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Regionalized neonatal emergency transport

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KEYWORDS

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Summary This article reviews the components that facilitate an effective neonatal emergency transport network, and discusses the human resources required for safe transport, including a section focused on the option of an expanded role for the paramedic. In addition, the topics of transport equipment, communications, quality assurance, data management, family support and education are addressed in the context of a neonatal transport programme. Finally, elements involved in the organization of neonatal transport and transport issues pertaining to networking of neonatal medical care are highlighted and illustrated with reference to local experience in British Columbia.

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Introduction

Treatment of the sick newborn in specialized neonatal intensive care units (NICU) has been associated with a decrease in mortality and morbidity.¹ In the early 1960s, neonatal transport was first used to make intensive care accessible to those newborns who needed it.² Subsequently, organized emergency neonatal transport systems developed and became an important element in the regionalization of perinatal care.^{3–6} Neonatal transport brings the intensive care environment to critically ill infants before and during interhospital transports.

As neonatal and, subsequently, maternal/fetal intensive care developed, the ability to vacate NICU beds when newborns no longer needed intensive care beds facilitated maternal/fetal transport. Figs. 1 and 2 illustrate the similar temporal

relationship between the growth in number of reverse (i.e. back/return) transports and the growth in number of infants delivered at a level III centre. As a result, many more high-risk infants could be delivered to their advantage in a facility with the resources to care for these infants.^{7–9} However, regardless of the efficiency of antenatal triage, some infants will inevitably need to be transported acutely in the neonatal period. Consequently, the outcome of such infants is partly dependent on the effectiveness of the neonatal transport system.

Neonatal transport programmes require appropriate referral systems, management structures and trained transport personnel. They need to utilize transport equipment, address transport logistics and have a quality improvement programme. Local factors such as geography, population density, philosophy and the organization of perinatal services affect the manner in which different transport programmes function.

This article reviews critical aspects of a neonatal emergency transport service and illustrates

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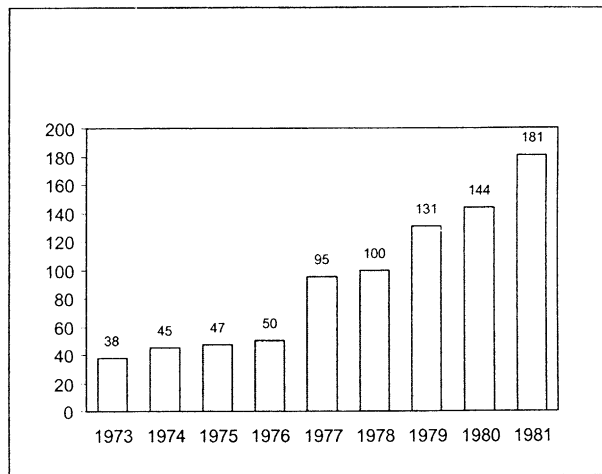


Figure 1 Infants delivered at Vancouver General Hospital, birth weight <1500 g.

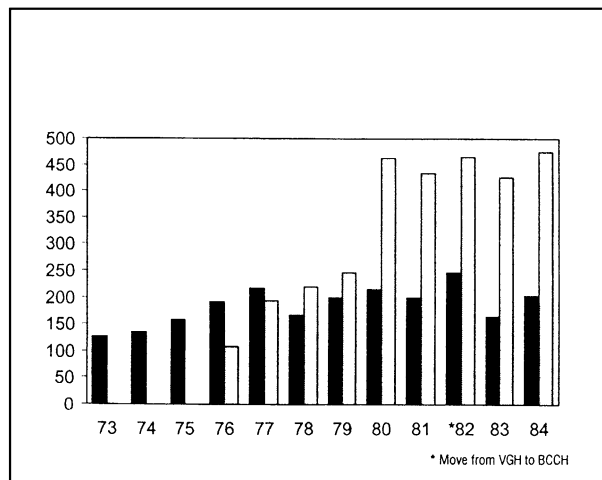


Figure 2 Acute (solid bars) and reverse (open bars) neonatal transports.

this with examples from local experience (see [Appendix](#)).

Human resources

Leadership

Medical director

A neonatal transport service, operated out of an NICU, should be led by a physician with specialty training in neonatology or equivalent expertise. In addition, this individual should have a working knowledge of transport medicine.^{6,10}

The medical director takes responsibility for overseeing, with other appropriate departments or agencies: (i) the development, implementation and

monitoring of patient care and transport standards (policies, protocols, procedures, patient and transport documentation); (ii) the scope of practice of the team members; (iii) team selection, training, supervision and continuing education; (iv) review of individual transports; (v) the development, implementation and maintenance of transport database for operational management and patient care evaluation; (vi) continuous quality improvement; and (vii) the support of perinatal partnerships and advocacy.

Manager

The manager working closely with the medical director may assume the following responsibilities: (i) budget and day-to-day management; (ii) team scheduling; (iii) ensure maintenance of equipment; (iv) assist in the organization of the transport; and (v) ensure data collection and assist in data analysis and quality assurance. This role may expand, particularly in organizations using nurse transport teams. Depending on the team model, the manager may be a nurse or a paramedic, or these responsibilities may be shared.

Transport co-ordinator

Each transport should be supervised by a physician with specialist training in neonatology or equivalent experience. This individual should have a good understanding of the perinatal network transport logistics, including their effect on neonatal care, as well as the expertise and limitations of the transport team. The transport co-ordinator should have the authority to make the decisions regarding transfer and admission.¹¹ The transport co-ordinator is responsible for: (i) assessing the infant's condition and need for transport; (ii) triaging in consultation with the referring physician; (iii) determining priority, equipment needed and personnel required; (iv) advising on interim care; (v) supervising patient care throughout the transport; and (vi) activating the transport team (e.g. call dispatcher).

Team members

Transport teams in different jurisdictions utilize different types of healthcare professionals. The base of most transport teams is a neonatal-trained registered nurse (RN). Other programmes use respiratory therapists, paramedics or a combination of these three disciplines.¹¹ Physicians are frequently added to the basic team depending on the needs of the patient and the competency of team members.

Independent of the discipline of the team member, some critical principles should be considered.

- All team members must be properly trained and competent in the delivery of neonatal intensive care, the transport environment and stress management.
- In emergency transports, two trained team members are highly desirable. The provision of intensive care by only one team member in a foreign environment is extremely difficult and very stressful.
- One team member needs to be delegated as the team leader.
- All team members must be aware of the contribution expected of each other. All involved in the execution of a transport need to work collaboratively, in a timely manner, and understand their respective accountabilities.^{12,13}

Paramedics as the base of a transport team

Locally, as trained nursing resources were in short supply in the early 1970s, British Columbia elected to train paramedics as the base of the transport team. It is noteworthy that the programme's paramedics remain highly focused on the transport environment and on operational issues pertaining to efficient transport function. Their close links to the dispatchers, pilots and drivers, and intimate knowledge of how to facilitate the transport itself have been invaluable. Furthermore, the programme has been rewarded by experiencing an extremely low turnover of transport provider personnel. Of all paramedics trained since 1974, 51% are still working as transport providers. This results in a group of transport providers with immense practical knowledge and experience, and a minimization of training needs and costs. Unless British Columbia is unique, this longevity may be an advantage inherent in choosing paramedics as the base of the transport team. However, it is noted that a large investment in time and effort was initially placed in the recruitment process and in the training of recruits. These paramedics have had a commitment and dedication to the care of newborns, high-risk pregnant women and children that is exemplary, but they also enjoy diversity.

The expertise the paramedics bring to the team is invaluable. They allow other team members to focus their attention on their specific expertise and not to be concerned with the mechanics of the transport—a particular problem in a training institution where other team members may turnover regularly. In addition, providing a higher level of

training to the two ambulance attendants accompanying the transport reduces the number of hospital staff needed to accompany a transport, and allows layering of expertise as necessary for patient care. All reverse transports and many stable acute transports are handled independently by paramedics.

Key to the success of this programme have been the selection criteria and the excellent working relationships we have enjoyed over the years with the British Columbia Ambulance Service at all levels.

Selection of paramedics

The selection process involved three stages—a written test of basic ambulance knowledge, an OSCE assessment and finally an interview process including the Medical Director and the British Columbia Ambulance Service Manager. Characteristics considered important in recruiting individuals have been developed over the years. More recently, desired academic credentials and characteristics have been sought using an evaluated formalized weighting performed by experienced medical and nursing staff involved in working with transport paramedics. The following were rated in hierarchical order: judgment/problem-solving ability, interpersonal skills, motivation, maturity/awareness, oral communication, listening, decisiveness, practical learning, leadership and tolerance for stress. It was also considered fundamental for paramedics to have an obvious orientation to infants and families, an interest in caring for the whole patient, and the attribute of being a team player. Intuitively and appropriately, these weightings select infant transport paramedics with different aptitudes and interests from those most prized in adult paramedic/advanced life support ambulance attendants.

Physicians

In a transport setting, a higher level of competency is needed than that required in an NICU, where help is seconds away.¹⁴ Knowledge, skills, equanimity and the ability to function in stressful situations are all part of the job description. Experience suggests that physicians accompanying neonatal transports should be, at a minimum, neonatal fellows or have equivalent experience.

Choice of a transport team model

The decision about the type of model to employ should be dependent on competencies, the local

situation and bear due regard to costs. In one study, three different types of transport team models have been used to transport acutely ill infants¹⁵:

- two nurses;
- a nurse and a respiratory therapist;
- two paramedics.

Physicians accompany these teams as determined by the infant's condition and the competencies of the team.

The safety of each team model was evaluated recently. No difference was found in patient care outcomes between any of the models.^{15,16} In this study, physician presence did not improve patient care outcomes. However, the paramedic team in this study was the team in British Columbia. Physicians accompanied this paramedic team when it was anticipated that an infant might require intubation or when respiratory care was unstable and needed careful monitoring (approximately 43% of all neonatal emergency transports). Consequently, the model of the paramedic working independent of physician presence was not examined, and may well differ. In other models, transport nurses and respiratory therapists routinely perform respiratory support tasks on transports.

The cost of the different transport models, safety standards having been met, is determined by the relative wages of the transport personnel, the volume of transports, and waiting time between transports.¹⁵

Where volumes were high and transports long, the paramedic model was the least costly. Otherwise, a non-dedicated RN model where RNs were productively employed when not on transport was generally least costly. This assumed that extra RNs were not employed to hedge against understaffing when two RNs left the nursery for extended periods of time. A dedicated RN team was the most expensive option under most circumstances.¹⁵

The work load of the transport team can be increased to improve cost efficiency, by expanding the range of services that the transport team provides. Comprehensive neonatal transport programmes usually handle return transfers. Reverse transports promote partnerships within the perinatal network and facilitate graduated discharge of the newborn to the local community. The paramedic team in British Columbia also transports high-risk pregnant women and children. Knowledge and skills required for neonatal intensive care include an understanding of high-risk pregnancies. Additional training for maternal and paediatric transports is complementary to the neonatal train-

ing. However, it is important to balance the utilization of the transport team and its ability to respond to all transports in a timely manner in such a way that it does not compromise patient care.

Educational issues and standards of practice

Most transport programmes will develop training programmes individualized to local needs, with the level of training dependent on whether, in various circumstances, the providers are paramedic, nurse or physician led. The scope of practice and curriculum is overseen by the medical director. Although there is no standard curriculum for transport providers, guidelines have been published by the American Academy of Pediatrics Taskforce on Inter-hospital Transport.¹⁷ Programmes utilizing air transport should ensure that all providers, including physicians who may be involved occasionally, have education on air safety and flight physiology (including air transport effects of barometric pressure, g-force, humidity change, potential temperature loss, noise and vibration). Each programme must focus most attention on the types of patients most frequently transported by the team. Many programmes make use of standard workshops that provide education on aspects of newborn care, for example, the Neonatal Resuscitation Programme.¹⁸

In addition, the programme requires a method for providing continuing education. This involves updating neonatal knowledge, maintenance of skills, reviewing practices, and introducing new patient management. Finally, there should be a mechanism for performance appraisal linked to career development and continuing education opportunity.

Both the type of patient and the transport environment can lead to stressful experiences. Team members need an understanding of the varying prognosis of their patients, some of whom have lethal congenital conditions. Stress management strategies should be in place for the assistance of all members of the transport programme. This includes unrestricted access to stress counselling and availability of critical incident debriefing sessions. The medical director should ensure that the attitude of the programme is one that facilitates the use of these interventions.

Educational needs extend to the referring hospitals where training in pretransport stabilization is important.¹⁹ In Canada, a new programme developed by the Canadian Pediatric Society, ACoRN, is being launched to address this issue.²⁰

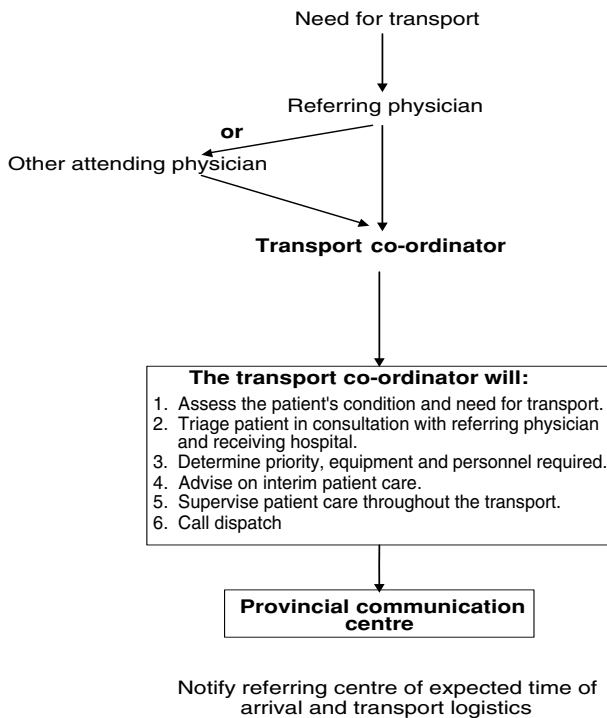


Figure 3 Flowchart for the organization of acute transports.

Transport provider

Regardless of whether the transport provider is operated by the hospital, employs an independent ambulance service or contracts out air transport services, it is desirable that management, dispatchers, ambulance attendants and pilots all have a good understanding of the goals and principles of neonatal transport. Formal orientation and a tour of the NICU have resulted in much better collaboration and support. These individuals enjoy feeling part of the team.

Policies need to be developed jointly with the transport provider that clearly define transport expectations (response times, personnel and equipment required) (Fig. 3). In practice, these standards have been useful for patient care and evaluation.

Mode of transport

Choice of the mode of transport depends on geography (distance, topography), weather, the newborn's condition, safety and costs. Consequently, the range of options needed (ambulance, helicopter, fixed-wing aircraft or ferries) is dependent on local factors, and the decision is individualized in each case.^{21,22} Ambulances are least costly, and fixed-wing aircrafts are less expensive than helicopters.

For short distances, up to and including 1 h driving time, road transport is usually quicker. When transport driving times exceed more than 2 h, air transport is usually more appropriate. Guidelines regarding modes of transport, developed jointly between the transport provider and the transport programme, are useful to facilitate patient and business decisions. Ultimately, the decision regarding the mode of transport used is determined by many variables (e.g. patient needs, traffic patterns, geography and weather) and should be the joint decision of the transport co-ordinator and the dispatcher. This is an area where experience and knowledge triumph over protocol.¹³

Communications

Accessing the transport co-ordinator in a timely manner is imperative. Communication between the referring physician, the transport co-ordinator and the dispatcher simultaneously can speed up decision making and the initiation of a transport. Throughout a transport, it is highly desirable that the team members, the referring physician, the transport co-ordinator and the dispatcher can communicate with each other rapidly and simultaneously. Changing patient or bed status, weather, logistics or equipment needs may all demand a review of the transport plan. We require the transport team to communicate with the transport co-ordinator once the patient has been assessed in the referring hospital in order to review treatment plans.

However, need for communication extends beyond the time period of the transport. Parents, referring and consulting physicians, and other involved healthcare providers require appropriate and timely feedback. In the broader context of supporting a regional transport programme, referring agencies should receive summaries of transport programme activities and their own involvement. This is a key step in developing successful partnerships.^{12,23}

Equipment

The transport team needs to be prepared for any emergency during a transport. Both the team and the equipment should be able to function independently of any support systems and for prolonged periods of time, as the transport environment may vary and be unpredictable. All electronic equipments should have their own independent power supply (AC/DC capability), adequate visual and audio alarms, and lack of electromagnetic interference; oxygen requirements should be determined

and estimated in advance of the transport commencing; and drugs should be anticipated and accompany the transport. Equipment must be lightweight, compact, durable, and motion and g-force tolerant. Lists of recommended equipment, supplies and drugs are available in several publications.^{17,24} All the equipments should be fully functional, properly maintained and ready for action immediately.

Equipment used in the care of newborns is constantly improving. Advances in equipment design and function can and should be extended into the area of neonatal transport. Strategies for cost containment include rotating infrequently used drugs and supplies with nursery stock to minimize loss via 'time expiration'.

Documentation and consent forms

Appropriate documentation of transport calls, the advice given, transport times (call received, dispatch notified, transport commenced, length and various other time parameters), team members present, patient history, condition of the patient and management all need to be carefully documented. Usually, transport designed forms or electronic clinical information systems, specifically designed for the transport environment, together with checklists for equipment and activities, ensure more consistent data collection and care. Consent forms need to be available during the transport and may be carried best in the 'transport equipment box'.

Quality assurance

Each transport should be evaluated at the end of the transport. Overall transport performance should be evaluated. This is assisted by systematic collection and analysis of carefully selected performance indicators. These indicators should monitor patient demographics, management and outcome, safety, logistics, equipment malfunction and costs.¹⁰ Using a transport validated physiological score such as 'TRIPS' to evaluate patient status before, during and after transports can assess team and transport performance.¹⁶ Incident reports play a different role in highlighting specific issues that may be important but hopefully occur infrequently. A process for addressing incident reports should be in place.

Family support

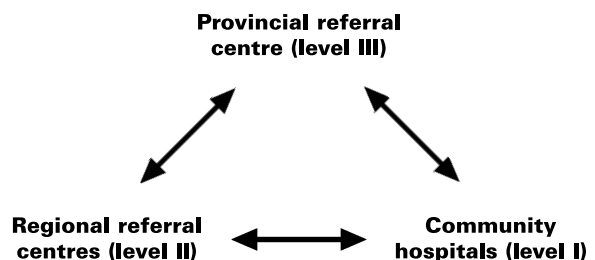
Families of the sick newborn are under considerable stress, and the transport team can provide

sensitive support. Parents need accurate information about the newborn's clinical condition and prognosis, and an opportunity to ask and have questions answered by the team. They need information about the anticipated timeframe of the transport and about the receiving hospital (location, contact telephone numbers, personnel). Information can be shared about anticipated procedures, operations or clinical studies. Parents should see and have an opportunity to touch their baby prior to the transport. Photographs can play a useful role. After completion of the transport, a subsequent phone call to the family should be a standard practice.

The programme's attitude towards parents accompanying a transport should be established by the programme ahead of time. The ability to accompany a transport is related to space available. The potential gain of having a parent accompany the neonate should be weighed against the effects of crowding, distraction and increased stress on the transport team. Facilitating relocation of parents to the receiving hospital is very important, particularly when the condition of the newborn is critical.

Organization of a transport and accountabilities

The triangular referral diagram below illustrates that the key concept of community, regional and provincial partnership is paramount.



The newborn should be able to move between institutions depending on need. Transport programmes can facilitate this occurring.

Within a perinatal care network, all parties involved need to understand how to organize an emergency transport. Table 1 summarizes how acute maternal, newborn and paediatric transports are organized in British Columbia.²⁵ The transport co-ordinator is responsible for patient care while the dispatcher is responsible for the transport logistics. This algorithm is distributed throughout the province of British Columbia (>40 000 total births) and has been supported by all organizations involved in perinatal care. We recommend that

Table 1 Priority categories for transporting a patient

Type of transport	Ambulance service priority	Patient care	Response time	Staff required
Acute	1 (red)	Very unstable patient; likely to deteriorate rapidly	Land: leave hospital in 15 min; air: leave airport in 1 h	One physician trained and experienced in intensive care (neonatal, paediatric or obstetric) <i>plus</i> (in order of preference) two ITT or one ITT and one trainee (completed part 1) or one ITT
	1 (green)	Sick patient unlikely to deteriorate quickly	2–3 h	As above
	2a	Stable patient requiring investigation or treatment	>12 h	One ITT and one trainee
Reverse	2b	Neonatal reverse transport when bed availability is a problem	<12 h	
	3	Reverse transport	<5 days	As above

ITT, infant transport team paramedic.

the pathway for the organization of transports should be clear and widely known, and that the onus for responsibility for each step should be well defined.

Responsibility for care shifts throughout the transport with care being shared equally once the transport team arrives in the referring facility.²⁶ All team members are expected to know the scope of their practice and their accountabilities.²⁴

Development of transport programmes

Those considering developing a transport programme must decide whether to start a transport service, or expand or contract an existing programme. Among the factors to be considered are: (i) current referral patterns and population growth; (ii) the optimal boundary of region to be served; (iii) the need to fill a void; (iv) the organizing centre's mission and goals; (v) financial issues; and (vi) medico-legal issues.²⁷ Overriding all the above should be the interest of the patient. The more specialized a treatment, the more complex the resources needed. Looking at the specialized end of the spectrum, the advent of 'extracorporeal life support' (ECLS) has led to some centres developing an ECLS transport service.²⁸ This involves substantial additional transport equipment, specialists and training of personnel. In order to achieve efficiency and effectiveness, a large potential referral population is required. Thus, one centre may network

with many regions. Alternatively, successful outcome for these newborns may be achieved by encouraging earlier referral, activating rapid dispatch, using optimal management protocols for potential ECLS candidates, and transferring efficiently to an ECLS centre.^{29,30} In either case, effective access to ECLS via a transport team is needed.

It is noted that transport programmes must work within the legislative framework of their jurisdiction. This encompasses regulations for safety standards including air safety, as well as scope of practice permitted by the transport providers' licensing body. In addition, many programmes are subject to or participate in regular accreditation processes. All the above may impose some restriction on working options, but they also assist in ensuring safe standards of practice, and are viewed as desirable.

Essentials of safe transport

Finally, we list a number of principles useful for the provision of best neonatal transport medicine.

Identify problems early

The length of time to transfer the newborn should be taken into consideration in the context of the natural time course of the neonatal disease processes, and decisions should be made with that in mind.

Optimize communications

Appropriate and adequate communication between the referring physician, transport co-ordinator and receiving physician is critical to the development of an effective management plan.

Provide transport expertise

The infant should be transported by an expert team which understands the transport environment and is competent to care for the sick newborn.

Adequate stabilization

The transport team should stabilize the newborn in the referring hospital prior to transport for numerous reasons. Since sterility, adequate lighting and space are a challenge in a transport vehicle, care is better delivered in any hospital. Thus, the team should receive the newborn in the primary nursery. As the sick newborn can destabilize very quickly once handled, transporting the infant without the immediate availability of necessary expertise or equipment can be disastrous.

No surprises

Adequate stabilization minimizes the chance of surprises en route, and prevents unexpected deaths or emergencies during transportation.

Transport—smooth and controlled

The trip from the referral hospital to the NICU should be smooth and controlled to avoid further compromise to the newborn.

Appendix

British Columbia has established one neonatal transport programme for the province based at the Children's and Woman's Health Centre in Vancouver. British Columbia occupies a very large geographic area and has a little over 40 000 deliveries per year, although a large proportion is born in the southwest corner of the province. As well as neonatal transport, the programme has maternal and paediatric transport arms, and utilizes a single pool of transport personnel for all three components. Each year, the programme undertakes close to 2000 transports, of which half are neonatal. Amongst neonatal transports, reverse

transports marginally outnumber acute transports as a result of highly effective antenatal triage.

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