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Further studies on the sources of *Klebsiella aerogenes* in hospital patients

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SUMMARY

We report an investigation into faecal carriage of *Klebsiella aerogenes* and the distribution of this organism in the environment of three wards. In all three wards faecal carriage rates were high (60–70%). The faecal carriage rate increased with antibiotic administration and with length of in-patient stay. *K. aerogenes* was widely distributed in the ward environment and was found on the hands of nursing staff. Clusters of isolations of *K. aerogenes* of the same serotype were demonstrated indicating either patient-to-patient transfer or a common source of infection. The results indicate that even under conditions in which there are no outbreaks of *K. aerogenes* infection, there is a large reservoir of this organism both in the bowel of patients and in the ward environment.

INTRODUCTION

In a previous investigation (Cooke *et al.* 1979) we reported the incidence, in a general hospital, of infections due to *Klebsiella* spp. In that investigation we could demonstrate faecal carriage of the same serotype of the organism as that causing the infection in half the patients. We report here a study of the faecal carriage of *K. aerogenes* in patients in three hospital wards and of the distribution of this organism in the ward environment.

MATERIALS AND METHODS

Patients

Patients in three wards were studied. These were: 100 babies aged from a few days to eighteen months; many were admitted for surgery, either surgery of the bowel or neurosurgery; 75 women patients admitted to an orthopaedic ward; 24 patients admitted for open-heart surgery.

Samples

Faeces samples were obtained from patients as soon as possible after admission and thereafter at weekly intervals. In addition, from the patients undergoing open-heart surgery, we aimed to obtain specimens just before operation and post-operatively.

The environment was sampled on three occasions on the paediatric ward, once

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Table 1. *Intestinal carriage rates of* Klebsiella aerogenes *in three wards*

Ward	No. of specimens of faeces	No. klebsiella positive	No. of patients	No. klebsiella positive
Paediatric	350	162 (46%)	100	64 (64%)
Orthopaedic	127	83 (65%)	75	55 (73%)
Open-heart surgery	94	52 (55%)	24	18 (75%)

Table 2. *Length of in-patient stay and intestinal carriage of* Klebsiella aerogenes

Ward	Carriage rate during 1st week	Carriage rate at 4 weeks or more
Paediatric	20/43 (47%)	26/30 (87%)
Orthopaedic	22/33 (67%)	12/15 (80%)
Open-heart surgery	11/24 (46%)	3/6 (50%)

Table 3. *Effects of antibiotic administration on intestinal carriage of* Klebsiella aerogenes

Ward	Carriage rate in patients not given antibiotics	Carriage rate in patients given antibiotics
Paediatric	28/55 (51%)	36/45 (80%)
Orthopaedic	37/55 (67%)	18/20 (90%)
Open-heart surgery	All given antibiotics	18/24 (75%)

on the orthopaedic ward and weekly for twenty weeks on the open-heart surgery ward. Swabs were taken from a variety of surfaces and from sinks, flowers, soaps and lotions. Infant feeds and medicaments were also sampled. Settle plates were exposed. Nurses' hands were examined on 17 occasions on the paediatric ward as previously described (Shinebaum, Cooke & Brayson, 1979).

Isolation and identification of Klebsiella *spp.*

Isolation and identification was carried out as previously (Cooke *et al.* 1979). Typing was by the quellung technique supplemented when necessary by a klebecin sensitivity typing system (Edmondson & Cooke, 1979).

RESULTS

The faecal carriage rates of patients in the three wards are shown in Table 1 and the effects of length of in-patient stay and antibiotic administration in Tables 2 and 3.

When the serotypes of the strains isolated were examined it was found that a great many types were present. Of the 77 capsular types examined for (1–72, 74, 79, 80, 81 and 82) 53 were present on at least one occasion. The 24 types not found were 1, 4, 5, 6, 11, 14, 19, 25, 26, 42, 43, 46, 49, 53, 57, 58, 59, 65, 67, 69, 71, 79, 81 and 82.

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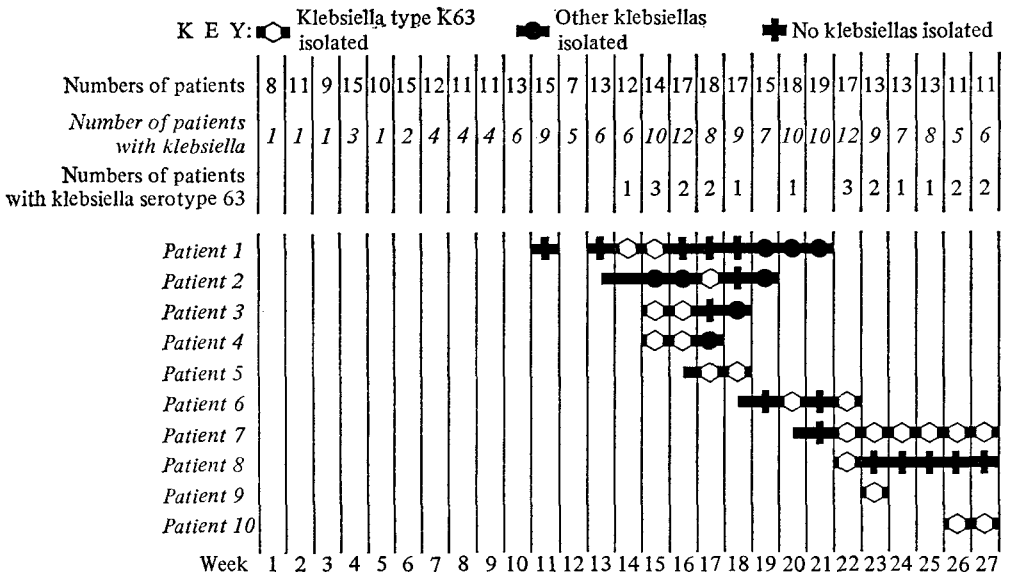

Fig. 1. Isolation of klebsiella serotype 63 from babies on a paediatric ward.

Table 4. Klebsiella aerogenes *in the environment of an open-heart surgery ward*

Site	No. of occasions on which examined	No. positive for *K. aerogenes*
Sinks	114	16 (14%)
Sink drains	124	50 (40%)
Surfaces	129	12 (9%)
Settle plates	112	3 (3%)
Flowers	26	9 (35%)
Flannels and toothbrushes	46	14 (30%)
Medicaments	87	0
Respirators	17	0

On all three wards clusters of isolates of the same serotype were found. On the paediatric ward serotypes 3, 55 and 63 were each isolated from a number of babies within a short period of time. Type 63 was isolated from nine babies over a period of 14 weeks at the end of the survey; no serotype 63 *K. aerogenes* being isolated during the previous 13 weeks of the survey (Fig. 1). The identity of this type was confirmed by klebecin typing. On the orthopaedic ward there were five small clusters; three patients with type 37 and two with types 28, 24/37, 31 and 35. On the open-heart surgery ward the clusters were of six patients with type 2, four with type 23/41, and four with type 47/52.

The only areas of the ward environment in the paediatric ward that were regularly contaminated with *K. aerogenes* were the soap dishes. *K. aerogenes* was not isolated from the soap itself but from the liquid which collected in the lower part

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of the dish. On two occasions the serotype present in the soap dish was the same as that carried by a baby in the same cubicle. Two investigations were carried out to determine how rapidly clean soap dishes became colonized with *K. aerogenes*. Of a total of 16 soap dishes examined, five were contaminated by the second day.

To determine whether *K. aerogenes* in the soap dishes was transferred to nurses' hands, on six occasions nurses' hands were examined before and after normal washing. On two occasions a klebsiella that was present in the soap dish was isolated from the nurses' hands after washing, but not before.

On two occasions *K. aerogenes* was isolated from settle plates. On one of these the organism was of the same type as that carried by a baby in the cubicle.

On two occasions *K. aerogenes* was isolated from nurses' hands; one was a type 51 from a nurse who was feeding a baby and one was a non-typable strain from a nurse who had just emptied a nappy bin.

K. aerogenes was not isolated from the commercially prepared feeds, the feeds prepared in the milk kitchen or from the baby food.

The results of the examination of the environment of the open-heart surgery ward are shown in Table 4. On eight occasions *K. aerogenes* of the same type as was present in the patients' faeces was present in the ward environment. On six occasions it was isolated from a sink-drain on the same part of the ward as the patient; on one occasion from a vase of flowers and on the other from the patient's own flannel and toothbrush.

In the single survey that was carried out on the orthopaedic ward, *K. aerogenes* was isolated from vases of flowers, a sink-drain and washed bedpans. None of the types isolated were also isolated from the patients' faeces.

DISCUSSION

High intestinal carriage rates of *K. aerogenes* have been demonstrated in patients on three hospital wards under conditions in which there was no outbreak of *K. aerogenes* infection. In addition, *K. aerogenes* was widely distributed in the ward environment and was also present on the hands of nursing staff. If all these isolates of *K. aerogenes* are potentially pathogenic, this indicates that there is a very large reservoir of these organisms able to cause infection when the situation on the ward becomes suitable.

The importance of intestinal colonization has been studied by Selden and co-workers (1971). In a situation in which infection by *Klebsiella* species was endemic, they found that of 162 patients studied, 30 carried *Klebsiella* species in the bowel on admission and 31 acquired them during the period of in-patient stay. Those patients who acquired this organism in the bowel were more likely to develop infection with it than were other patients. Selden and co-workers also demonstrated increased carriage of *Klebsiella* species with length of in-patient stay. This was shown clearly in this work also, on the paediatric ward, but was much less clear on the other two wards. The effect of antibiotic administration obtained here is also similar to that obtained by Selden and co-workers.

On a number of occasions on all the wards clusters of isolations of the same

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serotype were demonstrated indicating either patient-to-patient spread or a common source of infection.

The regular isolation of *K. aerogenes* from the environment and from the hands of nursing staff is of interest but it is difficult to assess the importance of the environmental strains. The isolation in this survey of the same types from the environment as from the patients' faeces indicates some transfer between the two.

In considering intestinal carriage of *K. aerogenes*, although we have some information about factors affecting it, we do not know the source of the strains nor the numbers of organisms which must be ingested to be detectable in the faeces. If the number is high, as in the case of *Pseudomonas aeruginosa* and *Escherichia coli* (Cooke & Buck, 1969; Cooke, Hettiaratchy & Buck, 1972) food is the most likely source of the organism, but there is some evidence that skin carriage may be more important with klebsiellas than in the case of other Gram-negative bacilli (Casewell & Phillips, 1977).

The most significant finding from this investigation is the large reservoir of *K. aerogenes* on wards in the absence of outbreaks of infection. *K. aerogenes* is widely distributed in the bowel of patients and in the ward environment. The control of infection due to *K. aerogenes* is perhaps best considered as the prevention of the conditions under which this organism causes infection, rather than attempting to eliminate its sources on the ward.

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