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CONTENTS

Working Party and Intensive Care Society of Ireland
Council Members..... Page 1

Contents..... Page 2

Introduction ..... Page 3

Definitions..... Page 4

Conference Abstracts..... Page 5

Issues Represented to Society..... Page 8

Current .status / Extent of problem ..... Page 9

International Arrangements..... Page 14

I.C.S.I. Recommendations..... Page 15

References..... Page 16

Acknowledgements..... Page 19

Transport of Critically Ill - Appendices

Appendix 1
Personnel/ patient equipment and medications..... Page 20

Appendix 2
Fixed facilities required of ambulance / aircraft..... Page 21

Appendix 3
A Rapid pre-transport check list..... Page 22

Appendix 4
A standardised referring letter..... Page 23

Appendix 5
A standardised transport record..... Page 24

Appendix 6
Document and recommendations of the
Faculty of Paediatrics, Royal College of Physicians of Ireland..... Page 25

INTRODUCTION

In response to persistent demand, the Intensive Care Society of Ireland held a conference at the New Park Hotel, Kilkenny, on 2nd November, 1991 on Transport of The Critically Ill. The conference and subsequent representations to the Society substantiated the general perception that there were pressing medical and organisational priorities to be addressed. Accordingly, the Society formed a working party to summarise and report on transport of the critically ill. This document provides conference abstracts, reports on problems identified and makes recommendations.

DEFINITIONS

- **Ground Transport** - ambulance / trolley (intra-hospital)

- **Air transport** - fixed wing or rotor wing (helicopter).

- **Referring hospital**

  Hospital initially providing care.

- **Receiving hospital**

  Hospital to which patient is transferred.

- **Primary (pre-hospital) Transport**

  Transport of patients from the scene of acute illness or injury to hospital.

- **Secondary or Inter-hospital Transport**

  Transfer of patient between a referring and receiving hospital. This is usually to secure specialist investigation and /or treatment not available in the referring hospital.

- **Emergency Secondary Transport**

  Refers to the situation in which an acutely ill patient requires emergency transport to a specialist receiving hospital. The stay at the local hospital is brief and is primarily to allow resuscitation and organise transfer.

CONFERENCE ABSTRACTS

(1) The Ambulance Service

Mr. Joe Foy (Chief Ambulance Officer, Catslebar.)

There are 261 accident ambulances in Ireland (Republic) ; 19 are specialised "mobile control vehicles" for major emergencies. Although response times to accident calls are similar countrywide, the "pick-up' time varies varies widely due to the average mileage involved per transport e.g. 14 miles in the Dublin area, 38 miles in the Western Health Board area.
Priorities for development include:

(1) Vehicle type : need for design standardisation e.g. single stretcher / air suspension units.

(2) Staff training : skill levels require upgrading (and retraining) to paramedic level.

(3) Communications : should be easy between all users e.g. GP's and hospital doctors and between ambulances and Accident and Emergency Departments.

(4) Helicopter ambulance services require smooth integration with the entire patient emergency transport system.

(2) Training of Ambulance Personnel

Mr. Brian Power (National Ambulance Training School, Dublin.)

The period of transport should not be the weak link of a system caring for the critically ill. Standardisation and optimisation of vehicles and training are complementary requirements. Currently ambulance personnel receive 190 hours of training; however only certain regions provide manual defribbilation tuition (a further 95 hours). There is evidence that experienced nurses and paramedics working to establish protocols yield optimum results[(1)] .

Currently the departments of Health both in Ireland and the UK appear committed to improving standards. Litigation has forced an improvement in the USA. If advances were achieved, certain efficiencies would accrue e.g. reduced need for varied anaesthetists to accompany patients. Consideration of health and safety for the transporting team should not be forgotten.

(3) The Referring Hospital's Perspective

Dr. A.E. Bourke, Nenagh Hospital

Although the number of secondary transfers in Ireland is substantial, the numbers from any given referring hospital are small e.g. Nenagh (Table 1).

Table 1 – Critically ill patients transferred (Nenagh)

Diagnosis	1989	1990
Neurologic	5	10
Spinal Injuries*	4	1
Others	2	2
Total	11	13

** Retrieval team sent from N.M.R.C., Dun Laoghaire.*

Audit of head injured patients[2] has illustrated the potential to aggravate a patient's condition during transport due to airway obstruction, hypoxia, hypercapnia and hypotension. The absence of dedicated transferring teams may result in patients being transferred by inexperienced staff with inadequate equipment.[3]

Several studies [4,5,6] on transporting the critically ill conclude:

1. The transferring team should be skilled and experienced.
2. Patient should be stabilised before transfer.
3. The transfer should include facilities for monitoring and continuing treatment.
4. Road journeys should be safe and slow.
5. Communication with base hospital should be continuous.

The sporadic nature of transfers from Irish peripheral hospitals supports the Association of Anaesthetists' recommendation that secondary transport should be the responsibility of the receiving unit [7]. Current evidence suggests a need for dedicated skilled transferring teams using standardised mobile intensive care units; these are not available in Ireland.

(4) Inter-hospital Transfer - The Receiving Hospital's Overview.

Dr. G. Lavery (Royal Victoria Hospital, Belfast).

Physiological instability occurs during transportation of severely ill patients[4]. Airway[2] and cardio-vascular[8] problems are frequent and are often due to lack of proper assessment[2] (and resuscitation) before transfer. They are largely avoidable if appropriate medical escorts, full monitoring and simple protocols are used [9,10]. Patients can be transported without clinical deterioration. The burden of inter-hospital transport falls almost exclusively on anaesthetic staff and occurs mostly outside normal working hours [11]. Manpower shortages ensue especially in smaller referring hospitals.

Appropriate preparation for transfer is time-consuming and may take longer than the transfer itself [12]. Patients are usually best served by smooth controlled journeys. When time is critical, air transport may be appropriate and is becoming increasingly available. It may however involve unexpected delays[13]. Potential problems during helicopter transport are at least as great as those of ground transport and the relative costs are astronomical[14] .

Nevertheless air transport can be very beneficial and each region should consider its desirability in the light of the local terrain, roads, traffic, inter-hospital distances and health budget.

The safe transfer of patients to and between hospitals is in the interests of the public and the hospitals. Both benefit when further physiological insult has not occurred during transfer.
Proper resourcing is required.

(5) The Cornwall View

Dr. G. Morgan (Royal Cornwall Hospital)

49% of deaths from injury occur at the scene of the accident or before admission to hospital. Central nervous system injuries, problems of ventilation and haemorrhage account for the majority [15]. Facilities for the transport of the critically ill in the United Kingdom are inadequate both inside and out of hospitals . A rapid and effective transport system might contribute to an improvement in survival.

This system should ensure adequate telephone communication between ambulance and accident/emergency department and should carry patients to an appropriately staffed hospital. Clinical descriptions of injury should be supported by a simple scoring system [17]. Before transport the patient's condition should be stabilised without wasting time. The cervical spine should be protected and hypoxia prevented by the administration of oxygen, if necessary through a tracheal tube. Intravenous cannulae should be inserted. These procedures may not be possible during transport when cardiovascular and respiratory disturbance is common [2,4,10,18,19]. It is an advantage to have an appropriately trained doctor as part of the transport team.

Helicopter emergency medical services may improve outcome from trauma especially in rural areas by rapidly delivering expert medical assistance to the injured [20,21]. In an urban environment their efficacy is less well demonstrated unless the road ambulance service is inferiorly equipped, which is often the case [22,23].

Once admitted to hospital, patients are frequently moved from critical care areas for investigations and other therapeutic events. Frequently these are not helpful in the patient's management and cause cardiovascular and ventilatory instability [25,26]. Monitoring should review those variables which affect morbidity and mortality i.e. oxygenation and carbon dioxide excretion and cardiac function. Portable ventilators, monitors and drug administration systems are now available so that the standard of care during transport can be as high as that delivered in a critical care area. Clear written guidelines for the provision of transport facilities for the critically ill and injured would be educative.

ISSUES PRESENTED TO THE INTENSIVE CARE SOCIETY OF IRELAND

(FROM CONFERENCE DISCUSSIONS ETC):

(1) *Specialisation of medical services requiring regionalisation of resources (in line with universal practice) is progressing in Ireland.*

(2) *Consequently a high number of inter-hospital transfers of sick patients occur.*

(3) *There are specific Irish topographic, demographic and infrastructural limitations to efficient transport.*

(4) *Many transports are for diagnostic purposes e.g. CT scan and may involve the double hazard of a return journey.*

(5) *Many facilities especially peripheral CT scanners are utilised ineffectively i.e.*

(a) operative during office hours only

(b) are not linked for diagnostic and consultation purposes with a central unit.

(6) *Deterioration of physiological status following transfer e.g. inadequate breathing and/or blood pressure is a problem.*

(7) *Accompanying personnel are often unsuitable due to inadequate training.*

(8) *Standard of equipment and of transport vehicle is often inadequate.*

(9) *Standardisation of facilities and personnel (see 7 &' 8) is urgently needed.*

(10) *Utilisation of medical personnel is inefficient e.g. absence of a consultant anaesthetist from local hospital during a transport may require cancellation of a day of operating (hospital closure).*

(11) *A regional or national system of co-ordination for transportation does not exist.*

(12) *The concept of retrieval, teams - apart from that operated for spinal injury patients - has not been affected or explored.*

(13) *There is a need to integrate air and road transport services to provide an appropriate level of response to individual circumstances,*

(14) *Communication between all parties participating in a patient transport should be modern and immediate.*

Although difficulties outlined were not universal, they occurred with sufficient frequency and seriousness to constitute a single major public health issue.

It was proposed that the efficiencies inherent in developing a centralised retrieval service(s) would mean that such an approach would not alone be better in medical terms but would be also self financing.

CURRENT STATUS / EXTENT OF THE PROBLEM
(DATA FROM VARIOUS PARTIES):

(1) Beaumont Hospital, Dublin.

Total Number of Transported Referrals (1992) 816

Approximate breakdown:

Neurosurgical 55%
Acute vascular and general Intensive Care referrals 45%

Percentage of neurosurgical referrals admitted to Beaumont (approx.) 50%

(2) Mater Hospital, Dublin.

Trauma Admissions & Transfers to Mater Hospital
September 1990 - September 1991.

Number (Total)	Admission	Transferred	
	725	56	(8%)
General Surgical	108	0	(0%)
Cardiothoracic	11	6	(55%)
Eyes	43	13	(30%)
Orthopaedic	469	7	(1.5%)
Spinal Injuries	46	25	(54%)
Facio-maxillary/ENT	10	5	(50%)
Patients re-routed:			
Transfers to Beaumont		4	(0.6%)
Transfers to St. James's		23	(3.2%)

(3) **National Medical Rehabilitation Centre, (N.M.R.C.), Dun Laoghaire.**
(Retrieval Service)

By the end of 1990 there had been 865 spinal injury admissions.
In the past three years there have been 140 helicopter transfers (see below).

*Helicopter Transfers n = 140**

Call out	*Local Doctor*
Time (usually)	*< 24 hrs. after accident*
Patient Location	*Local hospital or accident site*
Transfer Team	*N.M.R.C. Doctor and Nurse*
Stretcher	*Special design (to allow skull traction)*
Ventilator (if necessary)	*Portable Oxylog(R)*
Multiple injuries	*Most patients*
Restrictions	*At night and during severe adverse weather conditions*

**Location etc. of acute care of spinal injuries under current review.*
Management likely to be centralised at Mater Hospital.

(4) Our Lady's Hospital, Crumlin, Dublin.

Transfers to Intensive Care Unit
(N = 59. July '91 - Apr. '92).

Age

Neonates	*41*
Infants (<1 year)	*7*
Children (> 1 year)	*11*

Receiving Service

Cardiothoracic	*13*
General Surgical	*32*
Medical	*14*

Severity of illness (Prism* Score) on arrival

Neonates	*20*
Infants	*13*
Children	*12*

Outcome (Mortality)

Neonates (20/41)	*49%*
Infants (0/7)	*0%*
Children (4/11)	*36%*
Overall (24/59)	*40%*

Neonatal Mortality by subgroup

Cardiothoracic	*40%*
General Surgical	*58%*
Medical	*28%*

• PRISM Paediatric risk of mortality

Prism scores tended to be higher (greater severity of illness) in the neonatal group with associated higher mortality. This was partly due to transfer of babies whose diseases were incompatible with life e.g. hypo-plastic left heart. However deterioration during transfer also accounted for some high prism scores and deaths. Particular problems noted were hypoglycaemia, hypothermia, hypoxia, blocked tracheal tubes and failure to intubate before transfer.

(5) Our Lady of Lourdes Hospital, Drogheda.

Critically ill adult patients transferred from Drogheda.
3 years (July, 1988 - June, 1991).

Cranial Trauma	*32*
Aortic Aneurism	*12*
Vascular Trauma	*6*
Thoracic Trauma	*2*
Orthopaedic / Spinal Injury	*2*
Oesophageal Varices	*6*
Acute Renal Failure	*3*
Total	*63*
Accompanied by Anaesthetist	*75%*

(6) Royal Victoria Hospital/ Belfast / Regional Audit
- Inter-hospital (IH) transfer of trauma patients

A prospective one year study of trauma patients admitted to 12 hospitals, audited regional IH transfers of those with an injury severity score (I.S.S.) of >16.

Shortly after transfer, data were collected using case notes and a structured interview with medical staff.

IH transfer was required in 121 of 239 patients (51%). Forty-nine patients required emergency transfer for life-threatening injuries - 44 (90%) were intubated and 42 (86%) were ventilated during transfer. Anaesthetic staff escorted 41 (93%) of the intubated patients. In four cases manual ventilation only was available during transfer. Twenty-three of the intubated patients were monitored using pulse oximetry and in a further 4 the oximeter ceased functioning during transfer. Three patients underwent emergency transfer with no means to monitor blood pressure and/or ECG. Five patients (10%) arrived at the receiving hospital with undiagnosed injuries (2 splenic lacerations, 3 pneumothoraces). Thirty-seven (76%) of the emergency IH transfers occurred outside normal working hours. The mortality rate after emergency transfer (18%) was less ($p < 0.05$) than that in patients transferred less urgently or not transferred at all (34%).

Despite shortcomings, which should be eradicated, IH transfer of the seriously injured does not increase mortality rate.

(7) Standing Committee for Republic of Ireland
(Association of Anaesthetists of Great Britain and Ireland).
Data on Transport of Critically III from Survey of 1990˙

Total (no. of transports)˙	*(831)*
Accompanied by Anaesthetist	*44%*
Not accompanied by Anaesthetist	*56%*

Estimated that a further 19% would be accompanied by an Anaesthetist were it possible.
The survey question regarding transport of the critically ill elicited, more than any other question, voluntary comments indicating that respondents (consultant anaesthetists) were particularly unhappy

about the arrangements for the transfer of critically ill patients.

- Data relate to transports of which the anaesthetists were aware. Many others occur without reference to the Departments of Anaesthesia.

(8) Faculty of Paediatrics, Royal College of Physicians of Ireland.

RESULTS FROM NEONATAL TRANSPORT QUESTIONNAIRE
(sent to consultants with maternity unit appointments – 1991)

Questionnaires completed	18
No. of units from which replies not received	3

• *No. of deliveries represented (approx.)*	*48,000*	
• *No. of babies transported (approx.)*	*300*	
• *Babies transported per 10,000 deliveries (approx.)*		
(Higher where a good regional transport system exists)	*56 - 113*	
• *Destination of transported babies (approx.)*		
Paediatric surgeons	*100*	*(33%)*
Cardiologists	*90*	*(30%)*
Larger Neonatal Intensive Care Unit with fulltime		
Neonatal services	*110*	*(37%)*
• *Who accompanies transported infants?*		
Nurse with specialised training	*most*	
Consultant/Registrar	*Sometimes - when available*	
Nurses without specialised training	*one unit*	
• *Facilities available during transport*		
IV fluids	*18/18*	*(100%)*
ECG	*14/18*	*(77%)*
Ventilation	*15/18*	*(83%)*
	(2 more units getting ventilators)	
• *Is there a role for a Regional Transport Service?*	*Yes 18/18 (100%)*	
• *Staffing of a Regional Transport Service:*		
Preferences for centralised team/staffing	*7/18*	*(39%)*
Preferences for centralised team/staffing		
(in non-routine cases only)	*6/18*	*(33%)*
Equivocal	*5/18*	*(28%)*
Use of a centralised regional service where available	*35 (cases)*	
Estimated use of a centralised regional service where available	*62 (cases)*	
i.e. total use of a regional service (real and estimated)	*97/300*	*(33%)*
Need for guidelines for safe transport of specific		
neonatal problems	*18/18*	*(100%)*

CONCLUSIONS INCLUDE:
All respondents felt there was a need for a regional transport service.
All respondents interested in having guidelines for safe transport of specific neonatal conditions.
There is a limited demand for a centralised regional transport service – if a well organised service was in place this demand may increase.See Appendix 6 for Faculty's document (including recommendations) on transport of critically ill new-born children.

RESUME OF INTERNATIONAL ARRANGEMENTS

The sequential process of resuscitation from insult to definitive care has been termed the "chain of Survival" [27]. Although the differing survival rates reported from various emergency medical systems (EMS) may reflect a lack or uniformity with definitions, [28] the disparity in the results raises questions and concerns. Guidelines for uniform reporting of out of hospital cardiac arrests have now been agreed [29] by the American Heart Association, the European Resuscitation Council, the Canadian Heart and Stroke Foundation and the Australian Resuscitation Council.

The World Health Organisation (WHO) has made recommendations with a view to optimising the planning and organisation of EMS systems [30]. It emphasises unique telephone numbers for medical emergencies, regional co-ordination, appropriate training of participants, proper qualifications of participating hospitals and appropriate medical involvement in coordinating field intervention and training.

A survey of European countries' EMS-systems [31] which includes an evaluation of compliance with WHO recommendations concludes inter alia that there is an urgent need for co-ordination and "uniformisation" of the various aspects of emergency medical care in Europe and that in most European countries, the medical involvement and presence on the field is most important.

Reports and audits of systems of transferring critically ill patients relate mainly to retrieval systems organised by receiving hospitals. [32,33] Such systems appear generally to be the most effective and accountable. In the West of Scotland, however[34] a single specialist inter-hospital transfer team (mobile intensive care unit) conducted all critical care transfers for the area (47% to a base hospital).

Effective emergency medical systems generally appear to incorporate both a road and air transport Capacity. In the West of Scotland for example, 3.5% ($^{13}/_{365}$) of transfers are by air, the rest by road.[34] An Australian group[35] evaluating the relative merit of road v. air transport found that for distances of 80 kms. (by road) and greater that helicopter transport approximately halves the outward journey time e.g. for a distance of 250 kms. the time by road is 155 minutes, by rotor wing 80 minutes.

Although the details of how to transport critically ill patients and organise a retrieval system are well described[36,37] and minimum standards have been published[38] the financing of EMS services poses universal difficulties. The services of the US, UK, Australia and some continental European countries were recently summarised[39,40] with particular emphasis on mechanisms of funding (private v. public etc.). Regardless of funding sources the common theme is that these services are costly but that they constitute a public health issue with which all jurisdictions must come to terms.

RECOMMENDATIONS OF INTENSIVE CARE SOCIETY OF IRELAND

(1) Many interhospital transports of critically ill patients are semi-elective in nature and the highest standards should pertain.

(2) In these circumstances receiving-hospital-based retrieval systems generally provide the safest, most consistent, efficient and auditable services.

(3) A retrieval team should be located in all major receiving hospitals. The team should have a Director e.g. an Intensive Care or Accident and Emergency Consultant.

(4) Standardisation of the personnel and equipment involved is required (see appendices 1, 2 & 3).

(5) If a receiving hospital / ICU accepts an admission which requires retrieval/ the team should be ready at all times. The team should normally consist of a trained doctor and nurse and should carry standard equipment, (see appendix 1).

Intensive Care Units are very suited to the role of providing a retrieval team but if they are to undertake this service, their medical and nurse staffing arrangements will in general need to be upgraded. It may be possible in a metropolitan area for hospitals/ICUs to provide the medical teams on a rota basis.

(6) A purpose built road vehicle (mobile intensive care unit) should be quickly available to transport the retrieval team to the referring location. The presence of a trained paramedic as part of the ambulance (mobile ICU) crew would be helpful.

(7) Helicopters or aircraft may be required in particular clinical and geographical circumstances. They should be of adequate size and appropriately equipped to accommodate the
personnel and allow the monitoring and therapy required for the transport of the critically ill.

(8) Communications: modern two-way communication between all participating parties is vital. This is especially important between ambulances and receiving hospitals / accident and emergency departments (see appendix 2).

(9) Neurosurgical referrals. Head injuries constitute a high proportion of those transported.
When there is an on-site C.T. facility/ there should be a 24-hour imaging availability.
Diagnostic images should be transmissible to the potential receiving unit for rapid neurosurgical consultation. These measures should quickly identify patients in whom urgent surgery is required and also avoid the need for many emergency transports.

(10) Emergency inter-hospital transport. This is essentially interrupted primary transport and refers to patients brought to a local hospital but -whose urgent need is transfer to a specialist receiving hospital. Appropriate facilities and staff trained in resuscitation and appropriate facilities should be available at the local hospital. Normally one of these staff should then accompany the urgent transfer. In most local hospitals the appropriate person is an anaesthetist and staffing levels/ in general/ require upgrading to accommodate the above as a 24-hour service. Hospitals which cannot provide such a 24-hour capacity should not receive medical emergencies.

(11) Institution of above recommendations would not just improve capacity to deal with critical illness in the community but it would also greatly enhance our capacity to cope with a major disaster.

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- Ms. M Murray who prepared the document.

Appendix 1

Suggested Personnel, Equipment and Pharmacologic Agents

PERSONNEL

(1) Medical	The accompanying doctor should be skilled in resuscitation, tracheal intubation and other emergency procedures. He/she should be familiar with the general management of critically ill patients and related patient equipment.
(2) Nursing	The accompanying nurse should be skilled in the nursing management of critically ill patients.
(3) Paramedic	Ambulance service paramedic or a technician would be useful.

PATIENT EQUIPMENT

(1) Portable monitor(s) with facilities for monitoring:
   (a) E.C.G. e.g. Propaq, Datex
   (b) Blood pressure - non-invasive and direct arterial pressure e.g. Propaq.
   (c) SpO_2 (Oxygen saturation) e.g. Propaq.
   (d) $E_T CO_2$ if patient is ventilated
(2) Portable ventilator with PEEP e.g. Pneupac; Oxylog,
(3) Defibrillator e.g. HP Codemaster; Lifepak 10.
(4) Infusion pumps
(5) Self-inflating bag e.g. Ambu; Laerdal
(6) Portable suction and catheters - flexible and rigid (Yankauer)
(7) Adequate fluids, IV cannulae, tracheal tubes, chest drains and Heimlich valves.

PHARMACOLOGIC SUPPORT

Agents are required to manage:

Cardiac arrest	Raised intracranial pressure
Hypo / hypertension	Adrenal hypofunction
Cardiac arrhythmia	Narcotic/sedative depression
Pulmonary oedema	Convulsions
Anaphylaxis	Pain
Bronchospasm	Agitation
Hypo / hyperglycaemia	Severe electrolyte abnormalities
Uterine atony	Need for sedation and neuromuscular blockade

Drugs which are anticipated to be needed en route should be drawn up and labelled or brought in pre-loaded syringes.

Appendix 2

Suggested fixed requirements for Ambulances / Aircraft

Power:
Patient devices (e.g. monitors, defibrillators, ventilators, infusion pumps and some suction units) should be capable on their own internal power to function for at least one-and-a-half times the maximum anticipated transport time. Devices which facilitate the use of spare power packs considerably improve flexibility and increase the margin of safety. The 12v DC supply available on many ambulances is not suitable for many patient devices.

Gas Pressure:
Pressure required : 400 - 600 kPa (60 - 90 psi)
Outlets needed for flowmeters and to drive a ventilator.

Suction:
Adequate suction must be available e.g. capable of generating
(i) flow rate > 30 litres / min and
(ii) negative pressure > 600 mm(Hg) (79 kPa)

O2 Flow / Reserve:
The majority of critically ill patients requiring "interrupted primary" transport do not have serious pulmonary disorders and can therefore be managed using relatively unsophisticated ventilators. However, a small but important minority may have more complex ventilatory requirements. In the case of secondary transfer, there is a much higher probability that the patients will have such requirements. In view of this, it is necessary that an ambulance designed for the transfer of critically ill patients should have available a ventilator capable of delivering a flexible range of minute volumes (i.e. 2-20 litres per minute) at a flexible range of frequencies (in the case of adults, 8-40 breaths per minute). The ventilator should be capable of generating inflation pressures up to 100 cm of water and PEEP up to 20 cms of water. Some form of disconnection alarm as well as an adjustable relief pressure valve with alarm should be incorporated, i.e. ratio should be adjustable and the ventilator should be capable of delivering either continuously variable concentrations of oxygen or at minimum 2 fixed concentrations (40% and 100%). The mixture should be generated using air entrainment to avoid the need for a second set of cylinders and to cut down use of oxygen to a minimum. A purpose built transport ventilator conforming to the above specifications will be ideal in the majority of circumstances as such ventilators are designed to operate without mains electrical supply and with the most economical use of pressurised gas. The oxygen requirements of a typical transport ventilator using 100% oxygen will be the minute volume plus (20 mls. x respiratory rate) per minute. The ambulance must obviously be equipped with sufficient oxygen cylinders to satisfy such a demand during the longest conceivable journey (plus approx. 25% extra to cover unexpected contingencies).

A ventilator such as that described above will be adequate for the majority of patients. However, there may be occasions (e.g. secondary transfer of a patient with severe ARDS, long distance transfer of critically ill neonates and infants) where a "full ICU type ventilator" is required. For such specialised purposes, some ventilators e.g. Servo 900C may be adapted for use in transport. In these circumstances, special arrangements will be required to meet the demands of such machines in relation to both their electrical (high capacity batteries plus inverter) and gas supply requirements.

Communications:

Two levels of communication are recommended:

(i) to provide the driver with the ability to contact the ambulance control of the Health Board through which he/she is travelling.
(ii) to allow the medical crew to seek assistance or advice from the Intensive Care Unit or Accident & Emergency base should any change occur in the patients condition.

In practice this is best met through:

(i) the use of the existing Ambulance Service Radio network.
(ii) By fitting each of the Mobile I.C.U. vehicles with a cellular telephone.

Appendix 3

A Rapid Pre-Transport Check List

(1) Things to check:

(a) Patient:
Level of consciousness
Heart rate/blood pressure
Peripheral circulation
Oxygenation, chest movement, equal breath sounds
Urine flow
Abdomen
Eyes taped (if unconscious)

(b) Patient Equipment:	**Check:**
Tracheal tube:	position and security
Tracheal cuff:	degree of inflation - replace air with saline if flying
IV and CVC:	secure and flowing
IV Infusion(s):	flowing, adequate pump battery life
Monitor(s):	ECG, SpO_2, Bl. pressure - adequate battery life, Electrode and sensor positions OK
Chest drains:	fluid flowing and/or Heimlich valve 'blowing'

(c) Resuscitative equipment (incl. that in ambulance)
Suction
Oxygen delivery system (incl. self inflating bag e.g. Ambu)
Laryngoscopes x 2
Spare tracheal tubes
Adequate i.v. fluids
Resuscitation drugs
Defibrillator - chargeable, adequate battery life

(2) Things to do: (if not recently performed)
Chest x-ray
Blood gas analysis
Urinary catheter insertion
Consider central venous cannulation (e.g. multilumen)
Consider insertion of gastric tube for decompression (oral or nasal)
Consider arterial cannulation

(3) Things to bring:

{ } blood x-matched / group specific
{ } x-rays
{ } lab. results
{ } referring letter (see Appendix 4) or patient record

Appendix 4

A Standardised Referral Letter

Date:
Referring Hospital:
Referring Doctor:
Receiving Hospital:
Receiving Doctor:

Patient Name and Address

OR

Hospital Sticker

Patient's Next of Kin: Telephone:_____

Diagnoses: (1)

(2)

(3)

Reasons for transfer (if different from above)

(1)

(2)

Treatment at referring hospital:

Past history (incl. drug therapy):

Allergies:

Current medications:

Other important information:

Signed: _____

Appendix 5

A Standardised Transfer Record

Patient Name and Address
OR
Patient Sticker

Transfer from: to:

Principal Diagnosis:

Date / time of departure: ____ / ____ / 199 at _____ hrs.

Date / time of arrival: ____ / ____ / 199 at _____ hrs.

Mode of transport: Road ambulance : Helicopter : Aeroplane : Other
(please circle)

Escort: NAMES

_____

1. Dr / SN / Other

_____

2. Dr / SN / Other

_____

3. Dr / SN / Other

_____

PATIENT INTERVENTIONS/MONITORS:

Tracheal Intubation:	Yes / No	ECG:	Yes / No
Ventilated (manual):	Yes / No	Blood pressure (direct):	Yes / No
(mechanical);	Yes / No	(non invasive):	Yes / No
Urinary catheter:	Yes / No	Central ven. cath.	Yes / No
Chest drain:	Yes / No	SpO2	Yes / No

Any important episode(s) of: Desaturation : Hypotension : Arrhythmia : Other
(Please circle)

If yes, please elaborate:

Other comments/ if any:

Signed: _____

Appendix 6

Guidelines for Neonatal Transport: 1992

Reprinted with permission from the Faculty of Paediatrics' recommendations.

All maternity units must have available an efficient and safe method of transporting infants to other centres. This facility must, where necessary, be available at short notice.
In Ireland newborn infants require transport post-natally in four main situations:

(1) Surgical Emergencies
Infants who require a surgical procedure almost always require transfer to a children's hospital. This includes those with congenital malformations e.g. diaphragmatic hernia; those with acquired lesions such as necrotising enterocolitis.

(2) Cardiac Emergencies
Infants with severe congenital heart disease who require urgent cardiac assessment.

(3) Medical Emergencies
Infants requiring subspecialist care, e.g. rare inborn error of metabolism.

(4) Intensive Care
Infants requiring intensive care who are born in a smaller unit which provides only short term intensive care.

Maternal transport in the fetal interest should be considered when delivery is planned in a maternity unit with neonatal facilities that do not match the level of care likely to be required by the infant.
Maternal transport is only possible when delivery is not imminent - when the infant's problems can be anticipated, e.g. prematurity.

REQUIREMENTS FOR SUCCESSFUL TRANSPORT

A. PERSONNEL
All personnel accompanying an infant must have neonatal training, must be familiar with the equipment used during transport and must be trained in cardiopulmonary resuscitation.

(1) A nurse should accompany all infants.
(2) A doctor will not be necessary for all transports. When required a doctor with training and experience to match the infants requirement must be available.

B. EQUIPMENT
Modern equipment, in good working order must be available. This includes:

(1) Transport incubator with ventilator incorporated.

(2) Adequate monitoring equipment
(3) Portable infusion pumps.
(4) A case or portable container containing equipment for intubation, intravenous infusions, drugs and any other procedures anticipated during transport
(5) Portable oxygen.

Equipment must be battery operated with the facility to plug into main current when available. All equipment must be easily moved in and out of the transport vehicle. The need to transport twins must be anticipated and provision for this must be available at short notice.

C. TRANSPORT VEHICLE

There are 4 possible transport vehicles that can be used:

(1) Ambulance
(2) Helicopter
(3) Fixed Wing Aircraft
(4) Car or taxi

Ambulance: In Ireland, the vast majority of transports can be most successfully carried out using a surface ambulance without need for excessive speed while en route. Advantages include:

(a) Universal availability in short notice.
(b) Only two transfers of the patient during the transport e.g. hospital to ambulance - ambulance to hospital.
(c) Independent of weather.
(d) Can stop or be diverted to intermediate hospital en route if necessary.

Helicopter: Some journeys may be shortened. Disadvantages however are many:

(a) Few hospitals have landing pads nearby.
(b) Noise and vibration limit monitoring.
(c) Infants frequently get cold.
(d) Cabin space is limited.
(e) Infant may require four transports e.g. to ambulance, helicopter, ambulance, accepting hospital.
(f) Weather will limit helicopter flying time.

Fixed Wing Aircraft: The major advantage is speed of transport. However, there are many disadvantages:

(a) Unavailability at short notice.
(b) Four transports of infant required/ ambulance/ plane/ ambulance/ hospital.
(c) Cost.

Car or Taxi: This is an option where an infant is stable and well and does not require intensive monitoring or therapy during transport.

D. COMMUNICATIONS AND PROTOCOLS

Adequate communication between the referring and accepting hospital at an appropriately senior level is essential. Communication should be between senior paediatric staff.

Availability of space, method of transport and facilities that will be required upon arrival should

be discussed.

Baby's condition during transport and upon arrival must be recorded and a method of audit must be developed.

E. REGIONALISATION

The question of regionalisation for neonatal intensive care must be addressed. In Dublin there are presently three centres providing the medical intensive care. Ideally, a regional unit should be available in each major catchment area throughout the country. Infants with cardiac disease are transported to the National Cardiac Unit. Infants requiring surgery are transferred to a neonatal surgical unit

F. MEDICO-LEGAL ISSUES

Clarification of the insurance cover of all staff involved in transport during transport is essential both regarding medical malpractice and accidents.

G. SOURCE OF TRANSPORT TEAM

Each hospital delivering infants must be in a position to transport infants who are stable and who do not require intensive care. They should also be in a position to transfer critically ill infants on most occasions.

If the referring hospital is notin a position to provide staff to accompany a critically ill infant, either because of a heavy local workload or because of unavailability of sufficiently senior staff for the duration of the transport, a transport service based in the regional centre should be available on an ad hoc basis.

SPECIAL CONSIDERATIONS FOR SPECIFIC CONDITIONS

(1) Congenital Diaphragmatic Hernia

The diagnosis of congenital diaphragmatic hernia is usually easily made from characteristic physical findings and the chest x-ray appearance of a new-born infant with respiratory distress.

It is important to stabilise the critically ill neonate before transport. Some infants may never be stable enough to tolerate transport or surgery because of severe pulmonary hypoplasia.
Mask ventilation should be avoided as it will distend the stomach and increase the infant respiratory difficulty. A nasogastric tube should be inserted. An endotracheal tube should be inserted promptly and the infant ventilated. Rarely an infant’s pulmonary hypoplasia is so mild that ventilation is not required. Intravenous fluids should be given. Arterial access via an umbilical artery catheter should be established if possible. A radial arterial line may be inserted if preferred but this may be more difficult to watch during transport.

Vitamin K should be given. Fresh frozen plasma should be given as necessary. During transport an experienced nurse and doctor must accompany the infant requiring ventilation.

(2) Oesophageal atresia with tracheo-oesophageal fistula

Once a diagnosis of oesophageal atresia is suspected, the baby should be immediately transferred to the referral centre for surgery. The quicker the transport is accomplished the more likely it is to prevent respiratory complications. The infant should be kept in a warm environment.
To prevent aspiration of salivary secretions from the upper blind oesophageal pouch, a replogle

tube should be inserted and connected to low-intermittent or low-continuous suction. These double-lumen oesophageal tubes have a tendency to became blocked with mucus and therefore should be irrigated at frequent intervals. This is especially important during transport. The regurgitation of gastric contents through the tracheo-oesophageal fistula can he prevented by keeping the baby's head elevated at 45° or nursing the infant in prone position.
An intravenous cannula should be inserted to provide maintenance fluid and electrolytes as well as supplemental fluids to compensate for the loss of oesophageal secretions. Broad spectrum antibiotics should be started for the treatment of any existing pneumonitis and for prevention of infection. Vitamin K should be administered prior to transporting the baby to the referral centre. If any respiratory compromise is anticipated, the infant should be intubated and ventilated.

(3) Omphalocele and Gastroschisis

Following delivery of a patient with an omphalocele the initial objectives for the neonatologist are to assess and treat respiratory distress, to protect the evisceration from infection and rupture and to minimize heat loss. The sac should be covered with cling film, and the entire abdomen wrapped completely with dry gauze.

The patient with gastroschisis, due to the small size of paraumbilical defect and to the lack of a covering peritoneal / amniotic membrane, is at higher risk for infection and intestinal strangulation, necrosis, obstruction, excessive fluid loss and shock. Heat loss is a frequent problem and hypothermia can result. Careful attention should be given to stabilising these infants prior to and during transport. The exposed intestine should be covered with cling film and/or sterile gauze. The infant should be kept in a warmed incubator and the temperature monitored frequently. A nasogastric tube should be passed for intestinal decompression. Intravenous fluids, broad-spectrum antibiotics and vitamin K should be started.

(4) Myelomeningocele

The infant with myelomeningocele should be kept in prone position to avoid pressure on the spinal area. If cerebrospinal fluid (CSF) is leaking from the defect or if the myelomeningocele is open, it should be covered with jelonet and sterile gauze. If the defect is not open/ place sterile dressing over the site. Careful documentation of neurological function is essential before, during and after transport.

(5) Intestinal Obstruction

Intestinal obstruction can occur as a result of a number of conditions e.g. intestinal atresias, malrotation, meconium ileus, duplications of alimentary tract, Hirschsprung's disease, anorectal anomalies and necrotizing enterocolitis. The initial objectives for the neonatalogist in patients with intestinal obstruction are to decompress the bowel and prevent aspiration, maintain accurate estimation of fluid loss and to minimise heat loss. To prevent aspiration and facilitate gastric decompression, a nasogastric tube should be passed and suction carried out every 15-30 minutes prior to and during transport. Intravenous fluids should be started and add, base and volume deficits corrected.

CONGENITAL HEART DISEASE

Congenital heart disease is the most common major congenital abnormality and is responsible for one third of all neonatal deaths. The outcome is critically dependant on early recognition of the underlying congenital heart defect. Defects that present in the immediate neonatal period can be broadly divided into those that present with congestive cardiac failure and those with cyanosis.
In both instances the clinical presentation may depend on the behaviour of the Ductus Arteriosus. In the former, the systemic circulation may depend on adequate ductal patency e.g. Critical Coarctation of the Aorta, Interrupted Aortic Arch, Critical Aortic Stenosis, while in the latter ductal patency will determine the extent of pulmonary blood flow e.g. in severe Tetralogy of Fallot and Pulmonary Atresia lesions.
The specific anatomical diagnosis especially in the cyanotic group of cases is not important, however an appreciation of whether the defect has a ductus dependant pulmonary circulation may be vital. The cyanotic new-born with a single second heart sound, continuous murmur and oligaemic lung fields on x-ray would represent the usual findings. With increasing cyanosis indicating ductal constriction there may be no audible murmur

In an infant with a duct dependant systemic circulation, there would be no ductus murmur at all as the flow is from the pulmonary artery to the aorta. Indications for the use of prostaglandin relate to signs of increasing congestive cardiac failure in the presence of absent femoral pulses e.g. severe Coarctation, Interrupted Aortic Arch or increase in congestive cardiac failure with absence of all pulses e.g. ? Critical Aortic Stenosis versus Hypoplastic Left Heart.

The transport of neonates with congenital heart diseases should follow the general principles as outlined for all neonates. If prostaglandin. is to be used however, the infant should be electively intubated and ventilated for transport

Most neonates with congenital heart disease if recognised early do not require prostaglandin or other special intervention.

Where possible, consult with cardiologist before beginning prostaglandins.

CONGENITAL HEART DISEASE

Prostaglandin (Prostin E2 or El) Indications during transport

(1) Increasing cyanosis with diminution or absence of ductus murmur
(2) Increasing cyanosis in infant with transposition - preferably after septostomy though may b'e required for transport if infant is critically ill.
(3) Increasing signs of congestive cardiac failure in ductus dependant systemic circulation.

Intravenous Dose:
0.05 mcg/kg/min (may be increased to 0.1 mcg/kg/min continuous slow infusion).
This dosage can be decreased by 0.5 to 0.25 as soon as there is an improvement in colour in those infants with a duct dependant pulmonary circulation or the appearance of femoral pulses or systemic pulses in infants with the duct dependent systemic circulation.

N.B.: Infusion is maintained at all times.

Calculation
One ampoule added to 50 mis of 5% dextrose i.e. 750 mcg added into 50 mis = 15 mcg per 1 ml

Formula $\frac{0.05 \text{ mcg X weight}}{15 \text{ mcg}} \times 60$ = infusion rate per one hour

therefore 3 kilo infant = 0.6 ml per hour = 0.05 mcg/kg/min.

Side effects of Prostaglandin

(1) Apnoea
(2) Tachycardia
(3) Pyrexia
(4) Diarrhoea
(5) Hypotension
(6) Tremor may mimic seizure activity
(7) Phlebitis
(8) Inhibits leucocyte activity therefore more prone to infection
(9) Hyponatraemia

If temperature exceeds 38.5 c ... Septic screen.
If diarrhoea or tremor ... U & E calcium glucose check.
If severe side-effects ... dose may be reduced to minimum required to maintain adequate duct murmur

Stabilization of new-born with anterior abdominal wall defect prior to transfer to a referral centre

Evaluate respiratory status

Warm environment

Nasogastric tube

Cover sac with cling film

Intravenous fluids, correct deficits

Antibiotics

Vitamin K

Stabilization of a neonate with congenital diaphragmatic hernia prior to transport

Maintain Warm Environment

Nasogastric Tube

Intubation and Ventilation

Arterial Blood Gases

Intravenous Fluids

Antibiotics

Vitamin K