Position statement

The interfacility transport of critically ill newborns

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, Fetus and Newborn Committee
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Abstract

The practice of paediatric/neonatal interfacility transport continues to expand. Transport teams have evolved into mobile intensive care units capable of delivering state-of-the-art critical care during paediatric and neonatal transport. While outcomes are best for high-risk infants born in a tertiary care setting, high-risk mothers often cannot be safely transferred. Their newborns may then have to be transported to a higher level of care following birth. The present statement reviews issues relating to transport of the critically ill newborn population, including personnel, team competencies, skills, equipment, systems and processes. Six recommendations for improving interfacility transport of critically ill newborns are highlighted, emphasizing the importance of regionalized care for newborns.

Key Words: Interfacility transport; Intramural; Newborn; Transport medicine

The development of regionalized secondary and tertiary care for critically ill newborns in Canada has necessitated the transport of neonates among facilities providing different levels of neonatal care. Despite existing recommendations for the interfacility transport of neonates,[1]-[3] variations in practice exist both in Canada and the United States.[4] Most Canadian neonatal intensive care units (NICUs) rely on hospital-based transport teams and use local emergency medical services (EMS) vehicles. The populations served, team composition, training and evaluation, processes and transport infrastructure differ widely. A lack of standardization in equipment, education, clinical competencies and quality indicators, together with a lack of resources, create barriers to optimal care such that outcomes also differ widely.[5] The present statement focuses on recommendations for improving the interfacility transport of critically ill newborns to tertiary centres or other centres providing appropriate levels of care.

Methods

A comprehensive search for transport-related articles using the Ovid SP search platform in MEDLINE (1948-2014) and EMBASE (1980-2014) was performed. Articles in the English language that included the key words “transportation of patients”, “intramural”, “intra-hospital”, “newborn”, “premature”, “high risk pregnancy”, “ambulance”, “air medical transport” or “air ambulance” were identified. A total of 1358 references from the two databases were reviewed. Once duplicates had been excluded, the remaining 1065 references were scanned for relevance. A total of 170 articles from 1973 onward were reviewed in depth for evidence of best practice or guidelines.

Transport models

Key to the success of regionalized perinatal care is the identification and transport of at-risk pregnant women, including those with pregnancies complicated by threatened preterm labour and fetal anomalies.[6] In utero transport is superior to transport of the unstable newborn[7][8] and neonatal outcomes are improved.[9][10]

The use of a specialized retrieval team for transfer is associated with improved outcomes, especially enhanced neonatal survival.[11][12] Significantly more adverse events, including airway problems, the need for cardiopulmonary resuscitation, hypotension and loss of vascular access, occurred when a nonspecialized team transported paediatric patients (RR 41.5).[13] Similarly, one study by McPherson et

al[14] demonstrated a reduction in paediatric mortality rate from 23% to 9% when using specialized transport teams. Having dedicated transport teams rather than NICU staff on call for transport improves availability and mobilization as well as response times.[15]

Transport team composition

Teams usually operate under advanced medical directives with access to telephone medical advice, preferably from senior physicians with specific neonatal and transport expertise. Responsibility for patient care rests with the physician, who delegates to the team clinicians. Most transport teams consist of two members. In Canada, this team is typically a registered nurse (RN) and registered respiratory therapist (RT), both of whom have advanced practice skills and knowledge. Elsewhere, paramedics and/or emergency medical technicians (EMTs) may be used. Thompson[16] was one of the first to describe successful implementation of a team led by RNs who had completed an eight-week education program. The survival rate of neonates transported by the RN team was 81%, compared with a rate of 75% for neonates transported by the previous physician-led team. Other studies also report effective nurse-led retrieval teams, with shorter response times and equally effective neonatal care when compared with teams consisting of postgraduate trainees (residents and fellows).[17][18] There is no evidence that neonatal transport undertaken with staff from any particular professional background results in improved outcomes.[19] Lee et al[20] have shown that a RN/RN team is less costly than other models until the number of transports exceeds 2760 annually, at which point an EMT team becomes least costly.

It is unclear whether some transports may benefit from the presence of a physician. There is no scoring tool for the accurate prediction of intratransport morbidity, although one simple method of stratifying patients who develop complications during transport has been published.[21] Another study failed to show enhanced outcomes when a neonatal fellow attended the delivery of high-risk infants before their transport.[22] Adams et al[23] found greater success with intubations performed by RTs rather than residents, with an overall success of 92% versus 77%. McCloskey[24] examined predictability of the need for a physician before and after transport of critically ill paediatric patients. The responsible physician underestimated the need for a physician in only three cases (2%), whereas 73% had no decision discrepancy, suggesting that in three-quarters of the transports, it is possible at the time of the first call to determine whether a physician may provide additional benefit during patient transport. The cost effectiveness and health care effects of a physician-based transport team remain unproven.[25] However, participation in transport is an important educational component of residency programs in paediatrics and neonatal-perinatal medicine.[26]

A successful transport team requires good leadership, with team members who demonstrate flexibility, independence, critical thinking, timely judgment and problem solving skills, together with interpersonal and communication skills and appropriate crisis resource management. Team health and safety are also of primary importance, and should be considered when determining the best performance model.[2]

Team skills and training

Neonatal transfers generally require more interventions and involve more complications when compared with other populations. In one study of 295 neonatal transfers, 19.8% of the neonates required intubation, compared with 7.5% of infants and 4.9% children; almost half of transport complications in neonates were airway-related.[27] King and Woodward[28][29] provide a comprehensive list of necessary skills. Algorithms for such competencies as management of the difficult airway are recommended.[30] The Canadian Association of Paediatric Health Centres has recently made recommendations for clinician competencies to perform transport of maternal, neonatal and paediatric patients.[31] However, the acquisition and maintenance of competency in neonatal procedures is a challenge, and difficult skills need a longer time to master.[32] Assessing competence using an objective structured assessment of technical skills, checklists and global rating scales is ideal.[33] Retaining competencies requires regular practice and refresher courses.[34]

Although operating room (OR) experience remains the ‘gold standard’ for learning intubation, students are also turning to simulation and task trainers as a necessary adjunct. Many teaching sites rely exclusively on mannequins, especially high-fidelity models, and some show success rates equivalent to operating room training (although the high-fidelity model has not proven superior in simulation for this task acquisition).[35]

Transport equipment and vehicles

As a mobile intensive care unit, transport vehicles, equipment and supplies must reflect the needs of the

patient population. Neonatal transport equipment includes a portable isolette fitted with ventilator, medical air, oxygen and nitric oxide, suction, monitors for vital signs, pulse oximetry and capnography (end tidal or transcutaneous carbon dioxide monitoring) as well as a defibrillator. Point-of-care laboratory testing for blood work should be mandatory. The limited market for transport equipment has resulted in homegrown, nonstandardized systems, with a tendency to equipment failure.[36] The weight and bulk of equipment must not exceed standards for the occupational health and safety of crew members.[37] The use of light, synthetic cylinders for gas, lithium ion batteries and lightweight frames reduced weights by 23% on one team.[38] The limited availability of assistive power lifts and hydraulic stretchers in Canada makes crew injuries common. Recent recommendations require all equipment to be fixed and crash-tested before use in air or land vehicles.[39] Some transport teams have their own dedicated vehicles, permitting more customization of equipment and supplies, and faster response times.[40] Using local EMS vehicles permits operation of lights and sirens, although these signals may not save time[41] and actually increase risk.[42][43]

The transport environment is challenging. Hypothermia is a frequent occurrence[44] that is associated with increased mortality; using a warming mattress reduces the risk of hypothermia.[45]Ambient noise and vibration are concerns in both land and air transport.[46][47] Ear muffs, which are commercially available products and easily applied, have proven effective and should be used routinely to reduce noise effects.[48] Similarly, an air-foam mattress and gel pillow can reduce potentially harmful vibrations that may lead to morbidity.[49]

Although teams usually operate under advanced medical directives, ready access to round-the-clock telephone advice optimizes appropriate care. Smartphones and satellite phones enable such communications whether transporting by land or air, as well as permitting more secure transmission of photographs, medical images and electrocardiograms. It is increasingly possible to establish wireless connectivity with an electronic patient record, continuously track a patient's vital signs, trend stabilization and avoid transmission errors. Webcams can also provide visual information for the home base during transport.

Transport systems and processes

A centralized process for team dispatch with a single number to call to access medical advice, a receiving physician and facility as well as triage and access to an appropriate transport team provides the most efficient streamlined practice.[50] Triage tools for assessing illness severity can help to determine which infants require specific responses and resources.[51] The specific referral diagnosis is less relevant than identifying the need to transport in determining mortality and morbidity.[52]

Decreasing the time interval between receipt of the transport call and the team's arrival at the referring hospital is shown to improve outcomes.[53] Ideally, the team should be dispatched before determining bed availability or even identifying the receiving hospital. An accurate bed registry helps with assigning appropriate resources. When EMS vehicles rather than dedicated vehicles are used, the EMS mandate for emergency (ie, 911) calls competes with their availability, increasing mobilization and response times.[54] In one study, the absence of dedicated vehicles resulted in a median dispatch time of 45 min to 50 min.[55]

The decision to use an air ambulance or a land vehicle should be operational, dictated by distance, geography and weather. In Europe, helicopters reduced transport times by 75% while the costs per transfer doubled, on average,[56] and no consensus on cost versus benefit has emerged.[57] A comparison of air and land ambulances in Ontario showed that transport times for land ambulances were significantly shorter over distances <100 km and equivalent for distances of 100 km to 250 km, which reflects the extra time needed to coordinate helicopter transport.[58]

Fixed-wing aircraft used for longer flight distances (>250 km) necessitate airstrip availability and land vehicle transportation to and from airports. Special consideration must be given to patients in remote rural settings, where ready access to aircraft, typically a turboprop or small jet, is essential to making regionalized care possible.[59]

Responsibilities of referral and receiving institutions

While the transport team is responsible for the actual move, the referral institution should be considered part of the team and the responsibilities of both the referring and receiving facilities clearly understood.[60] [61] This is particularly true in remote and rural areas. Building strong links with these areas and offering

outreach training in both resuscitation and stabilization before transport will help to clarify roles and responsibilities. Consent for transport is implied when the referring physician informs the family of the need to transfer their infant. Copies of pertinent records and medical images, a maternal blood sample and colostrum for early feeding should be provided. The placenta may be retained, double-bagged in a sealed container without formaldehyde, for pathology examination. The referral and transport teams share a legal responsibility for patient care during stabilization, and all relevant documentation should be copied for the patient's medical chart.[62] The transport team should obtain written consent to treat, transport and disclose health information for feedback to the referral institution. Specific consent is required for blood product administration. The child's family should be provided with an information package on the tertiary facility's location and policies.

Tertiary institutions share medicolegal responsibility for patient care as soon as they are aware of the patient. Transport teams must plan for times of resource shortage by working together with other teams in an integrated system. Telephone contact should be made with family following admission to the receiving hospital. Feedback to the referring team is essential for ensuring quality care and also provides an opportunity for outreach education. Joint mortality and morbidity rounds are helpful.

Family-centred care

Open and honest communication with family members includes information about an infant's condition and general prognosis. Parents should be encouraged to be present throughout stabilization and, if possible, during transport.[63]

Transport quality assurance

Team policies and procedures must be adhered to, including safety reporting, risk management, morbidity and mortality reviews, uniform code and professional codes of conduct.[64] Evaluating the efficiency and effectiveness of transport teams and systems is problematic because transported patients vary in illness acuity and complexity. The Mortality Index for Neonatal Transportation (MINT) score correlates with mortality; the need for a blood gas measurement is a drawback and has not been further validated.[53] The Transport Risk Index of Physiological Stability (TRIPS) score uses four empirically weighted items (temperature, blood pressure, respiratory status and response to noxious stimuli) to predict mortality at seven days and overall.[65][66] Using the Risk Score for Transport Patients (RSTP), which differentiates infants requiring interventions en route from those who do not, has been proposed to aid triage.[67]

In one study involving 346 neonatal transfers, 36% had adverse events, of which 67% were due to human error, 21% to equipment failures and 9% to ambulance problems. Communication failures occur at every phase of the transport process, especially at the time of handover between teams.[68] A structured format for communication, such as SBARR (Situation, Background, Assessment, Recommendations, Read-back), enhances communication, reduces errors and should be used for handovers.[69]

All teams must collect and collate data, which provide utilization information and clinical outcome measures. Transport metrics have been recommended by the American Academy of Pediatrics,[70] and a Canadian initiative using a modified Delphi process resulted in similar metrics and definitions.[71] All transport times, including mobilization, response and stabilization times, should be tracked for quality improvement and benchmarking.[72] Neonatal stabilization time is typically double that for children (80 min versus 45 min).[73] The primary goal for improving infant outcomes is to minimize the length of time it takes to get to the patient (the response time) and the time to arrival at the receiving hospital (the transport time).[74] Transport time is often impacted by distance, weather and mode of transport, factors often beyond the control of care teams.[75] A Canadian Transport Network comprising all specialized teams offering neonatal transport has been established and funded with a view to developing a standardized transport database housed by the Canadian Neonatal Network.[76]

Recommendations

The following recommendations for improving transport teams are drawn from the literature and based on consensus opinion or observational studies. The literature regarding this topic does not lend itself to the application of a GRADE system.

- Teams used to transport newborns to tertiary neonatal-perinatal centres should be specifically dedicated for transport, based at a tertiary hospital and have expertise in the care of newborns. The inclusion of maternal and paediatric populations should depend on patient volumes, resources and needs.

- A collaborative practice model, with one RN working with either another RN, an RT or an EMT/paramedic with expertise in neonatal or paediatric transport, is the optimal neonatal transport team. Medical 'on line' control is best provided by an experienced neonatologist with expertise in transport medicine.
- Specific training in airway management and other procedural skills using effective teaching methods and validated assessment tools is recommended. Refresher skills courses and ongoing clinical assessment help to ensure maintenance of competencies.
- Transport teams must have the equipment and supplies necessary to provide intensive care and meet all land and air ambulance specifications for safety. Transport safety measures for thermal regulation and noise reduction must be employed. Dedicated team vehicles permit the storage of equipment, supplies and the hydraulic lifts or stretchers needed for team and patient safety.
- Policies and procedures must be in place to guide team performance and ensure optimal patient outcomes. A single access point, with provincial/territorial coordination and integration of transport modes, must ensure the immediate availability of medical advice, the rapid dispatch of a transport team, and the identification of a receiving hospital. Communication with families, referral and receiving staff from first contact to admission, is essential.
- Transport teams must have a database that captures both the severity of illness, and clinical and utilization metrics, including transport times, which can be used for benchmarking, quality improvement and research.

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References

1. Woodward GA, Insoft RM, Pearson-Shaver AL, et al. The state of pediatric interfacility transport: Consensus of the second National Pediatric and Neonatal Interfacility Transport Medicine Leadership Conference. Pediatr Emerg Care 2002;18(1):38-43.
2. Woodward GA, Insoft RM, Kleinman ME, eds. Guidelines for Air and Ground Transport of Neonatal and Pediatric Patients, 3rd edn. Elk Grove Village: American Academy of Pediatrics, 2007.
3. Stroud MH, Trautman MS, Meyer K, et al. Pediatric and neonatal interfacility transport: Results from a national consensus conference. Pediatrics 2013;132(2):359-66.
4. Karlsen KA, Trautman M, Price-Douglas W, Smith S. National survey of neonatal transport teams in the United States. Pediatrics 2011;128(4):685-91.
5. Eliason SH, Whyte H, Dow K, Cronin CM, Lee S. Variations in transport outcomes of outborn infants among Canadian neonatal intensive care units. Am J Perinatol 2013;30(5):377-82.
6. Jony L, Baskett TF. Emergency air transport of obstetric patients. J Obstet Gynaecol Can 2007;29(5):406-8.
7. Hohlagschwandtner M, Husslein P, Klebermass K, Weninger M, Nardi A, Langer M. Perinatal mortality and morbidity. Comparison between maternal transport, neonatal transport and inpatient antenatal treatment. Arch Gynecol Obstet 2001;265(3):113-8.
8. Akl N, Coghlan EA, Nathan EA, Langford SA, Newnham JP. Aeromedical transfer of women at risk of preterm delivery in remote and rural Western Australia: Why are there no births in flight? Aust N Z J Obstet Gynaecol 2012;52(4):327-33.
9. Kollée LA, Brand R, Schreuder AM, Ens-Dokkum MH, Veen S, Verloove-Vanhorick SP. Five-year outcome of preterm and very low birth weight infants: A comparison between maternal and neonatal transport. Obstet Gynecol 1992;80(4):635-8.
10. Ge WJ, Mirea L, Yang J, Bassil KL, Lee SK, Shah PS; Canadian Neonatal Network. Prediction of neonatal outcomes in extremely preterm neonates. Pediatrics 2013;132(4):e876-85.
11. Belway D, Henderson W, Keenan SP, Levy AR, Dodek PM. Do specialist transport personnel improve hospital outcome in critically ill patients transferred to higher centers? A systematic review. J Crit Care 2006;21(1):8-17.
12. Chang ASM, Berry A, Sivasangari S. Specialty teams for neonatal transport to neonatal intensive care units for prevention of morbidity and mortality. Cochrane Database Syst Rev 2008(4):CD007485.
13. Orr RA, Felmet KA, Han Y, et al. Pediatric specialized transport teams are associated with improved outcomes. Pediatrics 2009;124(1):40-8.
14. McPherson ML, Jefferson LS, Graf JM. A validated pediatric transport survey: How is your team performing? Air Med J 2008;27(1):40-5.
15. De Vries S, Wallis LA, Maritz D. A retrospective evaluation of the impact of a dedicated obstetric and neonatal transport service on transport times within an urban setting. Int J Emerg Med 2011;4(1):28.
16. Thompson TR. Neonatal transport nurses: An analysis of their role in the transport of newborn infants. Paediatrics 1980;65(5):887-92.

17. Leslie A, Stephenson T. Neonatal transfers by advanced neonatal nurse practitioners and pediatric registrars. Arch Dis Child Fetal Neonatal Ed 2003;88(6):F509-12.
18. King BR, King TM, Foster RL, McCans KM. Pediatric and neonatal transport teams with and without a physician: A comparison of outcomes and interventions. Pediatr Emerg Care 2007;23(2):77-82.
19. Fenton AC, Leslie A. Who should staff neonatal transport teams? Early Hum Dev 2009;85(8):487-90.
20. Lee SK, Zupancic JA, Sale J, et al. Cost effectiveness and choice of infant transport systems. Med Care 2002;40(8):705-16.
21. Vieira AL, Santos AM, Okuyama MK, Miyoshi MH, Almeida MF, Guinsburg R. Predictive score for clinical complications during intra-hospital transports of infants treated in a neonatal unit. Clinics (Sao Paulo) 2011;66(4):573-7.
22. McNamara PJ, Mak W, Whyte HE. Dedicated neonatal retrieval teams improve delivery room resuscitation of outborn premature infants. J Perinatol 2005;25(5): 309-14.
23. Adams K, Scott R, Perkin RM, Langga L. Comparison of intubation skills between interfacility transport team members. Pediatr Emerg Care 2000;16(1):5-8.
24. McCloskey KA, Johnston C. Critical care interhospital transports: Predictability of the need for a pediatrician. Pediatr Emerg Care 1990:6(2):89-92.
25. Beyer AJ, Land G, Zaritsky A. Nonphysician transport of intubated pediatric patients: A system evaluation. Crit Care Med 1992;20(7):961-6.
26. Kline-Krammes S, Wheeler DS, Schwartz HP, Forbes M, Bigham MT. Missed opportunities during pediatric residency training: Report of a 10-year follow-up survey in critical care transport medicine. Pediatr Emerg Care 2012;28(1):1-5.
27. King BR, Foster RL, Woodward GA, McCans KM. Procedures performed by pediatric transport nurses: How “advanced” is the practice? Pediatr Emerg Care 2001;17(6):410-3.
28. King BR, Woodward GA. Procedural training for pediatric and neonatal transport nurses: Part I – training methods and airway training. Pediatr Emerg Care 2001;17(6):461-4.
29. King BR, Woodward GA. Procedural training for pediatric and neonatal transport nurses: Part 2 – procedures, skills assessment, and retention. Pediatr Emerg Care 2002;18(6):438-41.
30. American Society of Anesthesiologists task force on management of the difficult airway. Practice guidelines for management of the difficult airway. Anesthesiology 1993;78(3):597-602.
31. Canadian Association of Paediatric Health Centres. Competencies profile – Interfacility critical care transport of maternal, neonatal, and paediatric patients: Recommendations for a minimum set of standards: www.caphc.org/neonatalpaediatric-transport-systems (Accessed February 26, 2015).
32. Konrad C, Schüpfer G, Wietlisbach M, Gerber H. Learning manual skills in anesthesiology: Is there a recommended number of cases for anesthetic procedures? Anesth Analg 1998;86(3):635-9.
33. Martin JA, Regehr G, Reznick R, et al. Objective structured assessment of technical skills (OSCATS) for surgical residents. Br J Surg 1997;84(2):273-8.
34. Mandel LP, Cobb LA. Reinforcing CPR skills without mannequin practice. Ann Emerg Med 1987;16(10): 1117-20.
35. Finan E, Bismilla Z, Whyte HE, Leblanc V, McNamara PJ. High-fidelity simulator technology may not be superior to traditional low-fidelity equipment for neonatal resuscitation training. J Perinatol 2012;32(4):287-92.
36. Droogh JM, Smit M, Hut J, de Vos R, Ligtenberg JJ, Zijlstra JG. Inter-hospital transport of critically ill patients: Expect surprises. Crit Care 2012:16(1):R26.
37. Health and Safety Executive. Manual handling: Manual Handling Operations Regulations 1992 (as amended), 3rd edn. 2004: www.hseni.gov.uk/l23_manual_handling.pdf (Accessed April 29, 2015).
38. Bleak T, Trautman MS. Use of composite material to reduce equipment weight during neonatal transport. Air Med J 1995;14(1):26-9.
39. Accreditation Canada. Emergency Medical Services – QMentum: www.accreditation.ca/emergency-medical-services (Accessed April 29, 2015).
40. Fenton AC, Leslie A. The state of neonatal transport services in the UK. Arch Dis Child Fetal & Neonatal Ed 2012;97(6):F477-81.
41. Hunt RC, Brown LH, Cabinum ES, et al. Is ambulance transport time with lights and siren faster than without? Ann Emerg Med 1995;25(4):507-11.
42. Becker LR, Zaloshnja E, Levick N, Li G, Miller TR. Relative risk of injury and death in ambulances and other emergency vehicles. Accid Anal Prev 2003;35(6): 941-48.
43. Ismail AK, Mohd Salleh NI, Hamdan NA, et al. The use of warning lights and siren by the ambulance crew in the Universiti Kebangsaan Malaysia Medical Centre. Eur J Emerg Med 2012;19(6):408-9.
44. Bowman E, Doyle LW, Murton LJ, Roy RN, Kitchen WH. Increased mortality of preterm infants transferred between tertiary perinatal centres. BMJ 1988;297(6656): 1098-100.
45. Singh A, Duckett J, Newton T, Watkinson M. Improving neonatal unit admission temperatures in preterm babies: Exothermic mattresses, polythene bags or a traditional approach? J Perinatol 2010;30(1):45-9.
46. Bouchut JC, Van Lancker E, Chritin V, Gueugniaud PY. Physical stressors during neonatal transport: Helicopter compared with ground ambulance. Air Med J 2011;30(3):134-9.
47. Romano E, Kaufmann M. Abstract: Quantification of vibration forces experienced by the newborn during ambulance transport. Air Medical Journal 2012;31(4): 167-68.
48. Karlsson BM, Lindkvist M, Lindkvist M, et al. Sound and vibration: Effects on infants’ heart rate and heart rate variability during neonatal transport. Acta Paediatr 2012;10(2):148-54.

49. Gajendragragadkar G, Boyd JA, Potter DW, Mellen BG, Hahn GD, Shenai JP. Mechanical vibration in neonatal transport: A randomized study of different mattresses. J Perinatol 2000;20(5):307-10.
50. B.C. Amulance Service (B.C. Emergency Health Services). Critical care program: www.bcas.ca/services/critical-care-program (Accessed February 27, 2015).
51. Broughton SJ, Berry A, Jacobe S, et al. The mortality index for neonatal transportation score: A new mortality prediction model for retrieved neonates. Pediatrics 2004;114(4):e424-8.
52. Philpot C, Day S, Marcdante K, Gorelick M. Pediatric interhospital transport: Diagnostic discordance and hospital mortality. Pediatr Crit Care Med 2008;9(1):15-9.
53. Al-Shanteer S, Lee K-S, Tomlinson C, Whyte H. Response times and severity of illness during the transport of neonates. Is there a relationship? Paediatric Academic Society meeting abstract, 2008.
54. Fenton AC, Leslie A, Skeoch CH. Optimising neonatal transfer. Arch Dis Child Fetal Neonatal Ed 2004;89(3):F215-9.
55. Leslie AJ, Stephenson TJ. Audit of neonatal intensive care transport. Arch Dis Child Fetal Neonatal Ed 1994;71(1):F61-6.
56. Hankins D. Air versus ground transport studies. Air Med J 2010;29(3):102-3.
57. Taylor CB, Stevenson M, Jan S, Middleton PM, Fitzharris MF, Myburg JA. A systematic review of the costs and benefits of helicopter emergency medical services. Injury 2010;41(1):10-20.
58. Rolnitsky A, Tomlinson C, Whyte H, Lee K-S. Abstract: The Achilles and the tortoise paradox in neonatal transport: Is the helicopter faster than land for response times? CPS Annual Conference, June 2013.
59. Jackson L, Skeoch CH. Setting up a neonatal transport service: Air transport. Early Hum Dev 2009;85(8):477-81.
60. Bolte RG. Responsibilities of the referring physician and referring hospital. In: McCloskey K, Orr R, eds. Textbook of Pediatric Transport Medicine. St Louis: Mosby, 1995.
61. Woodward GA. Responsibilities of the receiving hospital. In: McCloskey K, Orr R, eds. Textbook of Pediatric Transport Medicine. St Louis: Mosby, 1995.
62. Kage A, Akuma A. Audit on central newborn network transport documentation: Abstract. J Paediatr Child Health 2012;48(Suppl 1):278.
63. Mosher SL. The art of supporting families faced with neonatal transport. Nurs Womens Health 2013;17(3):198-209.
64. Bigham MT, Schwartz HP. Measure, report, improve: The quest for best practices for high-quality care in critical care transport. Clin Pediatr Emerg Med 2013;14(3):171-9.
65. Lee SK, Zupancic JA, Pendray M, et al; Canadian Neonatal Network. Transport risk index of physiological stability: A practical system for assessing infant transport care. J Paediatr 2001;139(2):220-6.
66. Lucas da Silva PS, Euzébio de Aguiar V, Reis ME. Assessing outcome in interhospital infant transport: The transport risk index of physiologic stability score at admission. Am J Perinatol 2012;29(7):509-14.
67. Markakis C, Dalezios M, Chatzicostas C, Chalkiadaki A, Politi K, Agouridakis PJ. Evaluation of a risk score for interhospital transport of critically ill patients. Emerg Med J 2006;23(4):313-7.
68. Lim MT, Ratnavel N. A prospective review of adverse events during interhospital transfers of neonates by a dedicated neonatal transfer service. Pediatr Crit Care Med 2008;9(3):289-93.
69. National Health Service (U.K.), Institute for Innovation and Improvement. Quality and service improvement tools: SBAR-Situation-Background-Assessment–Recommendation: www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/sbar_-_situation_-_background_-_assessment_-_recommendation.html. (Accessed February 27, 2015).
70. Bigham MT, Schwartz HP, Ohio Neonatal/Pediatric Transport Quality Collaborative. Quality metrics in neonatal and pediatric critical care transport: A consensus statement. Pediatr Crit Care Med 2013;14(5):518-24.
71. Gunz AC, Dhanani S, Whyte H, et al. Identifying significant and relevant events during pediatric transport: A modified Delphi study. Pediatr Crit Care Med 2014;15(7):653-9.
72. Wall M, Sinclair L, Berry A. Developing an Australasian minimum data set for neonatal transport. J Paediatr Child Health 2011;47:15. Abstract A026.
73. Whitfield JM, Buser MK. Transport stabilization times for neonatal and pediatric patients prior to interfacility transfer. Pediatr Emerg Care 1993;9(2):69-71.
74. Mori R, Fujimura M, Shiraishi J, et al. Duration of inter-facility neonatal transport and neonatal mortality: Systematic review and cohort study. Pediatr Int 2007;49(4):452-8.
75. Abdel-Latif ME, Berry A. Analysis of the retrieval times of a centralised transport service, New South Wales, Australia. Arch Dis Child 2009;94(4):282-6.
76. Lee KS, Whyte H, Shah P, et al. Improving quality of care during transport of sick neonates: A national collaborative partnership for outcome improvement and system enhancement. Canadian Institute of Health Research Partnerships for Health System Improvement Grant. June 1, 2013 – May 31, 2016.

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