February 2007 VOLUME 4, NUMBER 6

In this issue...

Safe and expedient transport is a key component of an effective system for neonatal critical care. The best outcomes are thought to be dependent on four inter-related mechanisms: the ability of clinicians to discern when delivery is imminent to ensure in-utero transport; the ability of clinicians to stabilize and sustain the neonate until the transport team arrives; the rapid response of the team itself; and the skill and expertise of the transport team members. When these components are effectively organized, the highest level of support and care can be provided while the neonate travels to the NICU.

In this issue, we summarize the literature describing the basis for safe and effective neonatal transport, including the configuration of transport systems, transporting special needs populations, and a best practice system to aid the transport team in stabilizing the infant.

This Issue

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Guest Faculty Disclosure:
Mary Terhaar, No relationship with commercial supporters.

Webra Price-Douglas, PhD, CRNP, No relationship with commercial supporters.

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At the conclusion of this activity, participants should be able to:

- Discuss transport as it relates to effective perinatal and neonatal care
- Explain additional considerations for transporting special populations
- Identify recognized best practices in neonatal transport

Commentary

Huxley once wrote, "Logical consequences are the scarecrows of fools and the beacons of wise men"[1]. One such beacon is the notion that the best outcomes result when the needs of the patients are matched to the skill, knowledge and experience of caregivers; the most advanced technology is employed; and the most appropriate support services are provided. Neonatal care is no different. The most favorable outcomes for acutely ill neonates are the result of a finely tuned collaboration between diverse disciplines and institutions, working together to ensure the best chance of survival and the best long term outcomes.

The literature that serves as the basis for safe and effective neonatal transport is a small body of work and predominantly descriptive in nature. The first publications describe the practice as an important component in perinatal regionalized care[2,3,4]. Subsequent papers have described the composition of the team, the training of the personnel, the equipment required, and the collaboration within communities necessary to promote the best possible outcomes. Notably lacking are multi-center studies which evaluate approaches to care during transport with an eye to improving outcomes.

Three themes can be identified in the body of literature related to neonatal transport. These are configuration and preparation of systems and teams, transport of special populations, and stabilization prior to neonatal transport. Regarding the first, Wheeler et al document the success of a program instituted at the Navel Medical Center of San Diego. Implemented by the military, this program effectively managed stabilization and transport to the NICU, accomplished favorable clinical outcomes, and realized significant savings. The authors attribute these positive results to careful planning and training of team members. The report by Lupton & Pendray provides several descriptions of transport team configurations, along with several sets of practical guidelines for establishing a regional transport system.

Some of the greatest challenges facing the neonatal transport team occur during stabilization and transport of neonates requiring surgery or with a probable diagnosis of cardiac defect. Paxton's article details the special considerations each major surgical condition requires, while Harter & Clingersmith address the special needs of neonates with cardiac defects prior to establishing a definitive diagnosis. Both reports emphasize protecting the airway, maintaining thermal stability, promoting normoglycemia, and similar critical considerations.

Tertiary neonatal centers are responsible for the education of all members of the neonatal team, and focus on effective resuscitation, stabilization and transfer. Training must provide both theoretical and hands-on clinical experiences that build the skill and confidence of the team so they can initiate safe and effective intensive care from the minute the baby is born. The Mears & Chalmers 2005 article reports on the success of the STABLE (an acronym/mnemonic for Sugar, Temperature, Airway/artificial breathing, Blood pressure, Laboratory analysis, and Emotional support) program in the UK. This approach to education and practice promotes consistent, effective and comprehensive early care, and holds promise for improved outcomes for neonates at the highest risk during the initial hours of life.

Each of the manuscripts reviewed in this issue offers recommendations for practice based on the experiences of the respective services. We strongly recommend that the transport team consult with the Medical Control Physician for the transport service, and that the transport team coordinate the approach to care with the specialists and sub-specialists who will provide for each neonate upon arrival at the tertiary care center.

In summary: care during transport is based on standard NICU practices. Currently, the evidence base for practice in the unit and for practice in the field is the same. Yet the transport team may be held to a different standard of care while stabilizing the infant in a transport vehicle[5]. There is a great need for studies which investigate practices during transport and the associated outcomes; such research would greatly assist in providing a consistently high quality of care and reducing long term morbidity and mortality for acutely ill neonates transported within any community.

References:

1. ThinkExist.com Quotations. "Thomas Henry Huxley quotes". ThinkExist.com Quotations Online 1 Dec. 2006. 31 Jan. 2007.

2. Segal, S. Transfer of a premature or other high-risk newborn infant to a referral hospital. Pediatric Clinics of North America; 13, 1995.

3. Segal S. Manual for Transport of high risk newborn infants. Canadian Pediatric Society, 1972.

4. Health & Welfare Canada. Recommended standards for maternity and newborn care, 1975.

5. Ginzburg, H. Legal issues in medical transport. In: MacDonald, M, Miller, M., eds Emergency Transport of the Perinatal Patient. Boston, MA: Little, Brown: 1989.

Sources for Additional Information:

1. www.nann.org Recently updated AAP guidelines
2. www.aap.org/sections/transmed/ Recently updated AAP guidelines
3. www.astna.org ASTNA guidelines
4. www.camts.org
5. www.stableprogram.org

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CONFIGURATION OF TRANSPORT SYSTEMS: EXPERIENCE AT A MILITARY MEDICAL CENTER

Wheeler, D. S., Sperring, J. L., Vaux, K.K., Poss, W. B. (1999). **Development of a Pediatric Critical Care Transport Team: Experience at a Military Medical Center**. Military Medicine, 154:3, 188-193.

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A pediatric critical care transport program was established at the Naval Medical Center in San Diego, California when military personnel assumed the responsibility for pediatric and neonatal transport which had formerly been the responsibility of civilian contractors. Leadership identified the need for formal training for pediatric residents in stabilization and transport of infants and children, and so a program was developed to provide military personnel with both empirical knowledge and practical experience. The goals were to assure quality of care, realize significant financial savings, and train capable clinicians. The authors report on outcomes in relation to all three goals.

Three phases of evaluation were conducted. The first two related to clinical and financial outcomes. A retrospective review of transports, outcomes and expenses was conducted and a database was developed so transport statistics and financial data could be tracked and evaluated concurrently. The third phase related to the caregivers' evaluation and application of the program content and approach, and used a participant survey to evaluate the perceived benefits.

Between 1994 and 1997, 404 transports were performed and served as the base for analysis. During 1997, a total of 64 transports were performed by the team: 31 neonatal and 33 pediatric. Average call to departure time was 49 minutes, including 13 cases reported as delayed. After removing those outliers from the data, the average time from call to departure was 34 minutes, with reasons for delay reported as: waiting for a vehicle (n=10), problem with a vehicle (n=2), and waiting for a doctor (n=1). The reason for transport was reported as: respiratory diagnoses (41%), neurological diagnoses (12%), prematurity (9%), cardiac diagnoses (9%), infections (6%), ingestion or poisoning (5%), surgical diagnoses (4%), metabolic or endocrine diagnoses (2%), and miscellaneous diagnoses (12%).

The authors report that the program successfully accomplished its objectives. Financial savings were documented to be approximately $2,000 for each transport – even allowing that not all incidental costs were identified, this figure represents significant avoidance of noncontributing cost. Although the primary benefit was the elimination of out-of-pocket expenses for the active duty member who was the parent of the transported neonate, the savings for the Department of Defense (and thus the taxpayer) were appreciable as well.

The perceived value of the education program was measured by a survey sent to previous participants, with the majority considering the program and the experience to be worthwhile and significant. Perhaps more importantly, the majority of program graduates were, at the time of the survey, practicing overseas and in rural communities 2-3 hours from any medical center. They placed value on the program as preparing them to stabilize and manage infants and children in settings removed from the support available in tertiary care sites.

CONFIGURATION OF TRANSPORT SYSTEMS: A REGIONAL PERSPECTIVE

Lupton, BA & Pendray, MR. **Regionalized neonatal emergency transport.** Seminars in Neonatology Vol 9, Issue 2 (2004),125-133.

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The authors describe the elements of a safe and effective neonatal transport program in the context of the needs of the neonates being transported and the evolving systems in which they receive care. They provide an historical review of neonatal care, including the concept of regionalization and the use of transport within this model. Both maternal and neonatal transports are discussed as well as return transports, which contribute to the effective management of neonatal intensive care beds. The roles of the medical director, manager, transport coordinator, nurses, respiratory therapists, paramedics, and physicians are considered, as are several models for configuration of the transport team.

Duties of the various team members are described, along with the rationale supporting their selection, training, and practice. Configuration of the team appears less dependent on the individual members' credentials than on the fit between the role each is expected to play and the knowledge, skill and experience each brings to the team: highlighting that finding, the authors note that teams of two nurses, a nurse and a respiratory therapist, and two paramedics all reported comparable outcomes. Further, they emphasize the need for strong contingency plans that make it possible to call in additional trained personnel when the needs of the neonate to be transported exceed the skill set available within the regular team. They further note that the medical director is ultimately responsible for the care provided by the team within parameters established in state practice acts.

The authors stress that education of team members needs to be ongoing. In addition to the content recommended by the American Academy of Pediatrics, they discuss the need for programs to address frequently encountered conditions and challenges likely to be faced by the team. For example, regarding mode of transport, they recommend that teams who fly be educated concerning barometric pressure, g-force, changes in humidity, vibration, noise, and heat loss – and their effects on human physiology in general and the neonate in particular. Regular programs to maintain and verify competencies, skills, and knowledge base are considered key to successful transport programs.

The authors also discuss equipment, documentation, and quality assurance, providing several practical sets of guidelines that include: an outline for organizing and developing a transport team, a classification for the types of transport, guidelines for prioritizing patients, and parameters for response time. They emphasize that when developing a neonatal transport team, the best interest of the patient must be considered first, followed by referral patterns, population growth, and the mission and goals of the institutions. Efficient use of specialized care, such as extracorporeal life support, should also be considered.

Communication – between members of the team, between facilities, and within the community – is considered essential. In addition, the report provides a list of principles useful for providing safe and effective neonatal transport, including: identifying problems early, optimizing communications, providing expertise throughout the transport, adequately stabilizing the neonate before mobilizing, preventing surprises, and promoting a smooth, controlled transport.

TRANSPORTING SPECIAL POPULATIONS: THE SURGICAL NEONATE

Paxton, J. M. 1990. **Transport of the surgical neonate.** Perinatal Neonatal Nursing. 3 (3) 43-49.

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Maternal rather than neonatal transport is recommended for infants with surgical conditions. Given recent advances in fetal diagnostics, this can often (but not always) be accomplished. In addition to the considerations common to transport of a neonate with a medical diagnosis, infants with surgical conditions and their families can present a set of particular challenges to the transport team.

Paxton emphasizes that thermoregulation requires careful attention. Neonates with surgical conditions like spina bifida, gastroschisis, or omphalocele face significant risk for heat loss. These conditions leave core body organs close to (if not actually exposed on) the surface – allowing radiation and evaporative heat loss from the body that can compromise core temperature and may result in cold stress.

Insensible fluid loss also represents a threat to the infant with a condition requiring surgical intervention, particularly regarding hypovolemia. Maintaining perfusion to tissues that are already vulnerable must receive careful attention; Paxton notes that placing the infant in a sterile plastic bag is a common strategy to reduce insensible fluid loss.

The neonate with a surgical condition is also vulnerable to glucose instability, a problem that cold stress, pain, hypovolemia, and respiratory challenge can all exacerbate. Maintaining normoglycemia helps to protect vulnerable tissue from further damage as well as to promote optimal post-op wound healing.

After attending to airway, breathing, circulation, temperature stability, normoglycemia, and comfort, the team needs to focus on gathering information to help plan the infant's long term care. This involves collecting the history, maternal medical records, fetal diagnostics, imaging, maternal blood, cord blood, and any additional information relevant to the care of the newborn.

The author presents special recommendations for each major surgical condition. Some examples:

- passing an oral-gastric tube and avoiding positive pressure ventilation is recommended in the presence of diaphragmatic hernia
- prone positioning with the head of the bed elevated 30 degrees or more is recommended in the presence of tracheal esophageal fistula or esophageal atresia
- gastro-intestinal decompression can be effective for omphalocele and gastroschisis along with actions to prevent heat and fluid loss
- neural tube defects can be managed by keeping the exposed tissue moist, clean, and free from fecal material, and by protecting it from pressure or trauma. Placing the infant prone or side-lying is recommended as a part of the safe care for this neonate.

In addition, the author notes that special consideration of the effect of altitude and barometric pressure on a volume of gas is indicated when air transport is required for the infant with a surgical condition. Infants with diaphragmatic hernias may become unstable due to the effects of altitude effect gas trapped in the body cavity. Similarly, as the partial pressure of oxygen decreases with altitude, in flight the diffusion of oxygen within the lungs may decrease as well – increasing the challenge of ensuring respiratory stability of the infant.

TRANSPORTING SPECIAL POPULATIONS: THE NEONATE WITH CARDIAC DEFECT

Harter, D. & Clingersmith, P. 1994. **Transport of the neonate with suspected or diagnosed congenital cardiac disease.** Critical Care Nursing Clinics of North America. Vol 6. Number 1. 121-131.

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Because the differential diagnosis often requires specialized technology and assessment usually available only in tertiary centers, the transport team frequently needs to provide effective care without a definitive diagnosis. As the authors point out, in the case of a neonate with a cardiac defect, this can become particularly challenging. The best outcomes for this population depend on careful assessment and early recognition of the critical indicators of cardiac compromise. Although infants with cardiac defects may appear to transition well initially, the parents and staff may notice subtle changes, such as poor nipple feeding, mild cyanosis (central or peripheral, at rest or when crying), or a murmur. Presentation may be consistent with a possible diagnosis of respiratory distress, sepsis, or congenital anomaly, and referral to tertiary care is indicated for the best possible outcome.

Absent a differential diagnosis, consultation between the tertiary and referring centers should enable presumptive diagnosis and proper preparation of the team as well as the neonate for safe transport. The authors note that unexplained tachypnea and cyanosis warrant cardio-respiratory monitoring, pulse oximetry, and establishment of vascular access. In addition, a "hyperoxia test" is frequently recommended. This test consists of obtaining arterial blood gas values to determine partial pressure of oxygen (PaO_2) in 21% and 100% FiO_2. A rise in the PaO_2 of >30mmHg or exceeding 100mmHg tends to indicate a pulmonary, rather than a cardiac, cause for evident cyanosis. Failed hyperoxia testing may indicate cyanotic cardiac defect, which cannot be remedied with oxygen due to persistent mixing of systemic and arterial blood or pulmonary blood flow impairment. Oxygen therapy during transport is used for this population, even though it may yield only minimal improvement.

The authors discuss specific lesions only in the context of the presenting signs, symptoms, and age of onset. They provide three concise tables that outline: the differential diagnosis of congenital cardiac disease, respiratory disease and sepsis; maternal conditions associated with congenital cardiac disease; and a graduated assessment form/worksheet utilized for quality assurance. The assessment form/worksheet can additionally be used to facilitate communication of essential information as well as to evaluate the transport process, both of which are essential to maintaining a safe and effective transport program.

STABILIZATION BEFORE TRANSPORT

Mears, M & Chalmers, S. 2005. **Neonatal pre-transport stabilization – Caring for infants the STABLE way.** Infant. 1(1) 34-37.

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While maternal transport for a neonate at risk is the gold standard, the authors report that over 5% of babies will require ex-uterine neonatal transport. The neonate is at additional risk during the transport period because the extensive support available in the NICU is miles away. This risk can be reduced by maintaining normal acid-base balance, carbon dioxide levels, oxygenation, blood pressure, glucose, and temperature. This is a challenge during transport, however, because of the environment with its reduced space and lighting and its limited resources and manpower. In addition, the stress that results from separating the neonate from the parents and requiring the family to travel long distances cannot be understated. All these variables have become the focus of negative media attention.

Mears and Chalmers report on the STABLE Program, a concise educational approach that organizes the myriad of details necessary to stabilize and care for sick neonates; reinforces neonatal life support efforts; and complements transport courses currently available. The STABLE mnemonic represents Sugar, Temperature, Airway/artificial breathing, Blood pressure, Laboratory analysis, and Emotional support, and is utilized to facilitate retention and recall when transport teams are faced with an uncommonly stressful situation. The program builds on the ABC (airway, breathing and circulation) basics to structure a seamless approach to stabilization by providing information on identifying hypoglycemia, hypothermia, hypoxemia, hypoxia, hypotension, sepsis, and parental issues in the post-resuscitation/pre-transport period.

The authors report on implementation of the STABLE Program in London with neonatal nurses, midwives, house officers, registrars, and consultants during 2002 and 2003. They describe the course as providing a review of fetal and neonatal development, physiology, and pathology, with an emphasis on promoting stability in relation to the critical conditions of normoglycemia, optimal thermal regulation, airway stabilization, respiration, normo-tension, and effective support for family members during the crisis of complicated birth. Skills components are both theoretical as well as hands-on, and address effective teamwork, communication, and focused intervention. Team members participate together in these training sessions and learn to appreciate the diversity of skills and the critical value of effective teamwork. Pre- and post-test scores with all 140 participants demonstrated improvement, with some exceeding 50%. The vast majority scored the requisite 84% on the post test to qualify for a certificate of completion. All 140 participants indicated they would recommend the course to their colleagues.

Future plans include further implementation of the STABLE Program nationwide and extending the program to include the STABLE CARDIAC module. The authors conclude that using the STABLE Program with all neonatal team members involved in resuscitation, stabilization, and transport of sick neonates promotes more comprehensive care for both neonates and their families, improved working relationships, sharing of ideas, and increased job satisfaction. In addition, when the parents observe a consistently collaborative approach to care, the transport process may seem less daunting.

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Ask the Authors

LAST MONTH'S Q & A   January 2007 - Volume 4 - Issue 5

In our January 2007 issue, we reviewed the clinical trial information for intravenous ibuprofen (pharmacologically related to indomethacin) for the treatment and prophylaxis of PDA, and its effect on intraventricular hemorrhage (IVH) prophylaxis.

Commentary:
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Our readers asked the January faculty the following questions:

Q Is there any evidence that oral ibuprofen is as effective as IV ibuprofen in the treatment of PDA for preemies?

A The experience with oral ibuprofen in treating PDA for preemies is currently limited to four small clinical trials: two open-labeled studies and two comparison trials to indomethacin. When combining the subjects of the two open label trials, ductal closure was achieved in 91.4% (32 of 35) of patients[1,2]. Ductal reopening did not occur in one of these studies (N=22)[1] and was not reported in the other (N=13)[2]. There were no drug related side effects of oliguria or bleeding[1,2].

The comparison pilot studies of oral ibuprofen to indomethacin have reported statistically similar rates of ductal closure at 77.8% (7/9) vs. 88.9% (8/9)[3] and 46.7% (7/15) vs. 66.7% (10/15)[3,4], respectively (p=NS for both). Slightly favorable response rates with indomethacin in both of these trials may be attributed to better drug absorption with the intravenous (IV) route of administration compared to oral ibuprofen. Indomethacin subjects in the Supapannachart et al[3] trial received their doses by either IV or PO, and indomethacin was administered exclusively intravenously in the study by Chotigeat et al[4]. Ductal reopening was statistically similar at 40% vs 33% (p=NS), ibuprofen vs indomethacin respectively, in one of these studies[4]. In regards to adverse drug events, favorable renal effects were observed with ibuprofen. Ibuprofen use was associated with higher urine output (with no significant increase in serum creatinine or blood urea nitrogen)[3]; and significantly less diuretic (furosemide) use ($p<0.01$)[4] Despite the lack of statistical significance, a higher rate of NEC was also observed with indomethacin (66.7% vs 40%) in the study by Chotigeat and associates[4].

Despite promising closure rates as high as 90% with open-labeled studies, unanswered issues in regards to dosing and other potential side effects still remain. Three different oral ibuprofen dosing regimens were used in the four aforementioned trials; 10 mg/kg/dose x 1 followed by 5 mg/kg/dose x 2 given every 24 hours (same as the IV treatment dose), or every 12 hours, or 10 mg/kg/dose x 3 given every 24 hours. A PO/IV bioavailability study is needed to determine the proper oral dose. Spontaneous intestinal perforation, without signs of NEC, has been reported in two very-low birth-weight infants receiving oral ibuprofen for PDA treatment[5].

References:

1. Heyman E, Morag I, Batash D et al. Closure of patent ductus arteriosus with oral ibuprofen suspension in premature newborns: a pilot study. Pediatrics. 2003;112:354-358.
2. Hariprasad P, Sundarrajan V, Srimathy G, et al. Oral ibuprofen for closure of hemodynamically significant PDA in premature neonates. Indian Pediatrics. 2002;39(1):99-100.
3. Supapannachart S, Limrungsiul A, Khowsathit P. Oral ibuprofen and indomethacin for treatment of patent ductus arteriosus in premature infants: a randomized trial at Ramathibodi Hospital. J Med Assoc Thai. 2002;85(Suppl 4):S1252-8.
4. Chotigeat U, Jirapapa K, Layangkool, T. A comparison of oral ibuprofen and intravenous indomethacin for closure of patent ductus arteriosus in preterm infants. J. Med Assoc Thai. 2003;86 (Suppl 3):S563-9.
5. Tatli MM, Kumral A, Duman N, et al. Spontaneous intestinal perforation after oral ibuprofen treatment of patent ductus arteriosus in two very-low-birthweight infants. Acta Paediatr. 2004;93(7):999-1001.

Q As a prophylactic protocol, is there any evidence that oral ibuprofen may be beneficial when the IV preparation is not available?

A The available clinical data on oral ibuprofen use with PDA prophylaxis is currently limited to a small, randomized, controlled study conducted in Thailand[6]. Twenty-two neonates between 28-32 weeks gestational age with a birth weight of approximately 1500 grams received PO ibuprofen, while 20 neonates of similar age, birth weight, and other clinical characteristics received placebo. An oral ibuprofen dosage of 10 mg/kg/dose every 24 hours for 3 doses, with the first dose initiated within 24 hours of life, was given. The investigators found the prevalence of symptomatic PDA to be lower in the ibuprofen prophylaxis group compared to placebo (0/22 vs. 5/22, $p<0.05$)[6]. Although there were no significant side effects, gastrointestinal bleeding did occur more frequently with ibuprofen (12/22 vs. 6/20, p=0.196)[6].

It is also important to consider the unpredictability of the oral administration of drugs in infants. Infants, especially premature infants, may have irregular gastric emptying and decreased intestinal and/or biliary function. Additionally, in the presence of a PDA, decreased mesenteric blood flow may also play a role in altering absorption. The pharmacokinetics of oral ibuprofen have been studied in premature infants and results have shown large inter-individual variability with respect to drug exposure, area under the curve (AUC), and peak plasma concentration (C_{max}). In a pharmacokinetic study by Sharma et al, the coefficient of variation was 88.5% for AUC and 74.1% for C_{max}[7]. This is quite variable considering a relatively homogeneous patient population [mean gestational age 30.45 +/- 1.48 weeks (range 26 to 32 weeks) and mean birth weight 1262.5 +/- 247.76 grams (range 750 to 1900 grams)]. Additional oral pharmacokinetic studies are needed to fine-tune the dosing strategy with oral ibuprofen by reducing the inter-individual variability of drug exposure (AUC and C_{max}).

References:

6. Sangtawesin V, Sangtawesin C, Raksasinborisuc C, et al. Oral ibuprofen prophylaxis for symptomatic patent ductus arteriosus of prematurity. J. Med Assoc Thai. 2006;89(3):314-21.
7. Sharma PK, Garg SK, Narang A. Pharmacokinetics of oral ibuprofen in premature infants. J Clin Pharmacol. 2003;43(9):968-73.

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- Explain additional considerations for transporting special populations
- Identify recognized best practices in neonatal transport

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