Autonome Provinz Bozen – Südtirol / Provincia Autonoma di Bolzano – Alto Adige / Provinzia Autonoma de Bulsan – Sudtirol

Südtiroler Sanitätsbetrieb / Azienda Sanitaria dell'Alto Adige / Azienda Sanitera de Sudtirol

The neonatal / pediatric Transport

Hubert Messner

NICU – Central Teaching Hospital of Bolzano

In collaborazione con

CORSO HEMS 2016 VENETO

Corso teorico-pratico di soccorso in ambiente impervio

per Medici ed Infermieri dei Servizi di Elisoccorso Sanitario

Tre Cime di Lavaredo (BL) , 14 – 18 MARZO 2016

Outline

- *Regionalisation of Perinatal medicine*
- *Responsibility for the transport*
- *Ground versus air transport*
- *Flight physiology*
- *Ventilation and monitoring during transport*
- *The „ really difficult“ transport*

  (ELBW, Hypothermia, iNO, ECMO)
- *Local transport data*

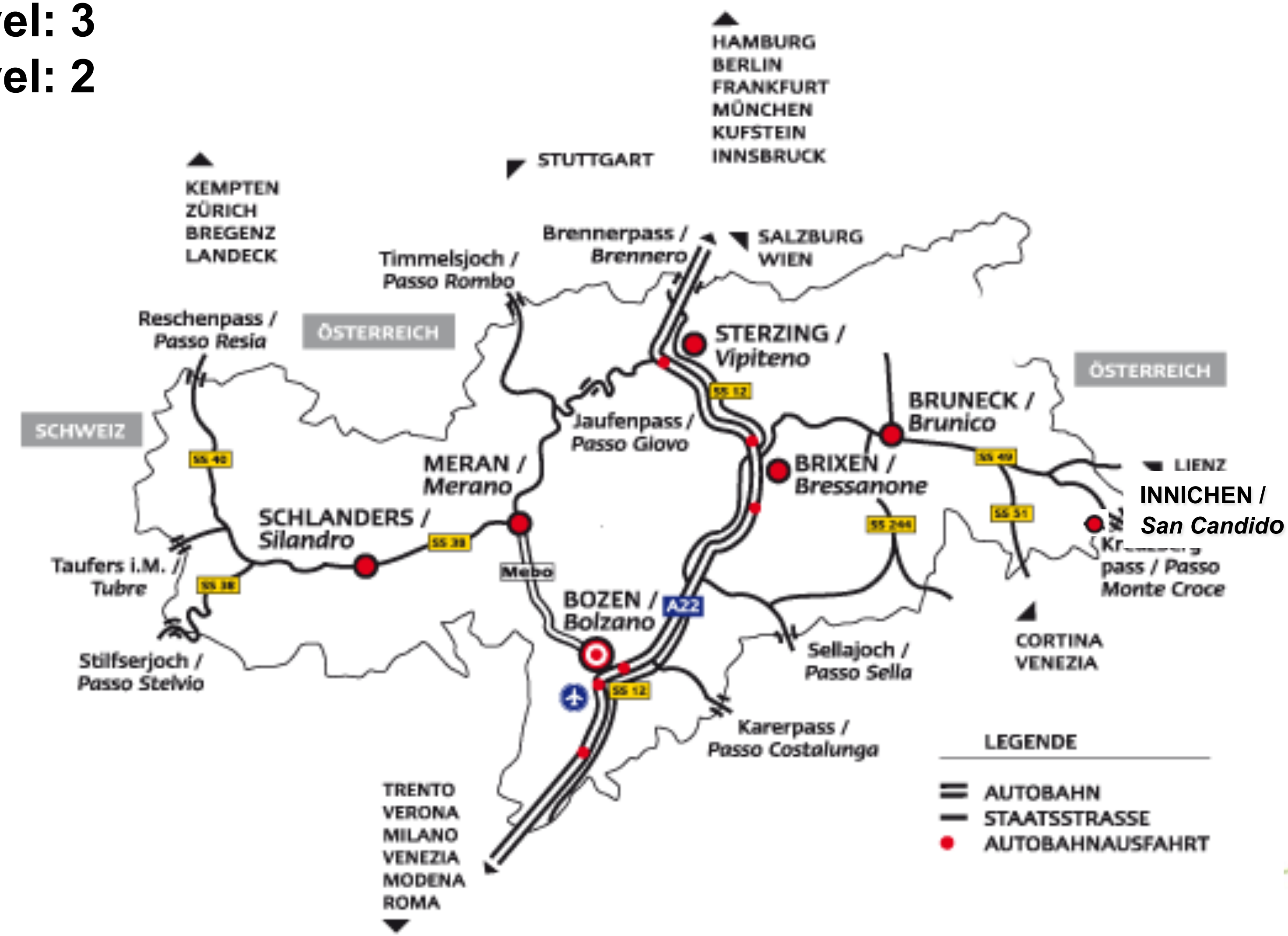
REGIONALISATION
OF HIGH RISK PERINATAL HEALTH

- *Intensive care left to local initiatives*
- *Risk – stratification*

- *Flexible organisation*
- *Establishing clinical networks*
- *Neonatal transport team*

Arch Dis Child Fetal Neonatal Ed. 2004 May; 89(3): F212–F214.

3° Level: 1
2° Level: 3
1° Level: 2



REGIONALISATION
OF HIGH RISK PERINATAL HEALTH

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Arch Dis Child Fetal Neonatal Ed. 2004 May; 89(3): F212–F214.

Neonatal transport

- ***Key component of neonatal- perinatal care***
- *High risk service*

  - type of patient (vital function,emergency)

  - changing environment

  - different equipment

  - high workload / stressors

  - medico-legal issues

Arch Dis Child Fetal Neonatal Ed. 2004 May; 89(3): F212–F214.

Priorities

for a modern neonatal transport

- *Early detection of the „high-risk fetus“*
- *Maternal referral (STAM)*
- *Regional guidelines on stabilisation (2015)*
- *Standard operation procedures*
- *Sharing practice/ collaborative working practice*

Cornette, L. "Contemporary neonatal transport: problems and solutions."
Archives of Disease in Childhood-Fetal and Neonatal Edition 89.3 (2004): F212-F214.

Neonatal transport

- *Responsibility of the referring team*

  (reanimation &Stabilization; SOP's ; direct comunication)

- *Responsibility for the transfer center*

  (→ 118,composition, mode,time frame, comunication during transport…..)

- *Minimum requirement for the transport team*

  (skillness, training, simulation..)

Procedural skills

- *Equipment orientation and troubleshooting*
- *Airway management*
- *Ventilator management*
- *Chest drain insertion*

- *Central lines and arterial access*
- *Stress management*
- *Audits/open transport meetings*

Early Human Development 85 (2009) 487–490

Neonatal medicine/Practical skills

- *Principles of transport medicine*
- *Hospital vs. Transport environment*
- *Pathophysiology of diseases*
- *Transport physiology*
- *Aeromedical physiology*
- *Vehicle safety (education, training…)*

Early Human Development 85 (2009) 487–490

Successful Transport team

- ✓ *Flexibility, independency*
- ✓ *Critical thinking*
- ✓ *Timely judgement*
- ✓ *Problem solving skills*
- ✓ *Interpersonal & comunication skills*
- ✓ *Documentation*
- ✓ *Approriate team resource management*
- ✓ *Recording of adverse event*

Transport and adverse events

346 neonatal transports

- 36% adverse events:
  - ***- 67% due to human errors***
  - *- 12% equipment failure*
  - *- 9% to ambulance problems*

!! Comunication failures (handover)

Lim Mt, Pediatr Crit care Med 2008;9(3):289-93

REVIEW

Optimising neonatal transfer

A C Fenton, A Leslie, C H Skeoch

Arch Dis Child Fetal Neonatal Ed 2004;**89**:F215–F219.

Linee generali : organizzazione interospedaliera, team dedicato, mezzi ,materiale necessario, formazione, corsi di simulazione avanzata

Table 1 Outline of key issues in stabilising neonates for transfer[19]

Airway/breathing

- Should the baby be intubated before transfer? A lower threshold for intubation should be used than on the neonatal intensive care unit, to minimise the need to intervene in transit. In an infant > 30 weeks gestation, if the vital signs (pulse, blood pressure, respiratory rate, temperature) have been consistently stable in oxygen < 50% and if the $PaCO_2$ is normal, it may be acceptable to move the baby without intubation. If the infant is: unstable
  - has a rising oxygen requirement > 50%
  - has a rising $PaCO_2$
  - has recurrent apnoea
  - is < 30 weeks gestation

then intubation and respiratory support is highly likely to be required, at least for the duration of the journey.

- If already intubated, the endotracheal tube (ETT) must be correctly positioned and secure. ETTs must be secured to a high standard, to avoid accidental extubation in transit.
- Adequate respiratory support must be given.
- Surfactant must be administered if indicated.

Circulation

- Arterial access, if not already established, should be considered in infants who require repeated blood gas analysis or accurate blood pressure measurement. If siting a line will not influence practice before or during the journey, then it may be acceptable to delay this until after the transfer.
- Correct positioning and security of the catheter must be checked.
- Circulation with fluids and/or inotropes should be supported early, as indicated.

Temperature

- Assess temperature and consider the support required for transfer.
- Use temperature maintenance adjuncts, such as chemical gel mattresses.[20 21]

Blood glucose

- Measure and stabilise blood glucose.
- Secure intravenous access.

Infection

- Screen for infection as indicated.
- Start treatment.

Parents' information and wishes

- Discuss plans with parents. Ascertain their plans about travelling to referral unit. Liaise with midwifery staff about maternal transfer.

Information

- Ensure the team at the referral unit will have all the necessary information to advance the care of the baby.

“STAY & PLAY” vs “SCOOP & RUN”

→ **NO „PLAY ON THE WAY“**

Stabilization time

- Influenced by:
  - patient related factors
  - transport related factors

! Indicator of team efficiency

Longer time needed for Heli - transport

Despite low number of Helicopter transports, we noticed an increased scene time and numerically, a reduced number of interventions.

MedSTAR Emergency Medical Retrieval

EL Borrows, Pediatr Crit Care Med 201

Ground vs Air Transport for Neonates. Does it Matter?

The choice of transport mode depends on:

- *Indication*
- *Emergency*
- *Availability*
- *Location*
- *Weather*
- *Traffic*
- *Human and tecnical resources*

When Humans „fly high“

Logistics

Aeromedical Physiology (altitude)

Airborn environment

Safety

More difficulties…technical….
Air versus Ground

Fit to fly: practical challenges in neonatal transfers by air

C H Skeoch, L Jackson, A M Wilson, P Booth

- *Operational decision* *(118)*
- *Dictated by distance, geography and weather*
- *No consensus on costs vs benefits*

Arch Dis Child Fetal Neonatal Ed 2005;90: F 456 – F460

- However the effect of the transport mode chosen on the neonate must be considered.

What are the effects of transport?

Physiological	**Physical**
Hypoxia	Weather
Vibration	Motion
Temperature	Psychology
Decreased humidity	Equipment
Noise	Fatigue
Altitude	

Effects of mode of transport

	Road	Fixed Wing	Helicopter
Vibration effects	High	Low	High
Sensory stimuli	High	Low	High
Altitude Effects	Low	Moderate	High
Temperature	Low	Moderate	High
Biophysical accelerometry	High	Moderate	Low
Weather	Low	Moderate	High

Air Transport/ Regulatory Bodies

- European aviation safety agency (EASA)
- European committee for standardisation (CEN)
- Health and safety executive

HELICOPTER

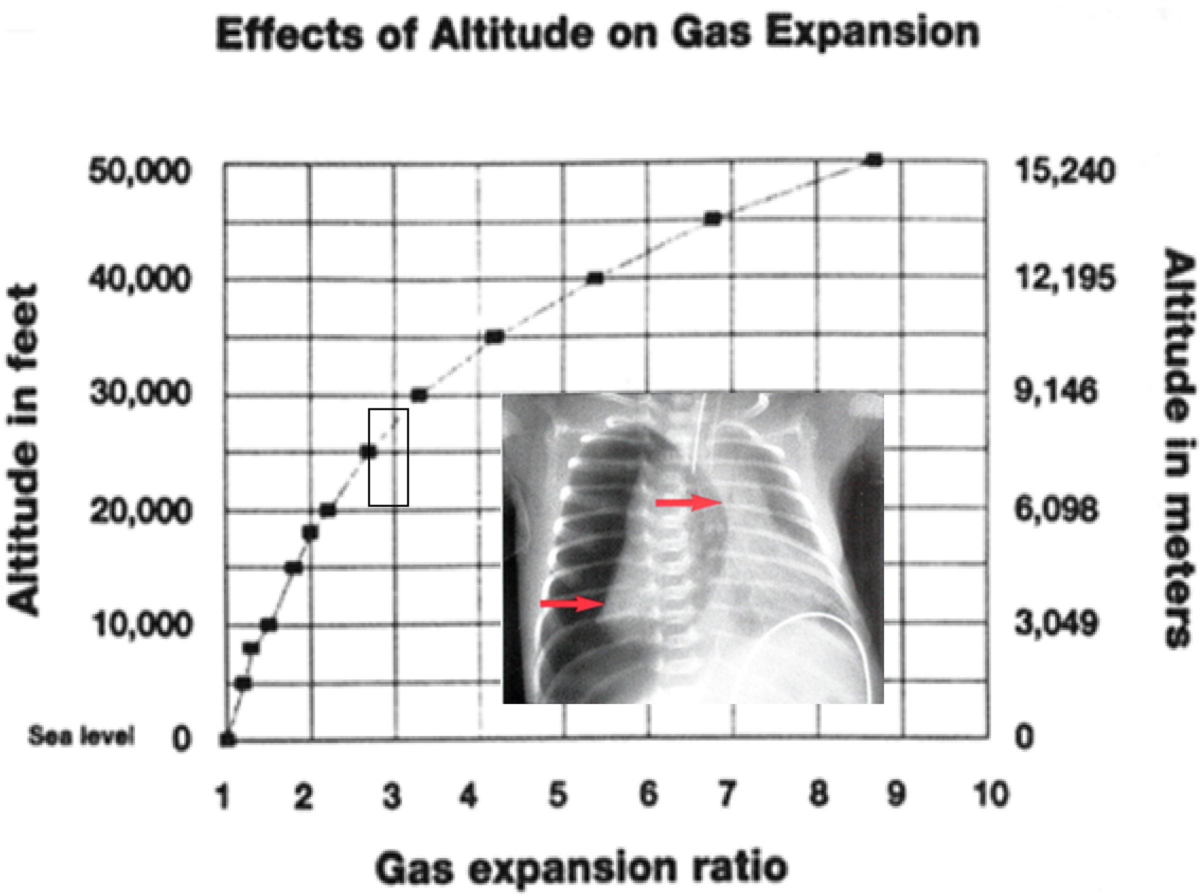
- *LIMITED USE*
- *LANDING PROBLEMS*
- *MANY LOADING AND UNLOADING EVENTS*

Flight Physiology

Science of Air Travel With Neonatal Transport Considerations

Boyle's Law and Dalton's Law.

BOYLE's Law : the effect of altitude on gas volume



BOYLE’ LAW

Altitudine (m)	Fattore di espansione dei gas
Livello del mare	X 1
3000	X 1.5
5500	X 2
8300	X 3
10200	X 4
11700	X 5

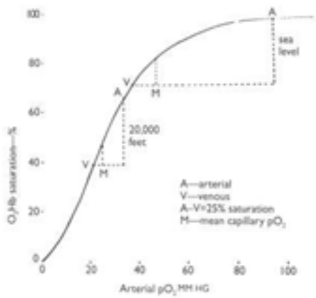
DALTONS'LAW

Pt = P1+P2+P3….Pn

↓ PB → ↓ PARTIAL PRESSURE OF ANY GAS

↓ PB → ↓ PARTIAL PRESSURE OF OXYGEN

Oxygen dissociation curve



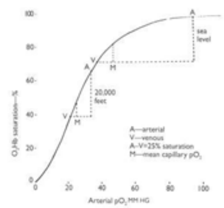
Dalton's Law. the effect of altitude on oxygen availability

TABLE 1. Effects of Altitude on Oxygenation

Altitude, ft	Barometric Pressure, mm Hg	PAo_2, mm Hg	Pao_2, mm Hg	$Paco_2$, mm Hg	Oxygen Saturation
Sea level	760	159.2	103	40	98
8000	565	118.4	68.9	36	93
10 000	523	109.6	61.2	35	87
15 000	429	89.9	45	32	84
18 000	380	79.6	37.8	30.4	72
20 000	349	73.1	34.3	29.4	66

Abbreviations: PAo_2, partial pressure of alveolar oxygen; Pao_2, partial pressure of arterial oxygen; $Paco_2$, partial pressure of arterial carbon dioxide.

Oxygen dissociation curve



DALTONS’LAW

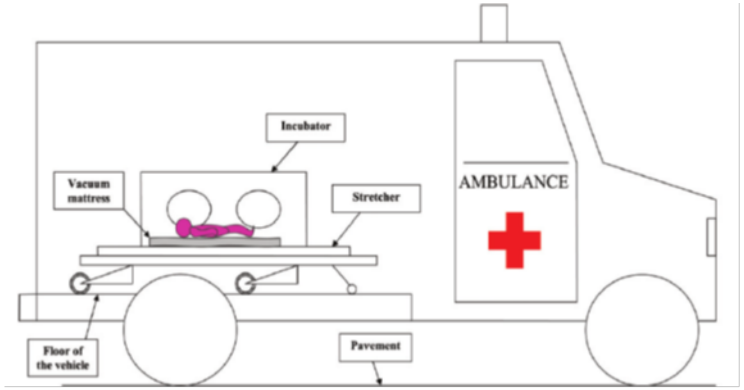
$$FiO_2 = \frac{(FiO_2 \times BP1)}{BP2}$$

ex.: transport from 600 to1800 m with initial FiO_2 of 0.30

0.30 x 706: 609 = 0.35

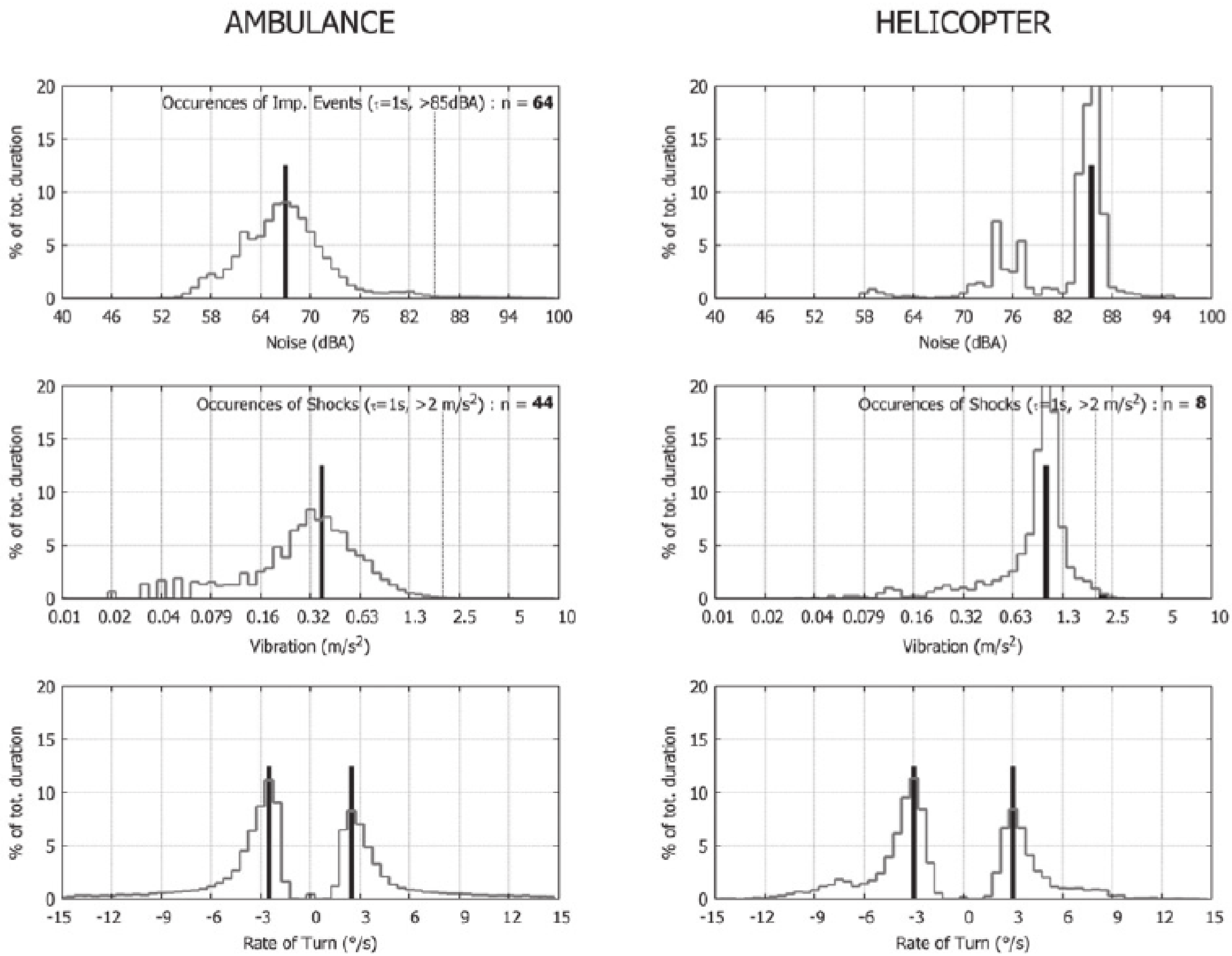
Stressors of flight

- *Barometric pressure*
- *Hypoxia*
- *Motion*
- *Noise,Vibrations*
- *Thermal changes*
- *Decreased humidity*
- *Dehydration*
- *Gravitational forces fatigue*
- *Exposure to fuel vapors*



Physical Stressors during Neonatal Transport: Helicopter Compared with Ground Ambulance

Jean-Christophe Bouchut, MD,[1,3] Eric Van Lancker, PhD,[2] Vincent Chritin, PhD,[2] and Pierre-Yves Gueugniaud, MD, PhD[3]



Noise levels in a neonatal transport incubator in medically configured aircraft

Steven E. Sittig[a,*], Jeffrey C. Nesbitt[b], Dale A. Krageschmidt[b],
Steven C. Sobczak[b], Robert V. Johnson[c]

[a] *Division of Intensive Care and Respiratory Care, Mayo Clinic, Rochester, MN, United States*
[b] *Division of Safety, Mayo Clinic, Rochester, MN, United States*
[c] *Division of Neonatal Medicine, Mayo Clinic, Rochester, MN, United States*

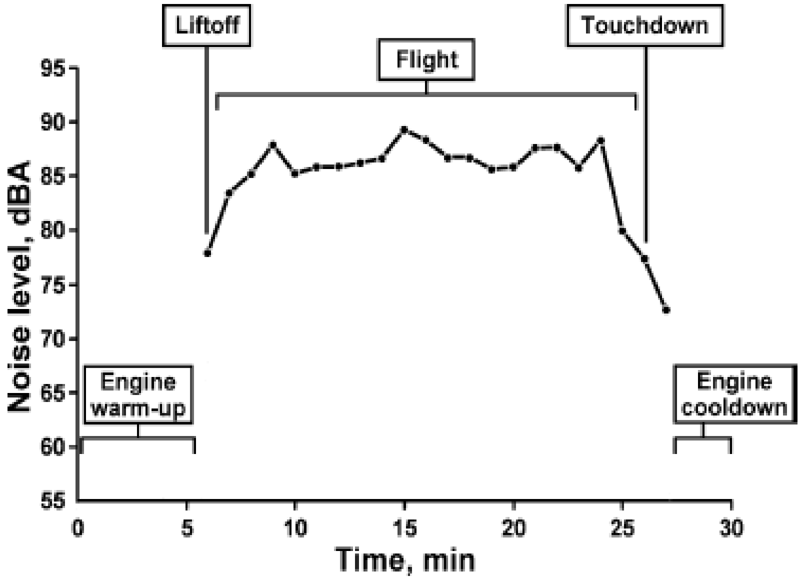


Fig. 1. Incubator Noise during BK 117 Flight Periods.

International Journal of Pediatric Otorhinolaryngology 75 (2011) 74–76

Additional physiologic stresses

3 major factors:

rate of ascent (or descent)

the altitude achieved

the lenght of stay at that altitude

Self imposed stress !!

„If a scientist were to create a stressful enviroment,it might look like our jobs“

Stress, burnout…Air Med J 2003;22:18 - 22

Challenging:

Ventilation during transport

VENTILATION DURING TRANSPORT

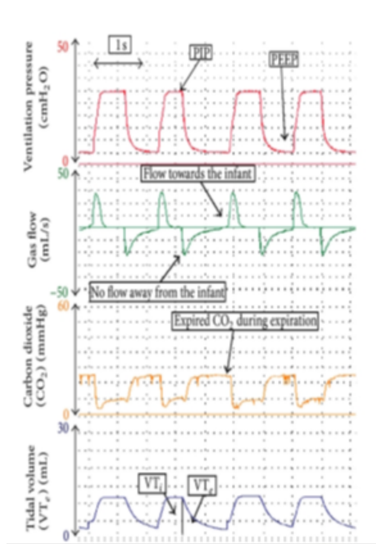
- Ventilation strategies (NICU → transport)

- Transport environment

  Certification for helicopter (Norma EN 1789-2007; EN ISO10993-1-20ß9)

IDEAL NEONATAL VENTILATOR
FOR TRANSPORT

- Hybrid between traditional NICU & transport ventilator
- Advanced ventilation features (AC / SIMV / PSV / HFOV / NIV / CPAP)
- Combination mode (VG)
- Advanced graphical features, waveforms, loops, numeric data…



Monitoring during transport

MONITORING DURING AIR-TRANSPORT

- Clinical assessment almost impossible
- Assessment of chest rise limited
- Limited space
- Poor light
- Certification for helicopter !!

! Increased vibration

Electromechanical interference

O'Reilly M,Emergency Medicine 2012

MONITORING under Transport Conditions

- Monitoring of

  → HR, SpO_2, $ETCO_2$, ($tcpaCO_2$ & $tcpaO_2$)

  hyperventilation !

- Graphical waveforms / numerical values of

  → PIP / PEEP / RR / IT / TV / MV / LEAK

- Flow and volume, compliance, resistance…

G.M.Schmölzer,Arch Dis Child-Fetal and Neonatal Ed 2010

MONITORING DURING AIR TRANSPORT ***TROUBLE ??***

- Minimal signal artefacts of pulse oxymeter
- HR by pulse oximeter as accurate as HR by 3-lead ECG
- Noninvasive BP measurement inaccurate (affected by vibration/motion)

Schmölzer GM,Critical Care Researche and Practice 2013

Colorimetric CO_2 detector pre- transport

- Start using the colorimetric CO_2 detector
- Verification of tube placement
- Tell you about: ventilation

  pulmonary blood flow

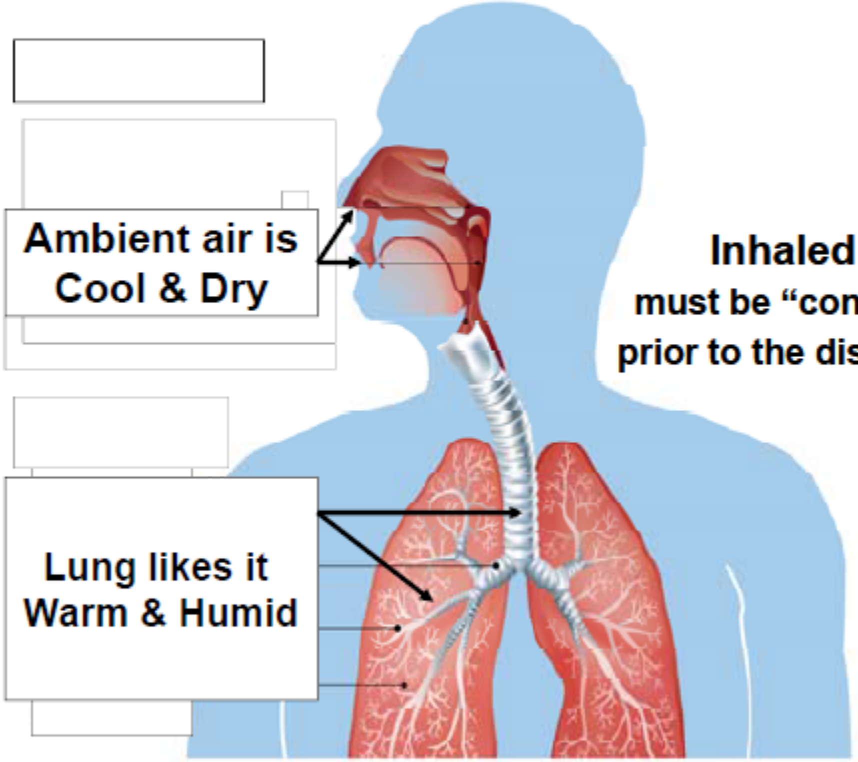
! No detection of hypercarbia

CO_2 MONITORING

- Noninvasive CO2 Monitoring important tool during transport
- No correlation between $ETCO_2$ & arterial CO_2
- $tcpaCO_2$ several limitations
- Arterial Blood Gas Analysis not feasible (?)

D.G. Tingay, Arch Dis Child-Fetal and Neonatal Ed 2005

RESPIRATORY GAS CONDITIONING & HUMIDIFICATION



Inhaled gas:
must be "conditioned" prior to the distal trachea

RESPIRATORY GAS CONDITIONING & HUMIDIFICATION

- *Medical grade gases no water content*
- *Inadequate humidification → progressive airway dysfunction*
- *Optimal temperature & humidity paramount*
- *Heated humidifiers (Neo-Pod „T“)*

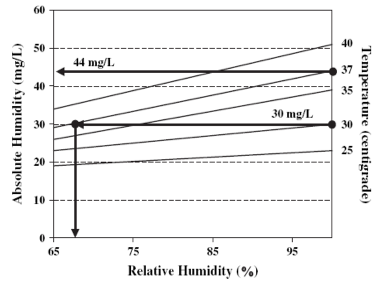
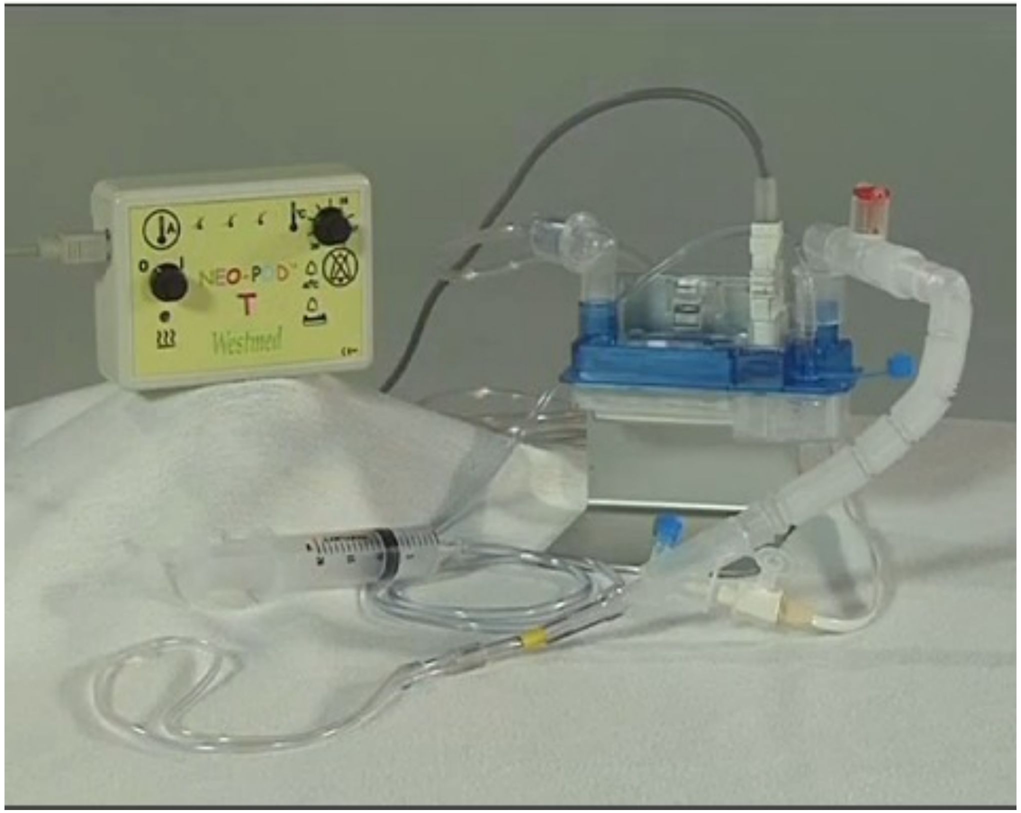


Fig. 1. The relative humidity of a gas depends on its absolute water content and gas temperature. At 37°C and 100% relative humidity, the respiratory gas has 44 mg/L absolute water content. If the gas is saturated (100% relative humidity) at 30°C, its water content is only 30 mg/L. When the gas is then warmed to 37°C, its relative humidity falls to less than 70%.

Clin Perinatol 34 (2007) 19–33



Neo-Pod "T" - Active Humidification & Warming System

AIR vs GROUND TRANSPORTATION of ARTIFICIALLY VENTILATED NEONATES

Respiratory complications (PNX / ET / CPR en route)

Ventilation adjustments

Volume infusion

NO differences

Hon KL. Pediatr EmergCare 2006

Helicopter transport of sick neonates: a 14-year population-based study

Acta Anaesthesiologica Scandinavica 49 (2005)

S. D. Berge[1], C. Berg-Utby[1] and E. Skogvoll[2,3]

[1]Faculty of Medicine and [2]Unit for Applied Clinical Research, Norwegian University of Science and Technology (NTNU), [3]Neonatal Intensive Care Unit, Department of Paediatrics, St. Olav's University Hospital, Trondheim, Norway

Clinical condition and measurements (median with IQR) among the neonates before, during and after Helicopter Emergency Medical Service assistance and transport. Percentages refer to all 256 missions. 'Missing' indicates the number of neonates in which no information was available.

	Before	During	After
Ventilation adequate	101 (43%)	188 (75%)	190 (75%)
missing	23	6	3
Oxygenation adequate	137 (59%)	217 (87%)	216 (85%)
missing	25	7	2
Circulation adequate	191 (84%)	226 (91%)	230 (91%)
missing	28	8	3
Temperature (°C)	36.5 (35.6–37.1)		37.0 (36.2–37.4)
missing	176		61
SpO2 (%)	90 (84–94)		94 (90–97)
missing	147		92
pH	7.24 (7.07–7.29)		7.33 (7.27–7.39)
missing	151		77
Glucose (mmol l^{-1})	3.3 (2.5–4.8)		3.6 (2.5–4.7)
missing	179		111

How comfortable is neonatal transport?

Cath Harrison (catherine.harrison@leedsth.nhs.uk), Liz McKechnie

Department of Neonatal Medicine, Leeds Teaching Hospitals Trust, Leeds, UK

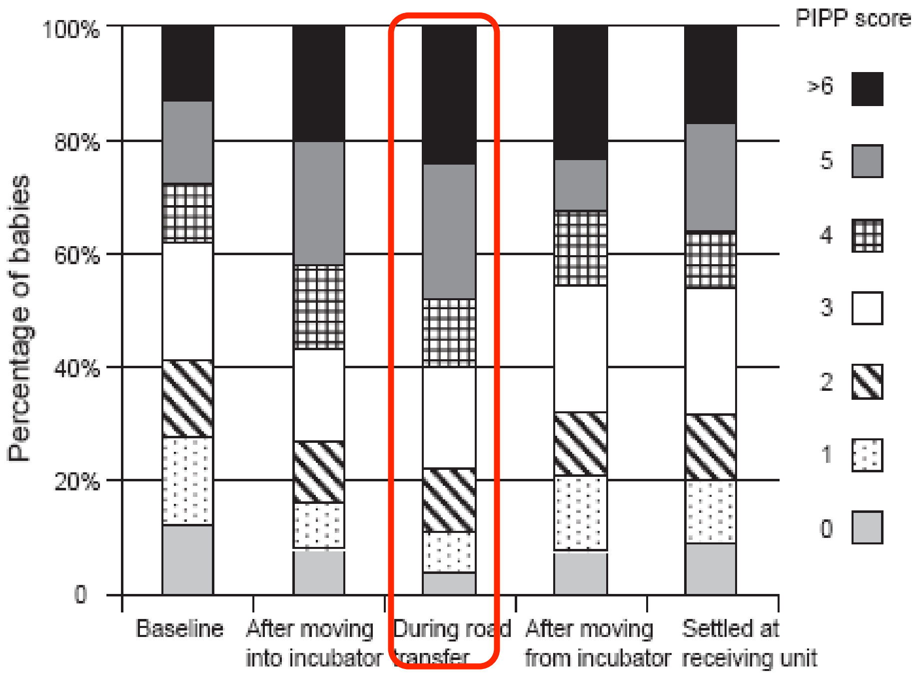


Figure 1 Total premature infant pain profile score for all babies

Foundation Acta Pædiatrica 2012 **101**, pp. 143–147

SAFETY of transport

- *Limited transport safety data*
- *1 crash/collision for every 1000 transports*
- *injury or death: 0.54/1000 transports*

(King and Woodward, Prehosp Emerg Care 2002;62)

Key to successful transport

- *Properly assessing the infant*
- *Preventing stressors*
- *Properly intervening*
- *Knowing physiologic changes*

The „really difficult“ neonatal transport:

Transport of ELBW

Perinatal morbidity and mortality for extremely low-birthweight infants: A population-based study of regionalized maternal and neonatal transport

J. Obstet. Gynaecol. Res. Vol. 41, No. 7: 1056–1066, July 2015

Masatoki Kaneko[1,2], Rie Yamashita[2], Katsuhide Kai[2], Naoshi Yamada[2], Hiroshi Sameshima[2] and Tsuyomu Ikenoue[2]

Mortality and handicap

(50.632 deliveries):

Maternal transport group: 23,2% vs 15,2%

Neonatal transport group: 44% vs 25%

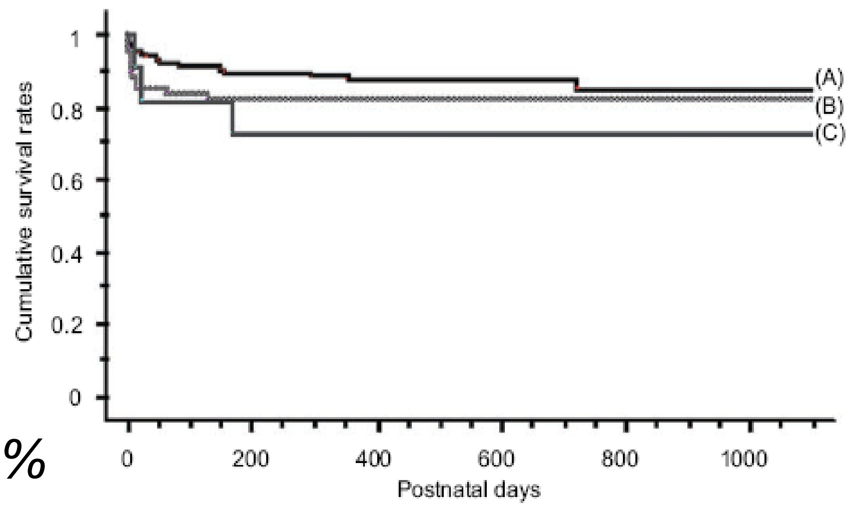


Figure 2 Comparison of the cumulative survival rates of neonates born at a secondary or a tertiary center and those transported to a tertiary center. (A) Neonates born at a tertiary center ($n = 68$). (B) Neonates born at a secondary center (not including transported neonates) ($n = 115$). (C) Neonates transported to a tertiary center ($n = 11$).

Transport of VLBW infants
Impact on the physiologic status

TRIPS score (temperature, blood pressure, respiratory status, response to noxious stimuli)

- *Indirect measure of the physiologic stability*
- *Correlated to mortality and morbidity*

Impact of Interhospital Transport on the Physiologic Status of Very Low-Birth-Weight Infants

Prem Arora, MD[1] Monika Bajaj, MD[1] Girija Natarajan, MD[1] Natasha Purai Arora, MD[2]
Vaneet Kumar Kalra, MD[1] Marwan Zidan, PhD[3] Seetha Shankaran, MD[1]

Table 6 TRIPS Variables Responsible for Change in the Physiologic Status (Measured in Terms of Change in TRIPS Score) During Transport

Variable	Deterioration in physiologic status during transport ($n = 57$)	Improvement in physiologic status during transport ($n = 20$)	Any change[a] ($n = 77$)
Temperature	34 (60%)	13 (65%)	47 (61%)
Respiratory status	4 (7%)	4 (20%)	8 (10.4%)
Blood pressure	4 (7%)	0 (0%)	4 (5.2%)
Response to noxious stimuli	4 (7%)	0 (0%)	4 (5.2%)
Combined (any combination of above)	11 (19%)	3 (15%)	14 (18.2%)

Abbreviation: TRIPS, transport risk index of physiologic stability.
[a]Deterioration or improvement.

Am J Perinatol. 2014 Mar;31(3):237-44.

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Table 5 Multivariate Regression Analysis for the Outcome of Deterioration in Physiologic Status During Transport

Dependent variable	Odds ratio	95% confidence interval	*p* values
Transport duration (5-min increase)	1.33	1.02–1.73	0.035[a]
Weight at transfer (100-g increase)	1.04	0.94–1.16	0.45
Postmenstrual age at transfer (per week increase)	0.94	0.79–1.12	0.47
Pretransport TRIPS score (increase by 5 points)	0.85	0.65–1.13	0.26
Indication for transfer			0.87
PDA ligation	1.32	0.43–3.99	0.63
VP shunt/reservoir insertion	1.006	0.31–3.29	0.99
Referral NICUs (A, B, and C compared with D, the farthest NICU)			0.66
NICU A	1.15	0.26–4.96	0.86
NICU B	0.97	0.20–4.63	0.97
NICU C	0.43	0.08–2.23	0.31

Abbreviations: NICU, neonatal intensive care unit; PDA, patent ductus arteriosus; TRIPS, transport risk index of physiologic stability; VP, ventriculoperitoneal.
[a]Statistically significant.

Am J Perinatol. 2014 Mar;31(3):237-44.

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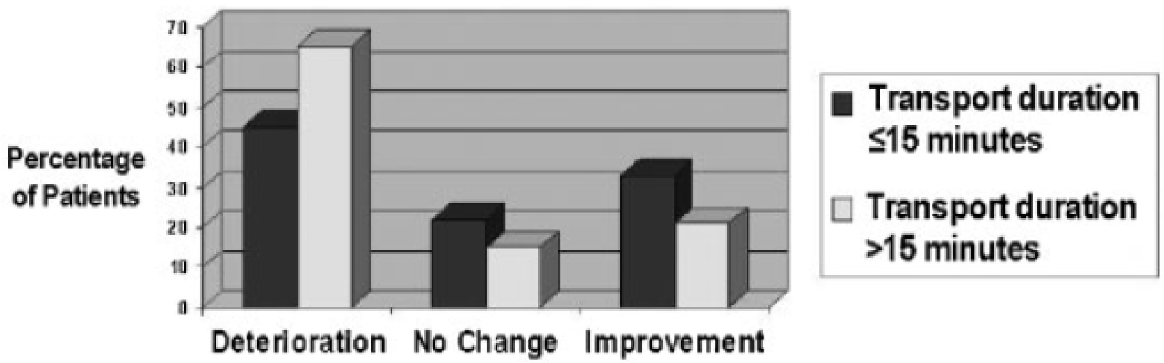


Fig. 2 Change in physiologic status following transport (measured in terms of change in transport risk index of physiologic stability score) in two transport duration groups.

Am J Perinatol. 2014 Mar;31(3):237-44.

Predictive score for clinical complications during intra-hospital transports of infants treated in a neonatal unit

CLINICS 2011;66(4):573-577

Anna Luiza Pires Vieira, Amélia Miyashiro Nunes dos Santos, Mariana Kobayashi Okuyama, Milton Harumi Miyoshi, Maria Fernanda Branco de Almeida, Ruth Guinsburg

Department of Pediatrics - Neonatal Division of Medicine. Federal University of São Paulo, São Paulo/SP, Brazil.

Table 3. Final model of the multiple logistic regression analysis for clinical complications during intra-hospital transports and the derived score.

Variables	OR	95% CI	p	Score
Gestational age <28 weeks	3.18	1.01-10.05	0.049	6
Gestational age 28-34 weeks	1.50	0.75-3.00	0.248	3
Gestational age >34 weeks	1.00	Reference		2
Pre-transport temperature <36.3°C or >37.0°C	1.53	0.82-2.87	0.184	3
Pre-transport temperature 36.3-37.0°C	1.00	Reference		2
CNS malformation	1.86	0.93-3.71	0.078	4
Other diseases	1.00	Reference		2
Transport for surgery	2.34	1.04-5.27	0.036	5
Transport for MRI or CT scan	1.237	0.60-2.56	0.567	3
Other destinations	1.000	Reference		2
Mechanical ventilation	3.98	1.52-8.93	<0.001	8
Supplemental oxygen therapy	3.26	1.72-6.17	0.004	7
No oxygen therapy	1.00	Reference		2

Table 4. Expected and observed frequency of clinical complications according to the predictive score intervals.

	Expected frequency		Observed frequency		Total	
Score	n/total	%	n/total	%	n/total	%
<13	10/125	8.0	13/144	9.0	23/269	8.6
13-15	17/70	24.3	18/106	17.0	35/176	19.9
16-20	27/71	38.0	43/123	35.0	70/194	36.1
>20	20/35	57.1	11/21	52.4	31/56	55.4
TOTAL	74/301	24.6	85/394	21.6	159/695	22.9

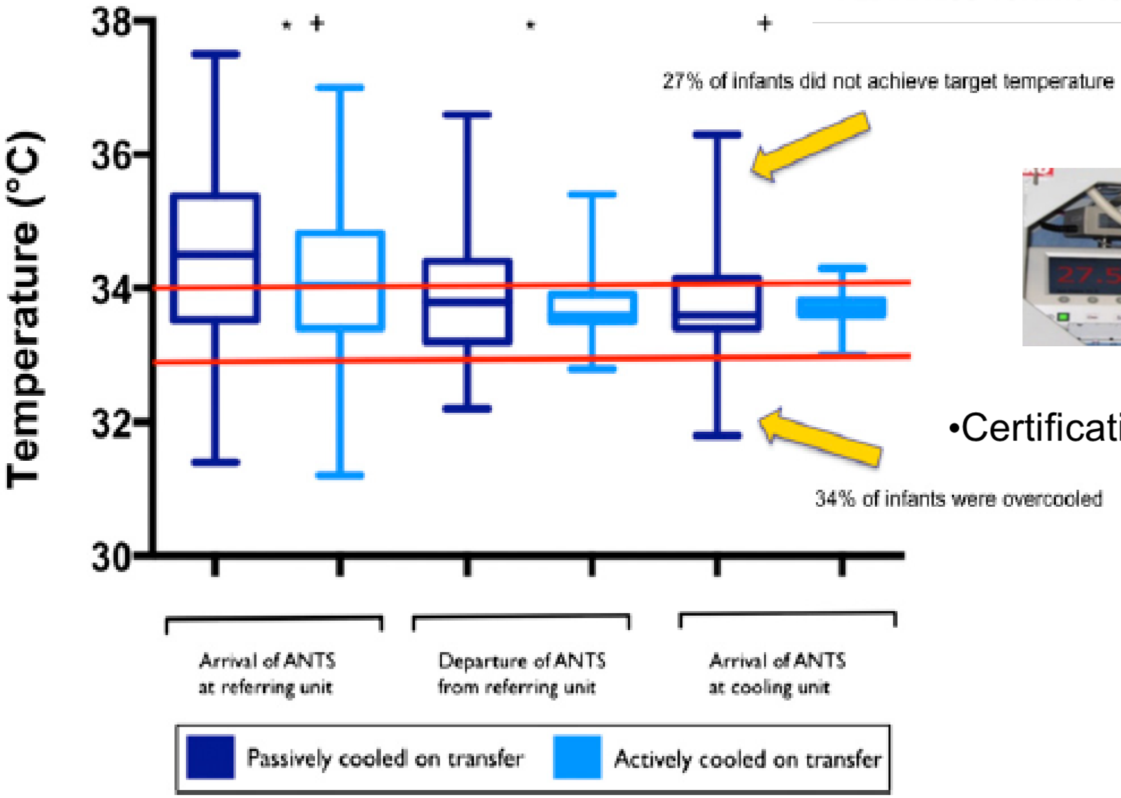
Hosmer-Lemeshow test χ^2: p = 0.827.

The „really difficult“ neonatal transport:

Therapeutic hypothermia during transport

Active Versus Passive Cooling During Neonatal Transport

CHAUDHARY et al
PEDIATRICS Volume 132, Number 5, November 2013



•Certification for helicopter !!

FIGURE 2
Box plot for temperature measurement at time of arrival of the transfer team (ANTS) at the referring unit, departure of ANTS from the referring unit, and arrival of ANTS at the regional cooling unit. The area between the lines shows the target temperature range of 33°C to 34°C; the percentages reflect those

The „really difficult" neonatal transport:

Transport with iNO

TRANSPORT with iNO…

- *iNO improves oxygenation*

- *iNO delivery vital*
- *Limited safety data*
- *No untoward events*

Transport Vehicle	Maximum (NO) With Complete D-Cylinder Release	Measured (NO	Measured (NO_2)
Lear Jet 35	31 ppm	NM	NM
King Air 90	40 ppm	<0.1 ppm	<0.1 ppm
King Air 200	25 ppm	NM	NM
Eurocopter A-Star	94 ppm	<0.1 ppm	<0.1 ppm
Ground Ambulance	34 ppm	<0.1 ppm	<0.1 ppm

NM indicates not measured.

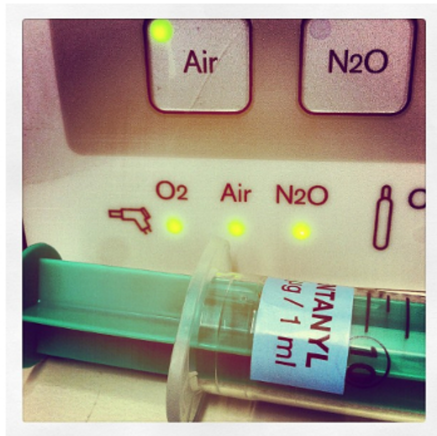
Pediatr Crit Care Med. 2004 Nov;5(6):542-6.

Experience with mobile inhaled nitric oxide during transport of neonates and children with respiratory insufficiency to an extracorporeal membrane oxygenation center.

Westrope C[1], Roberts N, Nichani S, Hunt C, Peek GJ, Firmin R.

Requirements for the use of iNO

- *Who on the transport?*
- *Approval by the carrier*
- *Proper storage*
- *Awareness of the crew*



Arch Dis Child Fetal Neonatal Ed 2014;**99**:

The „really difficult“ neonatal transport:

ECMO during transport

Interhospital transport on ECMO

- *highly complex*
- *efficient and safe*
- *mobile ECMO team (technology, communication…)*

The Stockholm experience: interhospital transports on extracorporeal membrane oxygenation

L. Mikael Broman[1*], Bernhard Holzgraefe[1], Kenneth Palmér[1] and Björn Frenckner[2]

Broman *et al. Critical Care* (2015) 19:278
DOI 10.1186/s13054-015-0994-6

Abstract

Introduction: In severe respiratory and/or circulatory failure, extracorporeal membrane oxygenation (ECMO) may be a lifesaving procedure. Specialized departments provide ECMO, and these patients often have to be transferred for treatment. Conventional transportation is hazardous, and deaths have been described. Only a few centers have performed more than 100 ECMO transports. To date, our mobile ECMO teams have performed more than 700 transports with patients on ECMO since 1996. We describe 4 consecutive years (2010–2013) of 322 national and international ECMO transports and report adverse events.

Methods: Data were retrieved from our local databases. Neonatal, pediatric and adult patients were transported, predominantly with refractory severe respiratory failure.

Results: The patients were cannulated in 282 of the transports, and ECMO was started in these patients at the referring hospital and then they were transported to our ECMO intensive care unit. In 40 cases, the patient was already on ECMO. Of the transports, 60 % were by aircraft, and the distances varied from 6.9 to 13,447 km. In about 27.3 % of the transports, adverse events occurred. Of these, the most common were either patient-related (22 %) or equipment-related (5.3 %). No deaths occurred during transport, and transferred patients exhibited the same mortality rate as in-hospital patients.

Conclusions: Long- and short-distance interhospital transports on ECMO can be safely performed. A myriad of complications can occur, but the mortality risk is very low. The staff involved should be highly competent in intensive care, ECMO physiology and physics, cannulation, intensive care transport and air transport medicine. They should also be skilled in recognition of risk factors involved in these patients.

The „really difficult“ neonatal transport:

??

Transport with a pneumothorax. diaphragmatic hernia, surgical problems …….

Table 1 Outline of key issues in stabilising neonates for transfer[19]

Airway/breathing

- Should the baby be intubated before transfer? A lower threshold for intubation should be used than on the neonatal intensive care unit, to minimise the need to intervene in transit. In an infant > 30 weeks gestation, if the vital signs (pulse, blood pressure, respiratory rate, temperature) have been consistently stable in oxygen < 50% and if the $PaCO_2$ is normal, it may be acceptable to move the baby without intubation. If the infant is:
  unstable
  - has a rising oxygen requirement > 50%
  - has a rising $PaCO_2$
  - has recurrent apnoea
  - is < 30 weeks gestation

then intubation and respiratory support is highly likely to be required, at least for the duration of the journey.

- If already intubated, the endotracheal tube (ETT) must be correctly positioned and secure. ETTs must be secured to a high standard, to avoid accidental extubation in transit.
- Adequate respiratory support must be given.
- Surfactant must be administered if indicated.

Circulation

- Arterial access, if not already established, should be considered in infants who require repeated blood gas analysis or accurate blood pressure measurement. If siting a line will not influence practice before or during the journey, then it may be acceptable to delay this until after the transfer.
- Correct positioning and security of the catheter must be checked.
- Circulation with fluids and/or inotropes should be supported early, as indicated.

Temperature

- Assess temperature and consider the support required for transfer.
- Use temperature maintenance adjuncts, such as chemical gel mattresses.[20 21]

Blood glucose

- Measure and stabilise blood glucose.
- Secure intravenous access.

Infection

- Screen for infection as indicated.
- Start treatment.

Parents' information and wishes

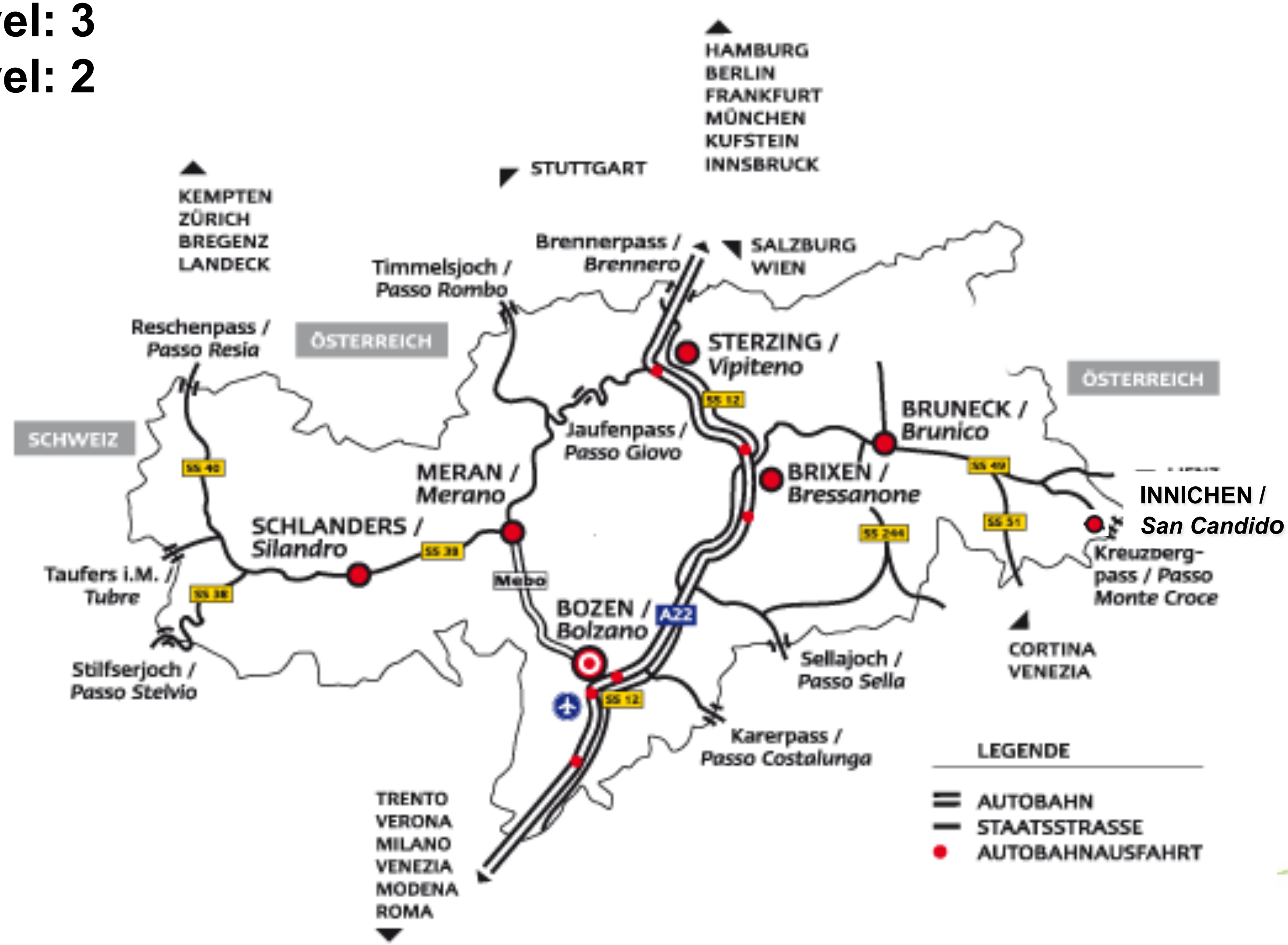
- Discuss plans with parents. Ascertain their plans about travelling to referral unit. Liaise with midwifery staff about maternal transfer.

Information

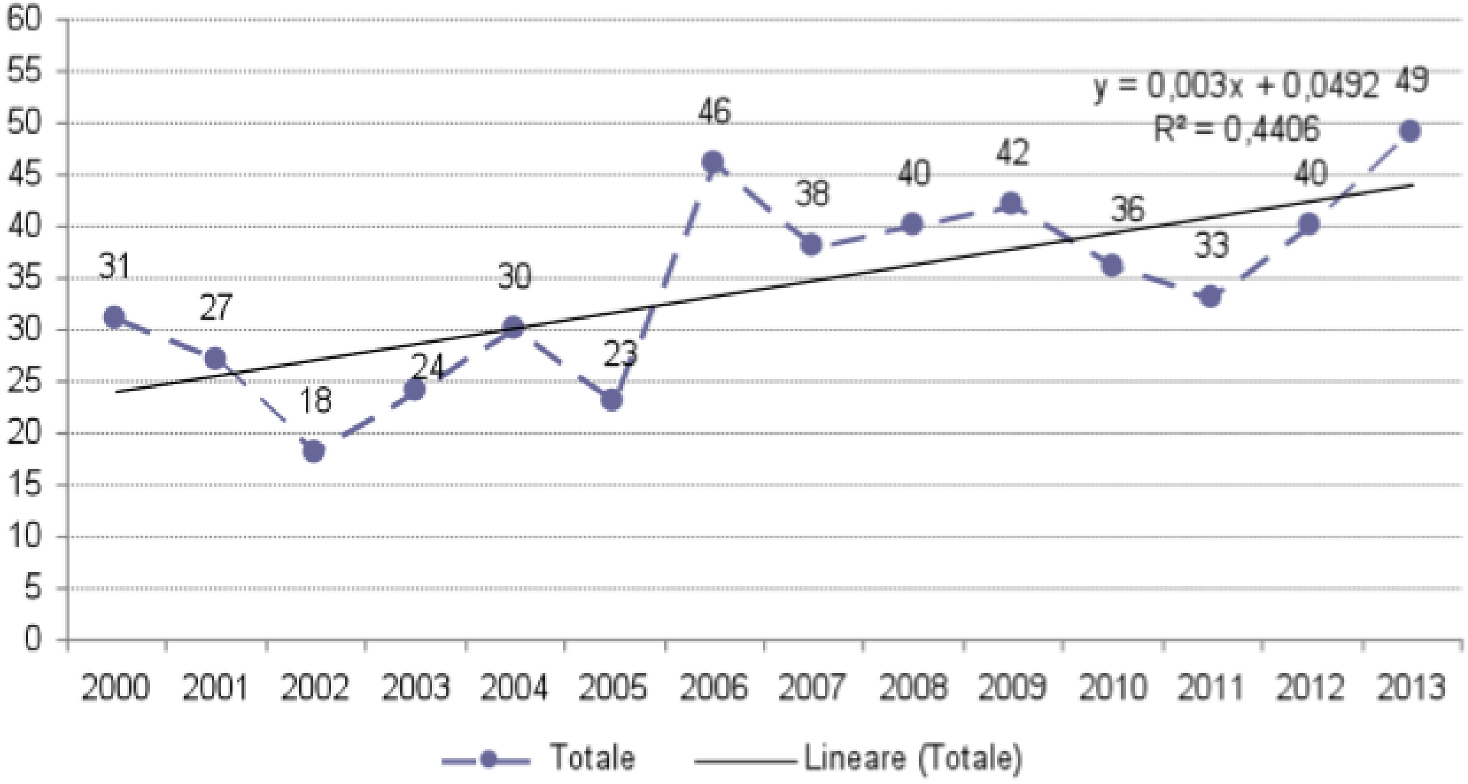
- Ensure the team at the referral unit will have all the necessary information to advance the care of the baby.

South- Tyrol

3° Level: 1
2° Level: 3
1° Level: 2

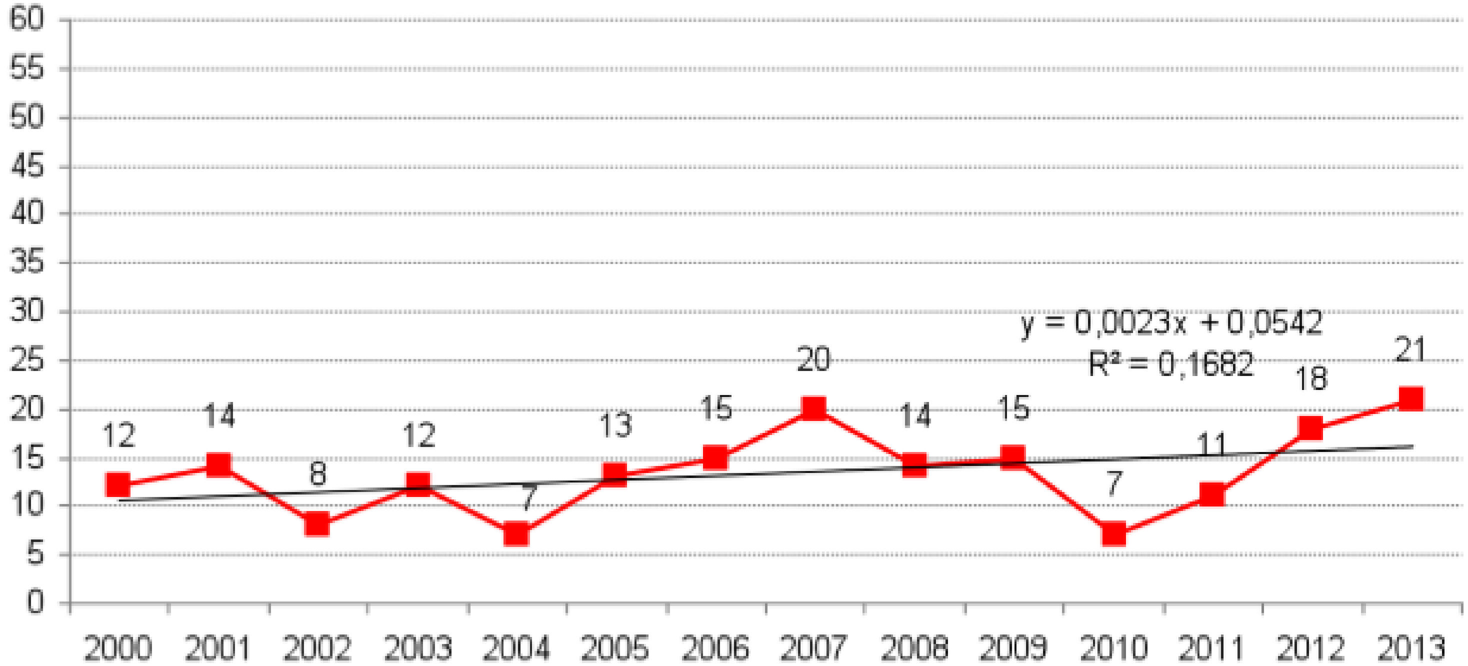


TOTAL TRANSPORT NUMBER



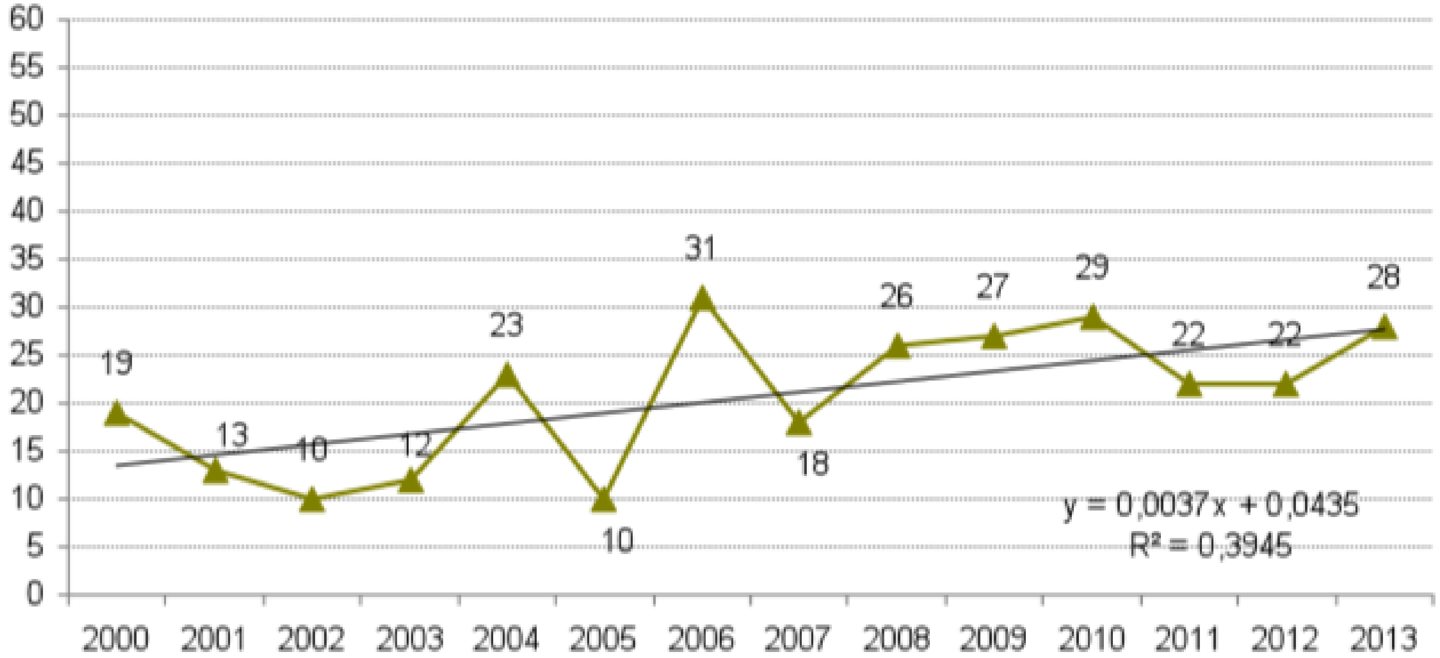
p=0.015

TRANSPORT NUMBER LEVEL II



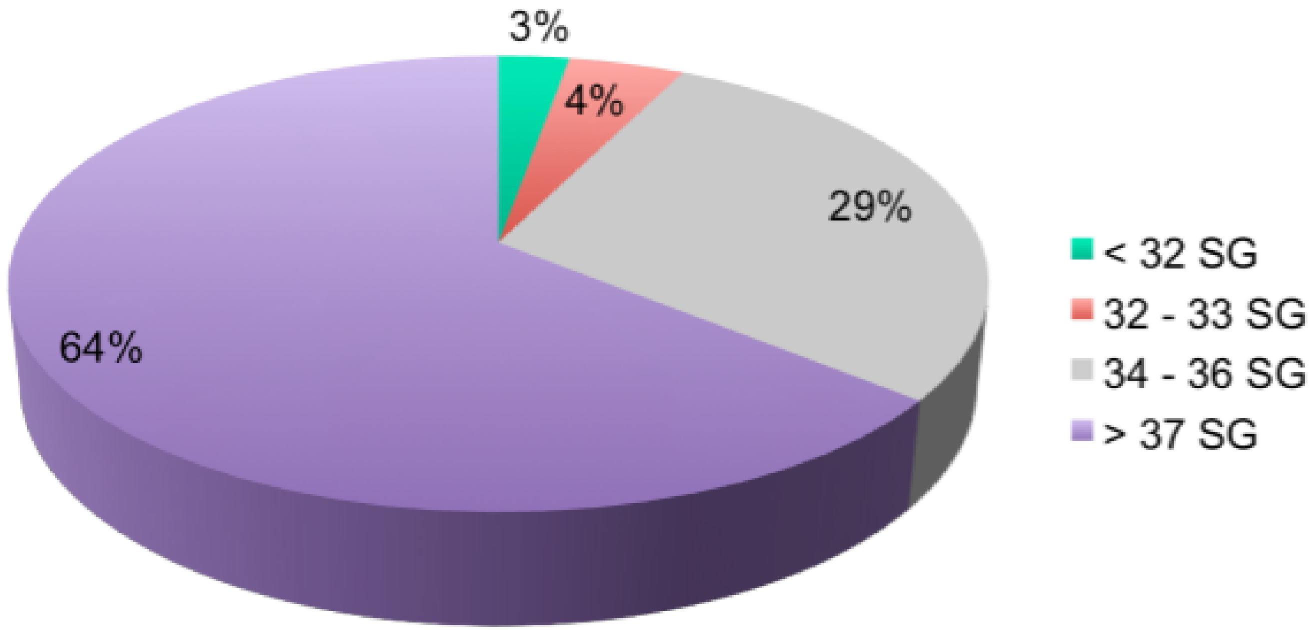
p=0.136

TRANSPORT NUMBER LEVEL I



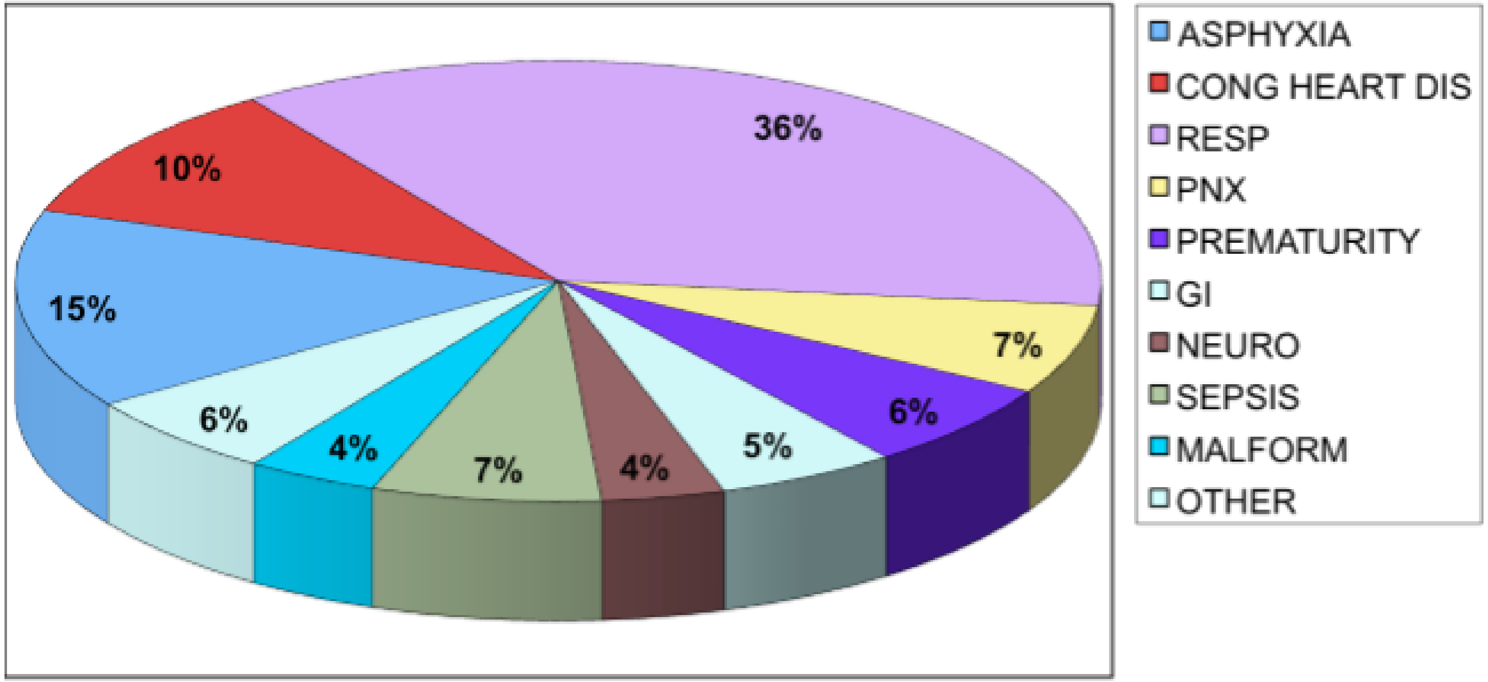
p=0.055

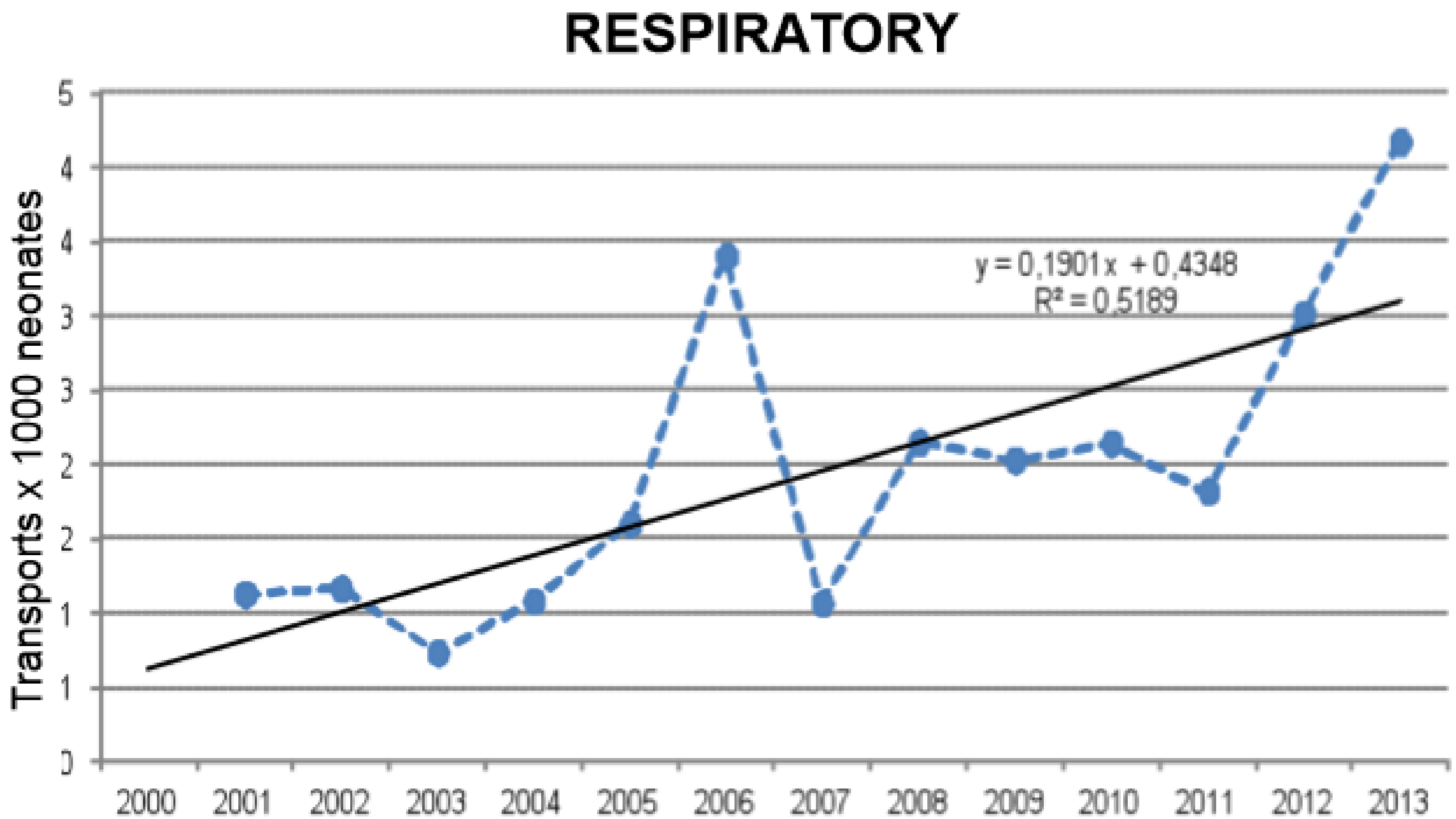
GESTATIONAL AGE



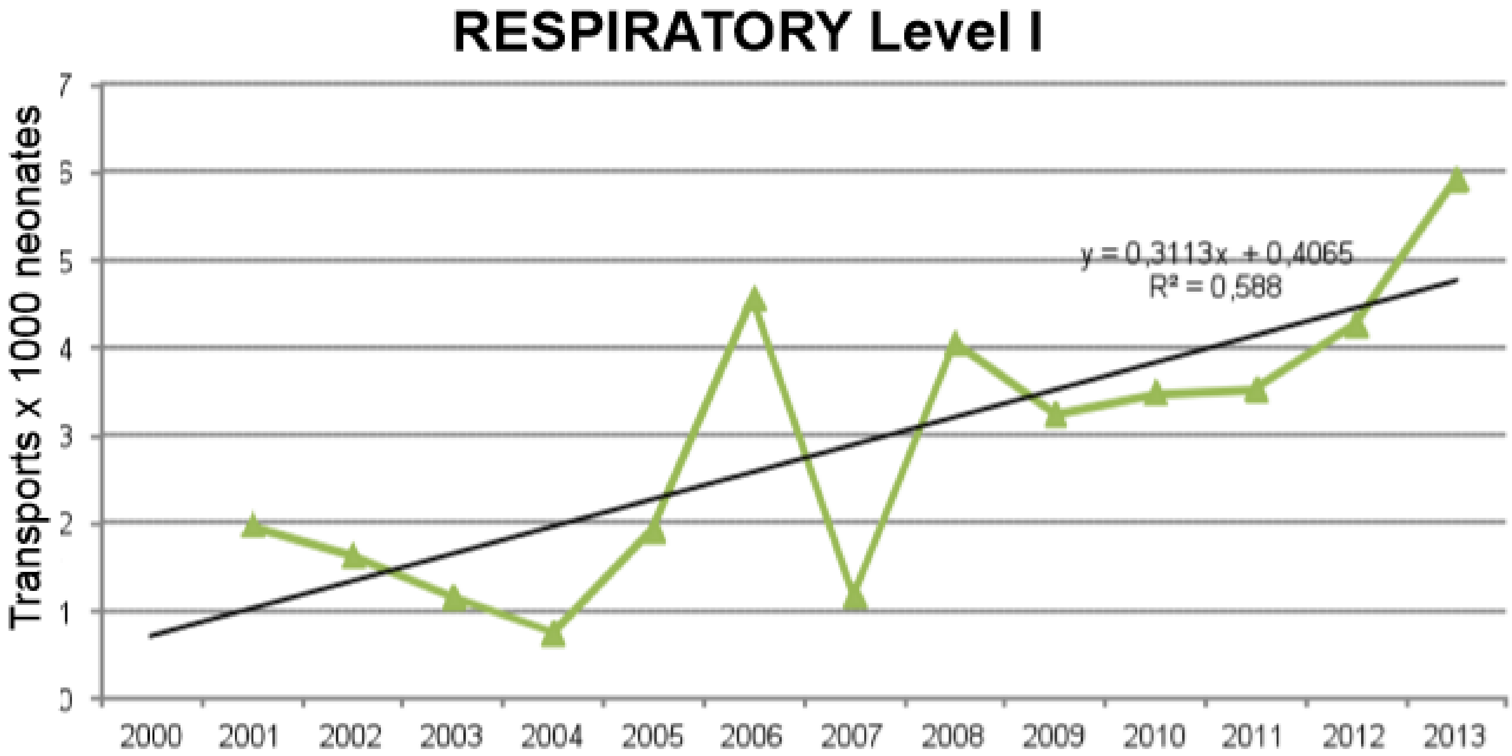
→ no difference over the years

MAIN PATHOLOGIES




RESPIRATORY
Transports x 1000 neonates
5
4
4
3
3
2
2
1
1
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
y = 0,1901x + 0,4348
R² = 0,5189

p=0.015


RESPIRATORY Level I
Transports x 1000 neonates
0
1
2
3
4
5
6
7
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
y = 0,3113x + 0,4065
R² = 0,588

p=0.015

Conclusions

The neonatal transport

- *Scientific information??*
- *Evidence ?? and clinical expertice !!*
- *Advanced Training (resuscitation, stabilisation ,simulatuion.)*
- *Data collection and analysis*
- *Audit and research, benchmarking*
- *Telemedicine for triage*

Thank’s
to the whole transport team
and organisation

(NICU, 118)