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Differences in Neonatal APGAR score and NICU Admissions between Spontaneous and Induced labour

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Abstract

The clinical relevance of differences in neonatal APGAR scores and neonatal intensive care unit (NICU) admission rates between induced and spontaneous labour remains uncertain. Evaluating these outcomes is particularly important in local hospital populations to better understand neonatal health and improve neonatal and obstetric care. To examine differences in neonatal Apgar-score categories and neonatal intensive care unit (NICU) admissions between induced and spontaneous labour , with the original thesis data set. This was a secondary analysis of the outcome of an existing parallel arm quasi-experimental study conducted over 6 months in 2022 in four hospital campuses of Ziauddin University, Karachi. For this original study 284 booked pregnant women with 37-42 completed weeks were selected, 142 pregnant women for each group. The original report had used either chi-square or Fisher exact test with a significance level of $p<0.05$. 134/142 neonates (94.4%) had normal Apgar scores after induced labour, and 136/142 (95.8%) had normal Apgar scores after spontaneous labour, for which the three-category comparison did not differ (reported $p=0.579$). NICU admission occurred in 20/142 (14.1%) and 14/142 (9.9%) neonates, in induced and spontaneous labour respectively (reported $p=0.273$). The difference in the absolute rate of admission to NICU was 4.2 percentage points. Overall, 270/284 neonates (95.1%) had scores of 7–10 and 34/284 (12.0%) were admitted to the NICU. Neonatal Apgar score distributions and NICU admission rates did not differ significantly between induced and spontaneous labour in this study. Further prospective research is needed to evaluate these outcomes while accounting for maternal and obstetric risk factors.

Keywords: Induction Of Labour; Spontaneous Labour; Apgar Score; Neonatal Intensive Care; Neonatal Outcome; Pakistan

Introduction

At birth there is a rapid respiratory, circulatory and physiological adjustment in the body of the neonate , which is necessary to shift from intrauterine to extrauterine existence. Neonatologists conduct immediate evaluation of newborn infants and decide whether further monitoring and/or special neonatal care is required. Apgar score is a measure of immediate neonatal condition, while a number of clinical features contribute to the necessity of NICU admission.

Induction of labour is the provision of labour stimulation by pharmacological and/or mechanical means prior to the onset of spontaneous labour. May be indicated if the risk of continuing the pregnancy is greater than the potential benefits of delivery. Some examples are hypertensive disorders, diabetes, premature rupture of membranes and post term pregnancies. Clinical decisions consider the fetal maturity, maternal and fetal status and the state of the cervix.

Medical complications in women offered induction may affect the outcome of the newborn. Therefore, absence of a significant difference in neonatal outcome does not necessarily indicate that induction was not the cause of this difference. Understanding the selection criteria, indications for induction, gestational age, parity, differences in maternal age , BMI between both the groups also need to be considered.

Rather, the parent thesis was examining and comparing the rate of caesarean delivery, Apgar score and admission in NICU between induced labour and spontaneous labour at Ziauddin University hospital, Karachi. This article focuses on neonatal outcome, with the aim of providing a deeper examination of the distribution of Apgar score categories and of NICU admissions.

LITERATURE REVIEW

Induction of labour refers to the artificial initiation of labour prior to the onset of spontaneous labour with the aim of improving maternal or fetal outcome where continuation of pregnancy carries increased risks. Common indications for induction of labour include ruptured membranes, diabetes mellitus, hypertensive disorders, post-term pregnancy etc. While induction of labour is a commonly used obstetrical practice but there is some uncertainty about the effect of labour induction on the neonatal outcome. Neonatal outcomes recorded in the study include admission to the neonatal intensive care unit (NICU) for further monitoring or treatment and the neonatal APGAR score which measures the newborn's status at birth. The study aimed to compare neonatal outcome following induction of labour to the neonatal outcome after spontaneous labour (Marconi, 2019; Coates et al., 2020).

The APGAR score is a measurement of the newborn based on five parameters including heart rate, respiratory effort, muscle tone, reflexes and colour. APGAR score is recorded at 1 and 5 minutes after birth. A score of 7-10 is generally considered normal, 4-6 is moderate fetal distress and 0-3 is severe fetal distress. A low score could indicate the need for neonatal assessment but it is itself not a diagnosis of birth asphyxia. There appears to be variability in the association between induction of labour and APGAR score with regards to gestational age, parity, maternal age, BMI and progress of labour. Therefore, the results from induced and spontaneous labour should be interpreted with regards to several obstetrical risks.

A study carried out by Aziz and Iftikhar (2020) in nulliparous women at 41 weeks found a higher rate of low 5-minute APGAR scores after induction as opposed to spontaneous labour. In the study 6.25% of induced labour had a five-minute APGAR of less than five as opposed to only 1.01% in spontaneous labour. This may indicate a negative effect of induction on the neonate but cannot be extended to all term pregnancies. In contrast, a study by Abisowo et al. (2017) carried out at a tertiary maternity care unit in Nigeria, did not find a statistically significant difference in one- or five-minute APGAR scores between induced and spontaneous labour. The results from these two studies appear to vary and may be influenced by study setting and indication for induction.

Akhtar.z et.al (2025) have concluded in their study that induction of labour was associated with a higher rate of caesarean section , with an APGAR score of less than 7 at 5 minutes and an increased number of NICU admissions.

Admission to NICU may be due to poor adjustment to birth, suspected infection, poor respiratory status or the need for further monitoring. In a Randomized Trial on Induction Versus Expectant Management (ARRIVE) there was no increase in the risks

for neonatal outcome in both induced and spontaneous labour groups.

In another study NICU admissions were 4.3% in induced labour and 5.4% in the expectant group, according to Grobman et al. as recorded in the study. This does not indicate that planned induction at 39 weeks will result in an increased number of neonatal intensive care admissions for low-risk nulliparous women. However expectant management is not equivalent in a study where all participants will spontaneously go into labour and so comparison between studies with this population should be used with caution (Grobman et al., 2018).

Melaku Laikemariam et al (2023) in a study conducted at Ethiopia has seen adverse neonatal outcomes in the induced labour as compared to spontaneous labour. Neonatal deaths (5% vs 1.14%), poor APGAR score and an increased number of NICU admissions were associated with induced labour.

Gestational age also appears to have some relevance in the maternal and neonatal outcome. A review of studies that compared induction at or after term versus expectant management found fewer neonatal and perinatal deaths and neonatal admissions with induction. (Middleton, Shepherd and Crowther, 2018). The Swedish SWEPIS study compared induction at 41 weeks with expectant management until 42 weeks and raised some concerns for adverse perinatal outcomes related to pregnancy prolongation (Wennerholm et al., 2019). These results are relevant to planned timing of labour rather than the natural onset of labour only. Hence, they can be used as complementary to, but not as a replacement for, comparisons between induced and spontaneous labour.

A study carried out by Riaz, Bano and Dojki (2020) in Pakistan compared the maternal and neonatal outcomes in nulliparous women undergoing induced as well as spontaneous labour. According to the study there were differences in five-minute APGAR scores between the two groups. Collectively the evidence does not seem to be uniform. Some observational studies have found poorer neonatal outcomes following induction whilst other randomised and comparative studies have not found any increased risk of poor neonatal outcome. Variability may be present in study design, neonatal admission criteria, gestational age, parity, indication for induction and maternal risk factors.

Rationale

International research into induction of labour and neonatal outcomes is inconsistent due to differences in study populations and in comparison of different management strategies. This is not a comparison of medically indicated induction vs spontaneous labour, but rather a comparison of trials of elective induction vs spontaneous labour. While the former can be sensitive to pre-existing differences in maternal risk, the latter reflects outcomes of competing care policies for eligible participants. This distinction needs to be considered when reading local service data.

Research question

Among women at 37–42 weeks of gestation included in the original hospital study, were there differences in neonatal Apgar score distributions and NICU admission rates between induced and spontaneous labour groups?

Objectives

The main aim was to determine whether there was any difference in the percentages of neonates that had Apgar scores of 7–10, 4–6 and 0–3 among induced and spontaneous labour.

The second primary aim was to compare the percentage of neonates admitted to the NICU between the two groups.

Secondary descriptive goals were to provide overall frequencies, absolute between group differences and pertinent study design characteristics that may affect

interpretations.

Hypotheses

The null hypotheses were that there was no difference in distribution of Apgar scores between the two categories of labour observed, and that there was no difference in the proportion of neonates admitted to the NICU between the two categories of labour observed.

The alternative hypotheses were that one or both neonatal outcomes were different.

Methods

Design, Setting and Participants

This paper is a secondary analysis of aggregate data regarding the outcome of the newborns reported in a completed institutional thesis. The main investigation was a quasi-experimental study with a parallel arm design and was carried out for 6 months from 2022 in the Department of obstetrics and gynaecology, at all four campuses of Ziauddin University, Karachi, Pakistan. Newly presented patients were not recruited for the current paper, and there was no patient-level dataset available for independent modelling.

Non-probability consecutive sampling technique was taken. A total of 284 booked pregnant women were included in the primary study with 142 in both the induced and spontaneous groups. Eligible women were between 37 and 42 completed weeks of gestation, had provided informed consent, and had no contraindications to vaginal delivery. The original study allowed women with pregnancy induced hypertension, established diabetes and gestational diabetes, post-term pregnancies and prelabour rupture of membranes.

The source thesis calculated sample size using OpenEpi with a stated minimum sample size of 228, but resulted in a sample size of 284, assuming the comparison was between vaginal and cesarean deliveries with a 95% confidence level and 80% power

Labour Management and Outcome Recording

Labour progress was recorded on a partogram, maternal observations were recorded and vaginal and abdominal examinations were conducted as required. The use of amniotomy, oxytocin augmentation and Foley's catheter was used as clinically indicated. The study highlighted relevant care protocols of women with diabetes and PROM.

All newborns were assessed by paediatric staff. The neonatal observation that was conducted in the thesis comprised Apgar scoring at 1 and 5 minutes, respiratory status, heart rate, reflexes, muscle tone and colour. Neonatal admissions were documented

Exposure classification

Onset of labour recorded; induced or spontaneous. No randomization of group allocations. The comparison is therefore present on labour onset groups rather than intention to treat with induction vs expectant management.

Primary outcomes

1. The categorical Apgar score (7-10, 4-6 and 0-3) was the same as in the thesis and was used for Outcome 1.
2. The outcome 2 was recorded as "yes" or "no" for NICU admission. The thesis prose did not generate supplemental neonatal outcomes, and no cases were added, removed or imputed.

APGAR Score Assessment and Timing

The original study methodology was used to assess neonatal APGAR scores at 1 and 5

minutes post birth. Five clinical parameters, namely, heart rate, respiratory effort, muscle tone, reflex response and skin colour were assessed. The scores were classified as normal (7–10), moderately depressed (4–6) and severely depressed (0–3). The results that were available, however, were reported as one categorical distribution and the reported values were not specified as being for 1 minute or 5 minutes. Thus, the present secondary analysis report is limited to reporting these findings overall as APGAR score categories (and not specific assessment time). This may be a limiting factor to consider when reporting neonatal outcomes, and when comparing results with those reporting 1-minute APGAR score separately from 5-minute APGAR score.

Clinical Context: NICU Admission

Admission to NICU is a significant measure of resource consumption and neonatal care requirements. Respiratory compromise, suspected infection, hypoglycemia, issues with thermoregulation, neurological issues, problems at delivery or other clinical indications may lead to admission. There is also the possibility of local monitoring thresholds and referral arrangements, and of availability of intermediate care services being reflected in admission. Thus, rates of NICU admission must not be taken as the sole or direct indicator of the severity of neonatal morbidity.

Neonatologist examined all babies and neonatal admission and demise was taken into consideration in the protocol of data collection. The group comparison tables do not show the reason for admission, length of admission, type of treatment received, end neonatal diagnosis or whether the admission to the neonatal unit was directly related to events at the time of the birth. These are omissions that limit inferences that can be drawn from the data clinically.

The two scenarios discussed in this article are to be taken together. Even if a neonate has a normal Apgar score, they may require NICU observation for other than immediate adaptation. On the other hand, a neonate who has a low score for a short duration might get better without a long stay. Because the thesis does not offer a joint table at the neonatal level between the Apgar sore categories and NICU admissions, it is impossible to see from the available aggregate data what portion of the NICU admissions are Apgar-related.

Statistical Approach

The original thesis includes an analysis conducted in SPSS version 21, categorical results are reported in frequencies and percentages. Chi-square or Fisher exact procedures were reported for between-group testing and a p value <0.05 was considered statistically significant. This manuscript preserves the original thesis p-values rather than being a set of individual record tests.

Simple unadjusted absolute risk differences are derived directly from the published 2×2 count table (proportion of the induced group minus proportion of the spontaneous group) for transparent clinical interpretation. These comparisons are descriptive and not adjusted by maternal or clinical features to reflect risk. The multivariable logistic-regression output and adjusted risk ratio and adjusted odds ratio are not reported as the thesis tables do not provide the underlying participant-level observations or verified adjusted neonatal estimates.

The Apgar distribution is shown in the form of a three-category contingency table. As only one infant had a score in the 0–3 group. Therefore, the reported p-value should be seen in the context of the original analysis method; an independent exact test would need to state the analysis method and confirm the data source. There is no justification to reinterpret the p-value as an equivalence statement.

Results

Study Sample and Overall Neonatal Outcomes

The original study included 284 women equally divided into two groups: induced

labour (142) and spontaneous labour (142). The Apgar score frequency table had 284 reported neonatal outcome observations, and the NICU frequency table had 284 reported neonatal outcome observations. Major number of babies' scores were in the 7-10 range, and a small number of NICU admissions.

Outcome	Count (n=284)	Percent
Apgar 7–10	270	95.1%
Apgar 4–6	13	4.6%
Apgar 0–3	1	0.4%
NICU admission: Yes	34	12.0%
NICU admission: No	250	88.0%

Overall neonatal outcomes as described in the thesis. Percentages are rounded, and the Apgar score counts and NICU counts equal 284 each. 14 babies, whose Apgar score reported was less than 7, were scattered throughout the labour group and only one baby was in the severely depressed Apgar score group. In the same way, 34 of the cases for NICU admission were divided between groups.

Overall, the proportion with Apgar scores of 7-10 was high. However, there is little information regarding rare neonatal severity, as there is not a large segment of the low score group. Likewise, 34 admissions are a moderate size number of events for an unadjusted group comparison, but not enough to determine whether significant differences in admission indications exist between labour onset groups.

Apgar Scores by Labour Onset

Reported Apgar category	Spontaneous (n=142)	Induced (n=142)	Total
Normal: 7–10	136 (95.8%)	134 (94.4%)	270
Moderately depressed: 4–6	6 (4.2%)	7 (4.9%)	13
Severely depressed: 0–3	0 (0.0%)	1 (0.7%)	1
Total	142 (100%)	142 (100%)	284

Table 2. The distribution of Apgar score according to the onset of labour. The overall comparison p=0.579.

Most of the neonates in both groups scored from seven to ten. For infants born by spontaneous labour, 136 of 142 (95.8%) were included in this category, while 134 of 142 (94.4%) infants born by induction were included in this category, representing an absolute difference of −1.4 percentage points for the induced group. In total, six neonates (4.2%) and seven neonates

(4.9%) had moderately depressed scores in spontaneous labour and induction, respectively. One severely depressed score (0–3) was noted following induction and none were noted following spontaneous onset of labour.

The three-level Apgar score showed no statistically significant difference between labour-onset type (p=0.579). There is a small absolute difference in the proportion of normal scores reported but no evidence that the clinical risks are equal in these data. The Apgar score of 0–3 only happened once and there are not enough events to make

any stable subgroup conclusion.

Eight newborns (5.6%) in the induced group and six (4.2%) in the spontaneous group have scores below seven, when the scores are combined descriptively from the source table. This is an arithmetic description of the original category counts and not an inferential comparison.

NICU Admissions by Labour Onset

NICU disposition	Spontaneous (n=142)	Induced (n=142)	Total
Admitted	14 (9.9%)	20 (14.1%)	34
Not admitted	128 (90.1%)	122 (85.9%)	250
Total	142 (100%)	142 (100%)	284

Admission to NICU by spontaneous and induced labour-onset groups. Between groups p=0. 273. 20 neonates (14.1%) were admitted to the neonatal intensive care unit following induced labour and 14 neonates (9.9%) were admitted following spontaneous labour. Consequently, 122 babies in the induced group (85.9%) and 128 babies in the spontaneous group (90.1%) were not admitted. The number of admissions in the induced group was 6, which represents an absolute unadjusted difference of ~4.2 percentage points.

The ratio of the two proportions of admissions observed was close to 1.43, which is the ratio of 20/142 to 14/142. This is not an adjusted causal relative risk and cannot be interpreted without considering clinical selection for induction. The source thesis gives a p-value of 0.273, which is greater than its significance level.

Therefore, no statistically significant relationship was found between labour onset category and admission to NICU. The numeric difference could also be significant for planning a larger future study, especially if it includes indications for induction, base-line maternal risk, neonatal diagnosis, length of stay, and whether admission decisions are based on a uniform set of criteria at sites.

Discussion

Interpretation of the Apgar Findings

The main result in the newborn period showed no significant difference in the distribution of reported Apgar scores between induced and spontaneous birth. Both populations showed a high proportion of normal births. There were a slightly lower number of babies within the 7-10 range following induction, but this was not significant. Only one baby was assigned to a score of 0-

3. This is consistent with a modest conclusion. In this population there was no significant difference between the two groups in this newborn measure based on the current pooled data.

Other articles referenced in the thesis also showed a modest difference in newborn outcomes between induced and spontaneous birth. Abisowo and colleagues in their study in a tertiary facility in Nigeria found no significant difference in the one minute and five-minute Apgar scores. Saccone and Berghella also found no significant increase in poor newborn outcomes with induction in uncomplicated term births. These comparisons can be useful but are not directly comparable. Indications for induction, policies for comparing results and inclusion criteria vary.

Aziz and Iftikhar found poorer newborn outcomes in induced nulliparous mothers at 41 weeks in the study referenced in the thesis. This does not necessarily mean there is an error in one of these pieces of data. Risk across populations, time in pregnancy, definitions of newborn outcomes and management may all have a large effect on the

results seen. Also, a study comparing induction to expectant management is studying a different question than a study comparing birthsin induced and spontaneous onset of labour.
Another issue with this analysis is the lack of one- and five-minute data tables. It would be useful to specify at what Apgar score the primary analysis occurs and ideally to include information regarding changes between the scores. Using a categorical analysis does not provide information about changes between scores and prevents comparison to studies that report five-minute scores under seven.

Interpretation of NICU Findings
Induced childbirth led to a numerically greater number of neonatal NICU admissions (14.1% versus 9.9%). There was no statistically significant correlation noted in the parent study (p=0.273). It is important to consider both aspects of this finding. A non-significant test does not mean that the data supports the null hypothesis at the pre-defined level. It does not mean that there is no clinical difference between induction and spontaneous birth.
In a study by Lavanya,s et al to observe the maternal and fetal outcomes in induced and spontaneous labour , there was an increased number of caesarean section (34.7% vs 15.3%) and an increased number of babies admitted in NICU (14.7%vs7.3%,p=0.03) in the induced group of labour.
This finding does seem to fit within the general body of evidence identified in the review. Some large systematic reviews and randomized trials have found comparable or reduced rates of poor neonatal outcomes with specific induction protocols. Other studies have found increased numbers of neonatal admissions with induced births. These findings could be partially attributed to the greater rate of medical indication for induction in high-risk pregnancies.
Context of the study is also important. All four Ziauddin hospital campuses provided neonatal and pediatrics services. Admission appears to be based on clinical judgement as well as facility practice and observed thresholds. There are no reasons for admission noted which makes it difficult to determine if the differences are driven primarily by blood-glucose monitoring, infection, intrapartum complications, respiratory status, or precautionary monitoring.
The magnitude of the difference noted (4.2 percentage points) could be useful in power calculations for future studies rather than in drawing causal conclusions. Future research should look at fetal monitoring, mother's medical status, mode of induction, indication for induction,
Apgar score timing, neonatal intervention, length of stay, and indication for admission. A method to control for initial differences or a prospective study design would be useful to assess if this difference remains after adjusting for confounders.

Strengths, Limitations and Implications
Strengths
There were equal numbers of induced and spontaneous labours in the original study allowing simple comparison of proportion of neonatal outcomes. Data are collected from more than one hospital at Karachi due to recruitment across four hospital campuses. The results are meaningful to clinicians. All neonatal numbers, denominators and p-values from the original study have been preserved and no additional neonates have been recruited.

Limitations
Firstly the study employed non-probability consecutive recruitment to a quasi-experimental study design rather than a randomized study. Medical indications and

baseline characteristics may affect interpretation of comparisons between the groups. Second , the sample size was based on maternal outcomes rather than common neonatal outcomes. Third , 14 neonates had a score of less than seven and only one had a score less than four. Thus, analysis of the results for scores less than seven is restricted.
Fourth , there is some ambiguity in the Apgar cross-tabulation regarding the distinction between one-minute and five-minute scores. Although there is a protocol for both times, the table does not make this distinction apparent. Fifth , there is a lack of information on an individual level regarding the association between low Apgar scores and NICU admission. Sixth, information on reasons for NICU admission and length of stay is not provided in the tables for each group. Seventh, there is not an independently verifiable multivariate estimate of neonatal outcomes using only aggregate data.

Implications

Clinical decisions regarding induction of labour should be made according to individual circumstances, clinical guidelines, net benefits to the mother and neonate and evidence-based practice. This study alone will not provide enough data to help in making decisions regarding induction of labour. Future studies should employ multicenter prospective registries with defined case mix, consistent criteria for NICU admission, full information on both one- and five-minute Apgar scores, defined neonatal outcomes and analysis adjusted for case mix to allow for more clinically relevant comparisons.

Conclusion

A total number of 284 women delivered at four hospital campuses of Ziauddin University hospital at Karachi, Pakistan were included in this study, APGAR score and neonatal intensive care unit (NICU) admission rates were compared between induced labour and spontaneous labour groups. At the time of birth, the majority of neonates in both groups were with 7-10 normal APGAR (94.4% and 95.8% respectively), and there was no statistically significant difference between the score distributions in the two groups ($p = 0.579$). NICU admission rates were found to be higher for induced labour (14.1%) as compared to spontaneous labour (9.9%) but this was not statistically significant ($p = 0.273$).
The results of this study imply no significant difference between the two groups in their neonatal outcome. The results should be treated with caution, however, as there may be other factors that could have affected the neonatal outcomes, such as maternal complications, indication for labour induction, criteria for neonatal admissions etc. Larger, multicenter, prospective studies with detailed assessments of neonates are suggested to further elucidate these associations. Decisions regarding labour induction should be individualized and guided by evidence-based obstetric practices to ensure maternal and neonatal safety.

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