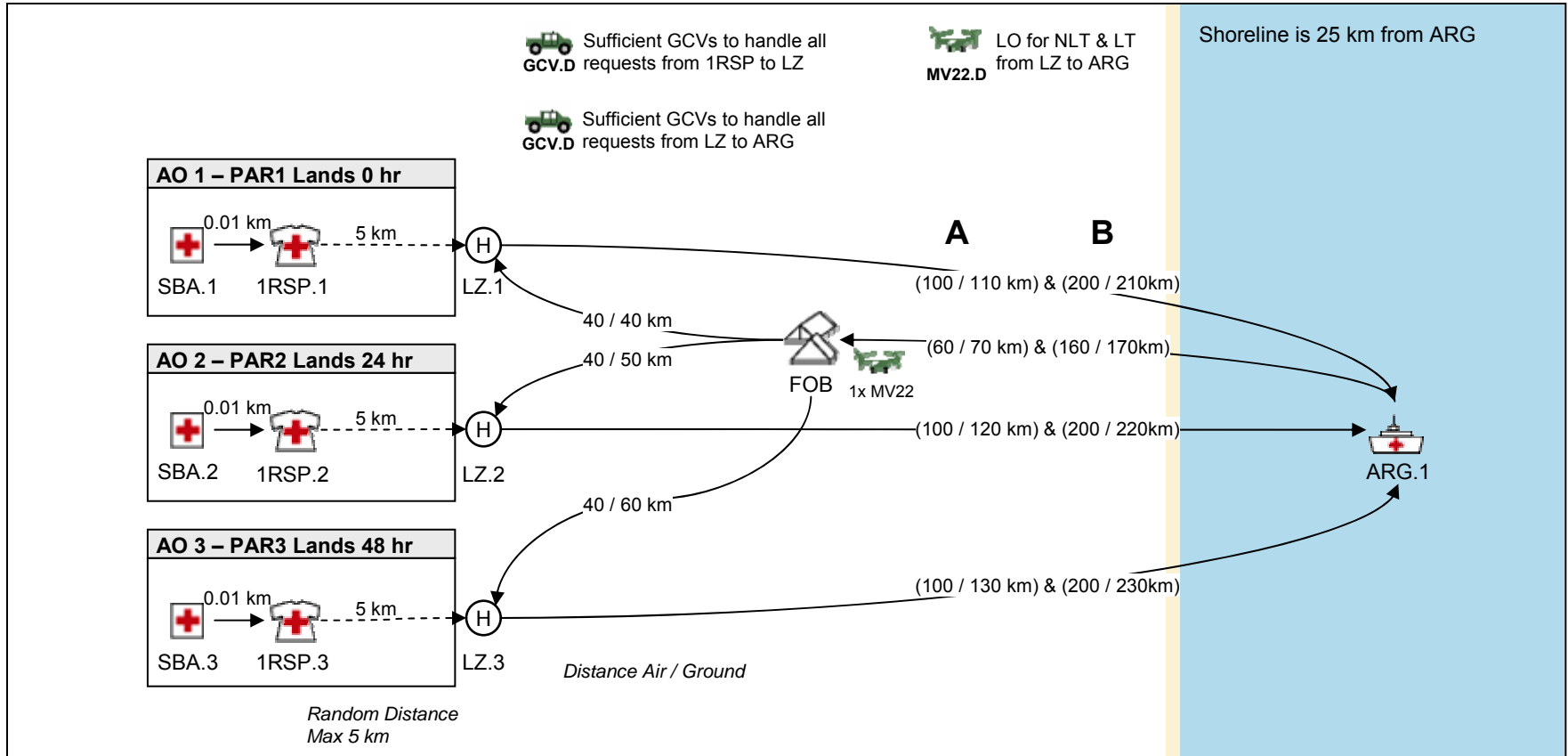
- Assume “trauma” patient means life-threatening (LT). These casualties have injuries that have a risk of death associated with them (high, medium, or low). Most, but not all, of these injuries require surgery. They have a higher priority for care than non-life threatening injuries.
- Each AO has 1 corpsman per 12 people (PAR1-19, PAR2-19, PAR3-24)
 - These corpsmen aid all casualties (to include casualties from the mass casualty events)
- The distance to the LZ from the 1RSP is a random uniform distribution on the interval 0-5 km.
- Sufficient Ground Combat Vehicles (GCVs) are available to handle all requests from 1RSP to LZ.
 - GCV may transport 2 ambulatory or 1 litter. Corpsman will go with casualty.
- One Designated MV-22 is located at FOB.
 - MV-22 makes diverted flight routes for pick-ups. May pick up at two LZs before going to destination.
- Non-designated aircraft (or lift of opportunity aircraft) are MV-22s (Sufficient MV-22s to handle all requests).
- Distance from LZ to ARG includes enough time for casualty to take LCAC from FOB to ARG.
- Non-life threatening:
 - Non-designated aircraft to ARG unless designated MV-22 en route and space available.



GCV's	
Request	Pickup
20%	2 min
20%	4 min
20%	6 min
20%	8 min
20%	10 min

Lift of opportunity MV22's	
Request	Pickup
10%	30 min
15%	45 min
15%	1 hr
10%	1.5 hr
10%	2.0 hr
10%	3.0 hr
10%	4.0 hr
10%	5.0 hr
10%	6.0 hr

No FRSS Cases (A1 and B1)



Route from 1RSP to LZ

- Sufficient GCVs to handle all requests from 1RSP to LZ
 - 40 kph / 2 amb & 1 litter / 0 wait time

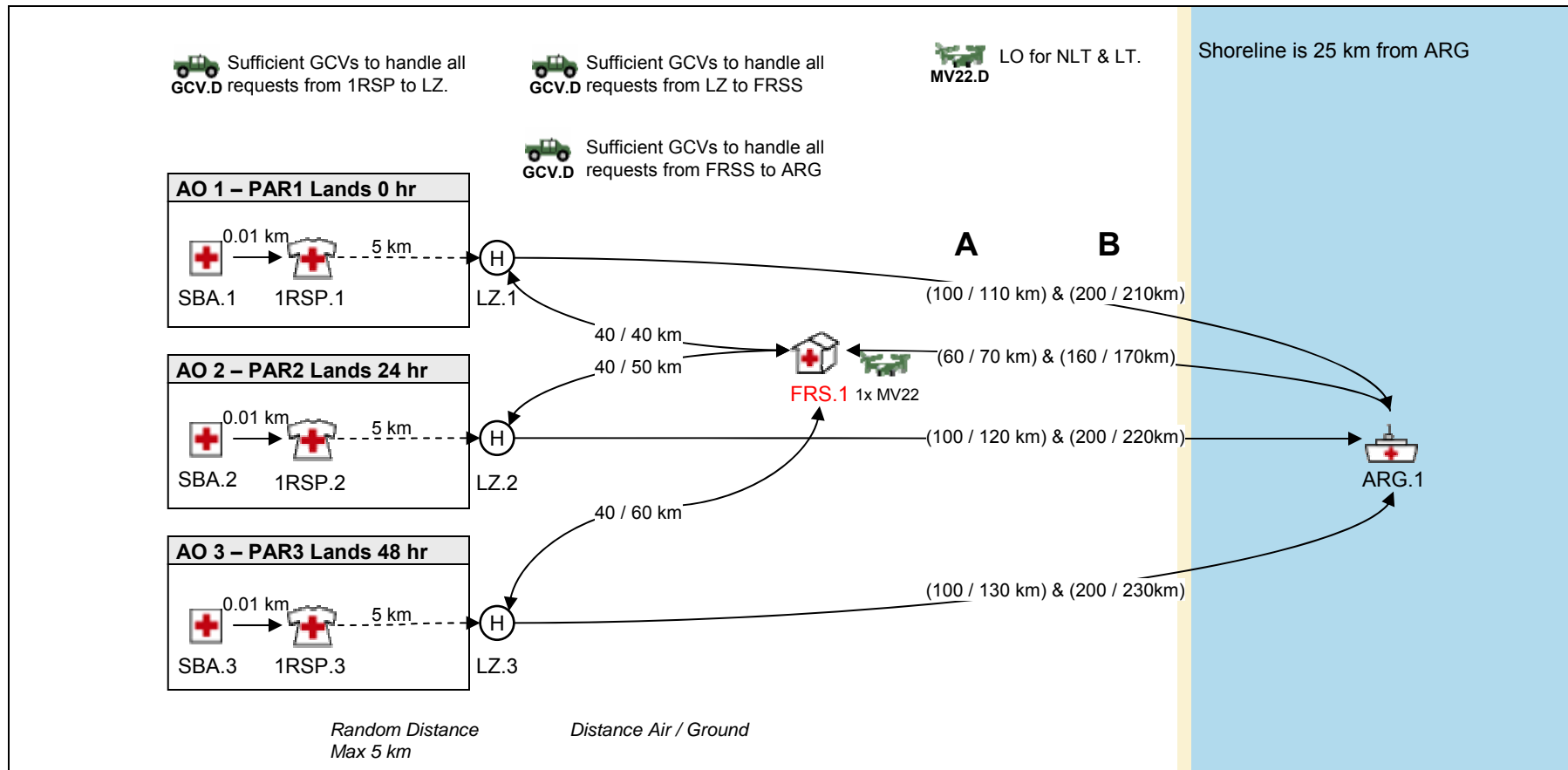
Route from LZ to ARG

- Priority of Life-Threatening:
 - Designated MV-22 from LZ to ARG
 - Lift of opportunity (LO) aircraft from LZ to ARG (no care)
- Priority of Non-life threatening:
 - Designated MV-22 from LZ to ARG (if already en route and space available, but may not request)
 - LO aircraft from LZ to ARG

Transportation Assets available:

- 1 Designated MV-22 (CASEVAC care with 2 corpsmen)
 - Based at FOB
 - May take diverted flight route
 - 12 amb & 6 litter / 15 min pre-mission / 0 wait time
- Sufficient LO MV-22s (no care)
 - 12 amb & 6 litter / 0 wait time
- Sufficient GCVs to handle all requests from LZ to ARG.
 - 50 kph / 4 amb & 2 litter / 0 wait time

FRSS at FOB Cases (A2 & B2)



Overview

- Same as No FRSS case except:
 - FRSS is available at the FOB at time 0 hr.
 - All FRSS and SC OR PCs go to the FRSS (imperfect triage).
 - Designated MV-22 has ERCS packages.

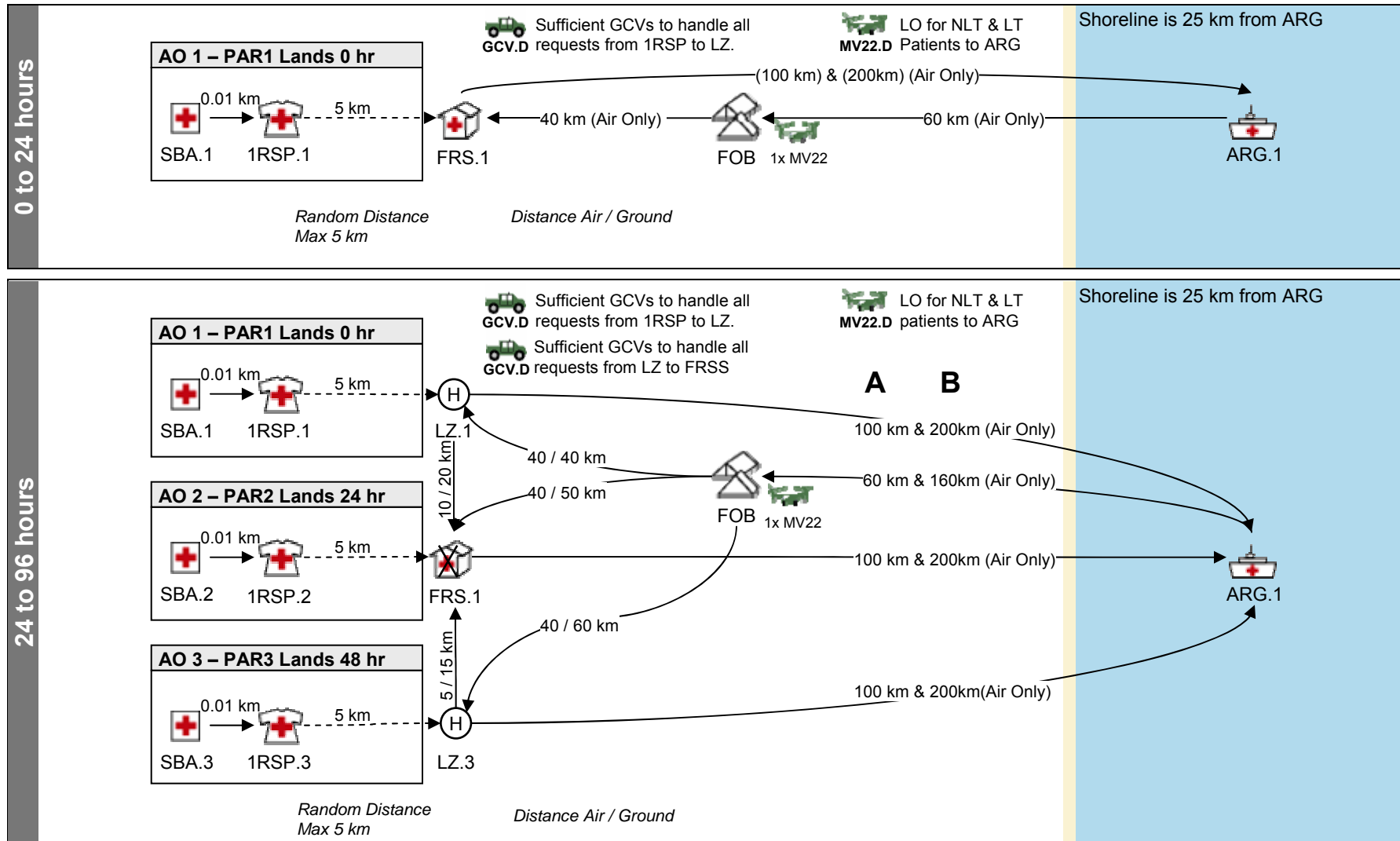
Route from LZ to FRSS

- Priority of Life-Threatening:
 - “Air Transport” means try Designated MV-22 first, if not available, try divert aircraft.

Route from FRSS to ARG

- Priority of Life-Threatening:
 - Designated MV-22 only.

FRSS at AO Cases (A3 & B3)



Overview

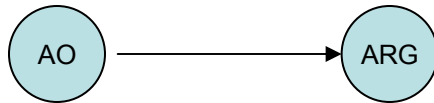
- Same as FRSS at FOB case except:
 - FRSS is available at AO1 from time 0 to time 24.
 - FRSS is available at AO2 from time 28 to time 96.

Route from LZ to FRSS

- Priority of Life-Threatening:
 - Sufficient GCVs to handle all requests from LZ to FRSS.
 - 50 kph / 4 amb & 2 litter / 0 wait time
 - If FRSS closed, air transport to ARG.

Simplified Transportation Rules

No FRSS



All Cases

LT take designated MV-22 if possible.

LT may take divert air if space available, but may not request.

No FRSS

LT Casualties go directly to the ARG for 1st surgery

FRSS located at FOB

FRSS always available

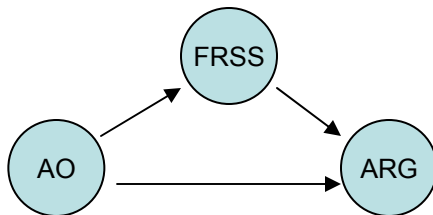
LT Casualties either go to FRSS or ARG for 1st surgery

FRSS located at AO

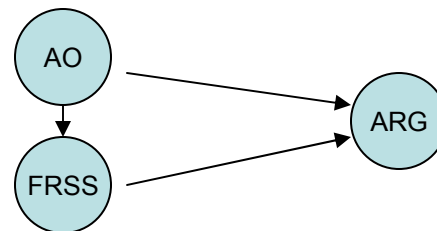
FRSS unavailable from hours 24 thru 28

LT Casualties either go to the FRSS or ARG for 1st surgery

FRSS at FOB Always available

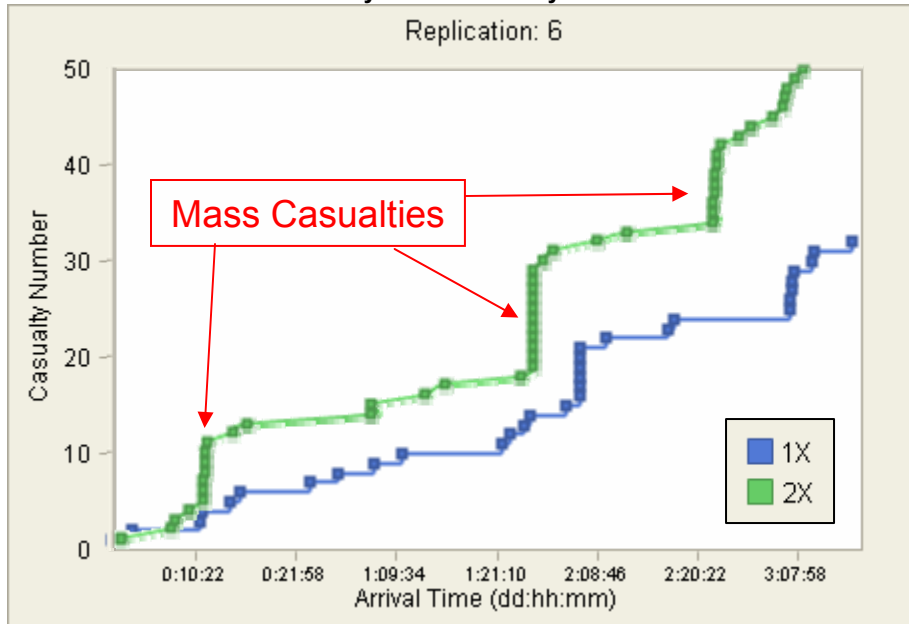


FRSS at AO Unavailable from hr 24-28



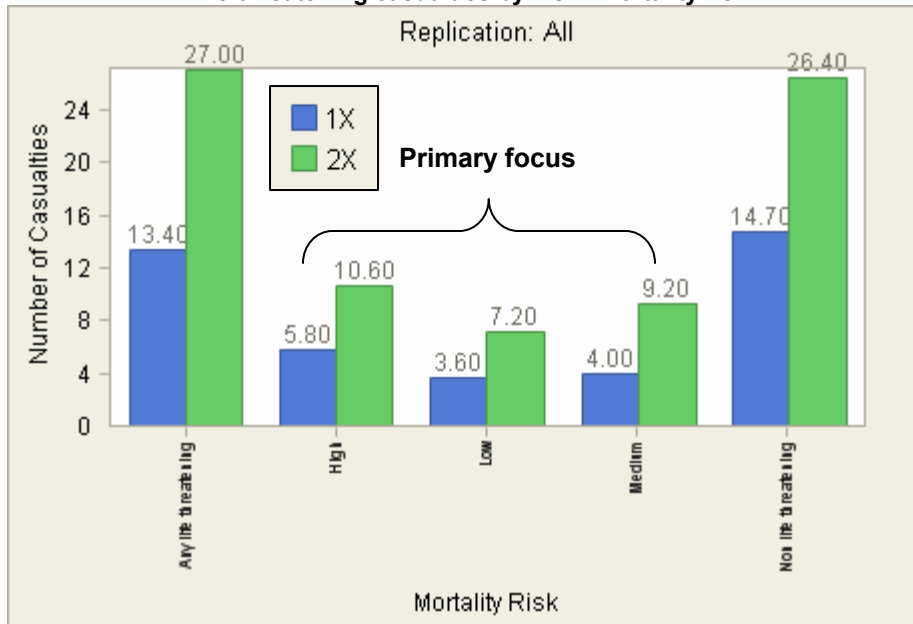
Casualty Estimations – All Cases

Casualty occurrences by time

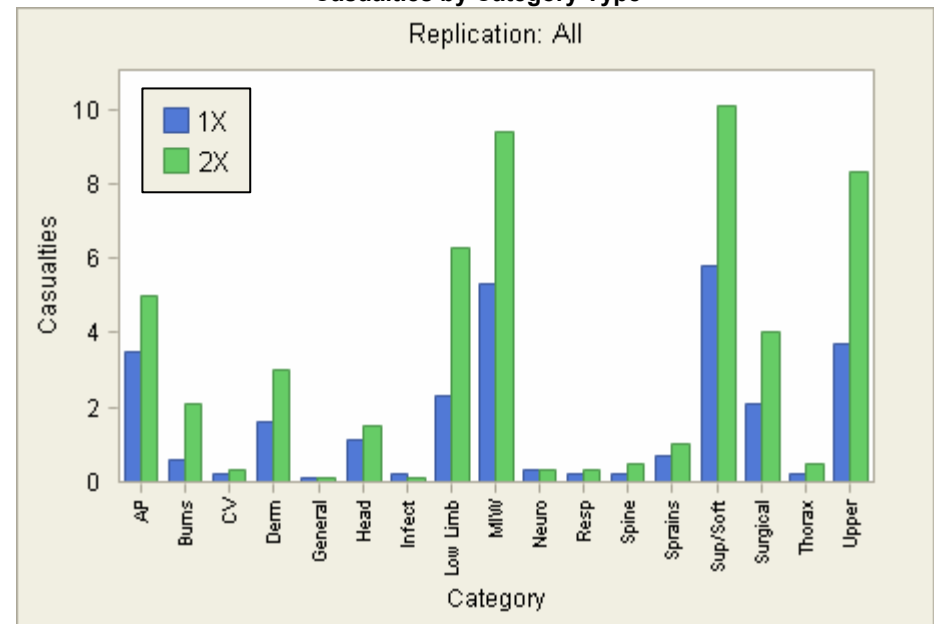


- 4 Mass Casualty events
 - 2 for PAR 1 (12 hrs and 56 hrs)
 - 1 for PAR 2 (80-81 hrs)
 - 1 for PAR 3 (56 hrs)
- Casualty Types (1x)
 - Average of 28 casualties (min 16 and max 45)
 - Average of about 14 casualties are life threatening; 42% of these have high risk of mortality.
 - About 54% of all casualties are superficial/soft tissue injuries, multiple injury wounds, or upper limb injuries.
- Casualty Types (2x)
 - Average of 56 casualties (min 39 and max 77)
 - Average of about 27 casualties are life threatening; 40% of these have high risk of mortality.
 - About 40% of all casualties are superficial/soft tissue injuries.

Life-threatening casualties by DOW mortality risk

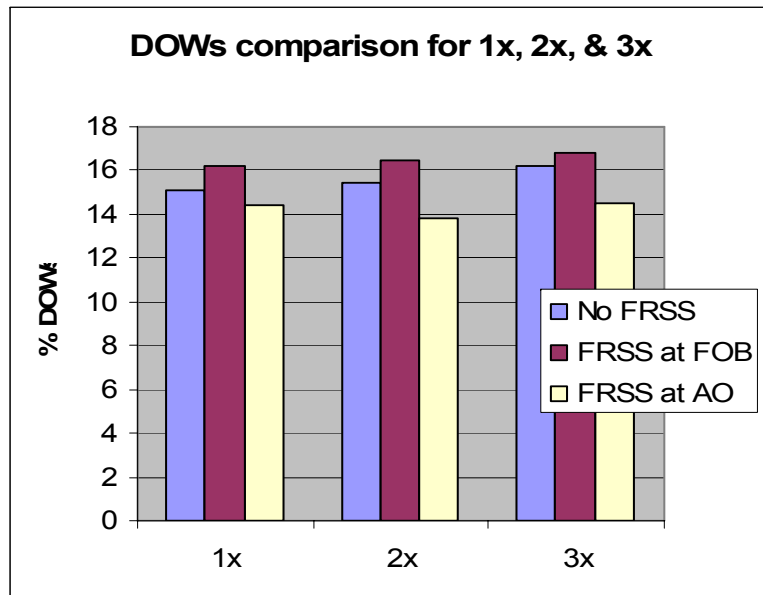


Casualties by Category Type



Time to 1st Surgery Relative to DOWs – 100 km from ARG

- Providing an FRSS at the AO reduces DOWs
 - Distance to FRSS is less
 - LO Ground is much quicker than MV-22 or LO air
- As more injuries occur, providing an FRSS at the AO becomes more important.
- Providing an FRSS at the FOB, results in higher DOWs than no FRSS for 1x, 2x, 3x.
 - Sharing and MV-22 is taxing and causes more LT casualties to rely on LO air or transport to the ARG.



- **% casualties treated at FRSS** = the % of LT casualties that should have been treated at the FRSS and were.
- **Avg time to 1st surgery** = Time from injury until time surgery begins. This includes time spent at 1RSP, travel time to LZ, wait time for transport & travel time to FRSS or ARG.
- **DOW (%)** = the % of casualties that died after some sort of treatment.

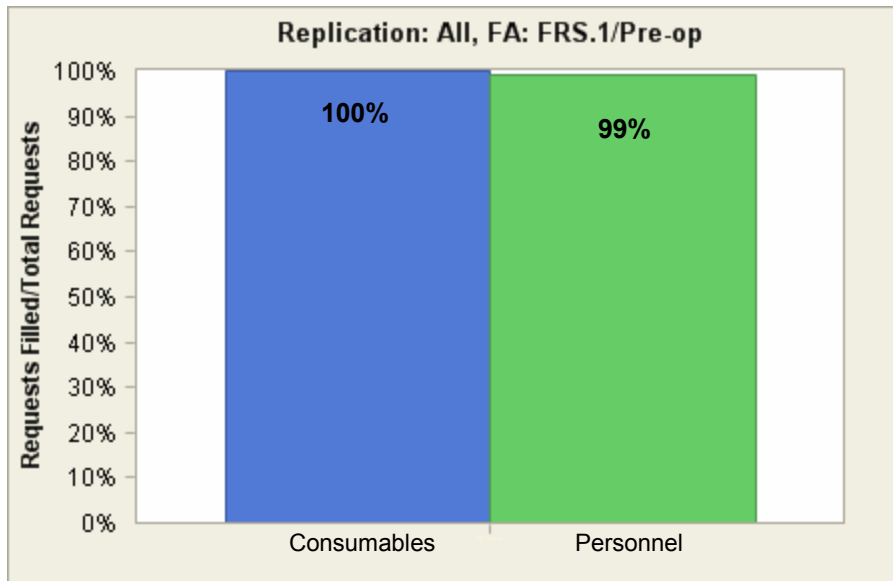
1X	No FRSS	FRSS at FOB	FRSS at AO
% casualties treated at FRSS	0%	97%	89%
Mean time to 1 st surgery at FRSS	0	93 min	67 min
Mean time to 1 st surgery at ARG	107 min	114 min	111 min
DOW (%)	15.1%	16.2%	14.4%

2X	No FRSS	FRSS at FOB	FRSS at AO
% casualties treated at FRSS	0%	87%	78%
Mean time to 1 st surgery at FRSS	0	105 min	68 min
Mean time to 1 st surgery at ARG	123 min	135 min	120 min
DOW (%)	15.4%	16.5%	13.8%

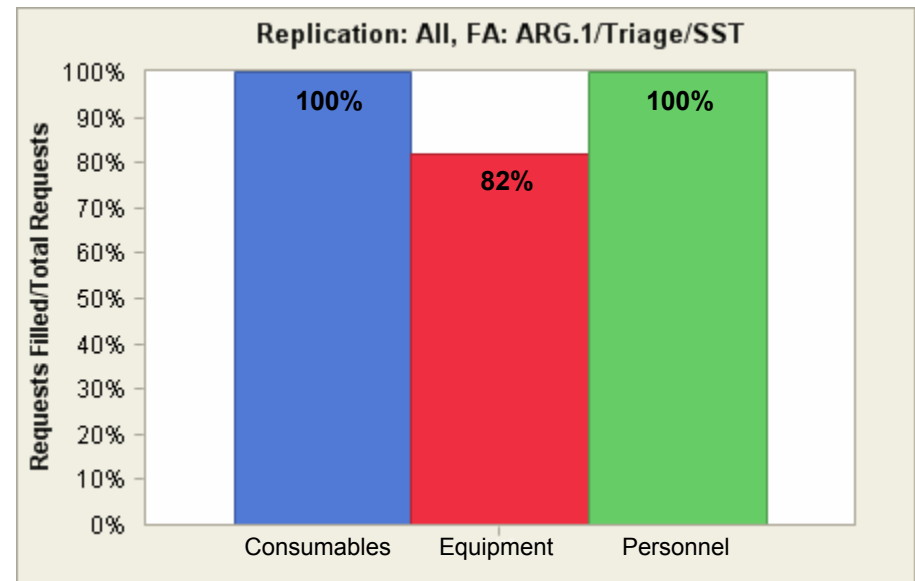
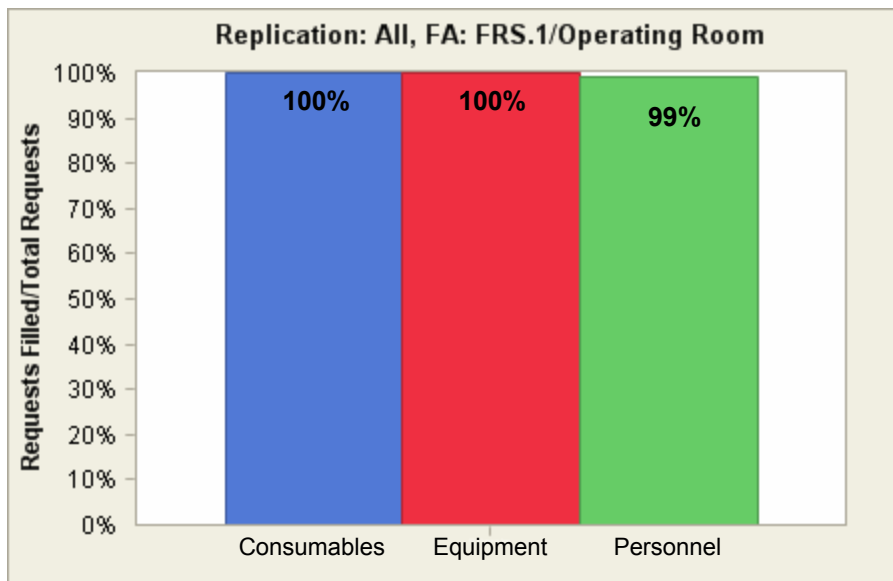
3X	No FRSS	FRSS at FOB	FRSS at AO
% casualties treated at FRSS	0%	78%	66%
Mean time to 1 st surgery at FRSS	0	115 min	68 min
Mean time to 1 st surgery at ARG	137 min	146 min	129 min
DOW (%)	16.2%	16.8%	14.5%

There is a direct correlation between time to 1st Surgery and DOWs.

Consumable, Personnel, & Equipment Effectiveness – All A Cases (3x)

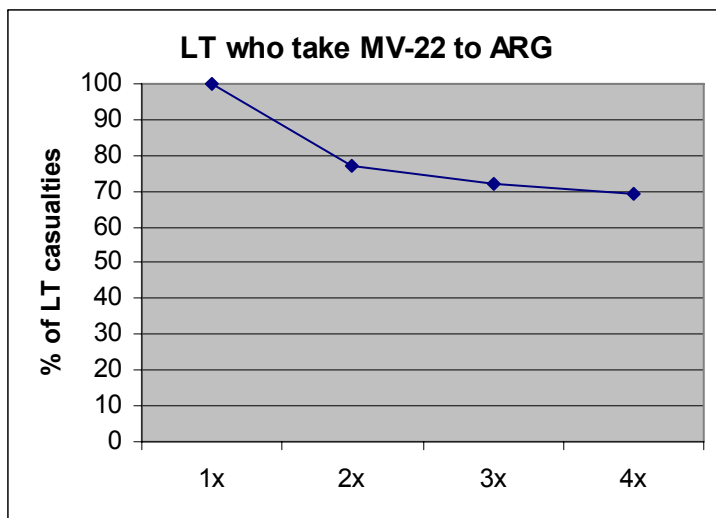


- “Effectiveness” is Requests Filled / Total Requests
- For 1x, 2x, & 3x runs, consumables were adequate for the FRSS and ARG.
- For 3x runs, casualties had a minimal wait for Personnel in FRSS/ Pre-op.
- Casualties began to wait for equipment once they reached the ARG.



**No significant delays due to personnel or equipment were observed.
Consumables appear sufficient for all cases.**

Transportation to Level 2 Care – FRSS at AO



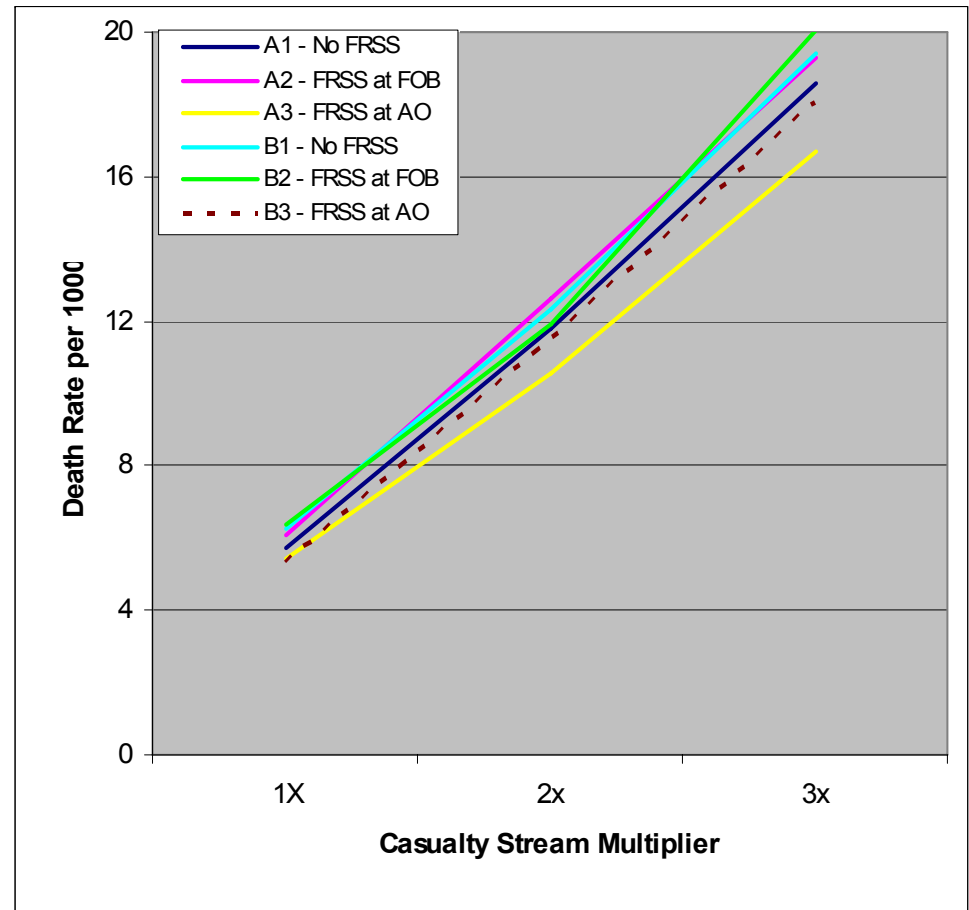
FRSS at AO	Time since injury
1x	111 min
2x	120 min
3x	129 min
4x	143 min

- The MV-22 transports casualties from the LZ directly to the ARG and from the FRSS to the ARG.
- As more casualties occur, more LT casualties must depend on LO aircraft for transportation.
- In the 1x case – 100% of the LT casualties who went directly to the ARG were transported by the designated MV-22 within 111 min of injury.
- In the 4x case – only 69% were transported by the designated MV-22. The fact that LT casualties must rely on LO aircraft for transport to the ARG increases the time to surgery. The average time since injury to surgery is 32 minutes longer than the 1x case.

Providing one designated MV-22 to transport LT casualties to the ARG is sufficient for 1x runs but must be assisted by LO aircraft for $\geq 2x$ runs.

DOW Summary

- **Providing an FRSS at the AO saves the most lives.**
- **An FRSS at the FOB with only one designated MV-22 provides no benefit over not having an FRSS.**
- **No FRSS at 100km from ship results in patient outcomes about the same as having an FRSS at the AO while being 200km from ship.**



Death Rate = Number DOW / 1000

Summary

- Problem: ensure effective medical care is provided to war fighters in a distributed operations deployment.
- Used TML+ to build baseline scenario and alternative COAs.
- Ran scenarios and analyzed information to learn:
 - How many casualties to expect and what kinds of injuries?
 - How many life threatening casualties might there be?
 - Does having a surgical capability at the FOB provide additional life saving capability?
 - Does having a surgical capability near the AOs provide additional life saving capability?
 - What are the time delays between injury to level 2 treatment?
 - Are the care providing assets (personnel, equipment, consumables) adequate?
 - Are the evacuation assets adequate?
- Information learned was shared with medical planners.

Questions?

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