Transferring Patients Throughout The World

What Is The Science?
What Are The Risks?
What Are The Costs?

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Risk Stratifying The Transfer of Patients
Topics

- Decision to transfer a patient - What are the medical risks?
  - Physiological Changes - Ground, Rotary, Fixed Wing
- Decision to transfer - Financial Risks
- Decision to place patient on Commercial Airline vs. Private Medical Plane
- Should we pay for higher level of care - Outcomes studies on transfer of patients?
Terms

- **Ground/Road Ambulance** - Transferring a patient in a regular ambulance with critical care capability
- **Rotary** - Transferring a patient in a medical helicopter
- **Fixed-Wing** - Transferring a patient in a medical plane with specialized equipment and personnel
- **Repatriation** - Transferring patients back to their own country/state or desired hospital/healthcare center
Levels of Evidence

Level I - Prospective Randomized Control Trials with superior statistical analysis
Level II - Observational Studies or Retrospective Studies
Level III - Case Reports or Case Series
Level IV - Opinion
Level MM - Experience
Accrediting Organizations for Transferring Patients (not standards)

- EURAMI - European Aeromedical Institute
- CAAMTS - Commission on Accreditation of Medical Transport Systems
- NAAMTA - National Accreditation Alliance Medical Transport Application
Comparison of Ground vs Helicopter

- Much Less Expensive
- Rigid Regulations
- Rigid Training Requirements
- Slow Transport

- Significant Cost
- Rigid Regulations
- Rigid Training Requirement
- Rapid Transport
...And now the science??
503 patients transferred to Tertiary Care Hospital

Comparison of Transfer from ICU or Transfer from ED in community hospitals

Group I-Intracranial Hemorrhage, Group II-Stroke, Group III-All others

Endpoint-mortality, Hospital Length of Stay, ICU Length of Stay

Significant mortality improvement in ED transfers/All LOS in Group II and Group III, NO difference in Group I

Ground vs. Rotary for Trauma Patients?

† Cochrane Review Updated in 2015. Comparison Ground vs Helicopter for Adult Trauma Patients

† Inclusion Criteria: Randomized, Non-randomized intervention, ISS>15  Age>16

† Included: 38 studies, all non-randomized

† Primary endpoint: Survival to discharge

282,000 patients in 38 studies-Too much heterogeneity to determine overall mortality

6 studies on TBI-No change in mortality

28 studies using multivariate regression mixed results with HEMS.

4 studies showed improved HEMS outcomes for trauma interfacility transport

“Due to the methodological weakness of the available literature, and the considerable heterogeneity of effects and study methodologies, we could not determine an accurate composite estimate of the benefit of HEMS.”

Which Is Better For Trauma-Ground or Rotary?

- Adult Trauma Patients in Japan. Comparison between Ground and Helicopter.
- Propensity Score Matching. Confounding variables controlled
- ISS>16
- 192 Hospitals 21,000 patients
- Significantly lower mortality of HEMS vs GEMS NNT 43
- Specifically falls, compression injuries, severe chest injuries, extremity (including pelvic) injuries, and traumatic arrest on arrival to the emergency department.

Ground EMS vs Rotary In Kids

- 166,000 patients  Propensity Matching for 25,700
- HEMS Associated with increased odds of survival
- No difference in disposition of survivors
- Children <=15
- All variables controlled

Cost-Effectiveness of Helicopters vs Ground

- Burn Patients transported with no airway issues <30% TBSA and no trauma
- LOS, Ventilator Days, Mortality
- Two years
- Patients matched for burns, age etc.
- Conclusion-Ground acceptable for <200 miles, no inhalation injuries and TBSA<30%
- Potential savings per year 12 million

J Burn Care Rehabil. 2000 Nov-Dec;21(6):535-40. Cost-effective use of helicopters for the transportation of patients with burn injuries. De Wing MD1, Curry T, Stephenson E, Palmieri T, Greenhalgh DG.
Time-Cost/Distance-Cost Effectiveness of Ground vs. Rotary vs. Fixed Wing (14)

- Prospective Study, Northern Sweden, Cost Effectiveness of three transport methods. Distance-Cost, Time-Cost analysis done

- Ground Ambulance Cost Effective for up to 155 Miles (250km) but not time

- Rotary-Most Expensive. Distance Effective for up to 310 miles (500 km)

- Fixed Wing Cost Effective for over 186 miles (310km) and time effective for over 310 miles

What Are The Risks Of Transferring Critical Children (4)

- 10 year retrospective review of 5609 critical children transferred in New Zealand

- No significant difference in risk adjusted mortality in cohort of transported vs nontransported.

- No difference in distance travelled, duration of travel (4.4hrs mean) or initial care/ICU level at referring center demonstrated and difference in risk adjusted mortality

- Critical children can be safely transport

- Children who were transported had 29 hours longer in PICU

Impact of Retrieval, Distance Traveled, and Referral Center on Outcomes in Unplanned Admissions to a National PICU. Katie Moynihan, MBBS, DCH, PGDipAeroRT1,2; Brent McSharry, MBBS, BSc, FCICM1; Peter Reed, Dphil3; David Buckley, BSc, MBChB, FCICM, FANZCA. eJediatr Crit Care Med 2016; 17:e34–e42)
Should Children Be Admitted And Transferred Or Transferred Directly? (2)

- Children <=18, Michigan Medicaid Program over 2 years who had interhospital transfers
- ED to referring center vs. ICU to referring centers
- All comorbidities controlled.
- LOS 13.5 days longer for ICU transfers

Cost-Effectiveness of Helicopter Transport

- Review of all studies on cost-effectiveness of HEMS
- Fifteen studies reviewed
- Five studies showed no benefit medically
- Eight Studies:
  - $3292 and $2227 per life year saved for trauma
  - $3258 per life saved and $7138 and $12,022 per quality adjusted life year for non-trauma

Ground Vs. Helicopter in Pediatric Trauma

- Children <=18 with Trauma
- Stratified Analysis ISS <15 or >15
- Propensity score matching and multivariate regression analysis
- Mortality = in ISS<15
- Mortality higher in grounds for ISS>15

Comparison of Helicopter Vs Fixed Wing

- More Expensive
- 100-200 MPH
- Longer Distances
- Minimal Pressure Changes
- Readily Available
- Rigid Regulations
- Strict Training Requirements
- Availability of Landing Zone

- Less Expensive
- 500 MPH
- Shorter Distances
- Pressure Changes
- More Limited Availability
- Very few Regulations
- Very Little Training Requirements
- Availability of Airport and transport to hospital
International Air Travel..What Are The Most Common Requests?

Two year retrospective analysis 2005-2007 on International Taiwanese patients

China to Taiwan

36 percent for Neurologic Emergencies

In-flight complications 10 percent for neurologic patients

In-flight complications 2 percent for non-neurologic patients

Risks of Air Medical (6)

- 4 year review of India Air Medical System for International and Fixed Wing.
- 586 patients-486 min mean flying time/patient
- 5.3 % complication rate (disconnection of leads, ventilator circuits, tubing issues.
- Overwhelmingly cardiac issues requiring transfer.

Air medical transportation in India: Our experience Himanshu Khurana, Yatin Mehta, Sunil Dubey Department of Anesthesia and Critical Care, Institute of Anesthesia and Critical Care, 1Emergency and Trauma, Medanta- The Medicity Hospital, Gurgaon, Haryana, India Journal of Anaesthesiology Clinical Pharmacology | July-September 2016 | Vol 32 | Issue 3
Cerebral Oxygenation Changes During Flight (7)

- In LA, 141 pediatric/neonatal transfer examining acceleration forces based on type of aircraft and patient positioning.
- 12 percent had physiologic deterioration
- Known—greater blood pooling when head is at read of plane and increased intracranial pressure. Head front leads to decreased cerebral oxygen pressure due to blood pooling in feet. And decreased venous return/cardiac output …but what are the physiologic consequences?
- Rs02—Regional infrared spectroscopy of cerebral oxygenation
- Drop in rs02 55% ground, 50 percent rotary 40 percent fixed wing
- NO difference in cerebral oxygenation between takeoff and landing

Is It Safe to Transport Ventilator Patients On Fixed Wing? (10)

- Eight Ventilator Patients. Case Series of Long-Term Vent patients
- Used both PTC and private charter planes
- One cardiac arrest-close to palliative care
- NO technical issues
- A few patients needed needs IVs
- Routine Blood Gases Used to determine oxygen changes

Does Obesity Increase Risk Of Transfer On Fixed Wings? (9)

Survey of all European Air Ambulance Companies on Obese patients. 79 percent response rate

21 percent of Air-Ambulances experience critical event from obesity

47% have SOPs

26% have extra personnel available.

Insurance Considerations for Fixed Wing Transport

руш Association of AirMedical Services Guidelines

руш Aams.org

руш One page document on insurance consideration for Fixed Wing.............................and it says..............not much

руш Medical Necessity is important

руш Transfer letter required before flight permits issued
Physiology Of Air Travel

- Travelling at 40,000 feet- Pressurized Cabin to 8000 feet
- It's not the pressure it’s the volume
- Patients At Risk……
  - Intracranial bleeds
  - Pneumothorax
  - Indwelling catheters...foley
  - DVT/PE/Thrombus
  - Bowel Obstruction/appendicitis/inflammatory bowel disease
DVT in Flight-Risk, Prophylaxis and The Science

- Economy Class Syndrome or Travelers Thrombosis

- Increased risk secondary to
  - Dehydration, immobility, compression of popliteal vein, low humidity, low oxygen levels and low cabin pressure results in increased viscosity
  - Elevation of thrombin levels (Schreijer et al, Netherlands)
    - Increased 223% in air vs 46% from immobility alone
DVT Risks (slide 2)

- www.airhealth.org (very critical of airline industry)
- 3-5% of air travelers develop clots
- Lonflit Studies
  - Compression Stockings-20 times less likely to develop DVT (4.5%)
  - Aspirin no effect on venous clots
- Business class travelers rate 4.5 percent
- Aisle Seats
- Tx-Hydration, compression stocking, anticoagulants
What about the patient who already has a DVT/PE/any thrombosis?

- The science says...........nothing
- Lovenox BID before take-off and on landing or two days before travel???
- INR therapeutic for seven days or one month??
- Oral agents (Xa inhibitors)?
How Much Oxygen Is Needed For Transport?

- D cylinder 1640 l
- 15 l/min
- $1640 / 15 = 109$ minutes = 1 hr 49 mins
How Does Pressure Change With Altitude?

[Diagram showing the relationship between pressure and altitude, with a graph indicating that 50% of the air lies below a certain altitude.]
Boyles Law-The Only One You Need To Remember!

For a fixed amount of an ideal gas kept at a fixed temperature, $P$ [pressure] and $V$ [volume] are inversely proportional (while one increases, the other decreases)
Air Spaces To Worry About
Fixed Wing Transport!

- Sinus, bowel, middle ear
- Pleural, head, lung. Bowel, air emboli, teeth
- Tube cuffs, IABP, drainage bags, air splints, ventilators
Solutions To Overcome Physiology Of Air Travel

♫ Fly lower
♫ 20,000 feet = ground level
♫ Plane goes slower
♫ More jet fuel burned
♫ More costly
## FLIGHT PHYSIOLOGY

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## $FiO_2$ REQUIRED AT ALTITUDE

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<th>$FiO_2$ (%) Required at Altitude to Maintain $p_aO_2 = 100$ mmHg</th>
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Temperature and Fixed Wing

Exposure

• Temperature decreases linearly by 2°C per 1000 ft up to ~ 35 000 ft (about -57°C)

• eg. sea level 16°C on a Winter’s day, 0°C at 8000 ft
Conclusions

- Very little good literature on best practice for patient transport

- Patients transported from a community hospital ED to an ICU will have shorter LOS and better outcomes

- Helicopter Transport has very little science as a best practice

- Fixed Wing can be less expensive and faster but not well regulated

- Cases must be reviewed by experience medical personnel to determine medical necessity and best method of transport. Ground vs. Rotary vs. fixed-wing
Questions?