The accuracy of the Thompson score in predicting early outcome in neonates with hypoxic ischaemic encephalopathy treated with therapeutic cooling in a tertiary hospital

J M Maphake,[1] MB ChB, MMed (Paed); **H Naidoo,**[1] MB ChB, Cert Neonatology (SA); **M Coetzee,**[1] MB ChB, Cert Neonatology (SA); **P J Becker,**[2] MSc, PhD

[1] *Department of Paediatrics and Child Health, Division of Neonatology, Steve Biko Academic Hospital and Faculty of Health Sciences, University of Pretoria, South Africa*
[2] *Research Office, Faculty of Health Sciences, University of Pretoria, South Africa*

Corresponding author: *J M Maphake (jabumaphake@gmail.com)*

Background. Hypoxic ischaemic encephalopathy (HIE) is one of the major contributors to neonatal mortality and morbidity in developing countries. Scarcity of resources limits clinicians in optimally caring for these patients. Optimal utilisation of clinical tools such as the Thompson score (TS) can assist in improving care by classifying the severity of HIE followed by appropriate treatment.
Objectives. The primary objective was to study the correlation of the TS and early neonatal outcomes in infants with HIE who received therapeutic hypothermia (TH). Secondary objectives were to investigate the correlation of blood gas values with the TS, need for resuscitation with TS, target organ damage (TOD) with TS and the most common risk factors associated with HIE in Tembisa Provincial Tertiary Hospital (TPTH).
Methods. This was a retrospective record review of infants admitted with HIE from January 2018 to August 2019 at the TPTH neonatal unit. Infants had to have successfully completed TH.
Results. Ninety-three infants met the inclusion criteria, with 32, 48 and 13 being classified into the mild, moderate and severe categories by TS, respectively. The median length of stay (LOS) was noted to rise with a rising TS, recorded to be 7, 8 and 9 days in the mild, moderate and severe groups, respectively. The mortality rate in the study was calculated to be 2.1%, and there was no significant difference across the groups (p=0.231). A need for antiseizure medication (ASM) on discharge was significantly associated with severe HIE (p=0.028). Hypertension was a frequent chronic illness, noted in 11.3% of the mothers. The most frequent perinatal risk factor was meconium aspiration (50.5%), followed by prolonged second stage of labour (PSSL) (17.2%). A higher TS (severe group) was associated with prolonged resuscitation for >10 minutes (p=0.001) and a need for adrenaline (p=0.008). The frequency of cardiac impairment, liver impairment and clinical seizures increased with a higher TS category (p=0.23, p=0.35 and p=0.51, respectively). On blood gas analysis, a low pH and a high base deficit were associated with severe HIE (p=0.027, p=0.061, respectively).
Conclusion. The TS is still a useful clinical tool in the era of TH as it is able to predict some early neonatal outcomes such as LOS and a need for ASM at discharge. It is also able to demonstrate increased frequency of duration of resuscitation and a need for adrenaline in severely encephalopathic infants compared with mild. A high TS is also associated with severe metabolic acidosis and increased frequency of TOD. Maternal hypertension, meconium-stained liquor and PSSL are the common risk factors for HIE at TPTH.

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Hypoxic ischaemic encephalopathy (HIE) is still a major contributor to neonatal mortality and morbidity in developing countries. It contributes significantly to the death of children under 5 years of age.[1] It is the second highest cause of neonatal mortality after prematurity, contributing to 23% of neonatal deaths worldwide and 8% of mortality in children under 5 years of age.[2,3] An incidence of 6 per 1 000 live births in developed countries and 132 per 1 000 live births in developing countries has been reported.[4] A South African (SA) study found an incidence of 8.7 to 15.2 per 1 000 live births at Chris Hani Baragwanath Academic Hospital (CHBAH).[5] A presumptive diagnosis of HIE is often made when an infant has an Apgar score of ≤5 at 5 and 10 minutes, requires continuous ventilatory support for >10 minutes, has a base deficit of ≥12 on a blood gas done within an hour of birth and has clinical signs of encephalopathy.[6] Multiple factors have been shown to increase the risk of developing HIE. Maternal factors include antepartum haemorrhage, hypertension and cardiac diseases. Other factors include abruptio placentae, uterine rupture, amniotic fluid embolisation, cord prolapse and prolonged labour.[7] Affected infants present with an abnormal state of consciousness that may include hyperalertness, irritability, lethargy or coma.[8] Associated respiratory compromise, cardiac compromise, feeding difficulties and seizures may also be noted.[8] Clinical tools such as Sarnat and Sarnat staging and Apgar scores are used in the immediate assessment of the neonatal depression and staging of the encephalopathy.[9,10] The Thompson score (TS) is another tool based originally on Sarnat and Sarnat staging, but in a simplified format (Table 1). The purpose of the TS was to predict neurodevelopmental outcome at 1 year of age in neonates suspected to have suffered an intrapartum hypoxic ischaemic insult.[3] This score was established before the era of therapeutic hypothermia (TH).

Bedside tests such as blood gas analysis of the infant or cord blood done within an hour of birth may support the diagnosis of perinatal hypoxic insult. Most studies suggest a pH <7 and/or a base deficit ≥12 to correlate with a perinatal hypoxic ischaemic insult.[7] Other investigations such as magnetic resonance imaging (MRI) of the brain and amplitude

integrated electroencephalography (aEEG) are valuable in assessing and prognosticating patients with HIE. aEEG is currently widely used as a convenient modality to monitor brain function at the bedside in neonatal intensive care units (NICUs).[8,11] MRI of the brain is the neuro-imaging modality of choice in determining the extent of the brain injury.[7]

However, developing countries such as SA are resource limited, which makes it difficult to conduct the recommended investigations in hospitals such as Tembisa Provincial Tertiary Hospital (TPTH). Given the above challenges, we believe optimal utilisation of clinical tools such as the TS may still be valuable in predicting early neonatal outcomes, namely length of hospital stay (LOS), mortality rate, need for nasogastric tube (NGT) feeds after day 3 of life, feeding gastrostomy tube (FGT) at discharge, antiseizure medication (ASM) at discharge and abnormal tone at discharge, in the era of TH. Encouraged utilisation of this cost-effective clinical tool will assist the Department of Health to divert budget to other resources without compromising quality of care of patients. The primary objective of the study was to investigate whether the TS is a useful clinical tool in predicting early neonatal outcome at day 7 of life, and discharge in neonates with HIE who received TH. Secondary objectives were to investigate the correlation of blood gas values with the TS, need for resuscitation with TS, target organ damage (TOD) with TS and the most common risk factors associated with HIE in TPTH.

Methodology

Study design and unit setting

This was a retrospective record review of patients admitted to the neonatal unit of TPTH. Records of inborn patients admitted to the neonatal ward at TPTH with HIE from 1 January 2018 to 31 August 2019 were audited. Only those who met TH criteria and successfully completed TH were recruited into the study. TPTH is an institution located in Ekurhuleni metropolitan municipality of Gauteng Province. It is a 66-bedded neonatal unit with 6 NICU beds, 20 high-care beds, 20 kangaroo mother-care (KMC) beds, 16 low-care beds and 4 isolation beds. Infants with HIE eligible for TH are admitted into NICU and cooled for 72 hours with Mira cradle gel packs.

Study population and definitions

Infants born ≥36 weeks' gestational age (GA), with a birthweight (BW) ≥2 000 g and moderate or severe encephalopathy (modified Sarnat staging) or clinical seizures with evidence of hypoxic ischaemia (pH <7 or base defici t>16) were included.[7,12] These criteria are used at TPTH for eligibility to TH. Infants must have completed 72 hours of TH as standard of care using the Mira cradle gel packs, which are phase-changing material.[13] Infants who were born outside of TPTH, born before 36 weeks' GA, had congenital anomalies, bilirubin encephalopathy, confirmed meningitis, no TS assessment, or BW <2 000 g, were unstable for cooling or had TH stopped before 72 hours were excluded from the study. Common risk factors for HIE were analysed as documented in the patient's records. Details of resuscitation were audited, with special attention to duration of resuscitation, bag and mask ventilation (BMV), chest compressions and need for adrenaline. The following systems were analysed for evidence of TOD: cardiac dysfunction was defined by signs of poor perfusion with a capillary refill count of >3 seconds, tachycardia of more than 160 beats per minute with/without hypotension, or a requirement for inotropic support to maintain normal perfusion and raised troponin T ≥100 ng/L.[14] Oliguria (urine output <1 mL/kg/hour) or a raised serum creatinine of >1.2 mg/dL (105 µmoL/L) were regarded as evidence for acute kidney injury (AKI), whereas elevation of transaminases with aspartate aminotransferase (AST)/alanine aminotransferase (ALT) >100 IU/L or raised international normalised ratio (INR) of >1.5 were noted to be a manifestation of hepatic injury.[14] The following early neonatal outcomes were analysed: mortality rate, need for NGT feeds after day 3 of life, FGT at discharge, ASM at discharge and abnormal tone at discharge. Unit policy regarding HIE infants with recurrent seizures at TPTH is to put them on maintenance ASM until they are seizure free for at least 2 weeks. Some are discharged on treatment, as they would not have achieved a 2-week seizure-free state.

Procedures and data collection

Infants with a diagnosis of HIE were identified from a register compiled by the paediatric team at TPTH. The Orbit system (electronic database) was used to access the hospital records of these infants. Relevant information regarding patients was extracted from the files.

Data analysis

An estimated sample size of 115 infants was required. Patients were categorised into mild (TS ≤10), moderate (TS = 11 - 14) and severe (TS ≥15) according to TS values. TS categories were then used to analyse various factors and outcomes. Descriptive continuous data are reported into mean, median and standard deviation, whereas discrete outcomes are reported into percentages. The Cohen intraclass Kappa statistic was employed to assess the accuracy of the TS prediction of outcome. Furthermore, following a logistic regression with TS of two and three categories, respectively, the area under the receiver operating characteristic curve was assessed for accuracy. Diagnostic statistics were determined and reported. Fisher's exact testing was done at the 0.05 level of significance.

Ethical considerations

The study was approved by the University of Pretoria ethics committee (ref. no. 138/2019) and National Health Research Database. Permission was granted by the paediatric head of department and the chief executive officer of TPTH. Patients' information was labelled anonymously on the data collection sheet (only reference numbers were assigned). Informed consent from parents for this retrospective study was not required, as granted by the ethics committee.

Results

A total of 168 infants' records were audited within the study period (20 months). Seventy-five patients met exclusion criteria as described earlier, leaving 93 participants eligible for analysis. Reasons for exclusion were meningitis (n=3), congenital anomalies (n=2), unable to initiate TH (n=21), not cooled due to shortage of NICU beds (n=26), TH stopped before 72 hours (n=20), no TS assessment (n=1) and born outside of TPTH (n=2). Eligible patients' variables were compared using the TS categories (mild, moderate and severe) on day 1 of life. There were 32, 48 and 13 infants categorised as mild (TS ≤10), moderate (TS 11 - 14) and severe (TS 15 - 22), respectively. The mean BW for the three groups (mild, moderate, and severe) were 3 166 g, 3 120 g and 2 989 g, respectively (p=0.531). All three groups had a similar duration of pregnancy, with a mean GA of 39 weeks (p=0.743). The mean head circumference (HC) for the mild and moderate categories was 35 cm. The severe group showed a lower mean HC of 34 cm, a difference of 1 cm compared with other groups (p=0.343) (Table 2). A majority of the mothers attended antenatal care (ANC), with 93.7%, 95.8% and 100% in the mild, moderate and severe groups, respectively, with an overall percentage of 95.7% (p=0.858) (Table 2).

Table 1. Thompson score[3]

Score sign	0	1	2	3
Tone	Normal	Hypertonic	Hypotonic	Flaccid
Level of consciousness	Normal	Hyper alert state	Lethargic	Comatose
Fits	None	<3 per day	>2 per day	
Posture	Normal	Fisting, cycling	Strong distal flexion	Decerebrate
Moro	Normal	Partial	Absent	-
Grasp	Normal	Poor	Absent	-
Suck	Normal	Poor	Absent/bites	-
Respiration	Normal	Hyperventilation	Brief apnoea	Intermittent positive pressure ventilation
Fontanel	Normal	Full	Tense	-

Table 2. Birth parameters, maternal antenatal information and details of resuscitation

	Thompson score category			
Parameters	**Mild (*n*=32)**	**Moderate (*n*=48)**	**Severe (*n*=13)**	***p*-value**
Head circumference (cm), *n*, mean (SD), median	31, 35.1 (1.5), 35.0	44, 34.7 (1.8), 35.0	13, 34.3 (2.0), 34.0	0.343
Birth weight (g), *n*, mean (SD), median	32, 3 166 (490), 3 150	48, 3 120 (478), 3 100	13, 2 989 (448), 3 100	0.531
Gestational age (weeks), *n*, mean (SD), median	32, 39 (1.8), 39.5	47, 39 (1.4), 40.0	13, 39 (1.8), 40.0	0.743
Mothers who attended ANC, *n* (%)	30 (93.7)	46 (95.8)	13 (100)	0.858
HIV-positive mothers, *n* (%)	6 (18.7)	9 (18.7)	3 (23.0)	0.876
Hypertensive mothers, *n* (%)	5 (15.6)	3 (6.2)	3 (23.0)	0.238
Diabetic mothers, *n* (%)	1 (3.1)	1 (2.0)	0 (0.0)	1.000
Resuscitation >10 minutes, *n* (%)	5 (15.6)	10 (20.8)	10 (70.9)	0.001
Bag-mask ventilation only, *n* (%)	31 (96.8)	47 (97.9)	12 (92.3)	0.538
Cardiac compression, *n* (%)	9 (28.1)	14 (29.2)	8 (61.5)	0.077
Received adrenaline, *n* (%)	0 (0)	1 (2.1)	3 (23.1)	0.008
pH, *n*, mean (SD), median	31, 7.05 (0.12), 7.07	48, 7.01 (0.13), 7.02	13, 6.93 (0.14), 6.91	0.027
Base deficit n, mean (SD), median	31, 19.6 (4.6), 19.0	48, 21.0 (4.7), 21.0	13, 23.5 (6.0), 22.0	0.061

ANC = antenatal care; SD = standard deviation.

Table 3. Target organ involvement and early outcomes

	Thompson score categories			
Parameters	**Mild (*n*=32)**	**Moderate (*n*=48)**	**Severe (*n*=13)**	***p*-value**
Cardiac impairment, *n* (%)	9 (28.1)	18 (37.5)	8 (61.5)	0.238
Renal impairment, *n* (%)	6 (18.7)	10 (20.8)	1 (7.7)	0.823
Liver impairment, *n* (%)	13 (40.6)	28 (58.3)	9 (69.2)	0.350
Clinical seizures, *n* (%)	9 (28.1)	16 (33.3)	6 (46.1)	0.513
Length of stay (days), *n*, mean (SD), median	30, 9.0 (8.0), 7.0	48, 8 (3.2), 8.0	13, 10.0 (4.2), 9.0	-
Mortality rate, *n* (%)	2 (6.2)	0 (0.0)	0 (0.0)	0.231
Nasogastric feeds after day 3, *n* (%)	15 (46.8)	27 (56.2)	10 (76.9)	0.124
Gastrostomy tube at discharge, *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	-
Antiepileptics at discharge, *n* (%)	0 (0.0)	1 (2.1)	2 (15.3)	0.028
Abnormal tone at discharge, *n* (%)	5 (16.6)	9 (18.7)	3 (23.0)	0.167

SD = standard deviation.

Table 3 demonstrates the early neonatal outcomes observed. LOS is expressed as number of days a patient was hospitalised. The moderate category had the lowest mean (8 days), followed by the mild group at 9 days and the severe group having the highest mean LOS of 10 days. Contrary to the mean trends, the mild category had the lowest median of 7 days, followed by the moderate (8 days) and severe groups (9 days). One patient in the mild category stayed in the hospital for 46 days, skewing the mean values in the mild category. The overall mortality rate was recorded to be 2.1%, with the mild category being the sole contributor (p=0.231). Feeding methods were assessed amongst the groups shortly after TH was completed. The mild category demonstrated the lowest proportion (46.8%) of patients requiring NGT feeds. In the moderate and severe groups, 56.2% and 76.9%, respectively, required a NGT to feed beyond day 3

of life (p=0.124). However, this difference was not statistically significant. None of the study patients required FGT at discharge. Significantly, 15.3% of infants in the severe category required ASM at discharge, compared with 2.1% in the mild and 0% in the moderate groups (p=0.028). The mild group reported the lowest number of patients with abnormal tone, followed by the moderate and severe group (16.6%, 18.7% and 23%, respectively) (p=0.167).

Maternal HIV positivity rate was noted to be 18.7% in the mild group, 18.7% in the moderate group and 23.0% in the severe group (p=0.876). Hypertensive mothers comprised 15.6% of the mild group, 6.2% of the moderate group and 23.0% of the severe group, with an average of 11.8%. Despite the higher percentage in the severe category relative to the other categories, this was not statistically significant (p=0.238). Diabetic mothers recorded the lowest incidence among the chronic illnesses, with 3.1% in the mild group, 2.0% in the moderate group and none in the severe group, with an average of 2.1% (p=1.00) (Table 2). The majority of patients (96.7%) required at least BMV as a resuscitative measure. Cardiac compressions were required in 33.3% of patients, and adrenaline in 4.3%. Approximately one-quarter (26.8%) of infants required resuscitation for a duration of >10 minutes after delivery, with 15.6% of the mild group, 20.8% of the moderate group and 76.9% of the severe group requiring resuscitation for >10 minutes (p=0.001). Almost all patients (96.8%) of the mild group, 97.9% of the moderate group and 92.3% of the severe group required BMV at some stage during the resuscitation (p=0.538). Cardiac compressions were provided to 28.1% of the mild group, 29.2% of the moderate group and 61.5% of the severe group (p=0.077). In the mild, moderate and severe groups, 0%, 2.1% and 23.1%, respectively, required adrenaline during resuscitation. A higher TS category was associated with an increased chance of requiring adrenaline during resuscitation (p=0.008) (Table 2). The blood gas (arterial cord blood or peripheral arterial blood taken within 60 minutes of birth) formed part of the initial investigations done for infants with suspected HIE. Table 2 demonstrates a significant difference in pH values among the groups (p=0.027). The mean base deficit increased with worsening TS category, with a mean base deficit of 19.6 for the mild group, 21.0 for the moderate group and 23.5 for the severe group (p=0.061). However, this was not statistically significant.

Fig. 1 demonstrates that the TS trends declined as days progressed across all categories. Risk factors associated with HIE were demonstrated to be meconium exposure in 50.5% (n=47), followed by prolonged second stage of labour (PSSL) (17.2%, n=16). Abruptio placentae and cord prolapse were reported in 6.5% (n=6) and 2.2% (n=2) of mothers, respectively. Chorioamnionitis was reported in 2.2 % (n=2) of the mothers, and none of the mothers had a ruptured uterus. The frequency of cardiac impairment, liver impairment and clinical seizures increased with a higher TS category (mild < moderate < severe) (p=0.23, p=0.35 and p=0.51, respectively), but this was not statistically significant (Table 3).

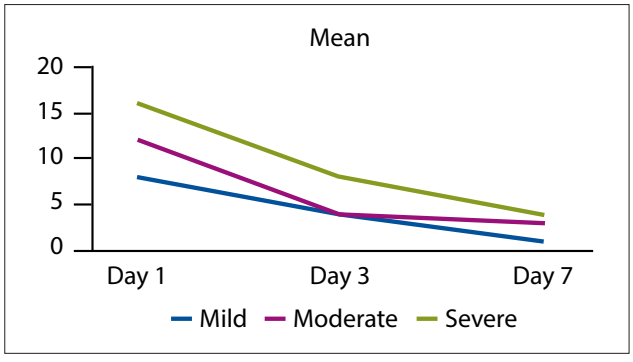

Fig. 1. Thompson score trends over time, mean.

Discussion

The pattern demonstrated in Fig. 1 shows that the mild group persist to have the lowest mean TS from day 1 to day 7, followed by the moderate group, with the severe group consistently having the highest mean values across the time period despite intervention of TH for all three groups. Fig. 1 also demonstrates that the TS declined from day 1 to day 7 across all the categories, indicating an improving clinical picture. Thompson *et al.*[9] also demonstrated declining scores in their original study where TH was not yet available. It is evident that regardless of the intervention (supportive care or TH), the TS values across the categories generally declined as days progressed, indicating an improving neurological function. What might have to be determined is the rate at which it declines for the different interventions. We excluded infants who did not receive TH in our study; therefore the two groups (supportive care v. TH) cannot be compared.

The median LOS for survivors is demonstrated to be shorter in the mild category and rises with an increasing TS category. This trend was also demonstrated by a US study, which showed that mild HIE infants have the shortest LOS, whereas severe HIE infants have the longest LOS.[15] However, their patients had higher median scores than those in our study. They demonstrated a median LOS of 10 days, 14 days and 26 days for the mild, moderate and severe categories, respectively, whereas our study demonstrated a median score of 7, 8 and 9 days in the mild, moderate and severe groups, respectively. The difference could be explained by the fact that the USA is a developed country with more resources than SA, hence patients stay longer for extensive investigations that developing countries do not have access to. This could also be a manifestation of limitation of hospital beds in developing countries, so that patients are discharged early. Two of the study patients died, with an overall mortality rate of 2.1%, which is lower than that in other studies.[5,15] Both patients were classified as having mild HIE by TS, with no deaths in the moderate or severe categories (p=0.231). The first patient had associated sub-aponeurotic bleed with suspected (not confirmed) choanal atresia, and the other patient had evidence of multi-organ dysfunction secondary to possible hypoxic insult. A Johannesburg (JHB) study demonstrated mortality rates of 1.4%, 7.1% and 62% in the mild, moderate and severe categories, respectively, and an overall mortality of 12.3%.[5] However, these patients did not receive TH. A US study where infants received TH demonstrated mortality rates of 0.6%, 11% and 88.4% in the mild, moderate and severe groups, respectively, with an overall mortality rate of 16.4%.[15] We postulate that the low mortality rate of included infants can be explained by the fact that 41 infants in the study were excluded for TH because of instability, or failed to complete TH. However, the difference could also be explained by the intervention of TH. All the patients included in the present study received TH (as this was part of the inclusion criteria), compared with 85% in the US study and none in the JHB study. Non-significantly, the need for NGT feeds after cooling increased with worsening TS (p=0.124). Similar findings were demonstrated by Massaro *et al.*,[15] where most patients in the mild category achieved full oral feeding, compared with the moderate and severe groups (95% v. 88% and 62%), and this finding was statistically significant (p=0.00). It was not clear in the study at what day of life this was achieved. None of our patients required FGT at discharge. Other studies also reported an overall lower percentage. Massaro *et al.*[15] reported a

need for FGT of 3.5%, 5.8% and 18% in the mild, moderate and severe groups, respectively, with an overall need for FGT of 7.2% in the study population (p=0.00). The different findings in our study could be related to the small sample size (n=93 v. n=945). Our study found that there is a significant (p=0.028) association between severity of TS category and a need for ASM at discharge. The need for ASM rises with a worsening TS category (0.0% v. 2.1% v. 15.3% in the mild, moderate and severe groups, respectively). A US study showed a similar pattern, with 16.7%, 25.8% and 52.3% of the mild, moderate and severe groups requiring ASM at discharge. However, their percentages were higher compared with our study (p=0.00).[15] The need for ASM at TPTH is based on clinical seizures only, as aEEG is not available. Abnormal tone is a common finding on admission, and this tends to improve or normalise as the infant gets older.[8] We found that only 18.2% of the infants had abnormal tone at discharge. Non-significantly, the most affected infants were in the severe category, and the least affected infants in the mild category (p=0.167).

Hypertension was the most frequent chronic illness, affecting 11.8% of the mothers in the entire study group. Our findings compare to those of Bhagwani *et al.*[3] (11%) in India, and differ from those in an SA study (19.6%) by Brukmann and Velaphi.[5] Meconium exposure was the most prominent risk factor, present in 50.5% of the patients, followed by PSSL (17.2%) and abruptio placentae (6.5%). Bruckmann and Velaphi[5] reported meconium exposure in 34.3%, PSSL in 7.3% and cord prolapse in 4.1%. However, the percentages for PSSL and cord prolapse were reported as indications for caesarean sections, hence could be higher if those delivered vaginally are considered. A study[16] in Iran also found meconium exposure to be the most common risk factor. However, the percentage affected was not indicated.

Our study reports that patients in the mild category were less likely to require extensive resuscitation for >10 minutes and adrenaline than the moderate and severe categories (p=0.001, p=0.008, respectively). Our study reported that 96.7% of the patients required BMV and 4.3% required adrenaline as a resuscitative measure. Comparable findings were also demonstrated by Bruckmann and Velaphi,[5] where 89.7% of asphyxiated infants required BMV only, and 3.1% required adrenaline. A higher number (33%) required BMV plus chest compression in our study, compared with 7.2% in Bruckmann and Velaphi's study.[5] The blood gas values demonstrate significant metabolic acidosis across all TS categories, a finding that makes the probability of neonatal encephalopathy being secondary to intrapartum hypoxia likely.[7] There was evidence of TOD in all categories. Liver impairment (53.7%) was the most frequent, followed by cardiac impairment (37.6%), with acute kidney injury (7.7%) being the least frequent. Our findings are different from those of Pattar *et al.*,[14] where liver, cardiac and kidney impairment were demonstrated in 24.5%, 54.3% and 29.8% of perinatally asphyxiated infants, respectively. The mild category had the least cardiac and liver impairment, with the severe category demonstrating the highest impairment. This phenomenon was also demonstrated in terms of clinical seizures, where the mild group had the lowest frequency of clinical seizures and the severe group had the highest frequency (p=0.238; p=0.35; p=0.513, respectively). The overall incidence of AKI in our study was lower than that observed in other studies. We observed an incidence of 18.2%, whereas other studies reported a variation from 38% to 70.1%.[14,17] The above observation could relate to the fact that most of our patients did not have urine output monitored or calculated. We therefore relied on elevated serum creatinine levels, which are routinely tested after 24 hours of life but before 48 hours in infants with HIE. The literature has shown that there is a delayed rise in serum creatinine in newborns after a kidney insult that peaks at 48 - 72 hours of life.[17] In our study, the creatinine sample was potentially collected before the peak, hence the incidence of AKI is likely higher.

Study limitations

This study was a retrospective review, and therefore a major limitation was the quality of the records. The sample size is also small (below the initial estimation), reducing the power of the study. There is no control group (infants who did not receive TH) to compare outcomes, and also, we did not look at the long-term outcomes post discharge as initially done by Thompson.

Conclusion

Our study shows that the TS is still a useful clinical tool even in the era of TH, and continued utilisation must be encouraged in resource-limited countries. TS on admission correlated with some of the early neonatal outcomes. There was a significant association between a higher TS and increased need for ASM at discharge. There was also a trend towards longer LOS with a higher initial TS. Patients with high TS significantly needed prolonged resuscitation, had increased need for use of adrenaline during cardiopulmonary resuscitation and had severe metabolic acidosis. Maternal hypertension, meconium-stained liquor and PSSL were found to be the common risk factors for HIE at TPTH. This study may have shown additional significant associations with the TS and outcomes had patients not been excluded who did not receive/complete TH. We recommend that future studies compare the initial TS to long-term neurodevelopmental outcomes in the era of TH.

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