ROUTINE NEWBORN CLINICAL SCREENING AND 6-WEEK INFANT POST-NATAL CLINICAL SCREENING IN ALEXANDRA HOSPITAL

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SYNPOSIS

A retrospective study was conducted on the data compiled at routine newborn clinical screening and 6-week infant post-natal screening of 4530 babies delivered at Alexandra Hospital in 1976. The obstetric as well as paediatric medical data were computer analysed to establish the disease pattern and some feeding data of the newborn and young infant, and conclusions drawn on the yield from such screening practices in the context of our hospital manpower situation.

INTRODUCTION

Since the opening of Alexandra Hospital (A.H.) in September 1971, the policy in the Department of Paediatrics has been for its medical staff to do a routine newborn clinical screening on the first day of life as well as a 6-week post-natal clinical screening on all babies born in the hospital.

Deliveries at A.H. have increased rapidly since then (Table I) and in 1976 there were well over 5000 deliveries.

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TABLE I

DELIVERIES IN ALEXANDRA HOSPITAL

Year	Number of Live Births
1972	2815
1973	3906
1974	3745
1975	5427
1976	5846

The routine screening of such a large number of babies by the medical staff of the Department of Paediatrics thus took up a significant proportion of the total workload of the Department, with the annual increasing number of admissions and outpatient attendances of general paediatric cases adding to the workload. It was thus felt timely to conduct a study to analyse the yield of routine newborn clinical screening and 6-week post-natal screening to

assess its level of priority in manpower planning for newborn areas. The study would hopefully also give us a clearer picture of the local disease pattern of the newborn and help us establish some aspects of local infant feeding practices and some physical and developmental norms.

MATERIALS AND METHODS

A retrospective study of all babies delivered in A.H. in 1976 was made. Though all the registration numbers of the cases were known, only case sheets that could be traced could be analysed. Also 948 patients who failed to attend at 6-week post-natal follow-up were not analysed. These included 30 patients who died in the Special Care Nursery before the age of 6 weeks. It should be emphasised that the study also excluded a few babies born with severe congenital abnormalities that were picked up by midwives at delivery and subsequently died, eg anencephaly, spina bifida with meningomyelocoele and multiple congenital defects. The nett result was that out of 5846 deliveries in 1976, 4530 cases were analysed, giving a coverage of 77.5%.

Due to the size of the study, the help of the Research and Statistics Unit of the Ministry of Health was sought, and all data which were obtained from routine screening forms at birth and at 6 weeks were transcribed into appropriately designed forms meant for computer analysis. The medical data were filled in by the paediatric doctors.

RESULTS

(A) SCREENING AT BIRTH

A total of 4530 cases were studied. These were made up of 2386 males and 2144 female babies.

Racial distribution by age

The distribution according to race and age of mother was as follows (Table 2):

A breakdown of the ages of mothers of parity 1 between the three major races of Singapore showed the following (Table 3):

TABLE 2

RACE BY AGE OF MOTHER

Age of Mother in years	Chinese	Malay	Indian	Others	Total	% Distribution
< 15	0	0	0	0	0	0
15 — 19	90	86	11	1	188	4.2
20 — 24	1004	356	77	15	1452	32.1
25 — 29	1612	191	78	10	1891	41.7
30 — 34	516	65	19	4	604	13.3
35 — 39	161	22	2	0	185	4.1
40 — 44	16	10	0	1	27	0.6
45 — 49	2	1	0	0	3	0.1
50 +	3	1	0	0	4	0.1
Unknown	117	51	7	1	176	3.9
TOTAL	3521	783	194	32	4530	100.0

TABLE 3

AGE OF MOTHERS OF PARITY 1

Age in Years	Chinese	%	Malay	%	Indian	%	Total	%
15 — 19	77	5.0	73	18.8	10	12.3	160	8.0
20 — 24	614	40.2	233	60.0	39	48.1	886	44.4
25 — 29	695	45.5	65	16.7	26	32.1	786	39.4
30 — 34	112	7.3	13	3.4	5	6.2	130	6.5
35 — 39	25	1.6	3	0.8	1	1.2	29	1.5
40 — 44	4	0.3	1	0.3	0	.0.0	5	0.3
45 +	0	0.0	0	0.0	0	0.0	0	0.0
TOTAL	1527		388		81		1996	

An analysis to see if there was any age difference between Chinese, Malay and Indian mothers of parity 1 gave the following results (Table 4):

TABLE 4

ANALYSIS OF AVERAGE AGE OF MOTHERS OF PARITY 1

	Chinese	Malay	Indian
Average age in years	25.1	22.4	23.8
Standard deviation	3.9	3.9	4.1

Tests at the 5% level show that Chinese mothers (of parity 1) are significantly older than either Malay or Indian mothers; Indian mothers are significantly older than Malay mothers.

Table 5 shows the racial distribution expressed as a percentage in comparison with the percentage distribution of live-births for Singapore in the same year. The table shows that significantly more Malay babies are born in A.H. which drains a good-sized Malay population in the Southern Islands and Pasir Panjang.

Birth weight

Birth weights according to ethnic group is given in Table 6 below. 88 (2.0%) of babies were recorded with weights under 2.3 kg. While there are no significant differences in the average birth weights for the 3 major races, Malays were observed to have a significantly higher proportion of birth weights under 2.3 kg when compared to the Chinese.

TABLE 6

BIRTH WEIGHT BY RACE

Birth weight	Chinese	Malay	Indian
Average	3.1 kg	2.9 kg	3.1 kg
Std. deviation	0.4	0.4	0.4
Percentage under 2.3 kg	1.6%	3.2%	3.1%

Head circumference at birth

There was no significant difference in the average head circumference as observed for all the 3 major ethnic groups at birth. The data is presented in Table 7 below.

TABLE 7

HEAD CIRCUMFERENCE AT BIRTH

Head circumference	Chinese	Malay	Indian
Average	33.7 cm	33.6 cm	33.8 cm
Std. deviation	1.3	1.5	1.3

Type of delivery

The type of delivery was as follows (Table 8):

TABLE 5

RACIAL DISTRIBUTION OF BIRTHS

Race	No. of Births	Percentage	Percentage Distribution of Live-births in Singapore, 1976*
Chinese	3521	77.7	78.6
Malay	783	17.3	12.8
Indian	194	4.3	5.4
Others	32	0.7	3.2
TOTAL	4530	100.0	100.0

*Report of the Registry of Births, Deaths and Marriage, 1976.

TABLE 8

TYPE OF DELIVERY

Method of Delivery	No. of Births	Percentage of Total
Normal	3928	86.7
Forceps: Neville-Barnes' 170) Wrigley 72) Kielland's 31)	273	6.0
LSCS: Emergency 101) Elective 98)	199	4.4
Breech	114	2.5
Others	15	0.3
Not stated	1	0.0
TOTAL	4530	100.0

Of these 4530 cases, 4031 (89%) were booked, 202 unbooked, and in 297 cases it was not stated in the case notes. Thus the vast majority of deliveries in A.H. were booked cases, is cases having at least 1 antenatal check-up before delivery.

Apgar score

The Apgar score at 1 minute was 7 and above in 96.1% of deliveries. The 5-minute Apgar score was 7 and above in 97.3%.

An analysis to see if Apgar score was related to the period of gestation showed significantly more babies below 36 weeks gestation with 1-minute Apgar scores of less than 7 (Table 9). However for the 5-minute Apgar score, there was no significant difference between the various gestation groups.

An analysis of Apgar score in relation to type of delivery showed that in comparison to normal delivery, delivery by emergency LSCS, elective LSCS, breech

delivery and delivery with Kielland's or Neville-Barnes' forceps all had significantly higher percentage of cases with 1-minute Apgar score below 7 (Table 10). With the 5-minute Apgar score, breech deliveries showed a significantly higher number of scores below 7.

Neither 1-minute nor 5-minute Apgar scores showed any significant relationship to maternal age.

Breastfeeding

2709 mothers of the 4530 babies either breast-fed or indicated they would breast-feed their babies, giving a figure of 59.8%.

A Chi-Square test to see if breast-feeding was related to birth order showed no relationship at birth. However a similar test done at 6-week screening showed a strong association between birth order and breast-feeding leading to the conclusion that as parity goes up, mothers tend to breast-feed for longer periods. (Table 11 A).

TABLE 9
APGAR SCORE IN RELATION TO PERIOD OF GESTATION

1-minute Apgar Score	Gestation in Weeks				Total
	<36	36-39	40-43	44+	
<7	13	63	51	1	128
7 and above	100	1904	1681	60	3750
TOTAL	113	1967	1737	61	3878

NOTE: % of those <36 weeks with score less than 7 is 11.5% and those 36 weeks with score less than 7 is 3.2%. Using the Chi-Square test, this difference is significant.

TABLE 10
1-MINUTE APGAR SCORE IN RELATION TO TYPE OF DELIVERY

1-Minute Apgar Score	Delivery Type						
	Normal	Elective LSCS	Emergency LSCS	Breech	Wrigley forceps	Kielland forceps	Neville-Barnes forceps
% under 7	1.5	10.2	27.2	25.4	1.4	6.5	5.9
Total No. of cases	3895	97	99	114	71	31	170

TABLE 11 A
BREAST-FEEDING AT BIRTH AND AT 6 WEEKS ACCORDING TO BIRTH ORDER

	Birth Order No. Breast-fed at birth	%*	No. breast-fed at 6 weeks	%*	Total
1	1294	61.8	361	17.2	2094
2	893	58.8	276	18.2	1519
3	342	54.8	140	22.4	624
Above 3	176	61.3	95	33.1	287
Unknown	4	66.6	2	33.3	6
TOTAL	2709	59.8	874	19.3	4530

*Percentage refers to the proportion of babies being breast-fed for each of the birth order categories listed.

An analysis of the breast-feeding pattern among the 3 major races (testing for significance at the 5% level) showed significant differences. Breast-feeding is more prevalent among Malay mothers than Chinese mothers, both at birth and at 6 weeks, with the Indian mothers in between (Table 11 B).

Abnormalities detected

Of the 4530 cases that were studied, a total of 1459 (32.2%) significant abnormalities were picked up during newborn clinical screening among 1291 (28.5%) babies (Table 12).

Although some of the newborn babies screened had more than one abnormality detected, the number of abnormalities detected are nevertheless surprisingly high. The abnormalities detected are listed in Table 13.

Splenomegaly was the commonest abnormality found, being present in 6.9% of the 4530 babies screened, followed by jaundice in 4.2%, skin abnormality in 3.4% and jitteriness in 3.0%. It should be noted however, that some of the abnormalities detected, eg jitteriness, renal

abnormalities (mostly palpable kidneys) and abnormal primitive reflexes may or may not necessarily be of any clinical significance.

It should also be pointed out that congenital abnormalities only form part of our list of abnormalities detected at birth, making it difficult to compare our findings with other studies which deal only with congenital malformations detected at birth (McIntosh et al, 1954).

Chi-square tests revealed that none of the abnormalities had any significant association with maternal age at the 5% level. Neither was there any statistically significant difference in the proportion of abnormalities detected for male and female babies at birth in respect of birth asphyxia, respiratory distress, low birth weight or any of the other abnormalities mentioned.

However in comparing these abnormalities between Chinese and Malay babies, there were significantly more low birth weight Malay babies and more Chinese babies with abnormal reflexes, skin abnormalities and cleft lip or palate.

TABLE 11 B
BREAST-FEEDING BY RACE

Race	% Breast-feeding at Birth	% Breast-feeding at 6 Weeks
Chinese	55.6	12.6
Malay	76.2	47.1
Indian	68.0	28.4

TABLE 12
ABNORMALITIES DETECTED AT BIRTH

Number of Abnormalities*	Number of babies	Percentage
None	3239	71.5
1	986	21.8
2	238	5.3
3	55	1.2
4	6	0.1
5	3	0.1
6+	3	0.1
TOTAL	4530	100.0

*Includes minority of abnormalities subsequently considered insignificant and excluded from Table 13.

TABLE 13

ABNORMALITIES DETECTED AT BIRTH (ranked in order of frequency)	No.	Rate per 1000 live-births
Splenomegaly	312	68.9
Jaundice	189	41.7
Skin abnormality	152	33.6
Jitteriness (no cause)	136	30.0

Abnormalities detected at birth		No.	Rate per 1000 live-births
Low birth weight:			
Prematurity	48)		
Small for dates	38)	88	19.4
Both	2)		
Orthopaedic:			
Torticollis	30)		
CTEV	29)		
Congenital dislocation of hip	) 10)	76	16.8
Fracture	4)		
Erb's palsy	3)		
Cephalhaematoma		65	14.3
Genitalia:			
Undescended testis	26)		
Hydrocoele	24)	62	13.7
Hypospadias	2)		
Other abnormalities	10)		
Respiratory distress:			
Aspiration pneumonia	32)		
Transient tachypnoea	16)	60	13.2
Hyaline membrane disease	2)		
Others	10)		
Birth asphyxia		60	13.2
Metabolic:			
Hypocalcaemia	35)	42	9.3
Hypoglycaemia	4)		
Hypoglycaemia + hypocalcaemia	) 3)		
General abnormality (unclassified)		41	9.1
Heart abnormality		40	8.8
Congenital abnormality (unclassified)		34	7.5
Renal		29	6.4
Sepsis		28	6.2
Primitive reflexes		24	5.3
Chromosomal abnormalities:			
Down's syndrome	11)	14	3.1
Others	3)		
Cleft lip/palate		6	1.3
Intrauterine infection		1	0.2
TOTAL		1459	100.0

Maternal drugs and abnormalities detected at birth

Herbs or sedatives taken by mothers antenatally showed no statistical difference when compared to controls as far as the following abnormalities were concerned — splenomegaly, jaundice, skin abnormality, abnormal genitalia and general abnormality.

However there were significantly fewer babies with heart abnormalities among mothers who took herbs antenatally (the reason for this is uncertain) and more babies who were noted to be jittery at newborn screening in mothers given sedatives antenatally. As this was a retrospective study and was not designed specifically to study the relationship between maternal drugs and abnormalities detected, the drug data may not have been complete.

Examiner at birth and congenital abnormalities detected at birth

Of the 4530 cases, 2359 were examined at birth by a Paediatrician and 2162 by a paediatric trainee, medical officer or house officer of the Paediatric Department, giving a Paediatrician: Non-paediatrician ratio of 1. 1 : 1 (In 9 other cases the examiner was not stated).

An analysis of abnormalities picked up by these 2 groups of examiners showed the paediatrician picking up statistically significantly more babies with splenomegaly, traumatic and orthopaedic abnormalities, and the non-paediatrician picking up more babies with jaundice, but there was no difference in the case of other abnormalities at the 5% level of significance.

(B) SCREENING AT 6 WEEKS

Weight at 6 weeks

There was no significant variation in the average weight at 6 weeks for the 3 ethnic groups (Table 14).

TABLE 14
WEIGHT AT 6 WEEKS BY RACE

Weight at 6 weeks	Chinese	Malay	Indian
Average weight	4.5 kg	4.4 kg	4.3 kg
Std. deviation	0.6	0.6	0.5

Head circumference

The average head circumference for Chinese babies was recorded at 37.1 cm, Malays at 37.0 cm and Indians at 36.9 cm with a standard deviation of 1.3 cm for all races.

Type of milk feed at 6 weeks

Table 15 shows that the most popular milk is Dumex followed by Lactogen and S26. However it should be noted that although only 4.1% of the infants were solely on breast milk, another 689 infants were on breast milk plus one of the powdered milks so that in fact a total of 874 (19.3%) infants at 6 weeks were breast feeding with or without the addition of powdered milk. Nevertheless this is a significant fall from the 2709 (59.8%) mothers breast-feeding at birth.

TABLE 15
TYPE OF MILK FEED AT 6 WEEKS

Type of milk	No. of infants	Percentage
Dumex	1722	38.0
Lactogen	791	17.5
S26	549	12.1
SMA	346	7.6
Mamex	287	6.3
Breast Milk only*	185	4.1
Nan	175	3.9
Cow & Gate	154	3.4
Enfamil	115	2.5
Frisolac	60	1.3
Pelargon	22	0.5
Similac	17	0.4
Soy Milk	3	0.1
Full cream milk	3	0.1
Others	101	2.2
Total	4530	100.0

(*Excludes 689 infants on breast milk plus a powdered milk)

Abnormalities detected at 6 weeks

The abnormalities detected at 6-week screening were made up of the following: (Table 16).

It should be noted that splenomegaly, which was the commonest abnormality found at birth, was again the most frequently reported condition, increasing from 6.9% of the 4530 babies screened at birth, to 11.9% at 6 weeks. Skin abnormality also increased from 3.4% at birth to 8.1% at 6 weeks. These two abnormalities in fact together accounted for 64.1% of the 1411 abnormalities found at 6 week screening.

As for genital abnormalities, the 26 babies with undescended testis detected at birth had been reduced, as expected, to only 6 at 6-week screening whereas hydrocoele, present in 24 babies at birth, was found in 80 babies at 6 weeks of age.

Heart abnormality, detected in 40 babies at birth, increased to 90 at 6-week screening, giving a surprisingly high rate of 19.9 per 1000 live births. The accepted incidence of congenital heart disease is in the region of 6 to 8 per 1000 live births (Morgan, 1978). Clearly, our 90 cases have to be carefully reviewed to see how many of them were actual cases of congenital heart disease and how many were babies with other heart abnormalities like functional murmurs, arrhythmias, etc, which might be benign or temporary defects.

Abnormalities of the special senses mainly refers to abnormalities of the eyes and ears.

Again, none of the abnormalities found at 6-week screening had any significant association with maternal age.

However a statistical comparison of the sexes showed that spleen and liver size was significantly larger in the male infant. Males were also more often jaundiced. These differences were not demonstrated at birth.

Comparison of abnormalities between Chinese and Malay cases showed that while there was no statistically significant difference for jaundice, liver and spleen size and abnormalities of skin, reflexes or lung, more Chinese infants had abnormalities of the heart, special senses and the spine.

Examiner at 6 weeks and abnormalities detected

Of the 4530 infants, 6-week screening was done by a Paediatrician in 1956 cases and by a non-paediatrician in 2573 cases (in 1 case the examiner was not specified). This gives a non-paediatrician to paediatrician ratio of 1.3:1.

The paediatrician picked up statistically significantly more cases of abnormality of reflexes, special senses and the heart.

DISCUSSION

Screening may be defined as the presumptive identification of unrecognised disease or defects by the application of tests, examinations or other procedures which can be applied rapidly (Frankenburg and Camp, 1975). Frankenburg and Camp also set out 10 criteria for selecting diseases to be screened. The definition and criteria have also been clearly set out by Carter (1976), Clayton (1976), Holland (1974) and Whitby (1974).

TABLE 16

ABNORMALITIES DETECTED AT 6 WEEKS (Ranked in order of frequency)		No.	Rate per 1000 live-birth
Splenomegaly		539	119.0
Skin abnormality		365	80.6
Genitalia:			
Hydrocoele	80)		
Undescended testis	6)		
Hypospadias	1)	99	21.9
Other abnormalities	12)		
Heart abnormality		90	19.9
Special senses		83	18.3
Primitive reflexes		43	9.5
Hepatomegaly (3 cm +)		36	7.9
Lung		30	6.6
Jaundice		21	4.6
Spine		8	1.8
Kidney		3	0.7
Others		94	20.8
TOTAL		1411	

The importance of screening all newborn babies in Singapore for Glucose-6-phosphate dehydrogenase deficiency in the prevention of kernicterus is well known (Wong, 1975).

In clinical screening of the newborn there are basically three principal types of examination:

(i) Immediate examination at delivery to assess the physiological status of a baby and its preparedness for extrauterine existence, and to note any gross malformations.

(ii) General clinical examination to determine intactness of baby and freedom from malformations.

(iii) Specific clinical examination, eg appraisal of a baby's neuro-developmental status by testing his alertness, reflexes and movements (Holt, 1977).

The midwife at delivery would be able to spot the gross abnormalities on immediate examination but the general and specific clinical examination would require the services of trained medical personnel.

Our study showed that the yield of detecting significant abnormalities at birth was relatively high, especially for the detection of serious or potentially serious conditions like neonatal jaundice, jitteriness and respiratory distress. Newborn screening should certainly continue.

The same however cannot be said of the abnormalities picked up at 6-week screening, the big majority of which were for splenomegaly and skin abnormalities (mainly sepsis). A worrying finding was the detection of 90 infants with heart abnormality at 6-week screening. However, as mentioned earlier, the majority of them may not be cases of congenital heart disease. Nevertheless it is disturbing to find that of the 40 babies considered to have heart abnormality at birth, only 8 were among the list of 90 picked up with heart abnormality at 6-week screening. This not only means that 32 of the 40 babies thought to have heart abnormality at birth had their condition resolved by 6 weeks, but more significantly, 82 of the 90 infants had their heart abnormality detected at 6 weeks for the first time.

The high proportion of cases at birth and at 6 weeks with splenomegaly is interesting and preliminary findings indicate the main cause as non-specific hepatitis which is self-limiting with regression of the spleen only on long term follow-up. However it is our intention to do a long term follow-up study on this group to break down the various causes and get a clearer picture.

It would appear that with Singapore's Primary Health Care Division and its Maternal and Child Health Services doing a useful coverage of the young infant with its immunization programme and well-baby clinics, 6-week screening could be incorporated into their programme to relieve the hospital's workload. The main aim would be to pick up cardiovascular abnormalties.

The study confirmed certain expected findings, eg there are significantly more low birth weight Malay babies as compared to Chinese babies, Chinese mothers are significantly older than Malay and Indian mothers, and more Malays breast-feed their babies than Chinese mothers.

Unexpected findings included the high incidence of heart abnormality at 6 weeks, the detection of fewer

babies with heart defects among mothers who took herbs antenatally, and the relatively high percentage of breast-feeding mothers.

As to the unresolved controversy over whether maternal oxytocins are related to neonatal jaundice (Chalmers et al, 1975; Friedman and Sachtleben, 1976), our study showed no statistical difference between the two groups of babies, though it must be added that our findings cannot be conclusive here because neonatal jaundice usually takes a few days to manifest, and in our study most babies were discharged from hospital with their mothers the day after delivery.

It was a pleasant surprise to find that 59.8% of mothers either breast-fed or said they would breast-feed their babies at the newborn screening interview. The number who successfully breast-fed was probably lower as the majority were discharged the day after delivery, making verification difficult as lactation takes a few days to be established.

Random surveys on breast-feeding in Singapore had been showing a tremendous decline from 82.5% in 1955 and 73.4% in 1961 to about 5% in the last few years, so that an upturn seems to be developing as has been happening in Western countries. Thus it can be considered somewhat heartening that at 6-week follow-up, 19.3% of all the infants studied were still on breast milk.

Comparison of abnormalities picked up by paediatrician vs non-paediatrician showed the former detecting significantly more newborn babies with splenomegaly, traumatic and orthopaedic abnormalities, and more infants at 6 weeks with abnormality of reflexes, special senses and the heart. The paediatrician probably makes a more conscious effort in trying to assess the neurological development of an infant.

CONCLUSION AND RECOMMENDATIONS

A wealth of data has been amassed from this study and can clearly be further utilised.

Our clinical impression that splenomegaly is a relatively common finding in the newborn and 6-week old infant has been confirmed in this study and our routine investigations for this condition (full blood count and blood picture, urine microscopy and culture, liver function tests and serology) and follow-up clinical notes on these infants should be carefully analysed to see if it is a real problem and whether it has any prognostic significance. This is an important question in view of the fact that a palpable spleen is said by some authorities to be normal at birth (Cockburn and Drillien, 1974), whereas it has been shown in a local study that a significant number of palpable spleens are associated with elevated IgM levels (Tan, 1972).

The pick-up rate of abnormalities detected at birth is high and in many instances vital in reducing the morbidity and even mortality of the newborn baby. Clearly newborn screening by the paediatric doctor must continue.

The case for continuation of the 6-week screening programme however is less certain. Apart from splenomegaly (the importance of detecting this in the majority of cases is still unclear) and skin abnormalities (mostly sepsis and relatively benign conditions) which together account for the majority of abnormalities found at 6-week screening, the yield here does not appear to be com-

mensurate with the amount of manpower utilised. The unexpectedly high incidence of heart abnormalities at 6-week screening, however, needs further analysis before any useful conclusions can be made.

It is thus recommended that the hospital 6-week screening programme be suspended until either the manpower situation improves or new data are found to justify its continuation in the local context. It could however be incorporated at Maternal and Child Health Clinic level with particular attention being given to the cardiovascular system.

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