

PERSONAL PRACTICE

A regionalised transport service, the way ahead?

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Units in the United Kingdom are now concentrating on improving the transport of neonates and children. The aim is to have a transport process that can offer a level of care akin to that of a neonatal or paediatric tertiary centre at the point of retrieval. Studies point to a high number of adverse events when inexperienced staff move children.^{1 2} There have been articles on neonatal³ and paediatric transport.⁴ We describe our transport model, which implements a combined neonatal and paediatric transport service for the State of New South Wales, Australia coordinated by a telephone triage mechanism.

The New South Wales newborn and paediatric Emergency Transport Service (NETS) has been an integrated service covering the State of New South Wales since 1995. It is responsible for coordinating the transfer of sick infants and children throughout the state. Before this, separate paediatric and neonatal transport services existed in a number of units. From the outset the service has evolved to suit local needs. Clinical guidelines have been developed, transport equipment modified, and vehicles purpose built. The goal has been to make intensive care available in the referring hospital before transport as well as during it.

Population and demography

NETS retrieves patients from hospitals in New South Wales or, when a town is too small for a hospital, from general practitioners' clinics. The area of New South Wales, and thus NETS coverage, is 801 428 square kilometres (10.5% of Australia's total area). The population in this state is 5 543 500 (32.6% of the total Australian population). Sixty per cent of this population live in the Sydney area. On occasion, NETS undertakes international retrieval from South East Asia, Pacific Islands, and beyond.

New South Wales health system

There are three paediatric intensive care units and nine neonatal intensive care unit hospitals in New South Wales. Another neonatal intensive care unit in Canberra is also part of the network. Private sector as well as government institutions provide medical care to the population, and NETS responds similarly to hospitals in both sectors.

Target population

NETS transfers neonates, infants, and children up to the age of 16. Adult teams are available

for scene rescue and trauma and these may be activated for some children. In New South Wales there are 150 hospitals where babies are delivered, of which 120 are outside Sydney and deliver fewer than 100 babies a year. These are all potential points of referrals and NETS has equal responsibility to all hospitals.

NETS mission statement

NETS is an independent service. The organisation guards its autonomy to ensure that every neonate, infant, and child receives optimal management during transport, and is then transferred to any hospital that can provide the best continuing care at that time. NETS provides clinical advice, transports sick children, and is a key component of the New South Wales perinatal services network. Preservation of autonomy ensures that referral patterns are the prerogative of the sending hospital, not the transport service.

Moving patients is disrupting to families; therefore, where possible, the child is placed at the most convenient location without compromising care. In cases where the child has a moderate illness this may be a level 2 (district) facility. NETS' knowledge of local facilities throughout New South Wales allows us to assist such decisions.

Funding of the transport service

The service is funded by the State Department of Health to provide a service to all hospitals within the State of New South Wales. It operates with a budget of AUS\$2.9 million (approximately £1 million; US\$1.6 million). This covers operating costs for a 24 hour coordination and clinical conferencing service, and the retrieval teams. The cost of the ambulance vehicle is excluded as this is charged separately by the ambulance service to the sending hospital. NETS has developed specialist ambulance vehicles for retrieval, which cost less than half that of a standard ambulance to commission and operate; therefore, the total cost of vehicles (to the system) is less than previously. NETS uses a helicopter ("Child Flight"), which is funded as a mobile intensive care unit bed. That is, when additional intensive care unit beds were funded across New South Wales nine years ago, the funds for one of those beds was directed to supporting Child Flight, which receives about 40% of its budget in this way, the remainder coming from corporate and

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community support. Child Flight now receives approximately AUS\$1.03 million per annum to provide a 24 hour, all weather service, which NETS selects for 28% of patients. Referring hospitals pay a distance based standard ambulance charge but this method is under review and an additional component (for the added clinical expertise) is being considered.

NETS charges overseas hospitals for its services on a full cost recovery basis and has recently started charging private hospitals wishing to use its services.

NETS “tele-triaging”

Vital to an effective transport service is an efficient triaging mechanism. This is served by a digital switchboard (Ericsson) and call conferencing system (ADTEC). Callers to the hotline number (1300 36 2500) can expect to make just one telephone call. This number has been advertised throughout New South Wales and takes priority over other calls being received at the NETS base. Any medical worker of any grade, doctor, nurse or paramedic, is allowed access to this number.

NETS’ nursing staff act as call coordinating practitioners. We feel that medically qualified staff are an important first point of contact. They can offer initial advice and tease out important clinical issues while the NETS consultant is conferenced into the call. Medically qualified coordinators also understand the workings of hospital facilities and are invaluable in sorting out logistic issues related to transport, leaving the activated NETS team to concentrate on the clinical problems on hand.

The conferencing system serves as a virtual system where callers can be placed in a “virtual room” together and can “meet” various experts on the telephone to discuss clinical management. At the same time the NETS team may listen to the call. Therefore, at any time there may be a number of people interacting on the telecommunications system. Several such conference rooms can be in use simultaneously.

The coordinating practitioner has a checklist of minimum information to be obtained and the full details are then entered onto a call sheet. Once initial details are obtained, the NETS consultant prompts the NETS team members and coordinator for any additional information or question. The call sheet is then given to the NETS team to take on retrieval. If the clinical situation merits it, the NETS consultant may elect to introduce a subspecialist consultant to the call, or may wait until the NETS team have arrived at the referring hospital before deciding on the ultimate destination.

An appropriate medical response depends on team composition, liaison with particular neonatal and paediatric consultants, mode of transport, terrain peculiarities, time of day, etc. The NETS consultant assimilates all these factors before team activation. Consequently, an experienced NETS consultant is paramount to the effectiveness of a retrieval team, especially when the success of a transfer is time critical. Further, a dedicated transport consultant

offers a holistic approach to the transport process, which disease specific physicians are unable to do.

Tele-triage and diagnosis by telephone are skills not easily learnt. It is aided by knowledge of the circumstances confronting the particular doctor; particularly the size, scope, and capability of the overall perinatal service in the referring hospital. Clinical conferencing is a complex procedure that is open to interindividual misinterpretation. All conversations are recorded.

Such a communication system not only provides a source of expertise for the peripheral health worker but also saves time for the referring physician. The referring doctor will not have to waste time calling neonatal and paediatric intensive care units tracking down a potential bed and then being able to obtain clinical advice. Nurses at the NETS base have access to the New South Wales “Bed State” database and are thus able to locate free beds more efficiently.

The activated NETS team does not wait until the end of the initial conference before leaving base. Any additional data can be given to the team en route and if necessary the whole call can be replayed to them. The neonatal incubator system has a telephone clamped to it and the team carry a mobile telephone for ease of contact. The team may even be redirected by the NETS consultant to a perceived higher priority call.

Owing to the distances involved, general practitioners and paediatricians are encouraged to call NETS for advice early. This invariably means a low threshold for team activation. Thus a number of neonates and children with mild or moderate severity of disease are retrieved. However, this policy ensures that NETS is able to reach most sick children in good time.

The NETS consultant is an important member of the perinatal advice service and is required to triage potential high risk deliveries with the help of the on call perinatal adviser. The aim is for the in utero transfer of high risk pregnancies to specialist units, with or without the aid of tocolytics. If, despite this, the delivery seems imminent then the NETS teams are activated. Any medical practitioner involved with antenatal care and screening may have access to the NETS advice line. In view of the success of this resource most preterm neonates are born at regional centres with NETS transferring mainly term or near term infants.

Team structure

The team consists of a doctor and nurse. The doctors are paediatric registrars from the New South Wales registrar rotation or clinical fellows. Nursing staff are highly trained intensive care nurses who have in depth knowledge of the procedures, equipment, and environment of retrieval. NETS registrars find that working with these nurses is both a learning and supportive environment for both parties.

At any given time there are three teams available, although because of an overlap in shifts up to six teams may be activated. One

team is first on call and is located on base. The other teams are on call at home.

Team training

For two days at the beginning of their secondment with NETS, doctors undergo an intensive orientation training programme. The team is taught about the three different modes of transport including related safety issues. Important points regarding aeronautical physiology are discussed. An arrangement is made for doctors to learn or revise nasal intubation skills in theatre, as this form of endotracheal intubation is preferred. Important life saving interventional procedures are illustrated by the NETS consultants using a series of interactive workstations. Procedures taught include chest drain placement, intra-osseous needle use, and bag and mask ventilation.

Doctors are taught to intubate neonates and children by a rapid sequence induction technique. This technique involves patient pre-oxygenation, followed by the intravenous bolus of a predetermined amount of sedative drug and a short acting muscle relaxant. Cricoid pressure is applied by the NETS nurse with the aim of preventing the reflux of gastric contents into the lung. The rapid sequence technique is contraindicated in situations where upper airway problems complicating intubation are envisaged, such as Robin sequence. Here an experienced anaesthetist should undertake intubation with an ear, nose, and throat surgeon being at hand to perform an emergency tracheostomy if there are problems.

After the initial introduction a consultant accompanies the junior doctor on a number of retrievals before they are allowed to go solo. Later, complex or challenging retrievals may require the addition of appropriately skilled medical personnel. This can be arranged from the tertiary teaching hospitals.

Nurses and doctors are trained to carry out a thorough checklist of equipment, especially the neonatal boxes and the paediatric "Tomas Rationi" designed packs. The aim is to familiarise oneself with the storage of equipment so that during transfer the doctor is not reliant on the nurse to locate equipment. Teamwork saves time in patient stabilisation and therefore on ultimate admission to the referral hospital.

Team training is based on APLS (advanced paediatric life support) training methods. Staff have found the use of scenarios using manikins informative. It is our belief that there is greater retention of important factual matter compared to rote didactic teaching.

The NETS team will base clinical management on advice given by the admitting consultant. There are interhospital differences and preferences in the fine details of patient management; however, by adhering to APLS guidelines, resuscitation protocols are similar. The variety of methods in tackling similar clinical conditions is a learning exercise for the transport team.

Junior doctors are seconded from participating specialist paediatric hospitals and tertiary perinatal referral centres for a six month attachment. Previously, they were attached for

three months but found the workload provided too few cases and insufficient diversity. Registrars are generally in the third year (or greater) of paediatric training. Others seek experience as part of training for anaesthesia, paediatric intensive care, or neonatology. These doctors are generally fully qualified (have passed post-graduate examinations). During an attachment at NETS, an individual doctor would expect to perform between 100 and 120 retrievals, 50% of which would be neonates.

Before NETS became an integrated service, retrieval experience was considered part of working in a children's hospital for training and accreditation purposes. With the integrated retrieval service, nine registrars are employed at any one time. They work exclusively in retrieval although the training programme includes participation in ward rounds and the postgraduate training activities of several of the 10 tertiary hospitals to which NETS takes patients.

Accreditation as a specific training activity is pending, with the indications being that NETS will be considered for both core and advanced training. It is expected that it will also be accredited for paediatric intensive care, neonatal intensive care, and paediatric emergency training. A one year neonatal training programme has been established by three perinatal referral centres, a children's hospital, and NETS. Here NETS' experience is complemented with work at either a perinatal centre or a children's hospital neonatal intensive care unit. This programme employs 18 to 20 registrars at a time.

Equipment

NETS have modified the transport equipment over time to cater for the different transport modalities. A number of safety features have been implemented to ensure safety to patients and passengers. A report in the United Kingdom highlighted a number of problems with transport equipment.⁵

NETS has five neonatal transport modules. They are mounted on an aluminium platform that can be attached to certain ambulance stretchers, and which consist of an incubator, ventilator circuit, and monitoring equipment. Baxter syringe pumps are attached to the top of the modules.

The neonatal systems weigh 113 kg. Injury with such weighty modules has happened at other centres.⁶ Therefore a number of features have been designed to ensure ease of loading and unloading these modules. The NETS ambulances have been modified to allow a ramp to ascend and descend between the ambulance and the ground to negate any need for lifting of equipment. The systems are securely anchored into place once loaded into the ambulance. Gaps in incubators can be a hazard⁷ therefore babies are always strapped in.

Each neonatal system has a cylinder of air and oxygen, which are replaced as needed. The gas cylinders each contain 1500 litres. External gas connections are colour coded and are connected to external sources whenever available.

The "paediatric bridge" is a custom made frame to which paediatric equipment is

attached. This in turn is fixed onto the ambulance stretcher. Components fixed onto the bridge platform include Propaq 106 paediatric monitor, Oxylog ventilator, and Baxter syringe pumps. Additional paediatric equipment includes a burns and asthma pack and a Ferno Pedi-Pac trauma board.

A number of back up monitors and syringe pumps are available so that malfunctioning apparatus can be sent to biomedical engineering. For international retrievals the biomedical department is able to modify various systems so they may be used in different voltage settings and be placed safely in different vehicles. The tele-triage system also allows an activated team to conference with a technician so that any problems encountered during retrieval may be fixed away from base.

Neonatal and paediatric drug calculations and surfactant

When dealing with different sizes of patients, errors in drug dosages may occur in the hands of inexperienced staff. NETS members use a user friendly chart to calculate drugs. One chart contains values for both neonates and children. As the child's weight is known when the NETS team leaves base, the NETS doctor calculates drug doses en route. It is more difficult to calculate doses on arrival as the team is then preoccupied with the patient. Our system of mixing paediatric and neonatal drugs is uniform so that this aids familiarity and makes dosage errors less likely.

For neonatal transport, surfactant is carried in a portable cool pack. Fortunately hospitals in New South Wales have agreed on the use of one type of surfactant, Survanta. This allows the NETS doctor to get accustomed to the administration and clinical effect of one form of surfactant. Once the Survanta vial is used it is swapped at the admitting hospital for a new vial. This ensures that there is always an in date vial at the NETS base and that the hospitals foot the bill for this expensive commodity.

Mode of transport

We have three modalities of transport available: ground ambulance, helicopter (generally the Child Flight helicopter); and fixed wing ambulance. On occasions when the helicopter is in use by a team or being serviced, an adult trauma team helicopter may be used.

NETS has three dedicated ambulances, operated by the ambulance service of New South Wales. These have been modified to allow for ease of movement of the neonatal incubator. The vans are used for neonatal ground transport where the distances involved are around one hour. The vehicles are also used to transfer the teams to hospitals for paediatric transfer. Vehicles have recently been modified to allow the transport of children. Additional vehicles may be provided by the ambulance service if all teams are out in the field.

Audit

Every morning the NETS consultant undertakes a review of the clinical cases from the previous day. The cases are discussed with

available NETS personnel. Difficult or "teaching" scenarios are identified for an in depth audit at the weekly paediatric or neonatal audit meeting. Separate neonatal and paediatric audits are performed once a week. Intensivists from the tertiary hospitals and any interested clinicians are invited to attend.

There will invariably be differing opinions on how patients should be managed and how they are actually managed. It is the function of NETS to highlight these differences to the tertiary care consultants. Then, if the situation warrants it, those consultants may take up the matter further with the individual or health authority involved.

Computerisation

Transport details are entered onto separate paediatric and neonatal databases. The database is used for the purposes of audit and research. Comments from the audit meetings are entered into the case record. NETS team members can then review cases later for improvement of personal practice or for research purposes.

Conclusions

We have described a model of a combined paediatric and neonatal transport team serving New South Wales. Paediatric and neonatal teams were amalgamated in October 1995; the aim was to pool resources so that tertiary level care could be offered at the point of referral.

There has been a comparison of a paediatric intensive care unit in the Trent region of the United Kingdom with facilities in Victoria, Australia.⁸ It has been suggested that centralisation of resources and expertise is a desired end point.^{9,10} Success in this, we suggest, is dependent on a reliable, effective, coherent transport service.¹¹

There has been an emphasis on centralising paediatric intensive care resources in the United Kingdom. In turn, the transport service to these units could also be centralised. For an effective transport service to exist in the United Kingdom it would need to have a high level of activity. We believe that amalgamating neonatal and paediatric teams can achieve this.

Registrars trained in such a specialised transport system would eventually be rotated through to the district general hospitals, and that can only be an asset to peripheral units.

No doubt there will be intense bureaucracy involved in the design of a transport system serving a number of localities. However, the advantages of an autonomous body dealing with the transport process are fast response times, improved team experience, and probably lower morbidity rates. If paediatric intensive care has been shown to be effective in lowering mortality rates for the care of sick children, then surely for those patients admitted to hospitals without a specialist paediatric or neonatal intensive care unit, this standard of treatment should be available before and during transportation; something a formal paediatric transport service can provide?

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