Air Medical Journal 38 (2019) 334–337

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Original Research

# Factors Affecting Stabilization Times in Neonatal Transport

Muzafar Gani Abdul Wahab, MBBS, MD [1],
Sumesh Thomas, MBBS, DCH, MRCPCH, FRCPC [2],
Prashanth Murthy, MBBS, MD, MRCPCH [2],
Aravanan Anbu Chakkarapani, MBBS, MD, RCPS(C) affiliate [3,4,*]

[1] *Neonatologist, Associate Professor, Division of Neonatology, Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada*
[2] *Neonatologist, Clinical Associate Professor, Division of Neonatology, Department of Pediatrics, University of Calgary, Calgary, Canada*
[3] *Neonatologist, Division of Neonatology, Department of Pediatrics, Sidra Medicine, Doha, Qatar*
[4] *Assistant Professor of Clinical Pediatrics, Weill Cornell Medicine-Qatar*

A B S T R A C T

*Objective:* During transport, the time spent in stabilizing sick infants before repatriation is crucial in optimizing the outcome and effective use of resources. The study aim was to assess individual components of neonatal transport time to identify opportunities to minimize delay, optimize care, and improve the overall efficiency of transport.
*Methods:* A single-center prospective observational study conducted at McMaster Children's Hospital, Hamilton, Ontario, Canada, with a dedicated transport team for over 12 months. The stabilization time was defined as the time interval between arrival and departure from the referring hospital.
*Results:* Of 223 neonatal transfers, 67 required no procedural or therapeutic intervention before mobilization to the receiving unit, with a mean stabilization time of 113 ± 52 minutes. In 156 transport events, 1 or more interventions were required, with a significantly higher mean stabilization time of 165 ± 89 minutes ($P < .0001$).
*Conclusion:* This study found that the local stabilization time was more than 1.5 times that of the comparable published data. The reasons identified for this delay were mostly because of waiting times for vehicle mobilization, waiting for blood and radiology results, and bed availability. Modifying these factors could save up to 28% of the stabilization time.
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In most countries with well-established neonatal services, regionalization of perinatal care via managed clinical networks maintains equity of access for neonates and high-risk pregnant mothers. Managed clinical networks also enable the use of established referral pathways and the shared use of evidence-based guidelines and policies. Central to this model is a reliable and effective neonatal transport service. Regional networks have invested in dedicated transport teams to transfer neonates requiring varying levels of care within the network. Although every effort is made to ensure the antenatal transfer of high-risk mothers to an appropriate perinatal facility, a proportion of neonates continue to be outborn, requiring postdelivery transfer to a level II or III neonatal intensive care unit (NICU) for ongoing care. The significant resources required for neonatal transport services justify the demand for high-quality and cost-effective service. There is little consensus on the parameters for evaluating the performance of transport services.[1] Several indicators, including the time to retrieval, safety, and user satisfaction surveys, have been used. Looking at retrieval times in both neonatal and pediatric patients, Abdel-Latif and Berry[2] concluded that establishing reference times could be a valuable quality assurance tool.

Stabilization periods in neonatal transports are dependent on several factors including illness severity, need for procedures, and availability of local resources as well as capacity in an appropriate care facility. Therefore, stabilization time, including waiting times at referral sites, can be quite variable. The present study was a single-center prospective observational study of factors affecting stabilization times in neonatal transport. The transport program considered the median time intervals for pretransport discussions, mobilization

* Address for correspondence: Aravanan Anbu Chakkarapani, MBBS, MD, RCPS(C) Affiliate, Weill Cornell Medicine, Sidra Medicine, Department of Pediatrics, Division of Neonatology, Doha, Qatar 26999
*E-mail address:* aanbuchakk@sidra.org (A. Anbu Chakkarapani).

1067-991X/$36.00
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https://doi.org/10.1016/j.amj.2019.06.005

time, stabilization time, and time to admission at the receiving unit. The objective of this study was to assess individual components in neonatal transport that took time and thereby identify opportunities to minimize delay, optimize care, and improve the overall efficiency of neonatal transports.

The American Academy of Pediatrics Section on Transport Medicine[3] emphasizes the need for such data for quality improvement and ongoing monitoring of transport processes to ensure that safe and efficient care is consistently delivered. Information from this study provided useful local reference values regarding mobilization and retrieval times and helped the transport program to identify factors that affect transport times in the region. Determination of this information was the preliminary step in identifying factors that have an impact on the quality and efficiency of neonatal transport team service.

## Methods

*Study Setting*

This was a single-center prospective observational study conducted at McMaster Children's Hospital, Hamilton, Ontario, Canada

*Study Duration*

The study was conducted with a dedicated transport team over 12 months from January 2012 to December 2012.

*Study Procedure*

Neonates (<28 days old) transported by the McMaster neonatal transport team to McMaster Children's Hospital or another level III NICU facility from the referring hospital are included in the study. All members of the transport team were provided with detailed time log sheets with a breakdown of individual essential and nonessential components of transport stabilization time. Two nurses in the nurse transport team recorded the individual components in a time sheet immediately after completion of a task in a contemporaneous fashion or at the earliest opportunity during the transport event.

*Definitions*

Stabilization time was defined as the time interval between arrival and departure of the transport team from the referring hospital.

This study fulfilled the criteria of the research ethics board of McMaster University and was approved and exempt from seeking consent.

*Statistical Analysis*

All essential and nonessential components of stabilization time are expressed as the mean ± standard deviation. The subgroups of stabilization time were expressed as categoric variables, and comparative analyses were performed with the Cochran-Mantel-Haenszel test. Two-sided $P$ values < .05 were considered to indicate statistical significance. SPSS software (Version 25; IBM Corp, Armonk, NY) was used for analysis.

## Results

*Intervention Versus No Intervention*

The number and types of procedures and interventions undertaken by the transport team are shown in Table 1. Of 223 neonatal transfers, 67 (30%) required no procedural or therapeutic intervention before mobilization for admission to the receiving unit. Such transfers had a mean stabilization time of 113 ± 52 minutes. In the remaining 156 transfers (70%), 1 or more interventions were required, with a mean stabilization time of 165 ± 89 minutes ($P$ < .0001), which was significantly higher in comparison with the no intervention group. In 80 cases, intubation and ventilation were required before transportation of the neonate, resulting in a higher mean stabilization time of 217 ± 80 minutes compared with the 143 transport runs in which intubation and assisted ventilation were not required (mean stabilization time = 126 ± 67 minutes, $P$ < .0001).

**Table 1**
Procedure and Interventions

| Procedures/Interventions | No. of Cases |
|---|---|
| Peripheral intravenous lines | 122 |
| Intubation and ventilation | 63 |
| Insertion of umbilical lines | 34 |
| Surfactant administration | 23 |
| Fluid boluses | 22 |
| Initiation of CPAP ventilation | 18 |
| Intercostal drainage for pneumothorax | 7 |
| Initiation of inotropic support | 6 |
| Initiation of inhaled nitric oxide | 5 |
| Managing seizures with anticonvulsants | 2 |
| Initiation of whole-body hypothermia | 2 |

CPAP = continuous positive airway pressure.

*Bed Availability*

In 178 of 223 neonatal transports, the neonate was admitted to the regional perinatal facility at McMaster Children's Hospital's level III NICU with a mean stabilization time of 153 ± 81 minutes. This stabilization time was less than in the 45 patients who were transferred to another level III NICU in the province (because they were born outside our local network and/or because of capacity issues at McMaster); they had a mean stabilization time of 183 ± 90 minutes ($P$ = .03, Table 2).

*Stabilization Time Components*

Among the components of stabilization time, approximately half of the time (mean = 80 ± 25 minutes) was spent on essential tasks like communicating with parents, history taking, and assessment of the baby and on procedural and therapeutic interventions. A significant amount of time (mean = 35 ± 19 minutes) was spent on avoidable or nonessential items like waiting for vehicle mobilization, blood results, and bed availability. The essential and nonessential components of stabilization times during retrieval are shown in Table 3.

## Discussion

Our study results indicate stabilization times that are over one and a half times longer in comparison with a previously published study by Chen et al.[4] The need for interventions and waiting time significantly prolonged stabilization times. As anticipated, there were significantly longer stabilization times, even in transfers in which a single procedure was required. Increased stabilization times were associated with the need for interventions, partly because of the technical complexity of the procedure but also related measures to ensure that the procedure was successful and safe. An additional impact on stabilization times occurred because of a need to check the patient's physiological status as a result of the intervention before mobilization. For example, radiographs and/or blood gasses in addition to careful physical assessment after endotracheal intubation added to the time taken to prepare the patient for mobilization.

Stabilization time was classified into 2 components: essential and nonessential. Important steps that are critical in ensuring the safe and efficient transport of the patient were classified as essential components of the transport. It is important to emphasize that the time spent on essential steps cannot be reduced significantly without potentially jeopardizing patient safety. In neonates not requiring any interventions, essential components primarily involved patient

**Table 2**
Stabilization Time

| Subgroups | | N = 223 | Stabilization Time | | *P* Value |
|---|---|---|---|---|---|
| | | | Mean ± SD (min) | Median (Range) (min) | |
| Ventilation | Yes | 80 | 217 ± 80.2 | 203 (85-450) | <.0001 |
| | No | 143 | 126 ± 67.2 | 115 (45-521) | |
| Interventions | Yes (1 or more) | 156 | 176 ± 88.9 | 160 (45-521) | <.0001 |
| | No | 67 | 118 ± 52.3 | 115 (45-260) | |
| Transfer to McMaster | Yes | 178 | 153 ± 81.6 | 135 (45-450) | .03 |
| | No (elsewhere) | 45 | 183 ± 90.2 | 182 (60-521) | |

SD = standard deviation.

handover from the referring team, clinical evaluation, obtaining patient history and documents, formulating a transport plan, connecting monitors and infusion pumps, securing the patient and equipment, communicating with the family and receiving hospital, and the completion of a pretransport checklist. Additionally, in patients requiring interventions, the procedural time was classified as essential. There are some aspects of interventions like waiting for x-rays and blood investigation results that are classified as nonessential aspects of stabilization time because the transport program thinks there is room for improvement of these times without any adverse effect on patient care. Other items classified as nonessential items in stabilization were waiting times associated with finding a receiving facility, especially when there were regional capacity constraints; waiting time for blood results; transcribing x-ray images onto a CD; and waiting for an ambulance to mobilize the patient. These are the items that need to be carefully studied and improved accordingly.

Like our study, in a prospective study, Kronick et al[5] reported that transported neonates required more procedural interventions than infants and children. This study suggests that this difference in the rate of procedural intervention is a significant contributor to a significant increase in stabilization time for neonatal transports.

In a previous study, Macnab et al[6] identified that the time dedicated to communication with the family did not add substantially to stabilization time. However, this study found that communicating with parents did contribute toward stabilization times. The McMaster transport program firmly believes that effective communication is an integral aspect of neonatal care and classified this as an essential component of stabilization time during neonatal transfers. Also, the neonatal transport team thinks that time spent communicating can be improved using parent information documents that include the process of transport, the suspected diagnosis, and information about the receiving facility.

Admittedly, whether or not optimal stabilization is achieved is a subjective assessment. However, the most robust evidence of adequate stabilization is shown by an uneventful transfer of the neonate without a requirement for additional interventions during transit. Inadequate stabilization before transport was identified as a principal cause of complications during transfer.[7,8] Although the length of time taken for stabilization may be a contentious issue in terms of quality improvement, the principle of optimal pretransport stabilization to minimize morbidity and mortality is well accepted.

**Table 3**
Components of Stabilization time

| Components | | Time in Minutes Mean ± 2 SD, Median (Range) |
|---|---|---|
| Essential | History taking | 17.5 ± 9.8, 5 (3-90) |
| | Clinical assessment | 20.7 ± 16.6, 20 (7-70) |
| | Procedures/interventions | 40.8 ± 57.3, 20 (0-180) |
| | Communicating with referring team | 15.5 ± 13.8, 15 (0-90) |
| | Communicating with parents | 24.7 ± 12.7, 25 (0-90) |
| | Communicating with McMaster physician | 13.4 ± 9.57, 10 (0-60) |
| | Waiting time for treatment response | 19.1 ± 21.7, 5 (0-180) |
| Nonessential | Waiting time for bed availability elsewhere | 11.7 ± 28.7, 0 (0-240) |
| | Waiting time for blood results | 19.9 ± 23.8, 15 (0-195) |
| | Waiting time transcribing x-ray images onto CD | 7.59 ± 14.2, 0 (0-85) |
| | Waiting time for arrival of inbound transportation | 19.9 ± 24.3, 15 (0-150) |

SD = standard deviation.

*Potential Strategies in Shortening Stabilization Times*

If the staff at referring hospitals can perform required interventions/procedures before the arrival of the transport team, the study data suggest that the time spent by the transport team at the referring hospital could be reduced significantly. For example, if adequate intravenous access is secured before the arrival of the transport team, stabilization time was significantly shortened. Even straightforward tasks such as performing a complete blood count or chest x-ray as required shortened the time spent in referring to the hospital and thereby shortened stabilization times. Improving procedural skills in referring hospitals is something that can be enhanced within the context of a perinatal network by outreach education and skills training workshops for referring clinicians working with neonates. Stabilization times can be significantly shortened if the referring hospital can undertake clinical interventions and commence implementation of the management plan. However, it is also important to emphasize that procedures in vulnerable neonates require a high degree of skill, and it is often challenging to maintain competence in these rare events. If personnel skilled in performing these highly specialized procedures are not readily available, this study recommends that it is safer for the transport team to undertake them even if stabilization times get prolonged.

The time spent in locating facilities with the capacity to receive infants requiring ongoing neonatal intensive care contributed significantly to stabilization time and thereby the total transport time. This time can have deleterious consequences to neonates waiting in referral sites and those embarking on longer than necessary transfer distances. The neonatal transport program firmly believes that this aspect of stabilization time is potentially avoidable with proactive regional capacity management and centralized call handling service with actively updated regional/provincial capacity dashboards integrated with the ground and air retrieval services operating within accepted response times.

The use of point-of-care testing devices with expanded panels to assess hematocrit, electrolytes, blood gas lactate, and possibly bilirubin would minimize reliance on laboratory testing, especially at sites where laboratory services are not readily available around the clock. The radiology waiting time can be minimized by adopting the use of

x-ray machines with screen displays to enable previous image review and expanding radiology information system integration within perinatal networks. Simple steps like informing radiology services of the potential requirement of their services may also shorten waiting times.

Overall, the study results will help the health care system to consider the modifications in regulatory guidelines in order to improve care and efficiency of the regional/provincial/federal neonatal transport team. Similar to the study by Ratnavel,[9] the conclusions of the present study will most likely serve as 1 of the most reliable drivers for change in terms of improving the quality and the standards of neonatal transport services in Canada and other parts of the world.

Because this was a prospective study, the transport team could collect information on all interventions performed by the transport team and look into delays encountered at the referring hospital. However, the study had certain limitations; the main limitation of the study was that it was not blinded. Members of the transport team were aware of the study's purpose, and the study relied on self-reporting questionnaires with associated limitations and bias. Another limitation was that the transport team did not report on all the transports conducted during the study period because of limitations with staff participation. Analysis of stabilization time did not include the suspected diagnosis or physiological markers of stability and the time of referral or admission to a receiving site. The individual components of stabilization time recorded in time log sheets by the neonatal transport team are not very precise if the events happened simultaneously or overlapped.

## Conclusion

This study found that local stabilization time was more than 1.5 times that of comparable published data in a neonatal population. The reasons for prolonged stabilization time was mostly because of waiting times for vehicle mobilization, blood and radiology results, and bed availability. Modifying these factors could save up to 28% of the time spent in stabilization. It is crucial for individual transport teams to carefully look at various aspects of transport and understand aspects in their respective system that lead to delays in transport. Further quality improvement research is required, including the previously mentioned potential strategies to shorten the stabilization time during neonatal transport as well as its impact on the health care system in various parts of the world.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amj.2019.06.005.

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