

# Observations on the epidemiology of *Candida albicans*

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**SYNOPSIS** The carriage rates for *C. albicans* were found to vary for different groups of people but hospital patients appeared to have higher rates than the non-hospital population.

*Candida albicans* was recovered more frequently from the bedding of patients than from that of school children. The variable concentration of this fungus in the air and on the bedding suggested that its presence might be related to the presence of individual patients.

There has recently been an increased interest in, and perhaps also an increase in the incidence of, disease due to *Candida albicans*. For this reason, the following data on environmental contamination and carrier rates of *C. albicans* may be of interest. The data were derived from a number of studies and in consequence the groups investigated are not strictly comparable. Nevertheless, these observations may add to our knowledge of the epidemiology of *C. albicans*.

## POPULATIONS

A total of 376 adult male and female, medical and surgical, patients in two London hospitals was studied (group A). None of these patients was known to have infections due to *C. albicans*. The majority were aged between 20 and 60 years. Seventy-three children under 14 years of age were in various hospitals in the London area (group B). Boarding school children were 126 boys aged 11 to 18 years in school A and 40 children aged 5 to 11 years and 209 children aged 11 to 18 years in school B (group C). The 138 boys aged 11 to 18 in school B were seen on two occasions. Twenty-three medical students aged 18 to 20 years (group D), and 254 police cadets aged 16 to 18 years (group E) completed the sample.

## METHODS

In all except group E, subjects were examined by swabbing the gums and mouth mucosa and by pressing their fingers on to the surface of solid culture medium. The use of medium containing no antibiotics revealed that common skin bacteria were easily recovered from the

fingers using this method, suggesting that the low recovery rate for yeasts reflected a low incidence rather than an inefficient technique.

Bedding was examined by the sweep-plate method (Williams, Blowers, Garrod, and Shooter, 1960) and the air of wards and dormitories was examined using a slit sampler and the size-grading slit sampler (Lidwell, 1959). Mucosal, skin, and environmental samples were usually obtained on the same day. No environmental studies were made in the case of group D.

The medium used throughout these studies was Sabouraud's dextrose agar containing 0.5 g. of actidione per litre and usually an antibiotic (streptomycin) to suppress bacterial growth.

Most of the material was incubated at 37°C. but environmental material from group E was incubated at 26°C. since the primary interest in this group lay in the recovery of dermatophytes.

## RESULTS

No differences were found between the results for the groups of adult patients from different hospitals. These results were, therefore, pooled, as also were

TABLE I

RECOVERY OF CANDIDA ALBICANS FROM THE MOUTH AND FINGERS

Group	Number Studied	Percentage Yielding			
		<i>C. albicans</i>		Other Yeasts	
		Mouth	Fingers	Mouth	Fingers
A Adult patients	376	32.9	7.7	8.1	10.6
B Child patients	73	16.4	6.8	0	0
C Healthy children	503	5.4		0.6	
	407		0.5		1.5
D Medical students	23	8.6	17	0	0

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those for the school children for the same reason. No differences were seen in *C. albicans* carriage rates of males and females in these studies.

**CARRIER RATES** Table I shows that there appears to be a tendency for *C. albicans* carrier rates, both in the mouth and on the fingers, to be higher in hospital patients than in normal subjects, although accurate comparison is not possible. Recovery of yeasts from the fingers did not simply reflect contamination with the oral flora; e.g., of 25 patients with *C. albicans* on the fingers, only 19 had this organism in the mouth. The medical students, who had little or no contact with the wards, had a higher carrier rate on the fingers than in the mouth but this may simply reflect the rather small numbers seen.

**ENVIRONMENTAL CONTAMINATION** Table II shows the results of the bed sweeps carried out in the wards and dormitories occupied by the various groups studied. The higher carrier rates in the patients are seen to be reflected in the sweep samples. It must be taken into consideration, however, that the hospital beds were more continuously occupied than were the dormitory beds. Some of the beds were very heavily

TABLE II  
RECOVERY OF CANDIDA ALBICANS FROM BEDDING

Group	Number Studied	Percentage Yielding	
		<i>C. albicans</i>	Other Yeasts
<i>Blankets</i>			
A Adult patients	635 <sup>1</sup>	8.8	18.2
B Child patients	73	9.6	0
C Healthy children	279	0	5.4 <sup>2</sup>
E Cadets	254	0.4	13.3
<i>Pillows</i>			
A Adult patients	62	12.9	0
C Healthy children	38	0	0

<sup>1</sup>Cultures from 22 unoccupied beds in a hospital ward yielded no yeasts.

<sup>2</sup>In addition, at the first visit to school B, 118 beds yielded *Trichosporon cutaneum*. This species was not recovered during the second visit. Culture studies at 37°C. except for Group E where 26°C. was used.

contaminated with *C. albicans*, more than 100 colonies being recovered on the sweep plate. The data for environmental sampling for adult patients are more extensive than those for the carrier rates, because environmental sampling was carried out in one hospital over a long period.

Routine air sampling for *C. albicans* was continued

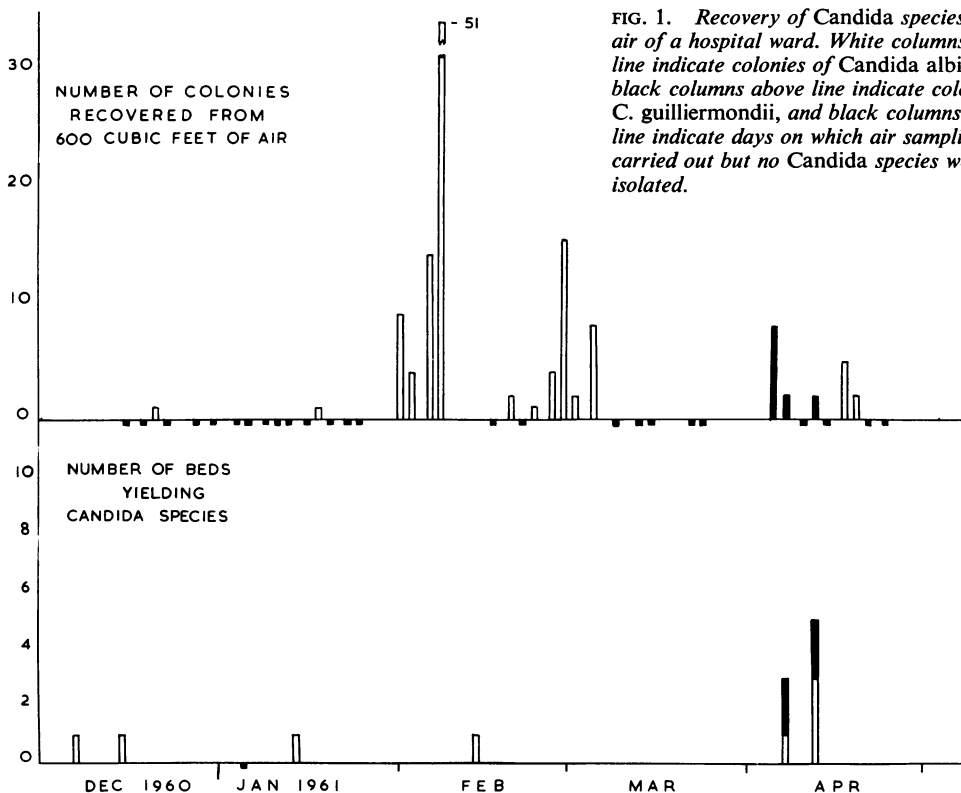


FIG. 1. Recovery of *Candida* species from the air of a hospital ward. White columns above line indicate colonies of *Candida albicans*, black columns above line indicate colonies of *C. guilliermondii*, and black columns below line indicate days on which air sampling was carried out but no *Candida* species were isolated.

for six months in one hospital; 43 samples each of 600 cubic feet were taken in each of two male surgical wards and a further 20 such samples taken in a nursery housing newborn infants. The isolation of *C. albicans* from the air was variable (Fig. 1) and the peak of count seen in the one ward suggested that some specific dispersal of *C. albicans* was taking place. No yeasts were recovered from the air of the nursery. Few of the air samples taken in the school yielded yeasts (Table III).

TABLE III

## RECOVERY OF CANDIDA ALBICANS FROM THE AIR

Group	Volume of Air Sampled (cu. ft.)	Number of Colonies Recovered	
		<i>C. albicans</i>	Other Yeasts
Hospital wards	70,020	148	132
Schools	4,600	3	0
Cadets	1,600	0	4

Culture studies at 37°C. except in the cadets study where 26°C. was used.

**SIZE DISTRIBUTION OF AIRBORNE PARTICLES** In addition to the samples recorded above, air in hospital wards was sampled using the size-grading slit sampler on four occasions, a total of 1,600 cubic feet being sampled. Only 67 colonies of *C. albicans* were recovered from these samples but the distribution was such as to suggest a median equivalent diameter between 10 and 15 $\mu$  for these particles, thus closely resembling that found for other bacteria and fungi of human origin (Noble, Lidwell, and Kingston, 1963).

**OTHER YEASTS ISOLATED** No other yeasts were isolated with the same frequency as was *C. albicans*, perhaps because of the incubation temperature used for cultures; no details of their spread can, therefore, be given except that, as seen in Fig. 1, the isolation of *C. guilliermondii* from the air was associated with its

TABLE IV

## LIST OF YEASTS OTHER THAN CANDIDA ALBICANS ISOLATED

Hospital Environment	Non-hospital Environment
<i>Candida guilliermondii</i>	<i>Candida guilliermondii</i>
<i>C. parapsilosis</i>	<i>C. parapsilosis</i>
<i>C. pseudotropicalis</i>	<i>C. pseudotropicalis</i>
<i>C. tropicalis</i>	<i>C. tropicalis</i>
<i>C. krusei</i>	<i>C. lipolytica</i>
	<i>C. mycoderma</i>
<i>Torulopsis glabrata</i>	<i>Torulopsis inconspicua</i>
<i>T. datilla</i>	
<i>T. famata</i>	
<i>Trichosporon cutaneum</i>	<i>Trichosporon cutaneum</i>
	<i>Rhodotorula species</i>
	<i>Sporobolomyces species</i>

appearance on the bedding. A list of the species found is given in Table IV.

## DISCUSSION

Although strict comparisons between the groups investigated cannot be made, there is a suggestion that hospital patients have a higher carrier rate of *C. albicans* than the people outside hospital. This agrees with the work of Vince (1959) who reported that 16% of healthy children carry *C. albicans* in the mouth but that 25% of children in hospital may do so. Marples and Di Menna (1952) found that adults had a higher carrier rate (50.5%) than children (37%) when all sources in the oral cavity were considered, but that the carrier rate on the gums was about the same in both groups (about 15%). Mackenzie (1961) isolated *C. albicans* from the throats of 34% of 79 hospital patients examined at random. Similar rates have been reported by Di Menna (1954) and Borowski, Kaminska, and Michalska (1963), although lower rates were recorded by Benham and Hopkins (1933). Allowing for differences in the actual site sampled, our results agree well with these findings.

It was found that the presence of *C. albicans* on the bedding was variable and that the mean size and size distribution of airborne particles carrying *C. albicans* was very similar to that of staphylococci. The presence of staphylococci in the air of wards and on bedding has been shown to depend on the presence of patients carrying, or infected with, the organisms (Noble, 1962). It seems possible that the mode of spread of *C. albicans* in hospital wards is similar to that of staphylococci, although more extensive studies are needed before this can be firmly established.

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