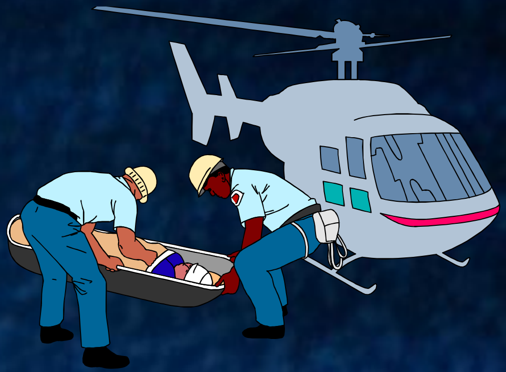


Transport of the Critically Ill Child in 2015

Allan de Caen MD FRCP

Pediatric Critical Care Medicine

Stollery Children's Hospital

Edmonton, Canada

Conflict of Interest Statement

- Medical Director of Stollery PICU Transport Team
- Co-Chair of CAPHC (National) Pediatric Interfacility Transport Steering Committee

No Financial COI

Objectives

- To review the literature supporting the role of pediatric critical care transport teams in stabilizing and transporting critically ill children
- To understand the infrastructure/ system supporting the air transport of children in Northern Alberta
- To understand how the transport care of children differs from in-hospital care
- To look to the future of pediatric transport

A 9 year old presents to a rural hospital with a history of fever, malaise, myalgias.

Upon ER presentation, the child appears mottled, is acting confused, and has moderately increased work of breathing.

Her ER vitals are T 39° C, HR 150, BP 70/50, RR 35, and a RA 02 saturation of 89%.

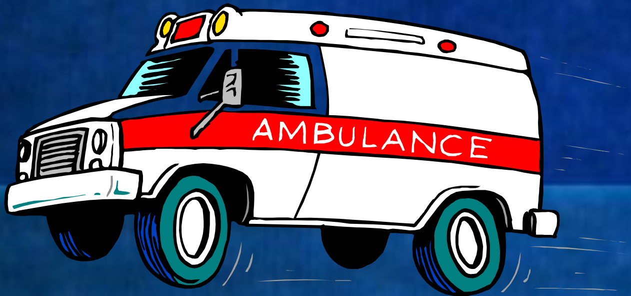
The referral hospital recognizes that her medical care will ultimately require tertiary care admission.

Pediatric Transport Medicine

- Care of critically ill/ traumatized children is best provided in a pediatric tertiary care environment

Pearson, Lancet, 1997

- Regionalized health care has lead to geographically limited pediatric tertiary care expertise



Children are spread over a large geographical area

- Over 60 referring centers in North/ Central Alberta with an catchment population of ~1.5 million
- Only 3 ‘rural’ Northern referring centers with pediatricians/ anesthetists/ EM
- Long transport times/ long distances

Pediatric Transport: Weighing Priorities

Referring Hospital

- limited MD/ RN resources
- limited technical skills/ experience
- limited equipment

Accepting Hospital

- MD/ RN resources
- abundant technical skills/ experience
- limitless equipment

Does transporting sick children contribute to morbidity?

Kanter, Pediatrics, 1992; Edge, CCM, 1994

- Transport may lead to adverse events
- Sicker patients (as defined by PRISM score) are at greater risk of adverse events
- The incidence of physiologic deterioration, as well as ICU-related adverse events, are directly related to transport distances and times

Who should transport the patient?

- Referral hospital/ regional team (MD/ RN/ Medic)
  - Removing local resources
  - Do they have setting specific cognitive and technical skills/ equipment?
- ALS/ adult critical care flight team
  - Predominantly adult-focused
  - Limited (non-trauma) pediatric experience
- Pediatric critical care
  - Best option for critically ill child (↓ mortality)
  - Limited resource
  - Prolonged time to patient bedside (av. 90-120 min)

Pediatric Transport Medicine

- Of all patients transported by local transport teams and critical care inter-hospital transport teams, less than 10% are children
- 800/ 9000 air medical evacuations in Alberta annually are pediatric

Alberta statistics, 2014

Does using specialized pediatric transport personnel reduce morbidity/ mortality?

Edge, CCM, 1994

- The use of specialized pediatric transport teams reduce patient complications during transport

Does using specialized pediatric transport personnel reduce morbidity/ mortality?

McNabb, J Trauma, 1991

	ALS	ALS (peds)	PICU
# tpts	34	44	52
# insults *(% total)*	64 (*72*)	18 (*20*)	7 (*8*)
Av. insult/ call	1.9	0.4	0.13

Pediatric Specialized transport teams are associated with improved outcomes

Orr, Pediatrics, 2009

- Multivariate analysis showed a significant association between the use of non-specialized teams and:
  - Unplanned events during transport

(OR 245.5, CI 95% 75.73–796.38)

- Airway events
- Cardiac arrest
- Equipment failures leading to patient deterioration
- Sustained hypotension

- Illness adjusted-mortality

OR 3.47, CI 95% 2.30–5.24)

Effect of specialist retrieval teams on outcomes in children admitted to paediatric intensive care units in England and Wales: a retrospective cohort study

Ramnarayan, Lancet, 2011

- 57,997children ≤16 years consecutively admitted to 29 PICUs in UK over 4 years (2005-2008).
- Unplanned admissions from wards within the same hospital as the PICU compared with patients transported from other hospitals
  - 53% of unplanned admissions from other hospitals
  - Interhospital transfers by non-specialist and specialist teams
- *Multivariable analysis: use of specialist team for transfer associated with improved survival (0.58, CI 95% 0.39-0.87).*

Can we predict the transport medical needs/outcome of a patient by phone triage?

- Pediatric intensivist subjective assessment has a high sensitivity (0.98) but poor specificity (0.18)

  Rubenstein, Crit Care Med, 1992

- PRISM can predict outcome of a population of critically ill children that are transported to PICUs, but individuals fall out of the predictive model

  Kanter, Pediatrics, 1997

Can we predict the transport medical needs/outcome of a patient by phone triage?

McCloskey, 1990

- In 2-3% cases, need for a transport M.D. (advanced care) was underestimated by medical control MD
- In 25% of cases, need for MD overestimated

Cost of undertriage vs. overtriage may be measured in morbidity and mortality !

Can we predict the transport medical needs/outcome of a patient by phone triage?

- Age < 1 year is a significant risk factor for deterioration on transport, independent of the patient's measured acuity (PRISM)

Amin, Ped Emerg Care, 1991

- The need for a major intervention increases significantly if the patients are already intubated, and increase by a further factor of 2 if they are also < 1 yr age

McCloskey, Ped Emerg Care, 1992

How is the decision made as to what kind of team transports?

- Patient acuity (acuity scores vs. gut feeling)
- Age (<5 years age vs. adolescence)
- Distance to tertiary care center
- Disease specific
  - Expanding intracranial mass
  - Traumatic shock (refractory-only)
    - <5% ped trauma needs surgical intervention
    - Time to tertiary care support more important than time to trauma center
- Team availability

Never accept a step-down in care for your patient

Stay and Play vs. Scoop and Run

Golden Hour of Trauma: Cowley, 1973

- adult patients
- little / no airway management in the field
- study never validated
- trauma, not medical patients

- The "golden hour" is very rarely an issue with pediatric trauma care
  - ~5% of pediatric trauma needs surgical intervention in this golden hour

- *Time to tertiary level care* is more important than transport time to trauma center

Do Critical Care transport teams take longer to do their job?

- *Significant difference in stabilization times comparing kinds of transport teams*

ALS	0.44+/-0.15 hr
ALS (peds)	0.98+/-0.21 hr
PICU	1.24+/-0.34 hr

McNabb, J Trauma, 1991

Transport stabilization times for neonatal and pediatric patients prior to interfacility transfer

Whitfield, Children's Emergency Transport Service, Denver,1993

Pediatric Stabilization Times 1988-1990

All transports (n = 1106)

55 (10-419)

Ventilated (n = 157)

88 (18-419)

Ventilated with Inotropes (n = 13)

156 (55-419)

Effect of patient- and team-related factors on stabilization time during PIC transport
Borrows, PedsCCM, 2010

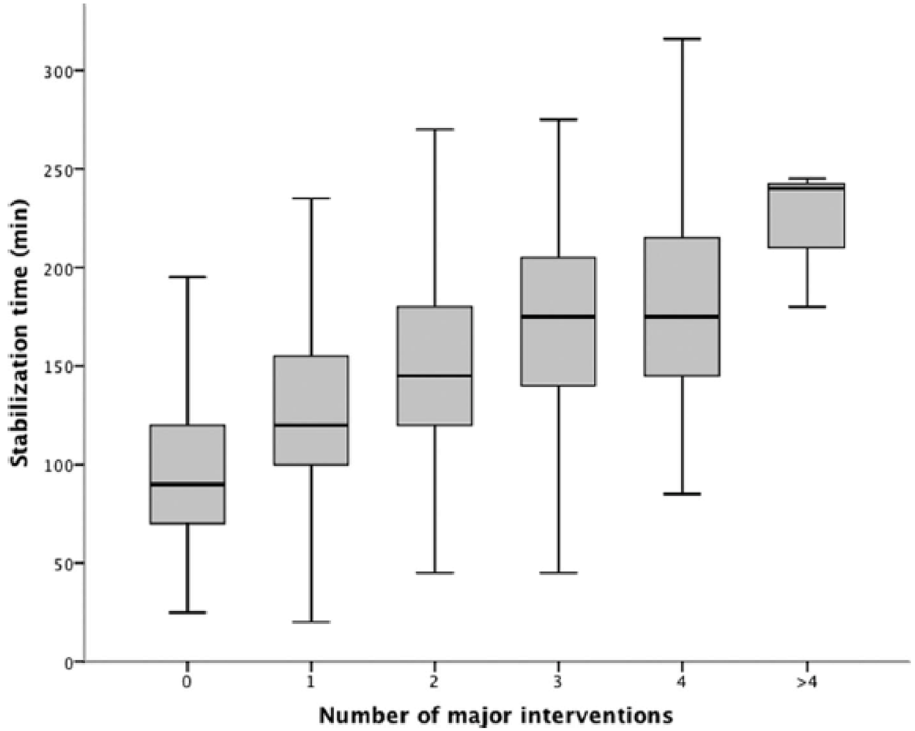


Figure 2. Changes in stabilization time with increasing number of major interventions performed during intensive care transport.

Independent effect on stabilization time:

- PIM2
- diagnostic category
- team response time
- number of major interventions performed

- Length of stabilization itself did not influence early mortality on the intensive care unit.

Medical Issues ‘Unique’ to Northern Transport

- Weather conditions
  - Take off and landing
    - Who makes the call?
  - Moose perils
  - Sliding onto a lake
  - Sliding sideways down a runway

Medical Issues ‘Unique’ to Northern Transport

Vehicular issues

- Time to de-ice
- Need for refueling
- Only certain planes can land in certain communities
  - Length of air-strips
  - Airstrips lit at night

Equipment

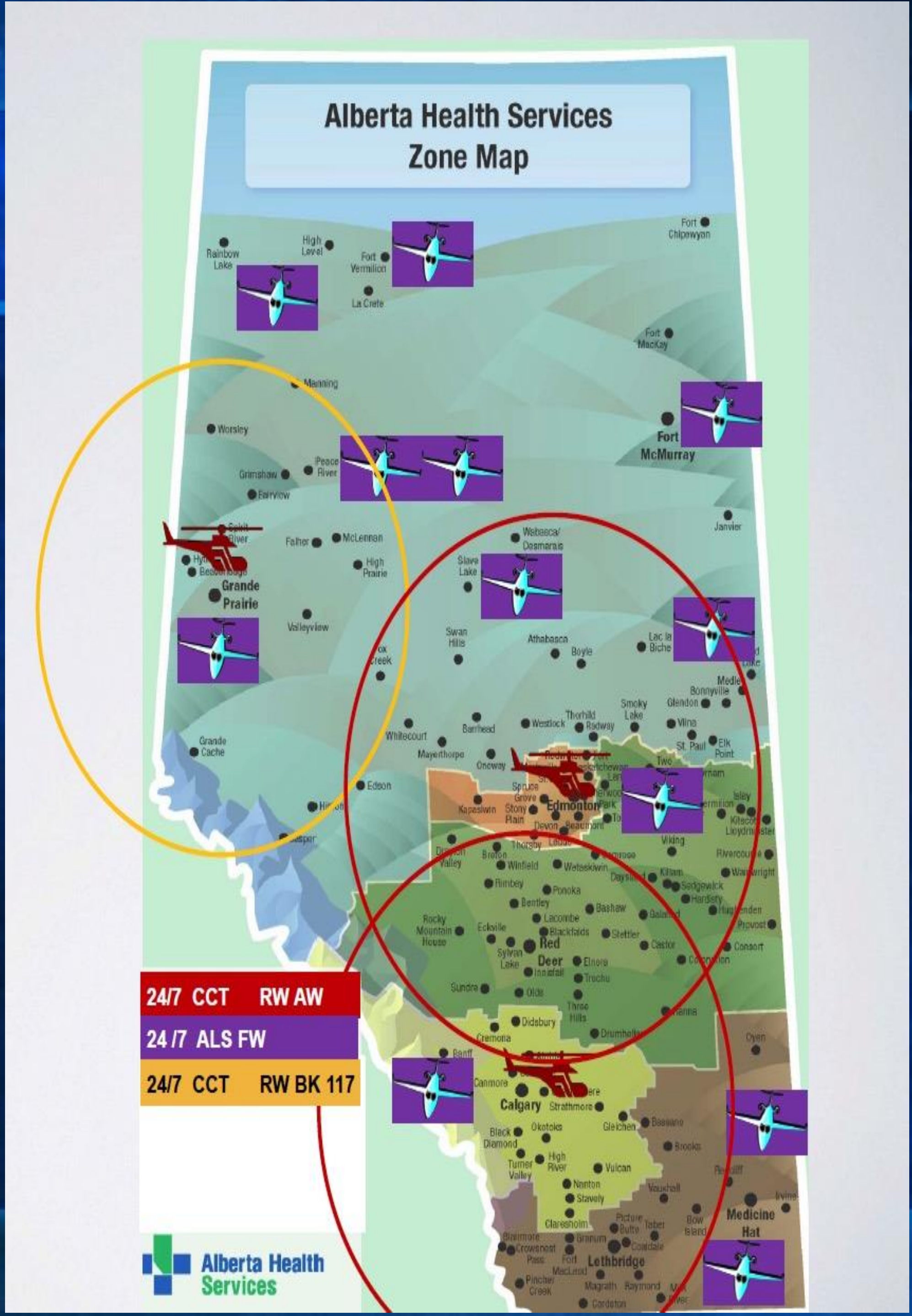
- Planes on the tarmac while waiting for the patient (everything inside freezes)
- IV lines freezing up
- Drugs freezing up (eg mannitol ice)
- Cold medical gases

Summary of PICU tpt data

- Sick patients get sicker on transport
- PICU teams reduce complications during transport care, and more importantly reduce ICU morbidity/ mortality
- Longer transports, sicker patients
- Sicker patients take longer to stabilize, and that is usually OK
- Accurate triage of the critically ill child is difficult

Does PICU transport all critically ill children ? (ie. What is the necessary or best team composition?)

- Disease-specific issues
  - Trauma vs medical (ALS vs PICU)
- Scene response vs inter-hospital (PICU vs ALS)
- Age-related tpt in the ALS world
  - Deskilling (technical and cognitive) of ALS services over time
  - All the necessary tpt equipment for all ages?
- Transport distances/ time away from tertiary care
  - Average tpt time to bedside = 2-3 hrs



Alberta Health Services
Zone Map
24/7 CCT RW AW
24 /7 ALS FW
24/7 CCT RW BK 117
Alberta Health Services
Fort McMurray
Grande Prairie
Edmonton
Red Deer
Calgary
Lethbridge
Medicine Hat

Remaining part of the regional transport network…

Creating a positive non-confrontational relationship with the various EMS communities that we interface with

- Pediatric CCM tpt team cares for high acuity patients requiring *inter-facility* tpt
- We do not do pre-hospital transport/ scene response
- We do not aspire to transport all children, just those at high risk for in-transport destabilization or those requiring pediatric critical care support

We are not 'the competition'

Remaining part of the regional transport network…

- Teaching Pediatric CCM principles to the EMS community that will still encounter these kind of patients (but infrequently)
    - PALS teaching
    - Assisting with pre-hospital morbidity and mortality review of pediatric cases
    - conferences/ continuing education sessions

Remaining part of the regional transport network…

- Real-time support of ALS teams while they are transporting critically ill/ injured children (enhancing, not replacing service-specific medical control)
- PICU can’t always be there to do the trip!

Too far as well as we are a limited resource

Allan's Perspective on Transport Medicine

An exciting transport is a often a poorly planned or anticipated transport

How does transport care differ from in-hospital care?

- Stabilize in the referring hospital, not in the back of the ambulance/ plane!
- Its difficult to intubate in the back of a helicopter or a moving ambulance!

Monitoring in the Transport Setting

Ability (or not) to clinically assess the patient during transport impacts ‘prophylaxis’

- Ambient lighting: is the patient blue/ pink/ white/ grey?
- Noise: the stethoscope is useless
    - ETT position, pneumothorax
- Motion artifact (BP cuff, 02 sat monitor)


ZOLL
00:05:07
162
2.0 101


i-STAT
BNP


SOMANETICS
L67 66
R67 67
S 79 90
S 55 70

Does the airway need to be secured?

Does the airway need to be secured?

- General indications:
  - altered LOC/ resp distress or ↓ effort/ shock
    its more than just about ABG/ 02 saturations
- Patient age/ size
- What is the trend?
- Patient co-morbidities (acute or chronic)?
- Transport distance (CT vs. another province)
- Transport Mode
  - Intubating in a moving ambulance/ cramped helicopter

Respiratory compromise during transport *or* reasons to intubate pre-transport!

- Abdominal distention in the infant (swallowed air, intra-abdominal bleeding, ileus)
- Gastric distention:
  - Displacement of diaphragm
  - Reflux and aspiration
- Gastric decompression vs. post-pyloric air and pressurization of plane

Respiratory compromise during transport *or* reasons to intubate pre-transport!

- Sedative/ analgesic needs (eg. pediatric burns)


3 12 2007

CXR post-intubation

- ETT position post-intubation
  - Clinical assessment is unreliable in small children (ETT position, pneumothorax)
  - Capnography: intra-airway (still either high or low…)
  - Brazelow tape: length not always = weight

Accurate volume measurement
- ✓ volutrauma

Pressure alarms
- ✓ barotrauma

O2 blender
- ✓ reduce toxicity

Vent modes
- ✓ Mandatory vs. spontaneous

Respiratory compromise during transport

- Increase in gas volume at altitude in unpressurized aircraft (pleural/ gastric), especially with use of positive pressure ventilation
- Drain the small Pneumothorax vs. pressurize the plane

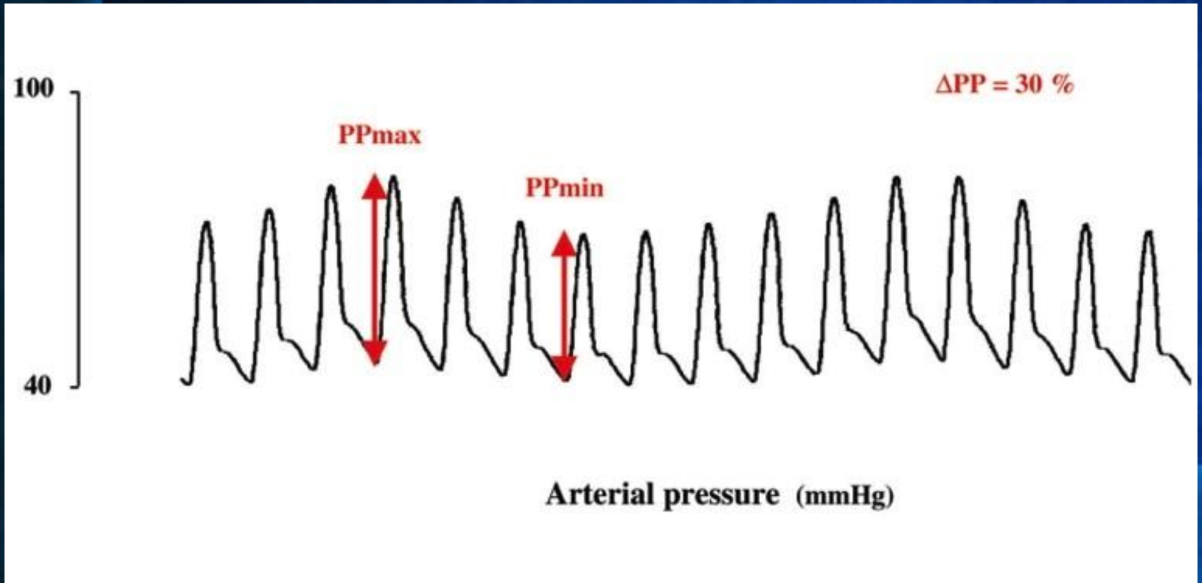
Once the ETT is in, keeping it in…

- Avoid benzodiazepines/ propofol due to vasodilatory effects
- Serial dosing of analgesic agents
  - Fentanyl: 1-2 mcg/ kg q30-60 min
  - Ketamine 0.5-1 mg/ kg q1hr
  - Morphine 0.05-0.1 mg/ kg q1-2hr

- The patient with residual paralysis
  - Titrate sedative/ analgesic dosing to jumps in HR/ BP
- Even these agents have vasodilator effects…
- Rocuronium 01.mg/ kg q30-60 min with patient movement

Hemodynamic Stabilization Pre-Transport

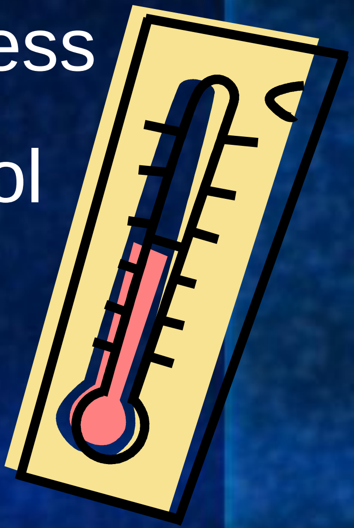
- On-going fluid requirements due to vasodilation/ capillary leak
- Reassess, reassess, reassess; fluid requirements change over time



Systolic Wave Variation/ Pulse Pressure Variability: check your pulse oximetry tracing (audio or visual)

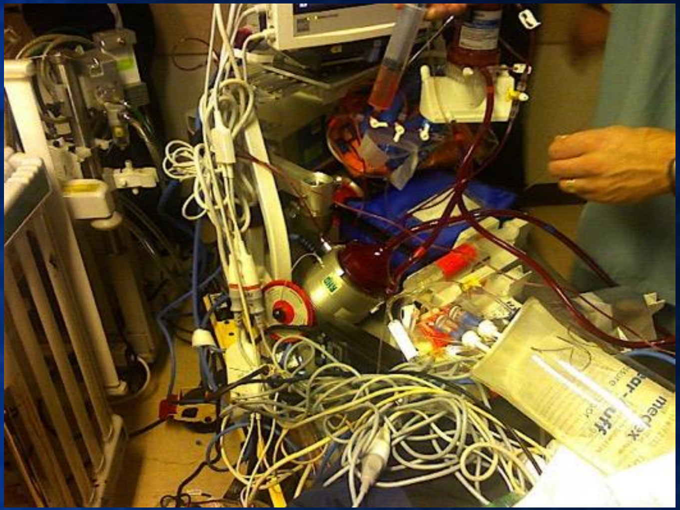
Temperature Management of the Pediatric Patient on Transport

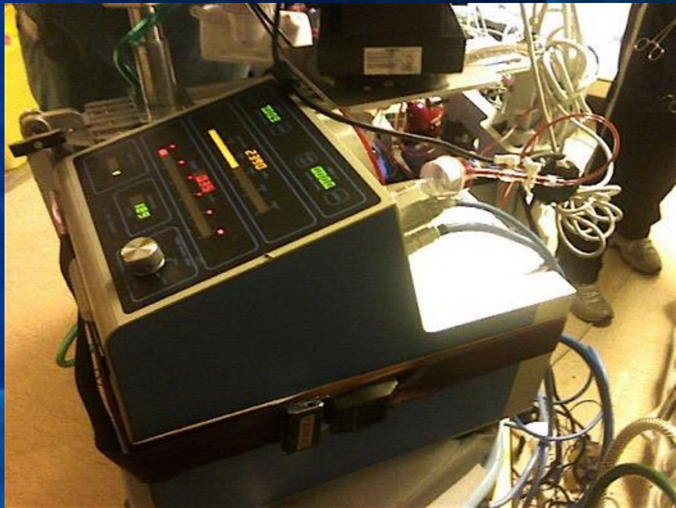
- Small children lose significant heat (radiant/ evaporative/ conductive losses)
- Hypothermia increases SVR/ myocardial stress
- The importance of temperature (fever) control is disease specific
  - Cardiac arrest: Avoid fever; don't cool
  - TBI: Avoid fever; don't cool (harmful)
- The earlier fever is managed, the better for the patient (window of dose effect starts early)



Transport Medicine: The Future (or now?)

Transport ECLS





Transport ECLS

Transport ECLS

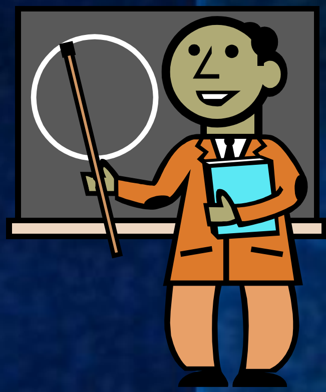
Canadian Pediatric Transport Teams 2015

	# tpts/ yr	# tpts admitted to PICU/ yr
Vancouver	1100	180
Edmonton	240 (85% Mdless)	145
Calgary	265	172
Saskatoon	462	200
London	150	135
Toronto	200	150
Halifax	187 (with neo)	
St. Johns	100-120	20-24

- Accreditation Canada Standards for Pediatric Interfacility Transport
- Coming to your center in 2016/17…

Tex Kissoon's Golden Rules of Transport

- Plan ahead
- Transports are palliative, not curative
- No form of transport is ideal for every patient
- Any hospital is a better hospital than an airplane or ambulance
- If it is possible for a sick person to become sicker, he probably will
- Big problems are simply small problems you have not anticipated
- Nothing lasts forever (eg. Air 02, battery, etc)



Objectives

- To review the literature supporting the role of pediatric critical care transport teams in stabilizing and transporting critically ill children
- To understand the infrastructure/ system supporting the air transport of children in Northern Alberta
- To understand how the transport care of children differs from in-hospital care
- To look to the future of pediatric transport

Thanks for your attention.

Questions?

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Adult Intrahospital Critical Care Transport

Waddell, 1975

- life-threatening complications during 20% of in hospital moves
  - Hypothermia
  - Changes in HR/RR/BP
  - Desaturation/ ABG deterioration
  - E.T.T. Displacements
  - Need for changes in vent./inotrope support

Over 50% patients suffered >1 event

Insell, 1986

- 13% morbidity rate in patients transferred from the O.R. to the I.C.U.

Indeck, 1988

- significant 'physiologic changes' 68% of in-hospital moves/ transports

Pediatric Intrahospital Critical Care Transport

Wallen et al., 1995

- prospective study (C.H.Pittsburgh) of intrahospital transports (n=180)

Effect of intrahospital transport on patient physiological parameters, equipment mishaps, and need for major therapeutic interventions.

- significant change in at least one physiological variable in 71.7% of transports
  - hypothermia
  - significant change in HR/BP/RR
  - desaturation or change in ABG

Pediatric Intrahospital Critical Care Transport

Wallen et al., 1995

- at least one equipment related mishap in 10% of intrahospital transports

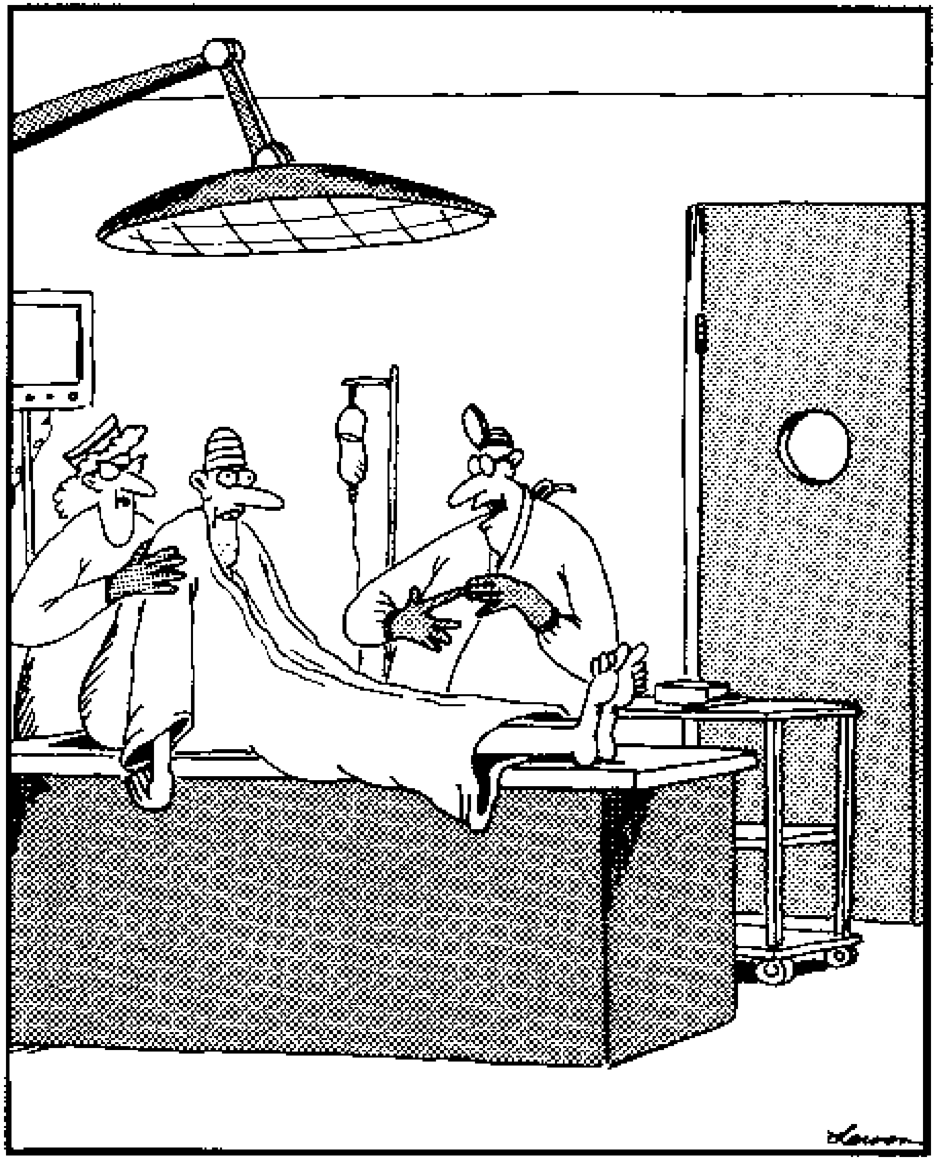
- E.T.T.-related
- equipment malfunction
- I.V.-related
- loss of NG or Chest tube
- medication error

- at least one major intervention performed in 13.9% transport
- vasoactive drug
- fluid bolus (>20 cc/kg)
- Change in ventilatory setting
- other

Pediatric Intrahospital Critical Care Transport

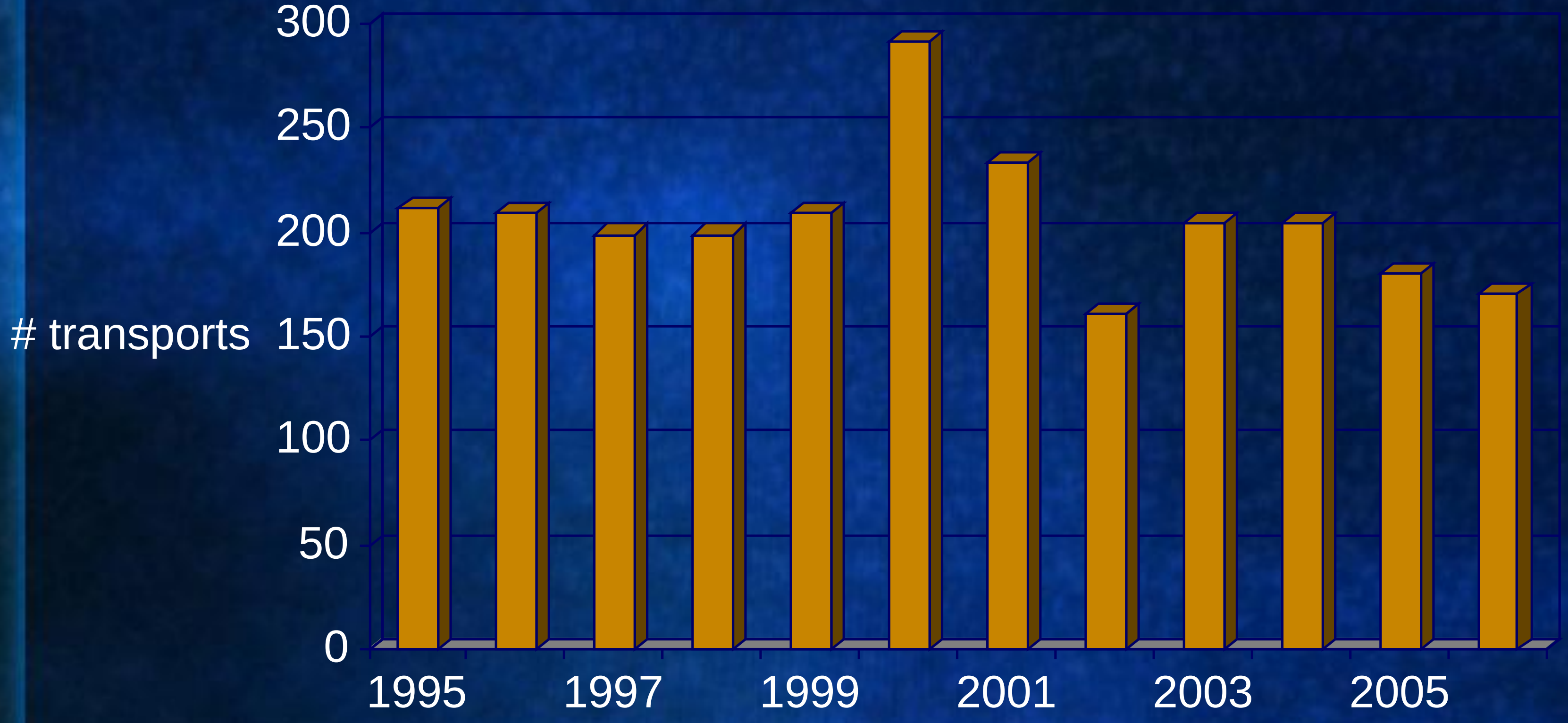
Wallen et al., 1995

- Acuity of illness (T.I.S.S.) and duration of time outside of P.I.C.U. setting were both significantly associated with requirement for a major intervention or a physiologic deterioration

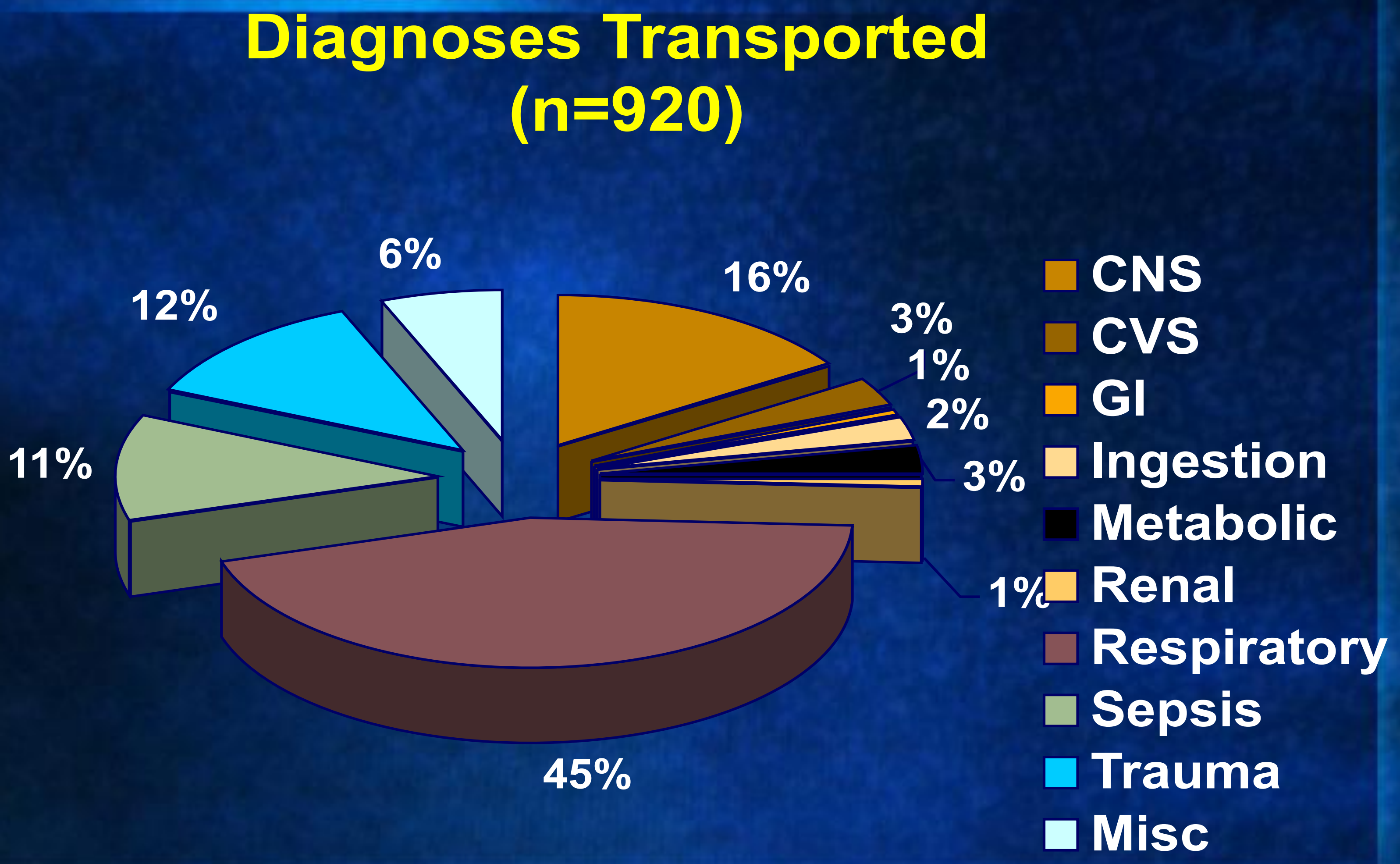


"OK, Mr. Dittmars, remember, that brain is only a temporary, so don't think too hard with it."

Stollery PICU Transport Team: 1995-2007

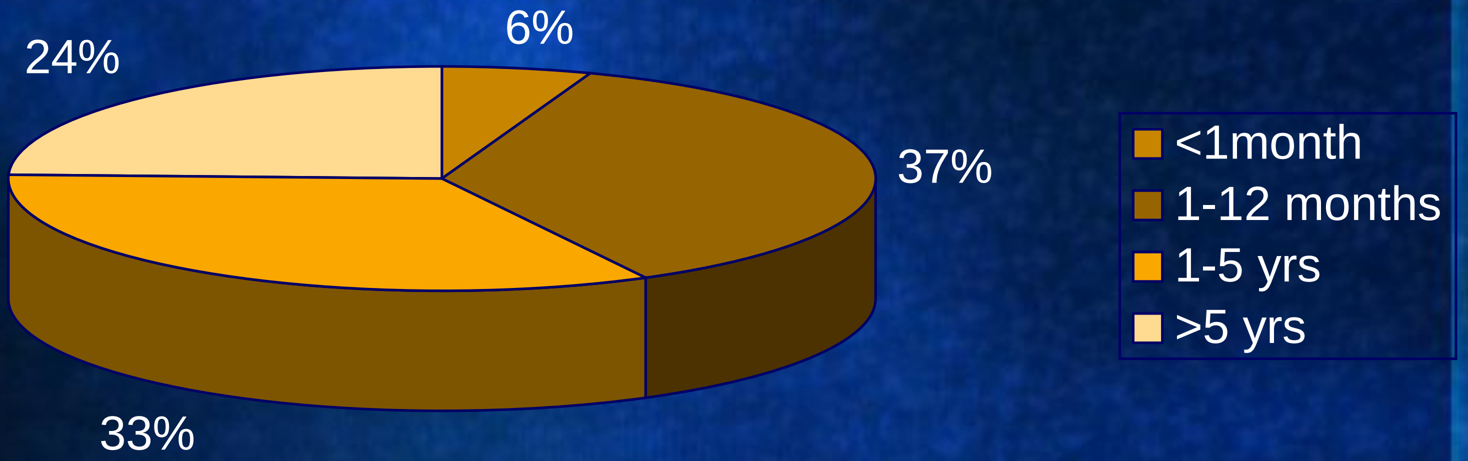


Stollery PICU Transport Team: 2002-2007

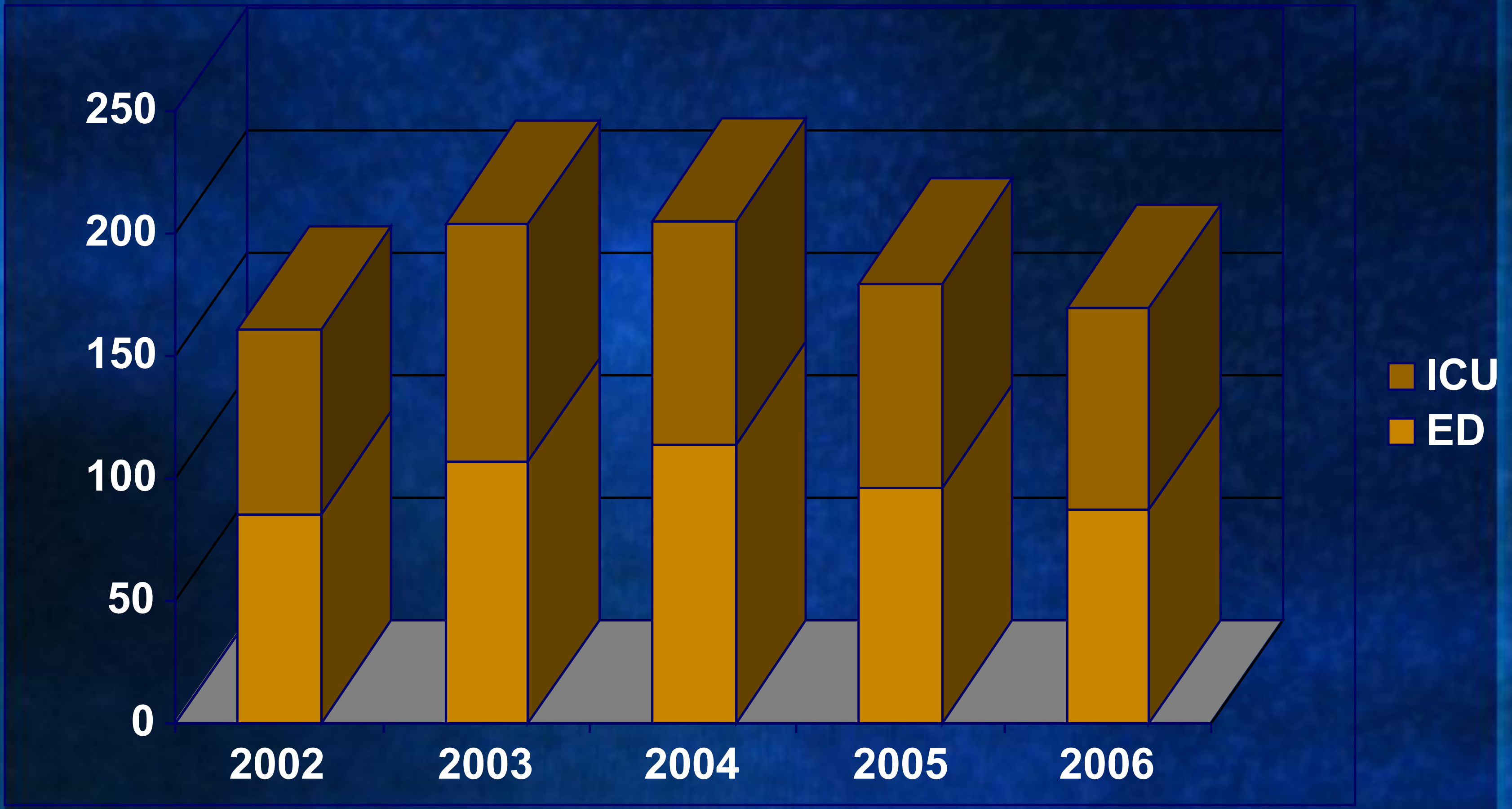


Stollery PICU Transport Team 2002-2007

Age of Patients Transported (n=920)

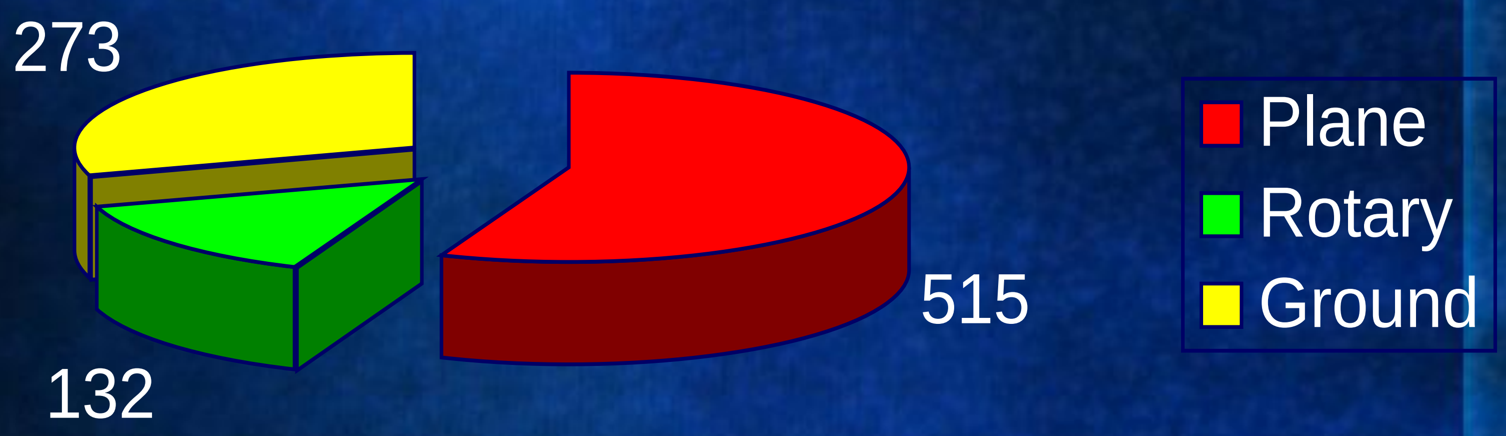


Stollery PICU Tpt Team 2002-2007 Admission Unit



Stollery PICU Transport Team 2002-2007

Type of Carrier (n=920)



Stollery PICU Transport Team: 2002-2007 (n=920)

- Average transport time: 4 hrs, 55 min
- Team Stabilization time (referring hospital)

Medical	51 +/- 32 min
Trauma	53 +/- 34 min

- Pts with chronics health conditions 26%
- 25% intubated

Pediatric Transport: Who should be on the team?

Fazio et al, Pediatric Emerg Care, 2000

- mail-out questionnaire to 213 pediatric transport centers
- 138 responses

- 106 had PICU transport teams
- Av. transports/ yr: 236 (4-1400)
- Av. PICU size: 14 beds (2-40)
- 71% University/ Children's Hospital Complexes
- 29% private/ community/ military

Pediatric Transport: Who should be on the team?

- 79% of PICU transport teams used residents

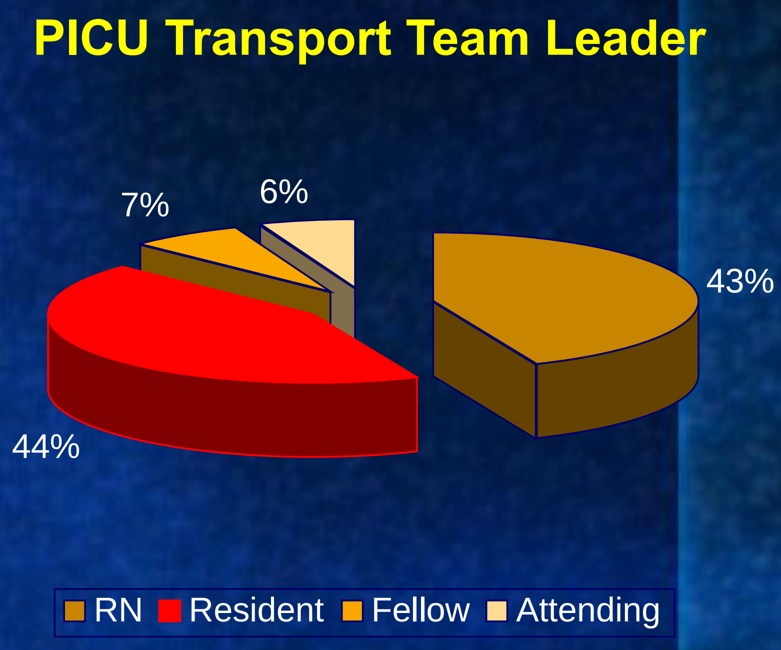
Resident Role

- Leader 70%
- Helper 16%
- Observer 14%

Resident Role Relative to tpt team volume (tpts/ yr)

- 166 +/- 207 team leader
- 306 +/- 292 non-leader

($p < 0.002$)



Fazio et al, 2000

Pediatric Advanced Life Support Skills and PICU Transport

Comparison of intubation skills between interfacility transport team members

Adams et al, Ped Emerg Care, 2000.

Loma Linda Children's PICU Transport Team

- 3616 transports/ 2044 intubated (1992-1996)
- 132 intubations on transport by team (4d.-11 yrs)
- MD (R2-3) first intubator
- RT (3.5 yr tpt experience) second line intubator

Intubation Skills and Transport Team Members

	# pts	Success %)	1st pass (%)	2nd pass (%)	>2nd pass (%)
MD	110	77 14/16 of failures successfully intubated by RT on 1st pass	58	22	20
RT	51	92	83	17	

Adams et al, 2000

Taking the Transport Call….

How you can support the referring center….

- Follow-up calls until the transport team arrives
- Walk through techniques (ETT/ IO/ chest needle)
- Help them run an arrest
- When to call off an arrest
- 'McGuivering' critical care supplies (hypertonic saline, IO if no IOs, etc)
- Positive support: time for criticism is later…

Skills Required to Transport Pediatric Patients

AAP Guidelines for Air and Ground Transport of Neonatal and Pediatric Patients, 1993

Procedural Skills

All standard emergency procedures for a child:

- airway management
- chest tube placement
- central venous access
- intraosseous line placement
- peripheral vascular line placement
- arterial access

Cognitive Skills

"... diagnosing and managing pediatric illnesses or injuries, and in recognizing the most likely types of potential deterioration in the patient's condition.

...generally achieved and maintained only through significant experience in caring for critically ill infants and children."

Communication Skills

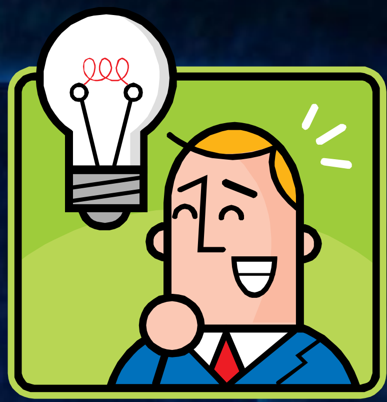
- intra-team (transport team and base unit)
- interhospital
- team-patient/ team-family

Transport Team Composition

Non-M.D.-Accompanied Team Issues

- less complex with teams with limited disease processes or patient sizes (ie. N.I.C.U./ adult transport teams)
  - cognitive skills
  - technical skills (ie. airway and vascular access)
- on-going experience

Preparation for Intubation

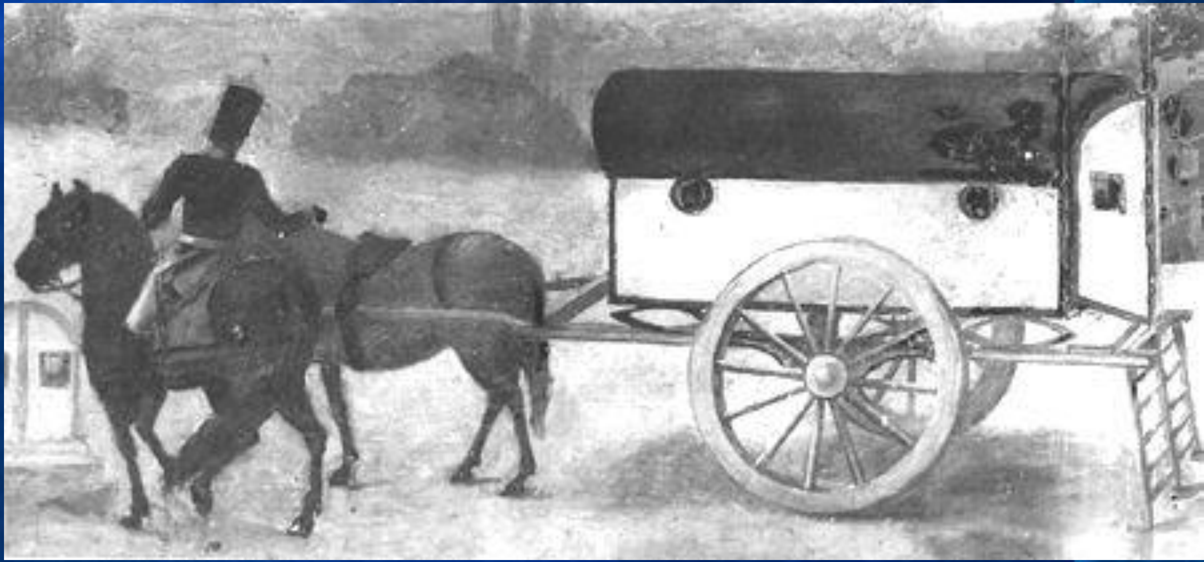


- Best available airway expert
- Stable intravenous access
- Pediatric-specific airway equipment
- Pre-oxygenation
- Adequate monitoring (HR/ 02 sat/ BP/ EtC02)
- A plan B for airway management
- Preparation for hemodynamic changes…

Do I have to intervene now, or can it wait for…

Hypotension Surrounding Intubation

- Hemodynamic preparation pre-RSI
  - Code dose epinephrine and NS boluses at bedside
  - Treat hypotension prior to starting RSI (start with volume)
  - Reduce anesthetic/ sedative doses, or withhold in setting of refractory severe hypotension
- Hypotension post-RSI is common but is usually fluid responsive
  - PPV reduces venous return to heart (slower IMV!)
  - RSI drugs vasodilate and reduce preload
  - PPV (pre-atropine) can reduce HR in small infants due to CNS reflexes

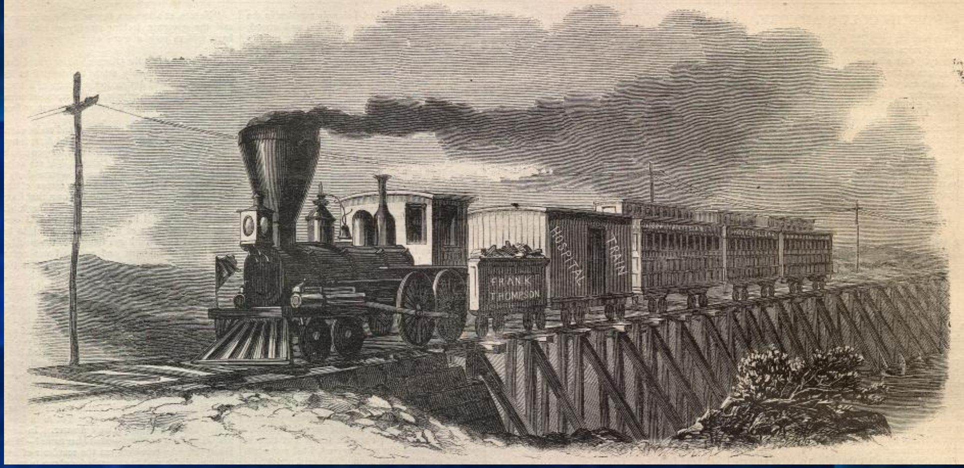


History

Napoleonic Wars

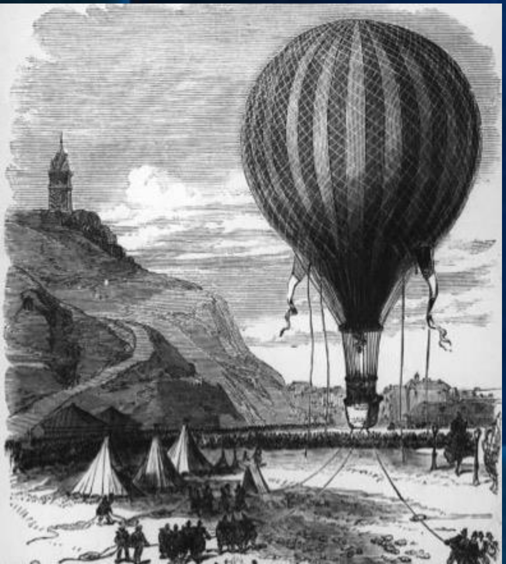
- first “ground ambulance”

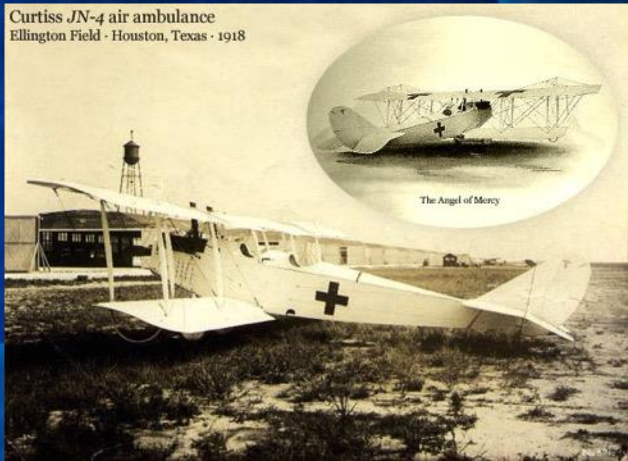
Transport Medicine



History

- 1860’s: railway
- 1870: hot-air balloon
- 1915: fixed wing





Transport Medicine

History

- Korean war (1951)

helicopter
20 min

injury (medic) → M.A.S.H → Trauma unit

1 hour

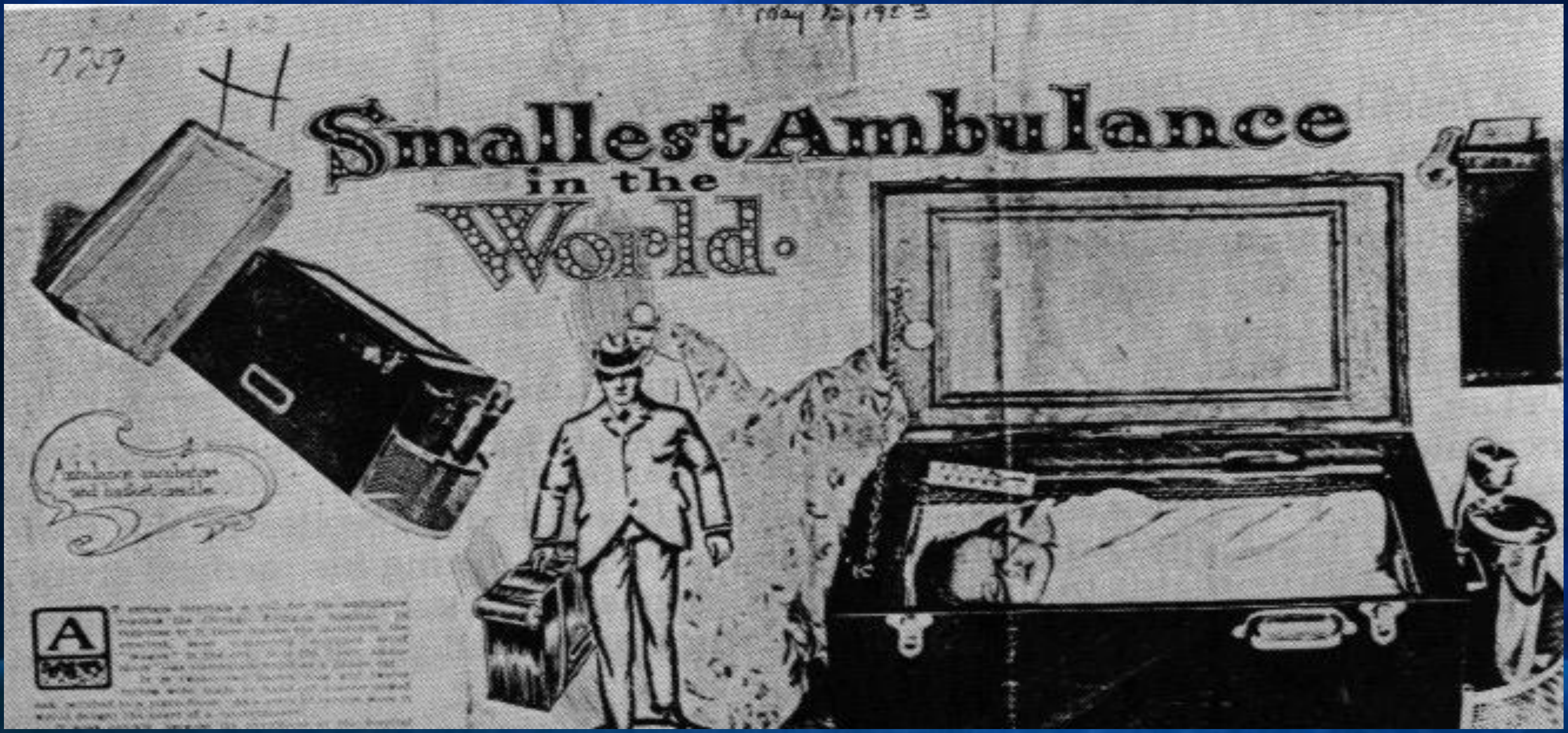
jet

military hospsital

Pediatric Transport Medicine

History

- early 1900's: premature/ "weakly-born" infants transferred to hospitals in "ambulance incubators" (hand-carried)



Pediatric Transport: A Short History

1960's (Quebec)

- Regionalized neonatal intensive care supported by transport team leads to 50% reduction in neonatal mortality rate

1970's (USA)

- Regionalization of pediatric intensive care leads to evolution of pediatric critical care transport teams

	Specialist retrieval team (n=13729)	Non-specialist retrieval team (n=3146)	Unadjusted odds ratio (95% CI)
Resource use in PICU			
Invasive ventilation	11831 (86%)	2168 (69%)	2·97 (2·71–3·26)
Vasoactive drugs	4641 (34%)	857 (27%)	1·37 (1·26–1·49)
Renal replacement therapy	524 (4%)	93 (3%)	1·29 (1·03–1·61)
Extracorporeal membrane oxygenation	291 (2%)	55 (2%)	1·21 (0·91–1·62)
Multiple organ support	449 (3%)	65 (2%)	1·60 (1·23–2·08)
Patient outcomes			
Stay in PICU (h; median, IQR)	82 (36–158)	59 (22–136)	1·31* (1·25–1·37)
Crude mortality	1092 (8%)	231 (7%)	1·09 (0·94–1·26)

Data are number (%), unless otherwise indicated. *Ratio of geometric means.

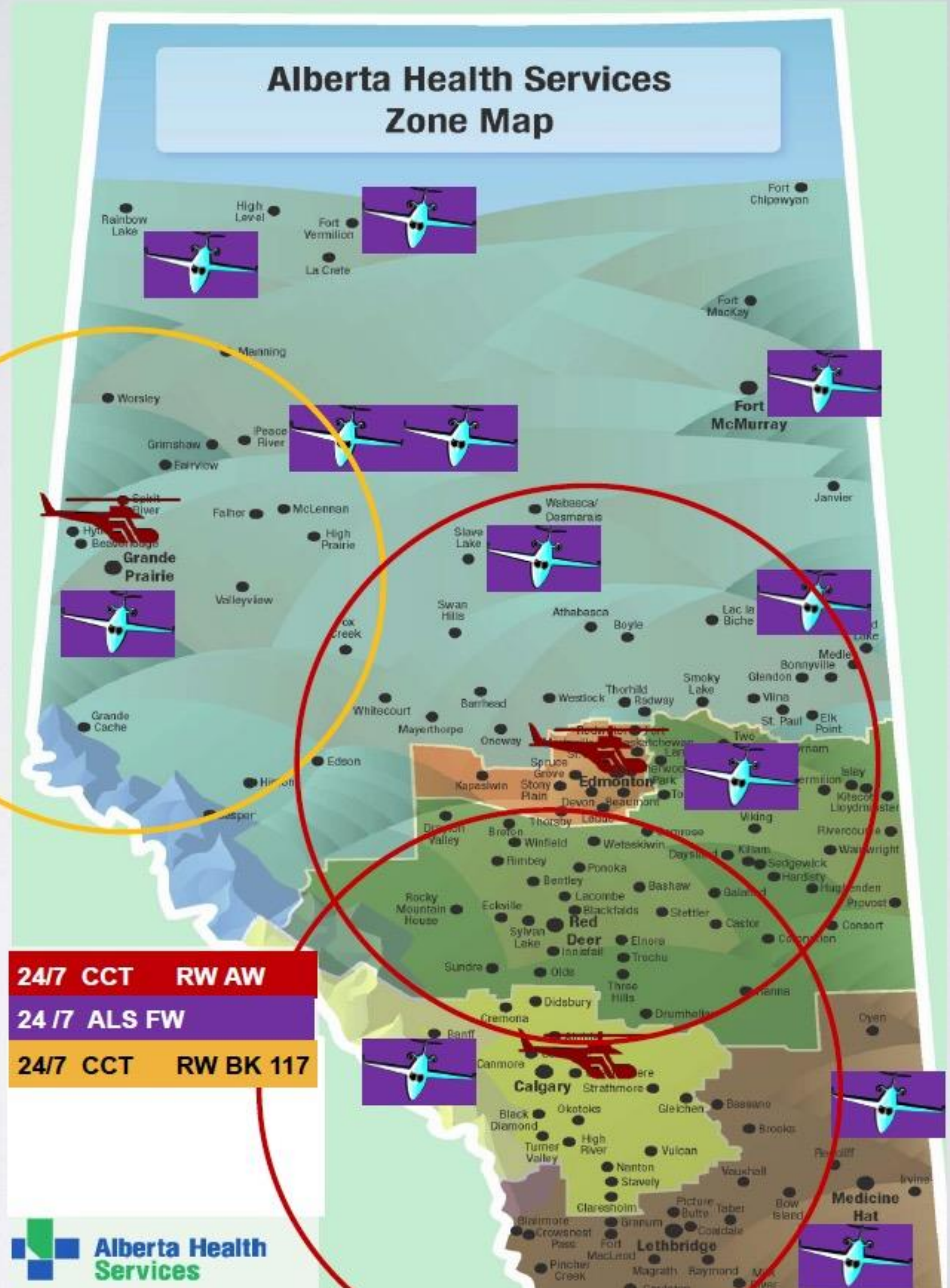
Table 5: **Resource use and outcomes for children transported for admission to paediatric intensive care unit (PICU) by specialist and non-specialist retrieval teams**

Ramnarayan, Lancet, 2011

	Odds ratio (95% CI)	p value
Age (years)	1·01 (0·97–1·04)	0·67
Boys	0·97 (0·74–1·28)	0·85
Postoperative admission	1·93 (0·44–8·41)	0·38
Admission department		
Operating theatres	Reference	..
Emergency	1·62 (0·63–4·17)	0·31
General ward	1·12 (0·41–3·06)	0·82
High-dependency care	1·89 (0·71–5·04)	0·20
Intensive care	1·80 (0·70–4·63)	0·21
Post procedure	0·94 (0·01–139·21)	0·98
Specialist retrieval team transfer	0·59 (0·39–0·88)	0·01
Paediatric index of mortality (medical history)		
Mechanical ventilation	3·25 (0·99–10·47)	0·05
Fixed and dilated pupils (>3 mm)	106·41 (46·47–243·66)	<0·0001
High-risk diagnosis	2·42 (1·75–3·35)	<0·0001
Paediatric index of mortality (acute physiology)		
Systolic blood pressure	1·01 (1·00–1·02)	<0·0001
Base excess	1·10 (1·08–1·12)	<0·0001
Ratio of fraction of inspired oxygen to partial pressure of arterial oxygen	1·24 (1·10–1·39)	<0·0001
Quartile of additional distance travelled to PICU		
No additional distance	Reference	..
Quartile 1 (1–4 km)	1·02 (0·67–1·55)	0·93
Quartile 2 (5–8 km)	1·08 (0·67–1·73)	0·76
Quartile 3 (9–32 km)	1·13 (0·76–1·70)	0·55
Quartile 4 (>32 km)	1·34 (0·87–2·06)	0·18

***Table 6*: Multivariable analysis of the effect on risk of mortality in paediatric intensive care unit (PICU) of additional distance travelled by patients not admitted to the nearest PICU**

Ramnarayan, Lancet, 2011


Alberta Health Services
Zone Map
Rainbow Lake
High Level
Fort Vermilion
La Crete
Fort Chipewyan
Fort MacKay
Fort McMurray
Manning
Worsley
Grimshaw
Peace River
Fairview
Falher
McLennan
High Prairie
Grande Prairie
Valleyview
Grande Cache
Edson
Wabasca/ Desmarais
Slave Lake
Swan Hills
Athabasca
Boyle
Lac la Biche
Janvier
Bonnyville
Glendon
Smoky Lake
Thorhild
Westlock
Barrhead
Whitecourt
Mayerthorpe
Onoway
Vilna
St. Paul
Elk Point
Edmonton
Spruce Grove
Stony Plain
Devon
Beaumont
Viking
Thorsby
Wetaskiwin
Winfield
Rimbey
Ponoka
Bentley
Lacombe
Blackfalds
Bashaw
Stettler
Castor
Consort
Rocky Mountain House
Eckville
Sylvan Lake
Red Deer
Elnora
Innisfail
Trochu
Sundre
Olds
Three Hills
Didsbury
Cremona
Drumheller
Oyen
Banff
Canmore
Calgary
Strathmore
Black Diamond
Okotoks
Gleichen
Bassano
Brooks
High River
Turner Valley
Vulcan
Nanton
Stavely
Claresholm
Picture Butte
Taber
Bow Island
Medicine Hat
Lethbridge
Coaldale
Magrath
Raymond
Cardston
24/7 CCT RW AW
24 /7 ALS FW
24/7 CCT RW BK 117
Alberta Health Services

Alberta Air Ambulance Network

- ~9000 Air Ambulance flights in Alberta annually
- ~10% (~800-900) provincial air tpts are Pediatric trips
- 70% provincial flight activity is in Central/ Northern Alberta
- ~500 advice/ transport calls to Stollery PICU intensivists/ year
- 200-250 PICU Air Ambulance trips (Stollery)

Hyperventilation and the Cardiovascular System

The Hemorrhagic shock victim

Table 1 Mean Values ($n = 8$) for Cardiopulmonary Variables Using Various Rates of PPV in a Swine Model of Moderate, Controlled Hemorrhage

	RR (breaths/min)				
	12	6	20	30	6
RA (mm Hg)*	1 ± 1	0 ± 1	4 ± 1	5 ± 1	0 ± 1
ITP (mm Hg)	15 ± 2	12 ± 2	16 ± 2	19 ± 2	11 ± 2
Ao Syst (mm Hg)*	65 ± 2	84 ± 4	73 ± 4	66 ± 5	95 ± 6
Ao Diast (mm Hg)	51 ± 2	71 ± 5	59 ± 4	52 ± 5	81 ± 6
Pao$_2$ (mm Hg)	68 ± 4	138 ± 13	113 ± 7	115 ± 3	174 ± 20
Paco$_2$ (mm Hg)	35 ± 1	62 ± 2	28 ± 1	19 ± 1	58 ± 2
pH (arterial)	7.46 ± 0.02	7.28 ± 0.02	7.51 ± 0.01	7.62 ± 0.02	7.28 ± 0.01
CPP (mm Hg)	50 ± 2	60 ± 4 *	47 ± 3 *	42 ± 4 *	71 ± 6
Qr (L/min)	2.4	2.8	2.5	2.4	3.0

RA, right atrial diastolic pressure; ITP, mean intrathoracic airway pressure; Ao Syst, aortic systolic pressure; Ao Diast, aortic diastolic pressure; Pao$_2$, arterial oxygen tension; Paco$_2$, arterial carbon dioxide tension; CPP, coronary perfusion pressure (averaged over 10 min); Qr, Cardiac output.

* Measured at end-expiration.

Pepe et al, J Trauma, 2003

•Reduced preload due to increased intrathoracic pressure and reduced venous return

Hemodynamic Stabilization Pre-Transport

- IV/ IO X 2
  - Not just trauma
  - 2nd IV allows for a back-up plan in the transport setting
- Shock states, repeated assessment every 10cc/ kg of fluid (NS): liver size, lung fields (creps)
- Titrate fluids not just to BP, but reversal of shock S/S (perfusion/ cap refill, HR,…)
- Tendency is to undertreat with fluids; most septic states require at least 60cc/ kg in first hr. of resusc'n

What is the best mode of transport?

Time to Patient

- < 1 hr transport
  - Ground vs rotary (rotary = limited resource)
  - Rotary range *currently* up to 250 km radius
- > 1 hr transport or >250 km radius
  - Fixed wing
    - Propeller if up to 3 hr flight
    - Lear if > 3 hr propeller trip

Transport Mode: Speed is not everything

- Ground
  - weather conditions can be an issue, but at least you can pull off at the side of the road/ local hospital
  - Traffic jams!
- Rotary
  - Weather conditions often limit flying
  - Pt reassessment/ management is difficult
  - Often direct to hospital parking lot
- Fixed Wing
  - Once you are up, you are up !
  - Ground transfer times add up

Pediatric Transport

Transport medicine differs from in-house E.R. Care and Critical Care

- different practice of medicine in the transport environment
- effects of transport on the patient and the team
- unique equipment and monitoring issues
- “critical care in a vacuum”: working in isolation