

Medication Use During Neonatal and Pediatric Critical Care Transport

Janice E. Sumpton and Jonathan B. Kronick

ABSTRACT

The Pediatric Critical Care Unit (PCCU) at the Children's Hospital of Western Ontario provides a transport service and team (critical care physician, critical care nurse, respiratory therapist) which transports critically ill newborns, infants, and children. The purpose of this study was to identify the medications used during transport and to determine age-related differences. Results of a prospective study of all drugs administered by the transport team to 174 patients during their stabilization and transport from November 1, 1987 through October 31, 1988 are presented. One hundred and twenty-one (69.5%) patients received at least one medication. The most frequently administered medications were antibiotics (38.5% of patients), followed by morphine (27.0%), anticonvulsants (23.6%), neuromuscular blockers (14.4%), respiratory drugs (11.5%), inotropes (10.9%), and sedatives (7.5%). Miscellaneous medications were administered to 48.8% of patients. The use of different classes of drugs varied with age; anticonvulsants were most frequently administered to children, sedatives and respiratory medications to infants, and antibiotics and miscellaneous medications to newborns. The wide range of medications used may reflect the diversity of diseases causing critical illness which reinforces that transport teams must have access to and knowledge of a variety of medications. The formulary of medications taken by the critical care transport team is included.

Key Words: *pediatric, emergency drugs, critical care transport, neonatal*

RÉSUMÉ

Le Service Pédiatrique des soins intensifs (SPSI) du Children's Hospital of Western Ontario assure un service de transport et une équipe de réanimation (comportant un médecin de réanimation, un(e) infirmier(e) de réanimation, un thérapeute des voies respiratoires) qui transporte des nouveau-nés, des nourrissons et des enfants gravement malades. Le but de cette étude était d'identifier l'utilisation des médicaments pendant le transport afin de déterminer les différences par rapport à l'âge. Les résultats d'une étude en perspective de tous les médicaments dispensés par l'équipe de transport chez 174 malades pendant leur stabilisation et leur transport entre le 1er novembre 1987 et 31 octobre 1988 sont présentés. Cent vingt et un malades (69.5%) ont reçu au moins un médicament. Les médicaments les plus fréquemment utilisés étaient des antibiotiques (38.5% des malades) suivi par la morphine (27.0%), des anticonvulsivants (23.6%), des agents bloquants neuro-musculaires (14.4%), des médicaments des voies respiratoires (11.5%), des inotropes (10.9%), et des sédatifs (7.5%). Divers médicaments ont été dispensés chez 48.8% des malades. L'utilisation de catégories différentes de médicaments a varié selon l'âge; des anticonvulsivants étaient plus fréquemment administrés chez des enfants, des sédatifs et des médicaments des voies respiratoires étaient administrés chez des nourrissons et des antibiotiques et divers médicaments étaient administrés chez les nouveau-nés. La grande série des médicaments utilisée peut refléter la diversité des maladies entraînant un état grave et d'où le besoin d'assurer que l'équipe de transport ait accès aux divers médicaments et en possède la connaissance. Le formulaire des médicaments pris par l'équipe de transport de réanimation est inclus.

Mots clés: *pédiatrie, médicaments d'urgence, transport de réanimation, néonatal*

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INTRODUCTION

Regional hospital-based pediatric and neonatal transport teams provide assistance in the stabilization and transport of critically ill patients from referring hospitals to tertiary care facilities. These teams appear to improve the outcome of critically ill patients.^{1,2} The Pediatric Critical Care Unit (PCCU) at the Children's Hospital of Western Ontario provides a transport team which transports critically ill newborns, infants, and children referred from hospitals throughout Southwestern Ontario (population 1.3 million). Referred patients are transported either to the Children's Hospital of Western Ontario or to the Neonatal Intensive Care Unit (NICU) at St. Joseph's Health Centre in London.

Critically ill children differ from adults because of both anatomical and physiological differences as well as in the spectrum of disease leading to critical illness.² Reliable information on the medications required during the stabilization and transport of critically ill pediatric patients is essential for hospitals implementing a pediatric transport team or considering expansion of an existing team to include both neonatal and pediatric patients. Unfortunately, little information is currently available.³⁻⁷ This study was therefore undertaken to systematically determine the medications administered by the Critical Care Transport Team, and to identify any age-related differences in medication use.

METHODS

All patients were transported by the Children's Hospital of Western Ontario Critical Care Transport Team (critical care physician, critical care nurse and respiratory therapist). Data were collected on

consecutive transports from November 1, 1987 through October 31, 1988. All medications administered by the transport team were prospectively recorded on standardized data sheets by members of the team. All critical care transports during the study period were considered for inclusion. Patients who died before arrival of the transport team were excluded. Medications were classified as follows: 1) antibiotics, 2) morphine, 3) non-opiate sedatives, 4) anticonvulsants, 4) neuromuscular blockers, 6) respiratory medications, 7) inotropes, and 8) miscellaneous medications. Lorazepam, diazepam and thiopental were classified as either sedatives or anticonvulsants depending on the indication for use in each patient.

Newborns were defined as less than one month of age, infants as one month to two years, and children as greater than two years. Differences in medication use among the age groups were assessed using the χ^2 statistic.

RESULTS

During the one-year study period, 176 transports were made of which 174 are included in the study. Two patients died prior to arrival of the transport team. The study patients included 107 newborns (61.5%), 35 infants (20.1%), and 32 children (18.4%). One hundred and twenty-one patients (69.5%) received at least one medication during stabilization and transport. The number of medications administered to each patient ranged from one to 10 (mean 2.6).

The most frequently administered medications included antibiotics (38.5% of patients), morphine (27.0%), anticonvulsants (23.6%), neuromuscular blockers (14.4%), and miscellaneous (49.0%). Table I illustrates the frequency of indi-

vidual medication use within each group of medications.

The frequency of medication use was age dependent (Table II). Antibiotics were administered most frequently to newborns while anticonvulsants were used infrequently in newborns and significantly more often among infants and children. In contrast, over one third of infants required respiratory medications compared to less than 10% of newborns and children. The use of other groups of medications did not differ greatly among the age groups studied.

DISCUSSION

The range of ages and spectrum of disease in the critically ill transported patient is reflected in the wide range of medications administered by the transport team. Approximately 70% of these critically ill patients received at least one medication during transport and many of them required more than one medication (mean 2.6). In some cases, multiple doses of one agent were administered. In order to meet the medication requirements of critically ill transported patients, the transport team must therefore have access to a wide range of medications in adequate supply. The stock medications routinely taken by the transport team is listed in Appendix I.

Antibiotics were the most commonly used class of medication followed by morphine, anticonvulsants, neuromuscular blockers, respiratory drugs, inotropes and sedatives. Similar medication use has been reported in other studies on transported pediatric patients.³ Morphine and other sedatives, which were administered to over 30% of this study's patients, were not however reported in the previous study.³ Morphine was frequently used for its sedative and

Table I: Medication use in all patients

Antibiotics (n=67)*		Morphine (n=47)	
	%		%
Ampicillin	40	Morphine	100
Gentamicin	40		
Cephalosporins	11		
Other	9		
Anticonvulsants (n=41)		Neuromuscular Blockers (n=25)	
	%		%
Phenobarbital	49	Pancuronium	72
Lorazepam	27	Succinylcholine	28
Phenytoin	12		
Diazepam	7		
Thiopental	5		
Respiratory (n=20)		Inotropes (n=19)	
	%		%
Salbutamol inhalation	30	Dopamine	74
Aminophylline	25	Adrenaline	21
Racemic epinephrine	25	Isoproterenol	5
Surfactant	20		
Sedatives** (n=13)		Miscellaneous (n=85)	
	%		%
Lorazepam	46	Atropine	24
Thiopental	23	Heparinized saline	16
Diazepam	15	Acetaminophen	13
Pentobarbital	15	Sodium bicarbonate	12
		Others***	35

* n = number of patients receiving medication
 ** excluding morphine
 *** Other medications included: chlorpromazine in six patients, alprostadil and vitamin K in four patients, mannitol and furosemide in three patients, Humulin R, potassium chloride bolus and calcium gluconate in two patients, and dimenhydrinate, ketamine, hydrocortisone, naloxone and 50% dextrose in one patient. Medications used and not routinely included in the Drug Box were Humulin R, ketamine and vitamin K.

Table II: Patient Age and the Class of Medications used

Medication	Age			P*
	Newborn (n=107)*	Infant (n=35)	Child (n=32)	
	%	%	%	
Antibiotics	50.5**	22.9	15.6	0.00019
Anticonvulsants	8.4	37.1	59.4	<0.00001
Respiratory	3.7	37.1	9.4	<0.00001
Morphine	27.1	28.6	25.0	NS
Inotropes	13.1	8.6	6.3	NS
Neuromuscular Blockers	12.1	17.1	18.8	NS
Sedatives***	5.6	14.3	6.3	NS
Miscellaneous	56.0	45.7	28.1	0.02

* n = number of patients. Newborns are defined as less than one month of age, infants as one month to two years, and children as greater than two years.
 ** % of patients administered at least one medication.
 *** excluding morphine.
 P* = probability with χ^2 , df = 2, NS = not significant.

analgesic properties especially in intubated patients where maintenance of the airway during transport is vital. In addition, the use of morphine may reflect the increased awareness of pain in both newborn and pediatric patients, and the importance of appropriate pain management.^{8,9} Forty-nine percent of the patients received a variety of medications in the miscellaneous group. This highlights the need to provide a comprehensive supply of drugs for transport. For specific clinical situations, it is important to include medications which may be used infrequently, and which may not be readily available at referring hospitals. For example, alprostadil and tolazoline may be needed for infants with cyanotic congenital heart disease or pulmonary hypertension.

The most frequently used antibiotics were ampicillin and gentamicin, often in combination. This reflects the large newborn population which often receives a penicillin and an aminoglycoside for empiric treatment of possible sepsis. Phenobarbital was the most frequently administered anticonvulsant followed by lorazepam. This demonstrated the emergence of lorazepam over diazepam as the preferred anticonvulsant in the pediatric population.^{2,10}

Medication use varied with age and the type of disease causing critical illness in the various age groups.^{11,12} Newborns accounted for the largest percentage of antibiotic use possibly due to the non-specific, subtle signs and symptoms of sepsis in this age group. Newborns also required the widest spectrum of medication. Sedatives and respiratory medications were required most frequently by infants from one month to two years of age reflecting the commonly encountered causes of respiratory failure in this age group (croup, bronchiolitis, asthma). In contrast,

anticonvulsants were most frequently required by children over two years of age due to the high incidence of neurologic disease among critically ill transported pediatric patients.^{11,12} All age groups received morphine, inotropes, neuromuscular blockers and sedatives with similar frequencies.

Given the wide range of medications required, we suggest that

a basic formulary of core medications be available for all critical care transports (Appendix I). Additional supplies of selected medications may be added based on the age of the patient and the individual case history. Ongoing review of medication use on transport is necessary to ensure access to appropriate medication supplies.



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Appendix I: Children's Hospital of Western Ontario Pediatric Critical Care Transport stock medications

- | | |
|---|--|
| (1) calcium chloride 10% 1 g/10 mL PRELOADED | (2) isoproterenol 0.2 mg/mL (1 mL) |
| (2) calcium chloride 10% 1 g/10 mL | (1) naloxone 0.02 mg/mL (2 mL) |
| (2) epinephrine 1 mg/ml (1 mL) | (1) naloxone 0.4 mg/mL (1 mL) |
| (2) epinephrine 0.1 mg/mL (10 mL) PRELOADED | (2) potassium chloride 2 mmol/mL (10 mL) |
| (1) lidocaine HCl 20 mg/mL (5 mL) PRELOADED | (2) chlorpromazine 50 mg/2 mL |
| | (4) salbutamol inj. 0.5 mg/mL (10 mL) |
| (2) verapamil 2.5 mg/mL (2 mL) | (1) neostigmine 0.5 mg/mL (1 mL) |
| (2) atropine 0.4 mg/mL (1 mL) | (1) neostigmine 2.5 mg/mL (5 mL) |
| (3) aminophylline 50 mg/mL (10 mL) | (2) hydrocortisone 250 mg/2 mL |
| (1) dexamethasone 4 mg/mL (5 mL) | (2) ampicillin 1000 mg |
| (2) phenytoin 50 mg/mL (2 mL) | (1) gentamicin 10 mg/mL (2 mL) |
| (3) diazepam 5 mg/mL (2 mL) | (1) gentamicin 40 mg/mL (2 mL) |
| (1) digoxin 0.05 mg/mL (1 mL) | (1) chloramphenicol 1 g |
| (1) digoxin 0.25 mg/mL (2 mL) | (2) cefotaxime 500 mg |
| (3) furosemide 10 mg/mL (2 mL) | |
| (1) heparin 1,000 units/mL (10 mL) | |
| (3) dimenhydrinate 50 mg tabs | |
| (4) dopamine 40 mg/mL (5 mL) | |
| (2) nitroglycerin 5 mg/mL (10 mL) | |
| (2) calcium gluconate 10% 100 mg/mL (10 mL) | |
| | |
| (1) dextrose 50% 0.5 g/mL (50 mL) | |
| (1) 100 mL 0.9% NaCl | |
| (1) 50 mL D5W | |
| (4) 10 mL 0.9% NaCl | |
| (4) 10 mL Sterile Water | |
| (1) ipratropium bromide 0.025% inhalation (20 mL) | |
| (1) salbutamol 5 mg/mL inhalation (10 mL) | |
| (2) sodium bicarbonate 8.4% (50 mL) | |
| (1) racemic epinephrine inhalation 2.25% (30 mL) | |
| (1) Transport Drug Charts | |
| (1) P.C.C.U. Drug Dosing Guidelines | |
| **NARCOTICS TO TAKE | **REFRIGERATED MEDS TO TAKE |
| (2) morphine 2 mg/mL | (2) pancuronium 2 mg/mL (2 mL) |
| (2) morphine 10 mg/mL | (2) paraldehyde 1 g/mL (5 mL) |
| (2) pentobarb supp. 50 mg | (1-2) alprostadil 225 µg/0.45 mL |
| (2-4) phenobarb 30 mg/mL | (1) succinylcholine 20 mg/mL (20 mL) |
| (2) phenobarb 120 mg/mL | (3) lorazepam 4 mg/mL (1 mL) |
| (1) thiopental 1 g vial | |
| **EMERGENCY RELEASE AND INVESTIGATIONAL MEDS TO TAKE | |
| (3) tolazoline 25 mg/mL (4 mL) | |
| (2 per pt.) surfactant 25 mg/mL (3-4 mL) (freezer) | |

** Above meds will vary depending on type of patient.

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