

EMERGENCY MEDICINE FOR MANNED SUBORBITAL SPACE FLIGHT

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3RD IAASS CONFERENCE, ROME, ITALY
“Building a Safer Space Together”
21-23 OCTOBER 2008



INTRODUCTION

- Emergency medicine is defined as 'a medical specialty concerned with the care and treatment of acutely ill or injured patients who need immediate medical attention'
- Suborbital flights are flown up to and beyond the FAI 'limit of space' (100km).
- Trajectories do not complete one orbital revolution around the earth but the altitude attained is high enough to view the earth from space and also to experience microgravity for a short period.



INTRODUCTION, contd.

- Human space flight is inherently dangerous
- Study looks at emergency issues associated with human suborbital transport, considering their applicability to commercial providers.
- Aim is to minimize the inherent risk as much as possible.



INTRODUCTION, contd

- Medical screening,
- Selection and training,
- On-board medical capability (Kit),
- Emergency ground support,
- Telemedicine infrastructure
- Psychological issues
- Legal issues



HISTORY

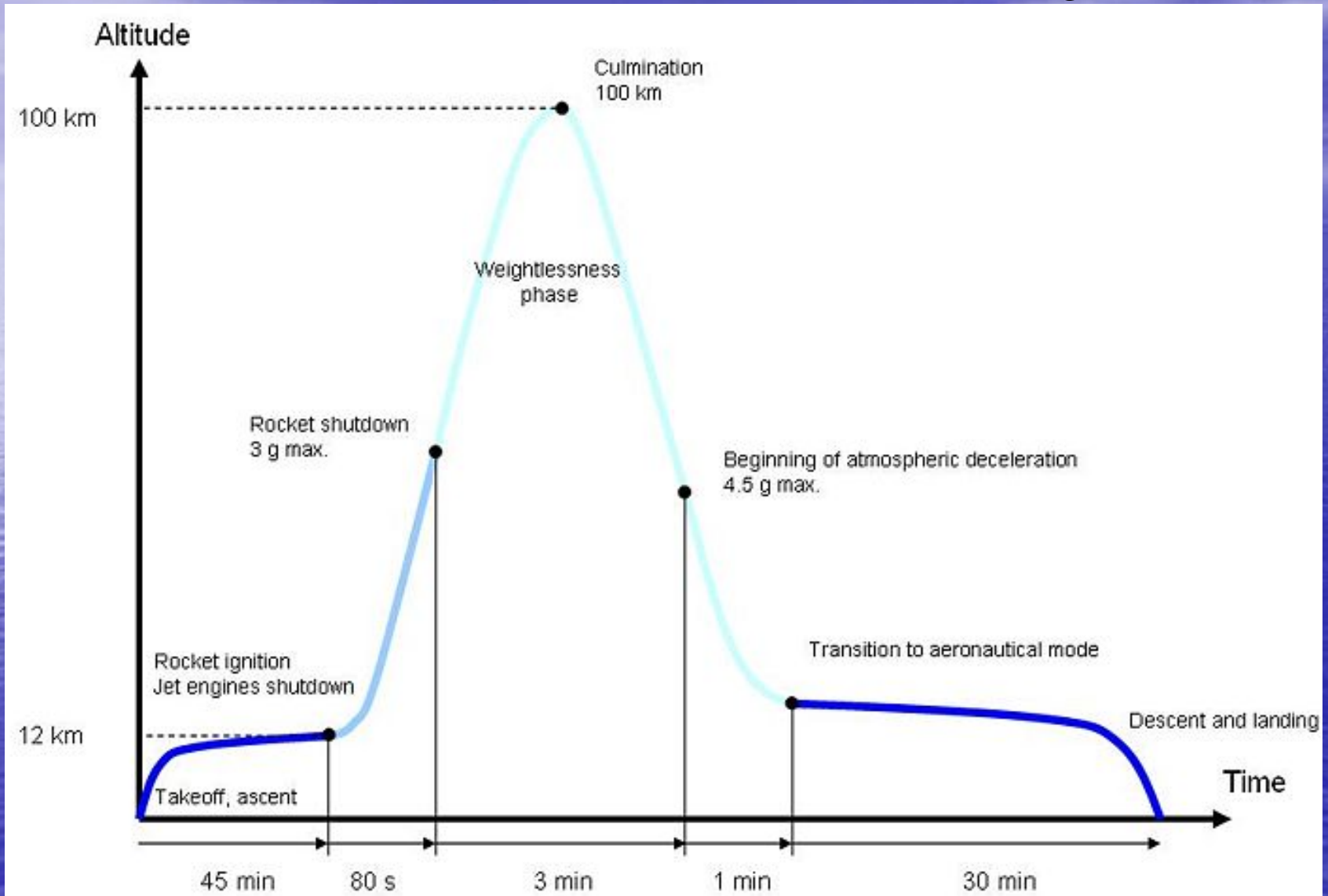
- Ultra-short space flight
- Mercury-Redstone 3 and 4
- X-15
- Spaceship One
- Spaceship Two
- Rocketplane XP
- EADS Astrium Space Tourism Project



Major Players

Company	Expected date of 1st flight	Cost of 1st flight per passenger	Number of minutes in microgravity
Virgin Galactic	Late 2009	\$200,000	45
EADS Astrium	2011	TBD	3
Rocketplane XP	2009	\$200,000	4

EADS Astrium Space Tourism Project



LITERATURE REVIEW

- AsMA Task Force on Space Travel 2001
- AsMA Space Passenger Task Force 2002
- FAA Notice of Proposed Rule Making (NPRM) 2005.
- FAA Final Rule: Human Space Flight Requirements for Crew and Space Flight Participants; Final Rule, (FAA 2006).
- Karim, A., 2005, *Taxi to the ISS- Medical guidelines for Space tourists with respect to gastrointestinal diseases.*



GAP ANALYSIS

1. These guidelines say very little on how medical conditions are expected to influence the training of SFPs.
2. What parts of the training procedure should be modified to accommodate the variety of prospective SFPs in case exceptions are granted?
3. What procedures would constitute adequate training exposure in terms of procedures such as rotating chairs, hypobaric chambers, parabolic flights, centrifuges, and which tests, and in what sequence should they be conducted?



GAP ANALYSIS, contd.

4. What form of clothing is considered appropriate for such flights? Would pressure suits (although cabins are assumed to be pressurized), G-suits or G-straps be necessary?
5. Would in-flight monitoring of patient physiological status be indicated because this would have an effect on bioinstrumentation and training?
6. How extensive should the screening procedure be to make it highly sensitive in detecting patients that may try to hide symptoms such as psychological problems e.g. claustrophobia?

GAP ANALYSIS, contd.

7. In terms of safety, would on-board entertainment, communication facilities, conveniences, meals and movement be appropriate for these flights?
8. In case a medical condition develops, who would be responsible for attending to the sick SFP? Would there be an onboard flight surgeon or would a flight crew member be trained to carry out such duties?
9. How much and what kind of onboard medical capability should there be?

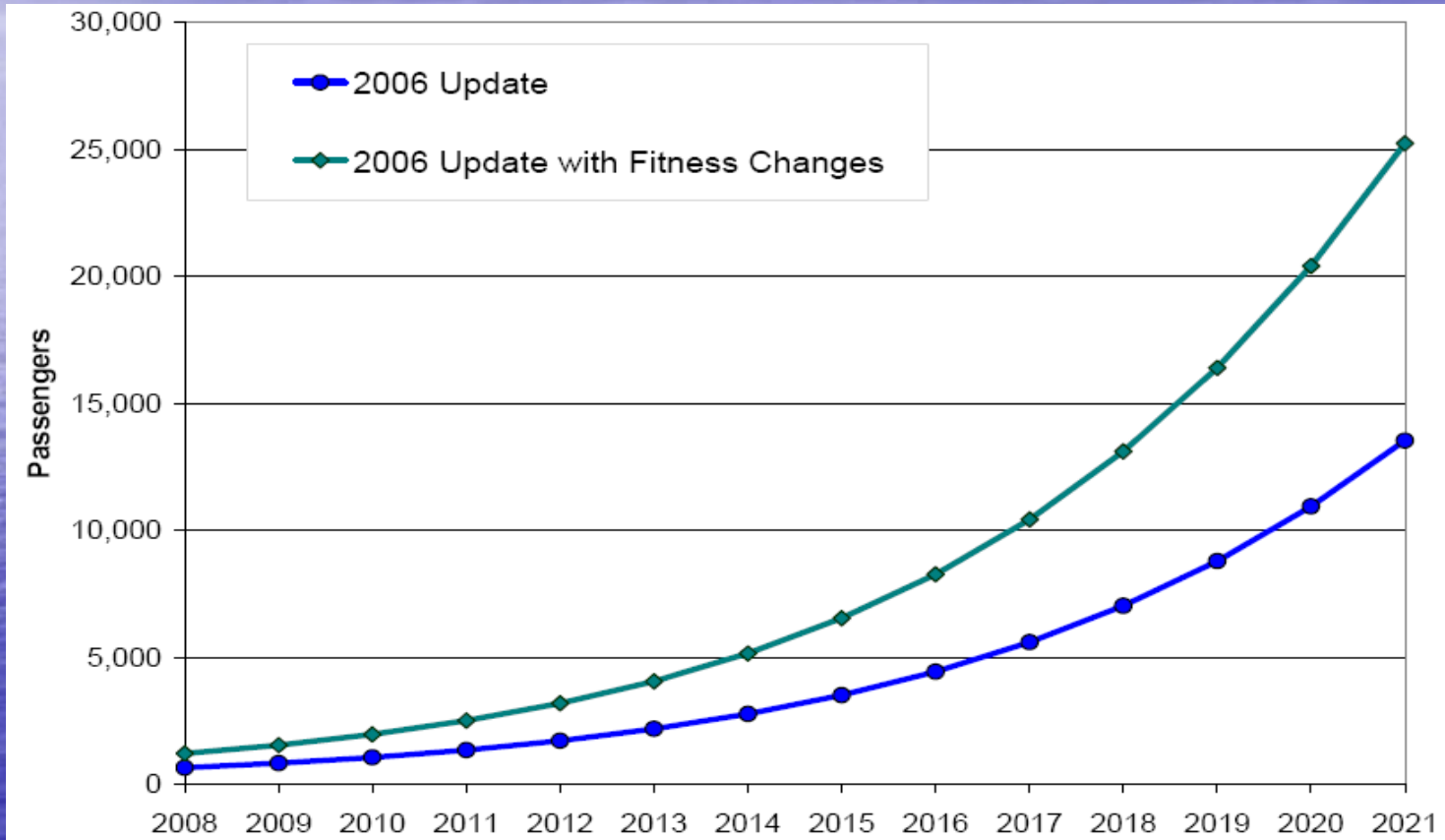


SELECTION

- Based on AsMA 2001 guidelines and Dr A. Karim's selection guidelines.
- FAA: ability to carry out emergency procedures, recommends an examination
- Minimum Age: legal age of responsibility
- Fitness rather than age
- Psychological fitness to rule out claustrophobia and panic disorders
- Aerospace Medicine practitioner and Psychologist or Psychiatrist.



FUTRON 2006 Projections



TRAINING

- Launch and entry forces (G-loads)
- Spatial disorientation and motion sickness
- Changes in atmospheric pressure, density and decreased partial pressure of oxygen
- Emergency egress and survivability
- Preceded by video demonstrations (CD)



DAY	PROCEDURE	HOURS
1	Medical history: select-out or proceed to in-depth examination. Physical examination and investigations.	1-2 hrs
2	-Training and Flight briefing- basic academic lectures on space and their upcoming flight, to include a tour of training facilities and space vehicle, conduct during spaceflight.	2 hrs
	-Lectures on the space environment, space flight and space operations (rockets, launchers, reusable launch vehicles, ground segments.	2 hrs
3	Rotating chair tests, Centrifuge training, hypobaric chambers	2 hrs
4	Emergency training: smoke, fire, loss of cabin pressure, accidental injury, cardiopulmonary conditions, loss of consciousness, vomiting, hypoxia, decompression sickness, breathlessness	4 hours
5	-Microgravity: Physical and biological science experiments in microgravity, Effects on the human body, Physical adaptation.	2 hrs
	-Introduction to life support systems and emergency exit procedures	1 hr
	-Performing your experiments in microgravity.	1 hr
	-Mock simulation of flight sequence	1 hr
6	Free Day. Light exercise	
7	Flight Day: pre-flight medical exam and briefing, premedication if indicated.	
	Main flight	
	Post-flight medical evaluation and discharge	
	Award ceremony and departure.	



ACADEMIC LECTURES

These would focus on:

- The physiology of space flight: altitude physiology, G loads and G-LOC
- Space and the space environment
- Microgravity: spatial disorientation/motion sickness
- Emergency situations: decompression sickness, hypoxia, vomiting, fire, smoke.
- Countermeasures: diet, Anti G straining manoeuvre (AGSM), preventing motion sickness, egress.
- Launch vehicles, space crafts and space operations.
- Activities in space: life in space, experiments in space, earth observation.



EMERGENCY TRAINING

- This should involve step by step information on what to do if there is an emergency.
- It should be noted that based on the duration of the flights and their likely flight profiles, it is not feasible that any serious medical intervention can occur inflight



SUDDEN LOSS OF CABIN PRESSURE

- The same procedure applies for hypoxia too.
- Immediate connection to the oxygen mask to ensure continued flow of oxygen to the body
- Pilot can either re-pressurize the space craft or descend his altitude
- Immediate attention to weak or incapacitated SFP, there might be a need to cancel the mission and get medical support on ground.



SMOKE OR FIRE

- Put on oxygen mask/goggles to prevent inhalational injury
- Attempt to locate source and extinguish or control it.
- Ensure continued ventilation of space craft in order to expel fumes.
- If severe, abort mission and return to ground.



TRAUMA/INJURY

- Emergency care: clean and bandage or use bandage as tourniquet if bleeding is severe (if a tourniquet is used, tourniquet time must be kept and the patient must be returned to ground immediately for medical attention).
- Stabilize for later treatment or return to ground if severe.



VOMITING

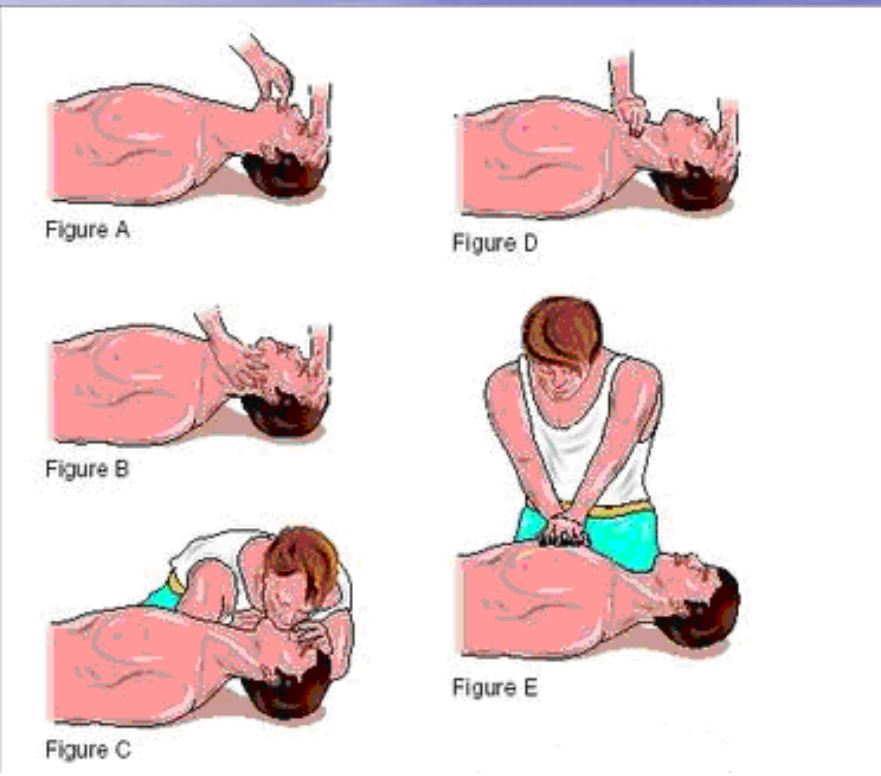
- This is best avoided by premedication with anti-emetics either for all SFPs or for those thought to be susceptible. An oral dose of 0.6mg scopolamine and 10mg d-amphetamine taken one hour before launch is helpful and has just minor side effects.
- Calm down the SFP, reassure and stabilize (emergency administration of anti-emetic drug may be necessary). Vomit bags should be made available.
- A trained person is best suited to handle emergencies.

CARDIOPULMONARY EMERGENCY

- Sudden breathlessness or loss of consciousness could be the presenting symptoms
- Perform basic life support (BLS), secure airway by positioning of head and neck and clearing of mouth and throat
- Ensure breathing by also administering oxygen through the airway
- Ensure circulation, make sure heart is beating, do cardiopulmonary resuscitation where necessary
- A trained person is best suited to handle emergencies such as these
- Return to ground for immediate advanced cardiac life support and other medical attention



Cardiopulmonary resuscitation (CPR) in basic life support (BLS)



- Figure A: The victim should be flat on his back and his mouth should be checked for debris.
- Figure B: If the victim is unconscious, open airway, lift neck, and tilt head back.
- Figure C: If victim is not breathing, begin artificial breathing with four quick full breaths.
- Figure D: Check for carotid pulse.
- Figure E: If pulse is absent, begin artificial circulation by depressing sternum.

OTHER ASPECTS

- Physiological Monitoring: smart vests
- Flight surgeon: on ground
- Ground medical support: doctors, nurses/paramedics, specialist facility
- Telemedicine Infrastructure
- G-suits or G straps
- Onboard Medical Kit
- Spacecraft design factors

TELEMEDICINE INFRASTRUCTURE

REQUIREMENTS FOR TELEMEDICINE INFRASTRUCTURE

Level of interactivity	Telemetry with command
Data acquisition	Physiological data e.g. heart rate, temperature, blood pressure etc. using a monitoring vest.
Data processing & storage	Onboard computer with text and graphic display, anomaly detection, alarm and data transfer to ground station.
Telecommunications links	A 128kps link is more than sufficient for all data, two-way voice and even one-way video communication.
Decision making	Flight surgeon
Command execution	Depends on the severity and the design of the mission.

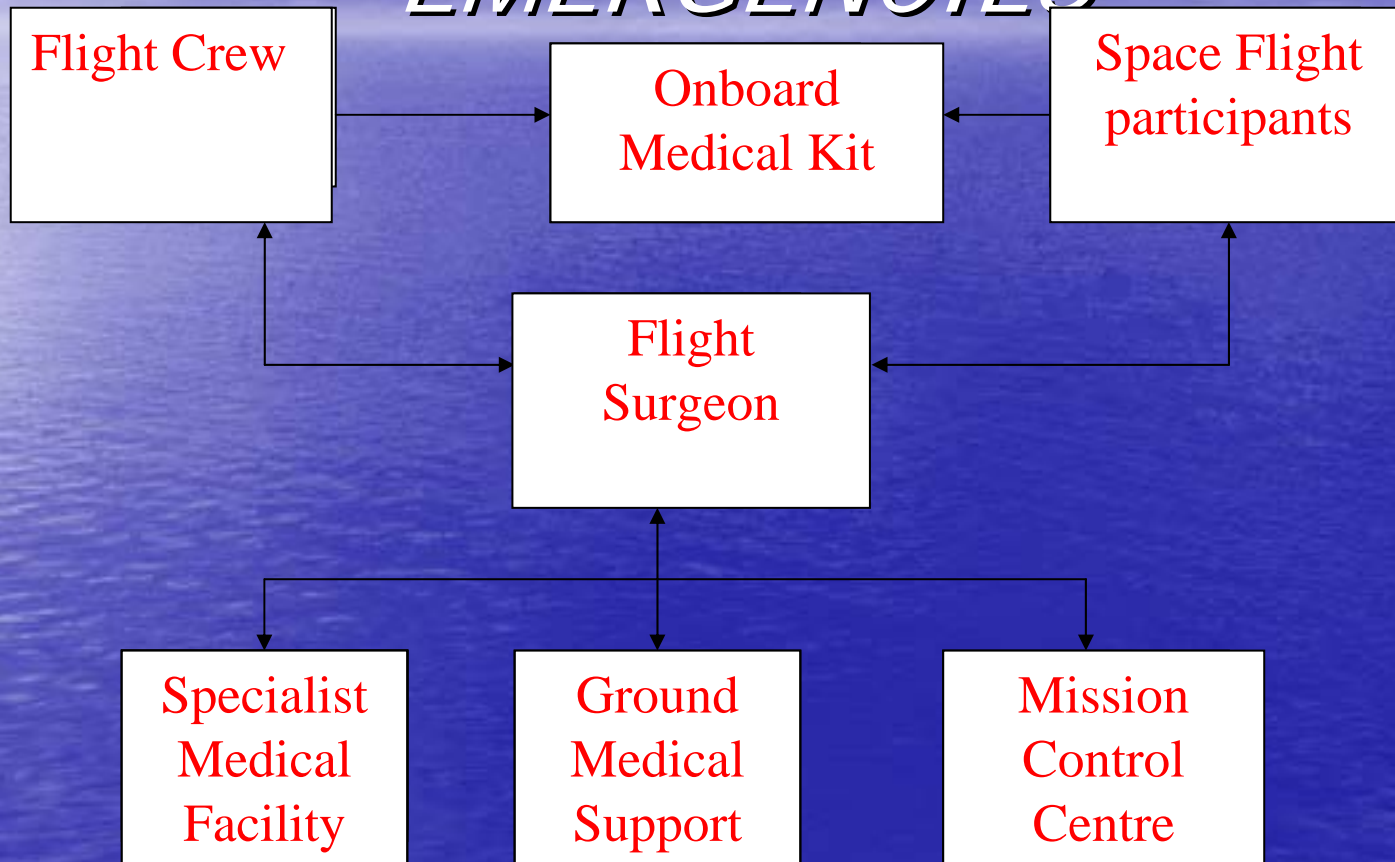
EMERGENCY MEDICAL KIT

PROPOSED EMERGENCY MEDICAL KIT.

Equipment	Gauze, alcohol sponges Antiseptic Blood pressure cuffs, sphygmomanometer, stethoscope
	Adhesive bandages, tourniquet Scissors and tweezers, gloves Manual resuscitation masks, CPR adapter
Recommended Drugs	Oro-pharyngeal airways Laryngoscope Acetaminophen
	Scopolamine Promethazine Amphetamine
	Morphine
	Dexamethasone Diphenhydramine Epinephrine Auto-Injector
	Nitroglycerin



FLOW OF TELEMEDICINE LINKS FOR MANAGEMENT OF MEDICAL EMERGENCIES



LEGAL ISSUES

- INFORMED CONSENT
- LIABILITY ISSUES
- INTELLECTUAL PROPERTY RIGHTS

INFORMED CONSENT

EMERGENCY MEDICAL CARE	State of available medical care facilities onboard, on ground and of specialist care within the vicinity of the 'spaceport'
	<p>Legal and cost implications of disqualification if the SFP is found to be unfit before the main flight, even if training has commenced, and consent to emergency care for the SFP in such situations.</p> <p>Quality of medical personnel and telemedicine infrastructure attached to the mission</p> <p>Consent to carry out any emergency procedure deemed necessary</p>
	All possible emergency procedures, their attendant risks and possible complications.
	<p>Consent to transfer to any medical facility</p> <p>Consent to allow any medical personnel at the spaceport and at any other facility to which SFP may be transferred to treat them</p> <p>Consent to have any medical intervention carried out on them by any medical personnel at such facilities.</p> <p>SFPs should state the individual(s) who will be responsible for making decisions on them if they become legally unfit to do so</p> <p>If there is no designated person, or the person cannot be reached consent be given to the operator to make all necessary decisions</p> <p>All costs for emergency medical care and all other complications will be borne by the SFP or his family irrespective of fault.</p>



CONCLUSION

- A review of regulatory guidelines and other related work to define the necessary selection criteria for the select-out process carried out in choosing SFPs
- Emphasis is laid on selection and training as preparatory aspects of emergency care
- Other issues relevant to medical support are also considered
- Laid a firm foundation for building a useful emergency medicine framework for commercial human suborbital space flights.



THANK YOU

QUESTIONS?

