*Archives of Disease in Childhood*, 1977, **52**, 794–804

# *Short reports*

## Candida species and yeasts in mouths of infants from a special care unit of a maternity hospital

The distribution of yeasts and yeast-like fungi in the mouths of normal healthy infants and neonates has been studied by a number of workers (Epstein, 1924; Ludlam and Henderson, 1942; Schaulow *et al.*, 1966–67). In a previous communication (Russell and Lay, 1973) we reported the results of a longitudinal study of such children up to 12 months of age and suggested that early colonization by *Candida albicans* was not necessarily followed by clinical candidosis.

Since candidal infections and candidosis are associated with reduced resistance to disease and a variety of systemic disorders (Winner, 1966; Jenkins *et al.*, 1973), it was of interest to determine the susceptibility to colonization by candidas of a group of infants born in hospital and, because of their own or their mother's abnormality, kept in the special care unit until discharged.

### Methods and materials

**Infants examined.** 99 neonates were transferred to the special care unit of the hospital. The reasons for doing so were: mother diagnosed as ill, e.g. with diabetes; neonatal jaundice; fetal and neonatal asphyxia; abnormal fetus, including prematurity; neonate infected. 29 of the infants were placed in an incubator; these were examined as a separate group while in hospital but were not further examined after discharge.

**Sampling procedure.** Within 24 hours of birth the mouth was sampled by means of a swab, gently rolled over the tongue, sublingual and vestibular mucosa, and the buccal pouch on the side on which the infant was lying. Further samples were taken on days 4, 7, and 14 from all infants. By the time of discharge from hospital 29 babies were still not colonized by *Candida* or yeasts. These were therefore sampled at home, initially weekly and then monthly or bimonthly until 8 months of age and finally at one year.

**Culture technique.** The swabs were placed in Sabouraud's broth containing antibiotics and processed as described earlier (Russell and Lay, 1973). No attempt was made to determine whether candidas, if present, were in the yeast or mycelial phase at the time of sampling.

### Results

Table 1 gives the isolation rate of oral candidas and yeasts among the 70 infants who were not kept in ncubators in hospital. The incidence of isolation rose rapidly with the length of stay in hospital, only one species of *Candida* occurring in any one case.

Table 1 *Isolation of oral candidas and yeasts during stay in special care unit*

| *Group* | *No.* | *Organisms* | *% colonized when sampled on day* | | | |
|---|---|---|---|---|---|---|
| | | | *1* | *4* | *7* | *14* |
| 1 | 7 | Candidas | 14 | — | — | — |
| | | Yeasts | 0 | — | — | — |
| 2 | 14 | Candidas | 7 | 14 | — | — |
| | | Yeasts | 0 | 0 | — | — |
| 3 | 30 | Candidas | 3 | 17 | 31 | — |
| | | Yeasts | 0 | 0 | 0 | — |
| 4 | 19 | Candidas | 11 | 32 | 47 | 53 |
| | | Yeasts | 0 | 11 | 26 | 32 |
| Overall results* | | Candidas | 7 | 21 | 37 | 53 |
| | | Yeasts | 0 | 3 | 10 | 32 |

*Calculated on the total sampled each day.

Table 2 gives the data relating to those 29 babies who left hospital while not yet colonized by either *Candida* or yeast. The rate of colonization, again by one organism alone, rose rapidly so that at 4 weeks of

Table 2 *Changes in isolation rate with age of infant at home*

| *Age (w)* | *No. examined* | *% colonized by* | |
|---|---|---|---|
| | | *Candida* | *Yeast* |
| 4 | 29 | 79 | 17 |
| 8 | 29 | 72 | 21 |
| 16 | 26 | 69 | 12 |
| 24 | 26 | 62 | 8 |
| 32 | 24 | 63 | 4 |
| 52 | 24 | 50 | 4 |

*Note:* No infant harboured the organisms on leaving hospital.

age 97% of babies carried 'yeast-like fungi'. The period spent at home before reaching this age ranged from 3½ weeks to 1 week. The distribution of organisms according to species of *Candida* or genus of yeast among these babies was as follows: 17 (59%) harboured *C. albicans* by the 4th week, of whom only 4 subsequently developed candidosis; 3 carried *C. tropicalis*; 2 *C. parapsilosis*; 1 *C. pseudotropicalis*; 3 *Saccharomyces* sp.; 2 *Torulopsis* sp.

Of the 29 babies reared in incubators, 3% harboured candidas when examined at 1 day of age, 21% at 4 days, 31% at 7 days, and 41% at 14 days. The period of 2 weeks facilitates comparison with the babies designated as group 4 in Table 1 and shows that the proportion colonized orally by candidas at any time was much the same in babies in incubators or not.

## Discussion

The overall prevalence of oral candidas in the 99 babies on the day of birth (6%) was very close to that found in 'normal' babies (5·7%) previously reported by Russell and Lay (1973). However, the subsequent isolation rate increased more rapidly in the present series, so that on day 7, 37% of the group of 70 babies were orally colonized with species of *Candida*, whereas only 14% of the earlier 'normal' group harboured these organisms at that time. This rapid colonization was also seen in the babies kept in incubators. Similarly, in a study of candidosis in preterm infants in a special hospital unit, Blaschke-Hellmessen *et al.* (1973) isolated *C. albicans* with increasing frequency from the mouth, rectum, and skin of the babies during their stay in the unit: the organism was present in 12·5% of cases on the day of birth, but in 46·5% at one month of age; unfortunately, figures are not given for oral colonization alone.

In contrast, in the infants at home the rate of accretion of oral candidas to infants who were not colonized at the time of leaving hospital was much the same in both 'normal' and 'special care' infants. Thus, in the former group (Russell and Lay, 1973) the isolation rate was 82% at 4 weeks, 67% at 16 weeks, 60% at 32 weeks, and 50% at one year; in the latter group the corresponding figures were 79%, 69%, 63%, and 50%. Furthermore, at 4 weeks of age, *C. albicans* itself was present in the mouths of 56% of the 'normal' group of whom 10% developed oral candidosis, and in 59% of the 'special care' group, of whom 24% developed candidosis.

Assuming that the home environment was similar in the two groups, the possibility of acquiring candidas from members of the family and from contaminated articles would also be similar. Therefore, there does not seem to be any difference between the two groups in their susceptibility to colonization by species of *Candida*, though there may be an increased tendency towards candidosis among the 'special care' group. However, the numbers concerned are low—3 with candidosis out of 28 'normal' carriers compared to 4 out of 17 in the 'special' group. The data support our previous conclusion that *C. albicans* is normally a harmless commensal even in babies with a degree of abnormality. Blaschke-Hellmessen *et al.* (1973) also stated that oral clinical complications after colonization with *C. albicans* were unusual in their series of preterm infants.

The difference between the two groups in their acquisition of candidas during their stay in hospital remains unexplained, however. Perhaps in the relatively closed system of the special care unit the transmission of organisms was more efficient. Disposable bottles and teats were not in use, 'Milton' fluid being used as sterilizing agent. Blaschke-Hellmessen *et al.* concluded that hospital candidosis among preterm infants in a special unit was a problem of hygiene and drew attention particularly to the possible transfer of *C. albicans* from the mouths of nursing staff and from neonatally colonized babies via soiled napkins, feeding bottles, and teats.

## Summary

A group of 99 babies born in hospital and subsequently transferred to the special care unit were examined for the presence of candidas orally. The rate of isolation rose from 6% neonatally to 53% on day 14 of life. Among infants who did not harbour the organisms when discharged from hospital, colonization rapidly took place so that 79% did so at 4 weeks of age, after which the rate fell to 50% at one year of age. The low incidence of clinical candidosis suggests that in these babies as in other groups *C. albicans* is normally a harmless commensal.

### References

Blaschke-Hellmessen, R., Hinkel, G. K., and Kintzel, H.-W. (1973). Zum Problem des Candida—Hospitalismus bei Frühgeborenen. *Dermatologische Monatsschrift*, **159**, 403–409.

Epstein, B. (1924). Studien zur Soorkrankheit. *Jahrbuch für Kinderheilkunde*, **104**, 129–182.

Jenkins, W. M. M., Thomas, H. C., and Mason, D. K. (1973). Oral infection with *C. albicans*. *Scottish Medical Journal*, **18**, 192–198.

Ludlam, G. B., and Henderson, J. L. (1942). Neonatal thrush in a maternity hospital. *Lancet*, **1**, 64–70.

Russell, C., and Lay, K. M. (1973). Natural history of *Candida* species and yeasts in the oral cavities of infants. *Archives of Oral Biology*, **18**, 957–962.

Schaulow, I., Spassowa, P., and Boschikowa, A. (1966–67). Investigations into the presence of yeasts in expectant mothers and neonates. *Archiv für Klinische und Experimentelle Dermatologie*, **227**, 985–992.

Winner, H. I. (1966). General features of candida infection. *Symposium on Candida Infection*, p. 6. Ed. by H. I. Winner and R. Hurley. Livingstone, Edinburgh.

K.M.L. was a recipient of a WHO grant.

K. M. LAY* and C. RUSSELL†
*Dental School and Department of Bacteriology and Virology, University of Manchester, Bridgeford Street, Manchester M15 6FH.*

*College of Dental Medicine, Rangoon, Burma.

†Correspondence to Dr. C. Russell.

# Diabetes insipidus, diabetes mellitus, optic atrophy, and deafness

## 3 cases of 'DIDMOAD' syndrome

Juvenile diabetes mellitus may be associated with diabetes insipidus, optic atrophy, perceptive deafness, Friedreich's ataxia, Refsum's syndrome, and Laurence-Biedl syndrome (Rose *et al.*, 1966). Of these variants, the association of diabetes mellitus, diabetes insipidus, optic atrophy, and neurosensory hearing loss is becoming frequently recognized, and is thought to represent a single genetic trait, inherited as a Mendelian recessive (Sunder *et al.*, 1972; Page *et al.*, 1976). Because polyuria and polydipsia are features of both diabetes mellitus and diabetes insipidus, the continuing presence of the latter tends to be overlooked after adequate treatment of the former. In addition, since the onset of the optic atrophy, the diabetes insipidus, and the high tone deafness is usually during childhood and adolescence, evidence of the 'DIDMOAD syndrome' (DI diabetes insipidus; DM diabetes mellitus; OA optic atrophy; D deafness) should probably be sought more frequently. The following 3 case reports are illustrative, 2 patients being brothers.

### Case reports

**Case 1.** A boy was born on 27 June 1961 in the UK of healthy, unrelated Italian parents, and weighed 3·2 kg. He progressed well but from the history obtained when he was 9·6 years he had had polyuria and polydipsia 'all his life', this having worsened during the previous year. Glycosuria in association with a fasting blood glucose of 12·5 mmol/l was noted and he was subsequently stabilized on Lente insulin 8 units daily with a diet containing 170 g carbohydrate. After 6 months insulin was withdrawn because glycosuria ceased, though polyuria and polydipsia persisted.

At 11·2 years because of growth failure he was reinvestigated and found to be frankly diabetic but without ketosis. Good control was achieved with Lente insulin 24 units daily. At 13·5 years when he complained of blurring of vision, height was 140 cm (3rd centile) and weight 38 kg (25th centile). There was no evidence of puberty and the bone age was 13·1 years. Blood pressure 110/65 mmHg. Vision in both eyes was 6/36. There was no vascular evidence of diabetic retinopathy but there was an enlarged blind spot bilaterally. Colour vision was markedly abnormal showing a red/green polarity indicating primary optic atrophy. Clinically the other systems were normal. An audiogram indicated bilateral high tone sensorineural hearing loss. Electroencephalogram (EEG) showed only a minor excess of slow-wave activity. Plasma and urinary antidiuretic (ADH) levels (Table) in the fluid-replete and fluid-deprived states were low, with little change across water deprivation. There was no specific aminoaciduria and the blood picture was normal.

**Case 2.** A boy was born on 27 September 1959 in Persia of healthy unrelated parents. Although the birthweight is not known he was normal at birth, was breast fed, and progressed satisfactorily, the milestones being reached at average times. At age 3·1 years he developed weight loss, polyuria, and polydipsia. A diagnosis of diabetes mellitus was made and insulin therapy begun without dietary control.

From age 6 years his growth was noted to be slower than average and from age 12 years he experienced progressive loss of vision and colour blindness. At age 16·5 years height was 147·8 cm (far below 3rd centile) and weight 37·6 kg (below 3rd centile). There was no evidence of puberty and the bone age was 13·4 years. BP 120/80 mmHg. Both optic discs showed central pallor, but the retinae were normal. No stigmata of disease were found in the other systems but there were several healing lesions of cutaneous leishmaniasis. Vision in both eyes was 1/60 and there was secondary type colour blindness with red/green polarity indicating optic atrophy. It was noted during his inpatient period that he had polyuria and polydipsia and fluid restriction caused considerable thirst and irritability.

An oral glucose tolerance test confirmed the presence of diabetes mellitus (fasting blood glucose 16·1; 30 min 29·0; 60 min 33·4; 90 min 31·0; 120 min 28·6 mmol/l (1 mmol/l glucose $\approx$ 18 mg/100 ml)).