



A Review of the Singapore General Hospital Neonatology Unit High Dependency Admission Criteria

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Abstract

Objectives: A retrospective cohort study was performed to evaluate the outcomes of asymptomatic term newborns admitted based on maternal risk factors to the Neonatal High Dependency (HD) unit of a tertiary center in Singapore. The data was used to evaluate the appropriateness of the unit's current HD admission criteria and identify risk factors which were predictive for newborns turning unwell during the HD monitoring period.

Methods: Anonymized clinical information of all live births in the unit were reviewed from April to June 2022. All term newborns admitted to the unit were included in the analysis. Maternal demographics, fetal characteristics, maternal and fetal risk factors, and neonatal outcomes were also retrieved from the clinical notes.

Results: Out of the total of 95 asymptomatic term newborns admitted to HD for observation during the study period, only 16% turned symptomatic during the six-hour observation period. Of these, a roughly equal proportion had single (53%) and 2 or more risk factors (47%). Most asymptomatic term newborns who remained well until discharge had only 1 risk factor (59%).

Conclusion: Our results are consistent with current literature that most asymptomatic newborns of mothers with risk factors remained well post-natally. Admitting these newborns to the nursery instead would decrease use of hospital resources and bill size, while promoting skin to skin contact at birth, rooming in of newborn with mother and increasing breastfeeding rate, satisfying the ten steps of Baby Friendly Hospital Initiatives (BFHI). HD nurses can also focus care on sicker newborns requiring closer monitoring.

Keywords: Neonatology; High-dependency; Admission criteria; Asymptomatic; Full-term

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Introduction

As with most tertiary centers worldwide, the care of newborns in the neonatology unit we studied is stratified into three levels. Whereas Neo3 or the Neonatal Intensive Care Unit (ICU) is the highest level of care with advanced life-support capabilities for Extremely Low Birth Weight (ELBW) newborns and all newborns requiring ventilator and inotropic support, Neo2 or the Neonatal High Dependency (HD) functions as a step-down unit for neo-natal ICU "graduates" while also directly admitting newborns who require closer monitoring and treatment without ventilator requirements.

In addition, the HD of the center we studied also admitted well term newborns who were born with a pre-defined set of maternal or peri-natal risk factors for a minimum six-hour observation period. This was deemed necessary due to the unique set-up of the unit, whereby the newborn nursery or Neo1 was located physically separate from the rest of the unit (in the maternal post-natal ward) and manpower constraints resulted in it being primarily staffed by nurses qualified to care for well term-newborns only. Admitting this group of newborns who were deemed high risk, allowed for more reliable monitoring that could lead to earlier detection of clinical deterioration and earlier initiation of treatment.

However, several disadvantages to this broader approach to HD admission were also recognized, chiefly in the dual areas of reduced maternal contact and value-based care. Newborns admitted to HD were separated from their mothers after delivery for a minimum of six hours reducing the initial time available for skin-to-skin contact and breastfeeding. Inevitable delays in transfer after the six-hour monitoring period and the diversion of advanced nursing care from sicker newborns to well newborns in the same HD were also deemed to compromise the value efficiency of the whole unit. As the unit prepared for revisions to its physical design and manpower structure in 2022, this audit

was performed to more accurately identify the population at highest risk for deterioration during monitoring in HD and to re-evaluate the admission criteria for well term newborns accordingly.

Materials and Methods

This was a retrospective review that included all term newborns born in the Department of Neonatal and Developmental Medicine at the Singapore General Hospital (SGH) for three months, between April to June 2022. Anonymized information regarding the newborns was obtained from the department’s internal anonymous database of patients which was derived from clinical notes. Information obtained included maternal and neonatal demographics, maternal risk factors, neonatal outcome, and postnatal course. Descriptive statistics, mainly percentages, were used.

Results

The department received a total of 359 live births during the three-month period. Their demographic characteristics are presented in Table I. Of a total of 115 HD admissions, there were 95 term newborns (defined as gestational age of 37 weeks and above).

The 83 of these newborns were asymptomatic at birth and admitted to the HD for a minimum of 6 h of monitoring based on the presence of maternal and peri-natal risk factors (Table II).

The diagram in Figure 1 depicts the inclusion criteria for this audit.

Among the 83 newborns admitted under these criteria, 68 (71% of all newborns) remained asymptomatic until discharge (Table III). Of these, only two newborns had two or more risk factors. Fifteen newborns developed symptoms during the six-hour observation period, among whom 8 had a single risk factor while seven had two or more risk factors (Table IV).

The majority of all asymptomatic term newborns who remained well until discharge had only 1 risk factor (59%) (Table V).

Discussion

We compared the unit’s admission criteria with that of 2 other local centers and several international practice guidelines (Table VI) [1-9].

We found that the unit had the most stringent guidelines for HD admission for asymptomatic term newborns among all centers studied.

We then conducted a literature review for studies evaluating the influence of individual risk factors on the eventual outcomes of asymptomatic term newborns.

Table II: Admission Criteria-risk factors necessitating HD admission for well term newborns.

No.	Risk Factor
1	Pre-existing DM or GDM on insulin therapy
2	GBS infection/colonization with inadequate IAP
3	Unknown GBS status with risk factors present
4	Maternal pyrexia (Temperature >38 deg)
5	PROM >18 hours
6	MMSL-TMSL regardless of vigour
7	Other maternal chronic medical condition • E.g., Systemic Lupus Erythematosus, Crohn’s disease

GBS: Group B *Streptococcus*; PROM: Prolonged Rupture of Membranes; M/TMSL: Moderately/Totally Meconium-Stained Liquor

Table III: Summary table of outcomes of all asymptomatic term newborns admitted to HD.

Presentation	Number of Newborns (% of All Newborns)
Developed Symptoms within 6 hours	N = 15 (16%)
Remained Asymptomatic Until Home	N = 68 (71%)
• Stayed in HD >6 hours HOL	• N = 42 (44%)
• Transferred to Nursery within 6 HOL	• N = 26 (27%)

Table IV: Term newborns admitted to HD who turned symptomatic during 6H of observation.

Risk Factor	Number of Newborns (% of Symptomatic)
Single risk factor	N = 8 (30%)
Maternal GBS+ w/o adequate IAP	
Maternal GDM on insulin	
Meconium-stained liquor	
Maternal pyrexia	
PROM >18H	
Combination (2 or more risk factors)	N = 7 (26%)

IAP: Intra-partum Antibiotic Prophylaxis; GDM: Gestational Diabetes Mellitus

A. Pre-existing maternal Diabetes Mellitus (DM) or Gestational Diabetes (GDM) on insulin therapy

Harris et al. [10] performed blood glucose screening of 514 newborns born at gestational age of 35 weeks or more at a New Zealand Tertiary hospital with risk factors for hypoglycemia to determine the incidence of hypoglycemia and the most strongly associated risk factors. This was part of a larger randomized control trial designed to evaluate whether treatment with dextrose gel was more effective than feeding alone for reversal of neonatal hypoglycemia [11]. They found that 49% of newborns of Diabetic Mothers (IDMs) who were screened developed hypoglycemia. This was in comparison to other risk factors such as large for gestational age newborns (39%), small for gestational age newborns (56%), prematurity defined as GA less

Table I: Summary of patient characteristics.

Characteristic	Total N=120					
Birth Weight (g)	Median: 2895.00 Mean: 2959.16					
Gender	Male: N = 61 (50.8%)			Female: N = 59 (49.2%)		
Mode of Delivery	NVD: N = 77 (64.2%)	Forceps: N = 8 (6.7%)	Vacuum: N = 7 (5.8%)	EI LSCS: N = 8 (6.7%)	Em LSCS: N =18 (15%)	Crash LSCS: N = 2 (1.7%)
Gestational Age (Weeks)	Median: 38.00 Mean: 37.87			Term (37 weeks and above): N = 95 (79%)		
	Preterm (Less than 37 weeks): N = 20 (17%)					
Reason for Admission	Asymptomatic with Maternal Risk Factors: N = 83 (69%)			Symptomatic: N = 12 (10%)		Asymptomatic: N = 13 (11%)
	Symptomatic: N = 7 (6%)					
Hours observed in HD	Median 7.00 Mean 7.91					

NVD: Normal Vaginal Delivery; EI/Em: Emergency/Elective; LSCS: Lower Segment Caesarean Section

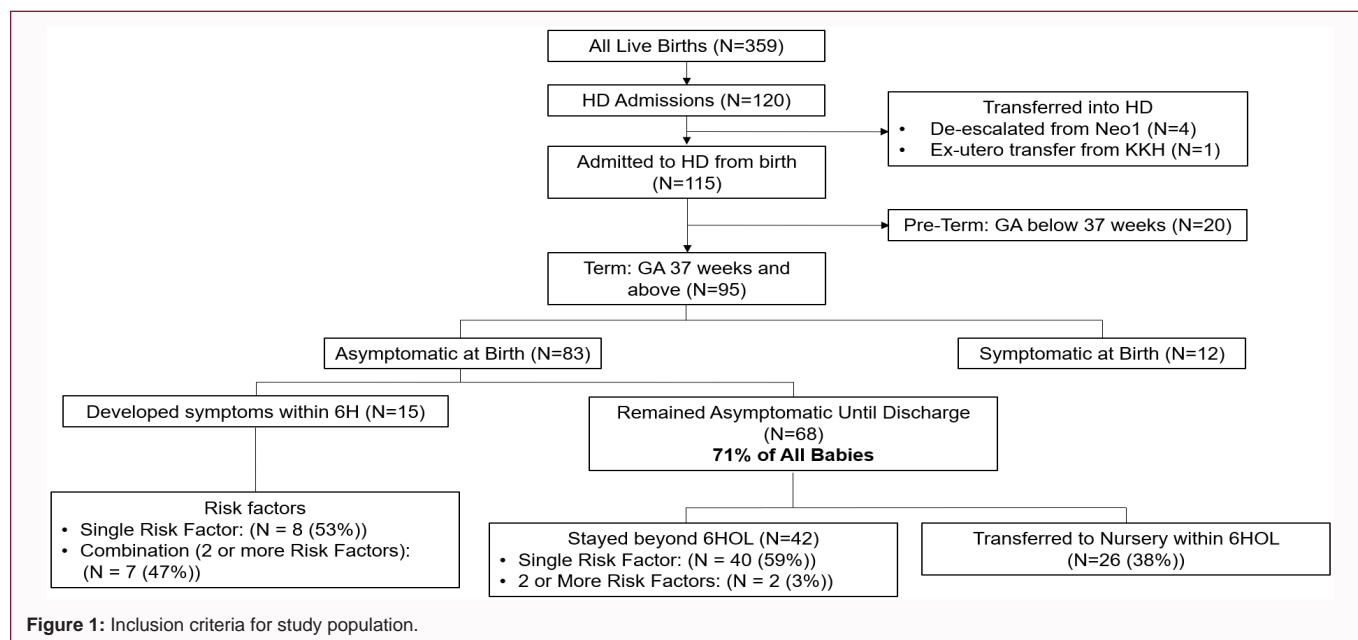


Table V: Term newborns admitted to HD who remained well until discharge.

Risk Factor	Number of Newborns (% of asymptomatic)
Stayed in HD More than 6HOL	N = 42 (62%)
Single risk factor	N = 40 (59%)
<ul style="list-style-type: none"> • Maternal GBS+ w/o adequate IAP • Maternal GDM on insulin • Meconium-stained liquor • Maternal pyrexia • PROM >18H • Large for Gestational • Small for Gestational Age • Pregnancy-induced Hypertension • Pregnancy-induced Hypertension • Low Birthweight • Maternal ulcerative colitis • Maternal sedation 	
Combination (2 or more risk factors)	N = 2 (3%)
<ul style="list-style-type: none"> • Maternal GBS with inadequate IAP • Maternal GBS with DM on insulin 	
Transferred to Nursery within 6HOL	N = 26 (38%)

than 37 weeks (59%) and others (61%). The 19% of all newborns who were screened (all risk factors) developed severe hypoglycemia. They further found that 50% of all hypoglycemic episodes and 75% of severe hypoglycemic episodes occurred within the first 6 h.

B. Risk factors for Early Onset Sepsis (EOS)

The factors affecting EOS have been discussed by several authors. Puopolo et al. [12] performed a nested case control study among newborns born at more than 34 weeks gestation at 14 California and Massachusetts hospitals from 1993 to 2007. A case was defined as a newborn with Cerebrospinal Fluid (CSF) or blood culture-confirmed bacterial infection at less than 72 h of life. Bivariate analysis showed a significantly increased risk of EOS in the presence of the following risk factors: Prolonged Rupture of Membranes (PROM) more than 12 h vs. less than 12 h and maternal pyrexia more than 38 degrees. Interestingly, no statistically significant increased risk was found in bivariate analysis between maternal Group B *Streptococcus* (GBS) positive versus maternal GBS negative newborns regardless of antibiotic status.

Beradil et al. [13] studied EOS cases among live births at more than 35 weeks gestation in Emilia-Romagna, Italy from 2003 to 2016. They found that the total incidence of EOS in the study period was 0.2 per 1,000 live births and that the median age at presentation with symptoms of EOS was 4 h of life for those exposed to IAP, and 6 h of life without IAP. Of these, only 39% of EOS cases had at least 1 risk factor (excluding maternal GBS positive). Of all the live births in the study period exposed to intrapartum fever only a small minority (0.31%) had EOS, of which only 39% were symptomatic within the first 6 h.

The American Association of Pediatrics (AAP) committees on Fetus and Newborn and Infectious diseases released a clinical guideline in 2019 [2], suggesting 3 possible strategies for the assessment of EOS risk in any newborn: (1) Categorical, (2) Multivariate (Neonatal EOS calculator) and (3) Enhanced surveillance. According to the categorical risk assessment, it suggested that newborns of mothers with intrapartum temperature more than 38 degrees Celsius should receive blood cultures and empiric antibiotics, newborns of GBS positive mothers with inadequate IAP should be observed for 36 h to 48 h after birth (serial physical examination and vital signs) and newborns of GBS negative mothers or GBS positive mothers with adequate IAP can receive routine newborn care. The EOS calculator can be further applied to assess the risk of any newborn deemed at risk of EOS to guide clinical decision making. For example, while PROM is not a categorical risk factor for EOS, its duration is a data point in the EOS calculator, and when taken in consideration with the newborn’s other risk factors, would affect the level of care and degree of observation.

C. Mildly (MMSL) and Totally Meconium-Stained Liquor (TMSL) regardless of vigour

Berkus et al. [14] conducted a retrospective cohort study to evaluate the rate of adverse neonatal outcomes in newborns born through meconium-stained amniotic fluid, namely: Admission to NICU for more than 24 h, oxygen support, death, significant complications and neurological sequelae. Among all the liveborn singleton newborns in over a period of 6 months, about one quarter

Table VI: Comparison of HD admission criteria for asymptomatic term newborns [1-9].

S/N	Unit's Admission Criteria	Guidelines from Other Local Units		International Guideline		
		UNIT A	UNIT B'	US/Canada	UK [4]	Australia/New Zealand
1	Pre-existing DM or GDM on insulin therapy	Not for HD	Not for HD	Not for HD [1]	Not for HD	Maternal insulin therapy is a consideration for admission to higher level of care than Nursery [5]
2	GBS infection / colonization with inadequate IAP	Either HD or Neo1 depending on clinical assessment (in the absence of other maternal risk factors)	Not for HD	Not for HD [2] Serial physical examination and vital signs	Not for HD	If other risk factors present: Assessment and consideration for FBC, Blood cultures and antibiotics [6]
3	Unknown GBS status with risk factors present	Not for HD	Not for HD	Not for HD [2]	Not for HD	Assessment and consideration for FBC, Blood cultures and antibiotics [6]
4	Maternal pyrexia (Temperature >38 deg)	Not for HD unless maternal GBS+	Not for HD	Blood cultures and empiric antibiotics recommender [2]	Not for HD	Assessment and consideration for FBC, Blood cultures and antibiotics [6]
5	PROM > 18 hours	Not for HD unless maternal GBS+	Not for HD	Not for HD [2]	Not for HD	Assessment and consideration for FBC, Blood cultures and antibiotics [6,7]
6	MMSL-TMSL regardless of vigour	TMSL – Admit HD regardless of vigour MMSL – Not for HD if well	Not for HD *Monitoring: Q30min x 2 > Q4H x 6. NICU.	Not for HD if well [3]	Not for HD if well	Not for HD if well [8,9] HD criteria: Meconium below cords, ongoing RD, need for active resuscitation

were born through meconium-stained liquor, the vast majority of which were thinly stained (81% Light (LMSL), 12.6% Moderate (MMSL), 4.0% Thick (TMSL)). There were only 8 cases of Meconium Aspiration Syndrome and 7 of them occurred in the MMSL and TMSL groups. The Relative Risk (RR) of neonatal seizures in MMSL and TMSL groups combined compared to that of LMSL or clear fluid was 6.9 and that of hypotonia was 4.6. In summary, the RR for adverse neonatal outcomes in MMSL versus the rest was 2.9 and TMSL versus the rest was 8.8. The study did not make mention of the time-period post-partum in which complications tended to occur.

Current consensus on the risk stratification and management of asymptomatic newborns born through meconium-stained liquor is reflected in the NICE clinical guidelines on intrapartum care [3]. It states that if there has been significant meconium staining and the newborn is healthy, to closely observe the newborn within a unit with immediate access to a neonatologist. The frequency of observations is recommended to be at 1 and 2 h of age and then 2 hourly until 12 h of age.

Conclusion

The unit studied in this audit admitted more asymptomatic newborns than would have been recommended by international guidelines and the evidence of the papers discussed above.

The literature review was supportive that most asymptomatic newborns at birth remained well. In cases where there were worrying clinical features, the use of objective measures to aid clinical decision making and risk stratification (such as the EOS calculator) and the judicious use of more frequent monitoring in the nursery setting was advocated above the pre-emptive transfer to a higher level of care.

The results of the audit also showed that HD observation of 6 h was not preventative of a significant number of adverse outcomes. It was therefore recommended that asymptomatic term newborns, especially those with only a single maternal risk factor could be safely admitted to the nursery. An enhanced regime of parameters monitoring at half-hourly for four hours, then 4-hourly was also suggested. A second audit to determine the outcomes of asymptomatic newborns monitored under this protocol would be helpful in further validating these recommendations.

The benefits of admitting these asymptomatic newborns to the nursery include the decreased use of hospital resources and reduction

of bill size for parents. It would also serve to promote skin to skin contact at birth, rooming in of newborn with mother and increasing breastfeeding rate while reducing reliance on formula feeding in the HD setting, measures which would also further the ten steps of the Baby Friendly Hospital Initiatives (BFHI).

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