Neonatal Transport in Hungary

Zsolt Somogyvári MD., PhD., MSc.

Neonatal Emergency and Transport Service
of the Peter Cerny Foundation Budapest

www.pca.hu
Background
Neonatal Care in Hungary -’80

10 million inhabitants in Hungary.
Total number of birth 92,000 - 96,000 per year
45% of the babies born in the PCA-covered “central region” of Hungary
Prematurity rate: 8-9 per cent
Perinatal mortality rate: was 15-20 per thousand
No inter-facility transport from referral hospitals into 22 NICU centres
National Emergency Ambulance Service (NEAS) – for adults only
Insufficient and non-specialized intrauterine transport
Two times increased mortality in outborn vs inborn ventilated neonates
Unsolved transportation of critically ill neonates for diagnostic and therapeutic interventions
Characteristics of „Central region” of Hungary-1988

Budapest + 6 counties
4.5 million inhabitants
120-140km radial surroundings of Bp.
Driving distance: 60-70 minutes
Few motorways

PNICU, NICU Level-III: 8 + 4
Referral hospital with DR: 31
Diagnostic centres: 10

- No traditions, tools, equipments and experience of inter-facility transport.
- High chance for simultaneous calls
- Resuscitation demand in the delivery room (DR)
- Low standard of care regarding stabilization in the referral hospitals
- Large number of prematures and asphyxiated neonates
- Demand on emergency care of neonates outside hospitals (prehospital care)
- High demand on transport for diagnostic and therapeutic interventions.
- High demand on return or back transport to NICU Level-II (to other hospitals)
<table>
<thead>
<tr>
<th>Decades</th>
<th>‘80</th>
<th>‘90</th>
<th>‘00</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prematurity rate</td>
<td>8-9 %</td>
<td>8-9 %</td>
<td>8-9 %</td>
<td>no change</td>
</tr>
<tr>
<td>Perinatal mortality rate</td>
<td>15-20 per thousand</td>
<td>7-18 per thousand</td>
<td>4-14 per thousand</td>
<td>improved</td>
</tr>
<tr>
<td>Intrauterine transport</td>
<td>poor</td>
<td>poor</td>
<td>poor</td>
<td>obstet. habit</td>
</tr>
<tr>
<td>NICU Level-III Network</td>
<td>12</td>
<td>24</td>
<td>22</td>
<td>too many</td>
</tr>
<tr>
<td>Neonatal Inter-facility interhospital transport system „mobile NICU-III”</td>
<td>No</td>
<td>in some regions</td>
<td>in the whole country</td>
<td>9 different regional challenges</td>
</tr>
<tr>
<td>Mortality outborn / inborn ventilated + transported babies</td>
<td>double</td>
<td>equal *</td>
<td>equal *</td>
<td>* depends on DR-NRP</td>
</tr>
<tr>
<td>Transportation of critically ill neonates for diagnostic and surgical interventions</td>
<td>unsolved</td>
<td>transport solved</td>
<td>transport solved</td>
<td>logistic problems</td>
</tr>
<tr>
<td>air/ground transfer of neonates</td>
<td>No</td>
<td>ground+air</td>
<td>ground</td>
<td>financial</td>
</tr>
<tr>
<td>Outreach education (delivery room resuscitation)</td>
<td>insufficient</td>
<td>From ‘94</td>
<td>PCA *</td>
<td>*AAP-NRP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Project Hope</td>
<td>Szeged</td>
<td></td>
</tr>
</tbody>
</table>
Covered area by the 9 different Neonatal Inter-facility Transport Services – as a Network – since 2002
<table>
<thead>
<tr>
<th>Central region of Hungary (Hospitals: 53 → 42)</th>
<th>‘80</th>
<th>‘90</th>
<th>‘00</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prematurity rate</td>
<td>8-9 %</td>
<td>8-9 %</td>
<td>8-9 %</td>
<td>No change</td>
</tr>
<tr>
<td>Perinatal mortality rate</td>
<td>15-20 per thousand</td>
<td>9-12 per thousand</td>
<td>5-11 per thousand</td>
<td>Improved</td>
</tr>
<tr>
<td>Intrauterine transport</td>
<td>poor</td>
<td>poor</td>
<td>poor</td>
<td>Bad habit</td>
</tr>
<tr>
<td>NICU–CICU Level-III Bp+al</td>
<td>8 + 4</td>
<td>10 + 6</td>
<td>6 + 5</td>
<td>Too many</td>
</tr>
<tr>
<td>Inter-facility interhospital neonatal transport system</td>
<td>no* from ’89</td>
<td>mNICU / NETS</td>
<td>mNICU / NETS</td>
<td>Regional challenges</td>
</tr>
<tr>
<td>Mortality outborn/inborn ventilated + transfered babies</td>
<td>double</td>
<td>NS</td>
<td>NS</td>
<td>No transport dependency</td>
</tr>
<tr>
<td>Transportation of critically ill neonates for diagnostic and surgical interventions</td>
<td>unsolved</td>
<td>transport solved</td>
<td>transport solved</td>
<td>carried facilities from 2010</td>
</tr>
<tr>
<td>Average N of transport/day</td>
<td>(1989) 3</td>
<td>6</td>
<td>8</td>
<td>financial</td>
</tr>
<tr>
<td>Outreach education</td>
<td>no</td>
<td>since 1994</td>
<td>yes</td>
<td>1300 people</td>
</tr>
</tbody>
</table>
Milestone - 1996: Comparison of 0-6 day mortality pre- and post development of the Peter Cerny Ambulance:

Mortality rate decreased significantly compared with the historical control group.

www.pca.hu

(Pediatric Emergency Care 1997 13:290-293)
Comparison of 0-6 day mortality in the Cerny Area covered by developed dedicated inter-facility neonatal transport system and other parts of Hungary, covered by non-neonatal inter-facility transport services:

Mortality rate decreased significantly compared with the control group in the same period.

www.pca.hu

(Pediatric Emergency Care 1997 13:290-293)
Our yearly activity:

There are **35 hospitals** that belong to the area covered by the Cerny Ambulance.

The ability of most of the referring hospitals to provide high-level first hour care for small or sick infants is much more less than in the UK.

**Patient number: 3000** neonatal transfer per year

- **1000** emergency cases, many with acute interventions
  (iv access, intubation, umbilical canulation, chest drains)
- **1000** back or return transfers to lower level NICU-s,
- **1000** inter-hospital transport for diagnostic interventions: ultrasound,
  CT, MRI, cardiac echo, surgical, cardiac surgical, neurosurgical and
  ophthalmologic interventions etc.
- **450-500** mechanical ventilations per year with measuring SAT, RR, HR,
  and mobile blood-gas analysis (iSTAT)
- **50** resuscitations per year in delivery rooms
- **30** critically ill patients per year from home deliveries
- **active hypothermia** treatment of asphyxiated newborns during transport
Covered area of the Peter Cerny Emergency and Ground Ambulance Service since 1989
Results of 20 years (1)

Transported number of neonates
n= 46,523
Results of 20 years (2)

Transported number of neonates **46,523 during 20 years**

**Mechanical ventilation** during the inter-facility transport: **9,205**
- every 5th from the 46,523 transports
- average respiratory support: 460 cases per year

- Blood-gas analysis done in the referral + receiving hospitals: 90%
- Blood-gas analysis of the ventilated neonates done **during** the transport: 25%

- Monitorization of HR, RR, BR, SAT happened: 100%

- **Surfactant treatment** was applied by the PCA for every VLBWI with RDS after delivery in the referral hospitals. (The average is 40 cases per year)

Number of successful **resuscitation** 1,010 from 1,124 (90%)
Characteristic of the mechanical ventilated group  
(IPPB, IMV. CPAP, nCPAP - Babylog-2, Babylog-20000, Biomed-2i respirators)

Start of respiration after delivery, in the first:
- < 12 hours: 57% (5,233 / 9,205)
- < 6 hours: 51% (4,694 / 9,205)
- < 3 hours: 41% (3,797 / 9,205)
- < 1 hour: 26% (2,418 / 9,205)

Birth weight of ventilated patients:
- < 1500 g: 35% (3,202 / 9,205)
- < 1000 g: 20% (1,801 / 9,205)
- < 500 g: 2% (165 / 9,205)

Gestational age:
- < 30 gestational age: 27% (2,473 / 9,205)
- < 26 gestational age: 8% (770 / 9,205)

Apgar score less than 7 after the 1st minute of life: 50% (4,608 / 9,205)
Apgar score less than 4 after the 1st minute of life: 24% (2,209 / 9,205)
Apgar score less than 7 after the 5th minute of life: 27% (2,527 / 9,205)
Apgar score less than 4 after the 5th minute of life: 12% (1,070 / 9,205)
Outcome characteristic of the ventilated infants
Change in the patient's conditions before and after the transfer
(n=9,205)

- no data: 1%
- better: 37%
- unchanged: 61%
- worse: 1%
Results of 20 years (3)

Peter Cerny Ambulance ensures a dedicated neonatal inter-facility transport for all babies
- who are less than 6kg of bodyweight and/or
- 60cm of body length independently for their age.

The Cerny’s know-how has served as a dedicated neonatal inter-facility model:
- for legislation of Ambulance Regulations 1995
  by the Ministry of Health
- for the National Neonatal Transport System
  of Hungary (2002-2007)

The first complete guideline for neonatal emergency care of neonate in Hungary is based on the Cerny’s know-how
How we do it…

The “9 Ws” as the key elements of our Neonatal Transport Service working in the Central Region of Hungary
WHY do about 3,000 infants per year need to be transported?

The infants have to be transported because they were not born
- in the right place or
- at the right time, or
- because the circumstances required special needs.

The so-called intrauterine transport proved to be insufficient and the facilities for specialist examinations have not been available in those hospitals without NICUs. (cardiac ECHO, ultrasound, CT, MRI)
WHO must be transported – generally? (1)

The target group is not only defined by age but also by body size.

Babies need much more neonatal inter-facility transport than pediatric supply when the body weight is below 6kg and/or the body size is less than 60cm (which ensure that babies fit into transport incubators).

And if we talk about neonate transport, we imply activities for emergency reasons, which require immediate intervention in any potentially life threatening cases. Worsening condition of the infant in any time and any place requires urgent and fast professional medical interventions, which are served optimally only by “a mobile NICU on four wheels”.

Asphyxia  ELBWI  CDH  Ectopia cordis
WHO must be really transported? (2)

1) Newly born infants who need **resuscitation** (in the delivery room / in pediatric wards of town hospitals / at home delivery / in emergency cases anywhere (prehospital care) or

2) Neonates during the first weeks of life who are critically ill for any other reasons, and need sub-intensive or intensive neonatal care and inter-facility transport.

3) **Return / reverse / back transport** to the referral hospitals with recovering infants, who have not yet needed high-level intensive care.

4) **Premature infants** in the 3-4 month of life after discharge from NICU, with 2-3 kgs body weight, who need emergency help, and more specialized neonatal care rather than the regular pediatric care in a critical situation at home.

5) Infants with problems during the transition period after “planned” home delivery.

6) **Earlier ELBWIs** by now 5-6 month old infants who suffer from typical chronic neonatal diseases like BPD and need acute care when the condition worsens.
WHEN do newborns need to be transported?

“In the right time” - Considering the different aims of the transport.

Call for interhospital transport with ongoing resuscitation by the referral team is the most urgent case for our emergency newborn transport. We have to leave within 3 minutes in the day and 6 minutes at night and drive as fast as safety and possible. (Average travel time inside Budapest is 10-12 min. and to rural areas 25-50 min.)

There are many situations and places when resuscitation has been done by our mobile NICU. Examples include deliveries at home or birth or death in an unexpected place (outside or inside of hospitals).

If our emergency-transport team is called before the caesarian section of an asphyxiated foetus, we have to start resuscitation wherever we are. We are able to use the controlled active hypothermia at the place of birth and continue it in the ambulance car as well.

Planned transports have been coordinated by our dispatch service (24/7 duty) which attempts to satisfy every demand. Response time of interhospital transports between NICUs is 5-10 minutes. For diagnostic or operative interventions, transports can be planned up to 1-3 days.
Planned transports for diagnostic or operative interventions (Logistic challenges)

**Cardiology:** ECHO, early cardiac intervention

**Radiology:** Ultrasound, CT, MRI, fMRI
   (fMRI postasphyxic protocol – since 2007)

**Ophthalmology:**
   ROP examination + cryopexy 1989-2000
   ROP examination + laser – since 2001
   ROP examination telemetry – from 2010

**Surgery:** early surgical intervention

**Neurosurgery:** shunt (hydrocephalus)

Developed possibility of inter-facility transport of critically ill, ventilated neonates for diagnostic examinations and surgical intervention since 1989:
Logistic Challenge from Everyday Routine

Transport to neurosurgical examination or shunt-operation and back transport in some days

3 different mNICU Service meet in rendezvous system

70 + 170 + 50 = 290 miles
1.5 + 2.5 + 1 = 5 hours
Example for an Extreme Logistic Challenge

The peak of the multiple parallel calling was:

**21 referrals in a 26-hour period**
(comparing with the average daily 7-8 cases)

**12 emergency transports callings**

**9 planned transports**
(back transports + inter-facility transports for medical interventions
+ rendezvous with the East-Hungarian Neonatal Interfacility Service’s van)

- 1 neonatologist + 2 nurses + 2 drivers in duty with 2 vans
- and other 3 neonatologists + 2 nurses + 1 driver ordered from day off.
- the 4th driver was the medical control physician temporarily.
- it was performed successfully by 4 vans. (1,255 miles with 4 cars!)

During the day the medical control physician left the car which carried the stable neonate left him the observation by the RN, before arriving NICU. He changed to a re-empty car without MD, and started the next case. He controlled the RN’s work through cellular phone.
Our telecommunication background for Logistic
– parallel systems for Safety:

**Freestanding dispatch service** dedicated to the PCA - 4 employees

**Phones:** general-lines
  + mobile phones
  + University lines

**Recording** of emergency phone-call permanently

**Video controlled** entrance and parking place of the headquarter

**Follower system** for all cars permanently by Satellite Sky-Guard

**Skype: virtual present** of the program director on the shift-change meeting every morning (7 days a week)

Ambulance Information System (AIS)
Informatic background for Logistic and Quality Assurance

1) Computerized data collection parallel with paper-based
   Transport and medical documentation – scanning data
   – software for recognizing character – statistics

2) Data collection by Satellite Sky-Guard Follower System (GPS)

Data collection: demographic data, system data, clinical data adverse events before or during transport, diagnosis at discharge, disposition

Data collection by Satellite Sky-Guard Follower System: on line control of the cars en route – speed, acceleration-deceleration, waiting and running time.

Indicators - Ambulance Information System (PCA-AIS)

Medical Internal Audit - Quality Improvement:
   Education, safety, administrative, communications, equipment, vehicles, patient care guidelines protocols reviewed regularly, and peer reviewed unexpected events. - Based on our Ambulance Information System

External Audit – by the Ministry of Health and the National Ambulance Org.
WHO transports neonates?

Our Ambulance has been working with standard team-framework generally, but it can be changed occasionally.

- **1x 24/7** MD + RN + Driver
- **1x 24/7** RN*+ Driver  
  (* RN + RN + driver would be optimal on the 2\(^{nd}\) 24/7 car)
- **1x 8/5** RN + Driver
- **1x 24/7** Dispatch staff

*You have to make it clear that our registered nurses are very experienced neonatal nurses. As most of them can even do basic procedures (such as iv cannulas) **they more or less correspond to the „nurse practitioners” in the UK.**
Medical doctors (6): neonatologists (5) + 1 pediatricians (emerg.med.specialist)

Drivers (11): skilled for neonatal emergency demands

Administrative (3) + Dispatch staff (4)

Nurses (11): high-educated nurse with minimum 5 year-practice in NICU

Colleagues, WHO transport neonates
WHAT TYPE OF EQUIPMENT do we use? 
(and how can we reduce the side effects of transport?)

Cars with anti-vibration system:
5 Mercedes Sprinter vans, 1 Ford Transit and 1 Toyota Hiace. All of them can imitate both an ambulance and NICU Level-III environments as well. Mercedes vans are equipped with anti-vibration + hydraulic platform systems, for holding two incubators at the same time. All car is equipped with double circuit oxigen and pressed air. Electric supply: 12V+220V

Transport tools:
Dräger 5400 ITI type intensive incubators with Babylog respirators, All babies are placed in vacuum mattresses during the transports. Propaque multifunction monitors, Terumo, Braun infusion pumps AVL and iSTAT mobile blood-gas analyzer, Tecotherm controlled active hypothermia equipment Resuscitation tools for neonates and adults Miscellaneous: sweat-es, photo,
Milestones of our Ambulance’s Concepts

- Smaller, faster, agiler Car-conception: Mitsubishi, Volkswagens, Toyota 1989 - 1997
- Bigger, slower, clumsier Van-conception: Fiat Ducatos, Ford Transit 1997 - 2005
„New” techniques

Photo for mothers:
  using Polaroid camera – 1996-2008,
  using mobile phones + printer since 2008

Surfactant for every VLBWI with RDS since 1994

Mobile blood - gas analyzer:
  AVL since 1999 and
  iSTAT since 2008

ELBWI plastic bag – since 2006

Active controlled hypothermia en Route – since 2009
Active Controlled Hypothermia
Starting in the Delivery Room
Based on the TOBY Study
Cooperation with NICU of the 1st Department
Paediatrics Semmelweis University
WHAT TYPE OF PROTOCOLS do we have?

Neonates are a unique transported population because of their physiological vulnerability (especially considering the transitory circulation). Even the most well-equipped vehicle can mean an unfriendly environment for a neonate – especially for ELBWIs.

For these reasons we use special medical and safety protocols in the transport environment for optimal care.

This book is a collection of local guidelines.

Protocols for the aims of the highest and the most safety transfer
MDs and Nurses: neonatal + emergency medicine + logistical + safety
Drivers: technical + logistical + safety + how to avoid transport side effects
Dispatch staff: emergency, logistical, legal, administrative, communication

Operation level of the Ambulance has been working systematically on the basis of the European ISO 9001 accreditation system.
WHAT TYPE OF EDUCATION do we have?

1. **PCA-staff education:**
   - Pre-transport training and qualifications, orientation course, procedural skills training, case simulations, supervised transport on line by the program director, case review and feedback, stress management seminars.

2. **Outreach education** at University hospitals and in community hospitals.
   - PCA method based on the AAP-NRP-2006 course expanded with:
     - recognition of neonatal illness,
     - preparation for transport,
     - transport medicine and transport procedures
     - improvement in stabilization of neonate
     - increased comfort and confidence in managing infants
     - the ability to make appropriate choices for mode of transport
     - improvement in long-term outcome of neonates

3. **Outreach education for parents and lay people.**
   - NRP outlines + basics of neonatal emergencies
   - education aspects of the early discharge – home care program

Results: 1,300 participants – 9,000 teaching hours since 1994

Renewed PCA-NRP courses certified by Semmelweis University 2009
WHAT TYPE OF BUDGET does the PCA have?

We have been working in a foundation form. Our „third sector” organization has got a **flexible budget**. It is based on governmental support, sponsorship, and donations. Investments, amortizations, and about one-third part of the operational costs are covered by the contributions and about two-third parts of the operational costs are paid by the State.

**Index-numbers of the year 2008**

- Transported neonates: **3,022 patients**
- Running distance: **103,000 miles**
- PCA’s running cost: **558,000 £**
- State’s support: **480,000 £ 86%**
- Average cost/km: **3,5 £ /km**
- Average cost/case: **185 £ /transport**
- Number of high educated employees: 37
- Around the clock shifts: 3x24/7 (+ 1x8/5)

(300 HUF = 1 £)
Budget needs special Marketing Communication = Results:

Collected and implemented money for the mission:
Improving neonatal transport and neonatal emergency care
by the Peter Cerny Foundation:

2,760,000 £ per 20 years (300 HUF = 1 £)

Investments: 860,000 £ per 20 years
for 16 vans, medical equipments, headquarter of the PCF

Operational costs for working the Ambulance:
1,300,000 £ per 20 years
for salaries, fuel, disposables etc.

Others: 600,000 £ per 20 years
for informatics (hardware + software) + know-how +
education + grants for satellite programs
WHAT TYPE OF TASKS do we have?

The basic goal of the Peter Cerny Emergency and Ambulance Service, as a mobile NICU Service, is to safely transfer a neonate to a tertiary care center in an environment as close as possible to that of the hospital NICU.

„Like other parts of the emergency medical and critical care systems, a neonatal-pediatric transport program must be tailored to the specific needs and resources of the region served.”


Mission Statement of Peter Cerny Foundation for Curing Sick Babies:

to support the very vulnerable population of sick babies, in the fields of: - emergency care of the newly-borns and neonates
 - inter-facility transport and neonatal intensive care
 - diagnostics and interventions
 - post-intensive and post-discharge care
 - outreach education of medical staff, parents and lay people, for ensuring the welfare of prematures as handicapped minority of the next generation. (Every 12th neonate is premature or SGA baby in Hungary!)
“Off label” Transport Activities of the PCA

Satellite projects based on the Mission Statement of our Foundation

• Support the follow up examination of prematures 1991-1993
• Developing Ophthalmologic Facilities inside NICU 1994-1998
• Early discharge and home care of prematures 1996-2001  
  (Starting again from 2010)

• Shipping Ophthalmologist + Laser Supplies  
  for avoiding the transport of neonates – since 2008

• Otoacustic-Emission Hearing Screening of neonates in NICU:  
  done by PCA transport nurses – since 2009

• Ophthalmologic Telemedicine for ROP– RetCam-Shuttle  
  Clarity Co./USA + Medicontur Co./Hungary  
  Just starting!
AAP: Transport Guideline 3rd Edition: „Like other parts of the emergency medical and critical care systems, a neonatal-paediaic transport program must be tailored to the specific needs and resources of the region served.”

The “9 Ws” as the key elements of the Neonatal Transport have been working successful in the Central Region of Hungary for 20 years by the Peter Cerny Neonatal Emergency and Ambulance Service.
Thank you very much for your attention!

www.pca.hu