Addiction

RESEARCH REPORT

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Finnegan neonatal abstinence scoring system: normal values for first 3 days and weeks 5–6 in non-addicted infants

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ABSTRACT

Objective The neonatal abstinence scoring system proposed by Finnegan is used widely in neonatal units to initiate and to guide therapy in babies of opiate-dependent mothers. The purpose of this study was to assess the variability of the scores in newborns and infants not exposed to opiates during the first 3 days of life and during 3 consecutive days in weeks 5 or 6. **Patients and methods** Healthy neonates born after 34 completed weeks of gestation, whose parents denied opiate consumption and gave informed consent, were included in this observational study. Infants with signs or symptoms of disease or with feeding problems were excluded. A modified scoring system was used every 8 hours during 72 hours by trained nurses; 102 neonates were observed for the first 3 days of life and 26 neonates in weeks 5–6. A meconium sample and a urine sample at weeks 5–6 were stored from all infants to be analysed for drugs when the baby scored high. Given a non-Gaussian distribution the scores were represented as percentiles. **Results** During the first 3 days of life median scores remained stable at 2 but the variability increased, with the 95th percentile rising from 5.5 on day 1 to 7 on day 2. At weeks 5–6 median values were higher during daytime (50th percentile = 5, 95th percentile = 8) than night-time (50th percentile = 2, 95th percentile = 6, $P = 0.02$). **Conclusion** Scores increase from days 1–3 to weeks 5–6 and show day–night cycles with 5–6 weeks. Values above 8 can be considered pathological. This data may help to raise suspicion of narcotic withdrawal and to guide therapy.

Keywords Finnegan, narcotic withdrawal, neonatal abstinence, newborn infants, normal values, opiates, score.

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INTRODUCTION

Withdrawal symptoms in an infant born to a mother addicted to heroin were first described 50 years ago [1]. In 1975 Loretta Finnegan published a scoring system for the neonatal abstinence syndrome she had devised as both a clinical and investigative tool [2]. This score lists all relevant clinical signs of withdrawal in newborn infants during the first days of life comprehensively, and assesses central nervous system hyperirritability, gastrointestinal dysfunction, respiratory distress and vague autonomic signs in a semiquantitative way. Unfortunately, all these signs lack specificity.

Originally Finnegan suggested that the score should be improved further in order to avoid 'ambiguous and redundant items which may contribute to the error variance' [2]. As a consequence, a variety of modified Finnegan scores, as they were called, have been used widely to guide and compare various therapies of the neonatal abstinence syndrome [3]. As substance abuse during pregnancy is still a common problem in many countries, the Finnegan score is still useful today [4].

Compared with the original version, the following modifications of the Finnegan score are usually applied: [5] 'hyperactive Moro reaction' was dropped, as it is a sign of central nervous system hyperirritability and therefore redundant to 'tremors'. 'Myoclonic jerks' shown to be highly specific for opiate withdrawal were added instead [6]. Excoriations on nose, knees or toes were changed to 'excoriation of the skin' and only one point was given, instead of one for each area. Excoriations of the skin are due to vigorous movements and are thus also

consequences of central nervous system hyperirritability. Because, in contrast to the 1970s, newborns are now put to sleep on their backs, these excoriations are no longer seen on nose or knees.

In clinical practice scores above 8 are considered high and suggestive of neonatal withdrawal. Pharmacological treatment of withdrawal is started if the modified Finnegan score is above 9 on at least two occasions. Originally the scoring was applied every 4 hours, which may be appropriate for scientific purposes. For clinical use scoring every 8 hours, i.e. once per shift, proved to be adequate.

Although the score is used widely, only a few studies have assessed its reliability and validity. We therefore applied the score to a cohort of non-addicted neonates and infants to define its variability in the absence of drug withdrawal, its day–night cycles and its course with age.

METHODS

A total of 102 healthy neonates born after 34 completed weeks of gestation, whose parents denied opiate consumption and gave informed consent, were included in this observational study. Exclusion criteria were malformations, birth trauma and infants at increased risk for group B streptococcus infection (mother carrier without appropriate antibiotic prophylaxis).

Each infant was examined and history about alcohol, nicotine or drug use during pregnancy was taken from the mother. A meconium sample was collected and stored in a deep-freezer. These samples were analysed later for substances in all cases in whom Finnegan scores exceeded the 95th percentile once or the 90th percentile twice during the observation period to exclude drug exposure during pregnancy. Meconium analysis offers an accurate method of quantifying the level of drug misuse in pregnancy, as shown in several large studies [7–9]. The meconium samples were analysed by a validated procedure which consisted of the extraction of the drugs abused by the mother into organic solvents and thereafter an immunological drug screening test (Roche, Basel, Switzerland). Positive results were confirmed with high pressure liquid chromatography (HPLC) (Remedi, Bio-Rad, Riehen, Switzerland).

The infants were observed in the maternity ward by trained nurses. Episodes of sleeping, crying and feeding were noted for the first 72 hours. A modified Finnegan score ranging from 0 to 37 was applied every 8 hours (Table 1).

Twenty-six infants from the original cohort were observed again at weeks 5 or 6 of life for 72 consecutive hours. Infants who had feeding problems, had been vaccinated during the last 2 days, showed any signs or symptoms of disease or whose parents were unlikely to comply were excluded. The same nurses who had observed the infants during the first 3 days assessed the infants at home at 8 a.m., at 4 p.m. and at midnight for 3 consecutive days assisted by the mothers, who had been instructed to monitor their infants during their first 3 days at hospital. The same observation form with 8-hour assessments of the modified Finnegan score was used as for the first 3 days. A urine sample was deep-frozen for investigation of drugs if scores were once above the 95th percentile or twice above the 90th percentile. Urine samples were analysed using commercial automated drugs-of-abuse immunoassays on the Integra instrument (Roche).

The study protocol was approved by the local ethics committee and all parents gave informed consent.

The results were plotted with percentiles given a non-Gaussian distribution of the scores. The upper limit of the normal range was defined at the 95th percentile. The Mann–Whitney *U*-test was used to compare two groups with significance levels at 0.05.

Table 1 Modified Finnegan score.

CNS symptoms	
High-pitched cry	2
High-pitched cry >2 hours	3
Sleeps less than 3 hours after feeding	1
Sleeps less than 2 hours after feeding	2
Sleeps less than 1 hour after feeding	3
Mild tremors when disturbed	1
Marked tremors when disturbed	2
Mild tremors when undisturbed	3
Marked tremors when undisturbed	4
Increased muscle tone	2
Excoriation of skin	1
Myoclonic jerks in sleep	3
Generalized convulsion	5
Vegetative symptoms	
Sweating	1
Temperature 37.5–38.0°C	1
Temperature >38.0°C	2
Frequent yawning	1
Mottling	1
Nasal stuffiness	2
Sneezing	1
Gastrointestinal symptoms	
Frantic sucking	1
Poor feeding	2
Regurgitation	2
Projectile vomiting	3
Loose stools	2
Watery stools	3
Respiratory symptoms	
Tachypnoea >60/minute	1
Tachypnoea >60/minute with retractions	2
Total score (minimum 0, maximum 37)	

CNS: central nervous system.

RESULTS

The characteristics of the infants included in cohort 1 (first 72 hours) and cohort 2 (weeks 5 or 6) are given in Table 2. The two cohorts did not differ significantly in any aspect. Fifteen (cohort 2: 4) mothers reported smoking one to 10 cigarettes per day and five (cohort 2: 1) mothers reported sporadic alcohol intake, never exceeding two glasses of wine per day during pregnancy. All mothers denied illicit drug consumption.

In cohort 1 median scores remained stable at 2 during the first 3 days of life but the variability increased, with 95th percentile rising from 5.5 on day 1 to 7 on day 2 (Fig. 1). Five infants had scores between 8 and 11 at one assessment but dropped below 8 at the next assessment. Meconium analysis performed in these infants did not reveal opiates, methadone, cocaine, benzodiazepines, barbiturates or amphetamines.

There was no statistically significant difference between girls and boys and between day and night. Infants delivered by ventouse or whose mothers had smoked during pregnancy did not show higher scores than the others. A detailed analysis of the singular components showed that high-pitched cry, short sleep after feeding, vomiting and sneezing were frequent during the whole observation period (Fig. 2).

At weeks 5–6 median values were significantly higher during daytime (50th percentile = 5, 95th percentile = 8) than during night-time (50th percentile = 2, 95th percentile = 6; $P = 0.02$) (Fig. 3). Sleep duration after feeding and sneezing contributed most to the circadian cycles (Fig. 4). Urine samples of six infants with high scores were analysed for opiates, methadone, amphetamines, cocaine, barbiturates and benzodiazepines. None of those substances were detected.

DISCUSSION

We report the distribution of the Finnegan score in infants not exposed to drugs *in utero*. These findings are important for interpretation of the score in neonatal abstinence syndrome, providing a baseline for healthy infants against which withdrawal symptoms can be com-

Table 2 Patient characteristics.

	Cohort 1 (first 72 hours)	*Cohort 2 (weeks 5 or 6)*
n	*102*	*26*
Gestational age (median, range)	39 4/7 (36 5/7–41 5/7)	39 4/7 (36 6/7–41 5/7)
Birth weight (median, range)	3 255 (2380–4620) g	3 250 (2380–4620) g
Girls (*n*, %)	42 (42%)	11 (42%)
Smoking in pregnancy (*n*, %)	15 (15%)	4 (15%)
Apgar scores at 5 minutes (median, range)	9 (8–10)	9 (8–10)
Umbilical artery pH (median, range)	7.26 (7.02–7.42)	7.26 (7.02–7.42)
Spontaneous vaginal delivery	65 (63%)	18 (69%)
Caesarean section (*n*, %)	31 (31%)	6 (22%)
Delivery by ventouse (*n*, %)	6 (6%)	2 (7%)

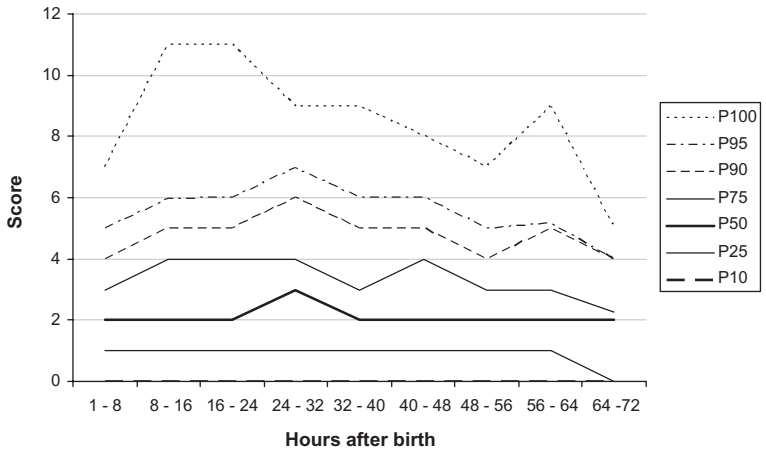

Figure 1 Score during the first 72 hours of life ($n = 102$)

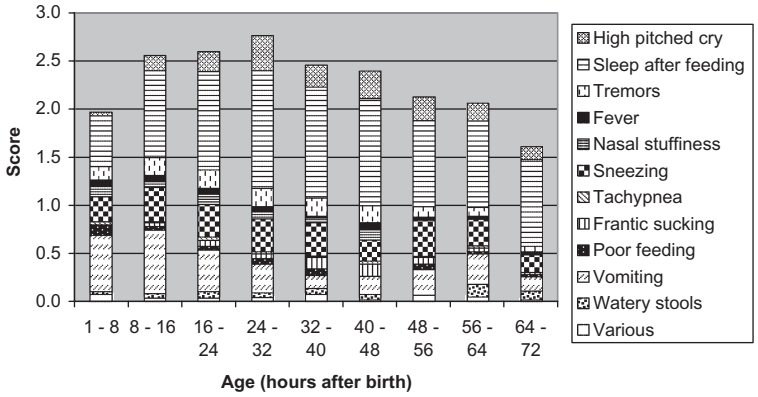

Figure 2 Single components of the score during the first 72 hours of life. Excoriation of skin, myoclonic jerks in sleep, sweating, frequent yawning, mottling and tachypnoea were observed rarely and are summarized as 'various'. Generalized convulsions never occurred

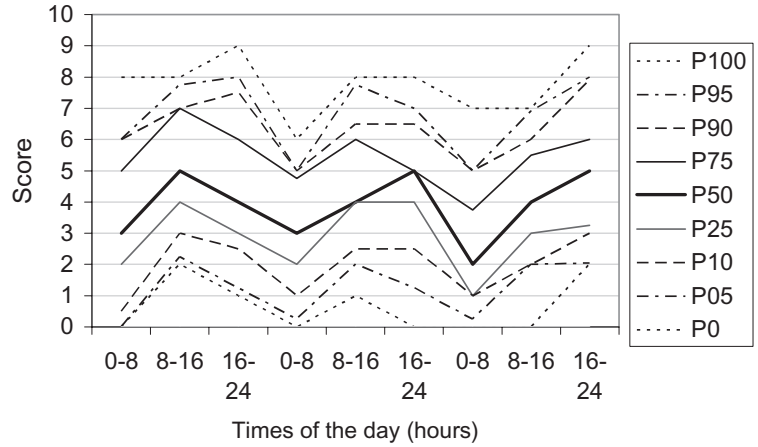

Figure 3 Score at weeks 5 to 6 ($n = 26$)

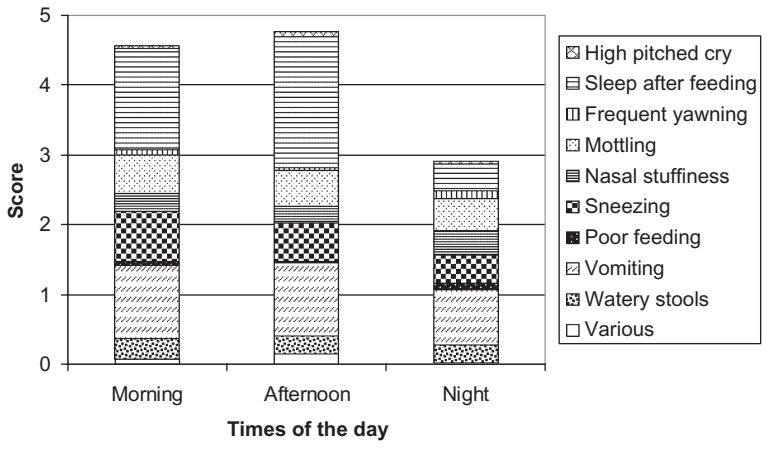

Figure 4 Single components of the score at weeks 5 and 6. 'Various' includes tremor, excoriation of the skin, myoclonic jerks in sleep, fever and tachypnoea

pared. As the 95th percentile never exceeds 8, this cut-off may be reasonable to raise suspicion for drug withdrawal and to initiate pharmacological treatment in infants of substance-abusing mothers.

Employing an extended literature search in MEDLINE and EMBASE, we were not able to find a similar study. Two important features of the score should be pointed out: (i) the score increases with age—this phenomenon is related to brain maturation and reflects well-known developmental changes in behaviour, especially in crying patterns [10]; and (ii) a circadian rhythm is established by weeks 5 or 6. This fact also reflects developmental maturation [11]. It is noteworthy that this variation is due mainly to longer duration of night sleep.

The original score suggested by Finnegan was modified, as described in the Introduction. As the modified items occurred very rarely in our cohort, the results are scarcely affected by these modifications.

The strengths of this study are the selection of patients with exclusion of drug ingestion by meconium

analysis in subjects with high scores, the inclusion of patients after ventouse delivery and nicotine exposure before birth and the use of an observation scheme identical to that used in narcotic abstinence syndrome by nurses who have experience with scoring infants with withdrawal symptoms.

Weaknesses are that the score was applied by various nurses and in part by the parents for weeks 5 or 6, which may increase variability. A video recording which would allow *post-hoc* analysis would be more objective, but would need much more time without improving variability.

Up to 5% of infants born to mothers not reporting drug use may have been exposed to opiates *in utero* [8,12]. We examined meconium or urine samples only in infants with high scores in order to ensure that these elevated scores were not due to an unknown opiate abstinence syndrome. Our methodology does not exclude that an infant with permanent low scores was exposed to opiates *in utero*. This limitation does not affect our results, at least not the 95th percentile, because any infant with significant signs of opiate withdrawal should have been detected.

Monitoring the abuse of drugs during pregnancy is a difficult task, as mothers may take these drugs intermittently and urine tests may therefore be negative. Instead, analysis of meconium samples, which act as garbage accumulation bins during the last 5 months of pregnancy, is the contemporary approach for detecting drug exposure in neonates. As no standardized procedure for the extraction and analysis of meconium samples has been published to date, each laboratory has to develop and validate its own procedure. This leads to different results of meconium drug screening tests in different laboratories. Therefore, clinical methods are indispensable for the identification of infants suspected of narcotic withdrawal [13].

CONCLUSIONS

From this study two implications for the use of the Finnegan score can be drawn: in infants who score higher than 8, narcotic withdrawal should be suspected. If the score is used to guide therapy for abstinence syndrome, an increase of the baseline and day–night cycles present at 5–6 weeks must be taken into account.

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Declarations of interest

None.

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