J. Hyg., Camb. (1978), **80**, 295
Printed in Great Britain

Epidemiological patterns of klebsiella colonization and infection in an intensive care ward

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(*Received* 12 *August* 1977)

SUMMARY

Twenty-four per cent of 2315 patients admitted to the intensive care unit of St Thomas's Hospital in the 4 year period from November 1969 became colonized or infected with *Klebsiella* species. Capsular typing of 986 klebsiella isolates from 551 patients showed that there were 695 patient-isolates, mostly derived from the respiratory tract. Capsular types 47 and 21 were the commonest types and together accounted for 19·9% of the patient-isolates. The 14 commonest types accounted for 47·3% of all patient-isolates and all these strains showed clustering, strongly suggesting a changing common source, cross infection, or both.

INTRODUCTION

Klebsiella species often colonize or infect intensive care patients. The emergence of klebsiella strains resistant to several antibiotics, including gentamicin (Martin, Ikari, Zimmerman & Weitz, 1971; Rennie & Duncan, 1977), has reinforced the need for a clearer understanding of the epidemiology of these organisms in this group of vulnerable patients. Published studies of common-source outbreaks (Bassett, 1971; Meers, Calder, Mazhar & Lawrie, 1973) have shed little light on the more subtle epidemiology of endemic klebsiella infection.

Until recently klebsiella typing has not been readily available in this country. Having established a method for capsular typing in this laboratory (Casewell, 1972, 1975) we considered that a close examination of clinical isolates from a single intensive care unit (I.C.U.), where patients receive particularly thorough routine bacteriological monitoring, would yield useful epidemiological information regarding the frequency distribution of the 75 capsular types and their distribution in time over a 4 year study period.

MATERIALS AND METHODS

Intensive-care ward

The 10-bedded multidisciplinary I.C.U. of St Thomas's Hospital has been described fully elsewhere (Bell, Bradley, Jenkins & Spencer, 1974). It does not include chronic haemodialysis or chronic respiratory patients, as special care units exist elsewhere within the District. Approximately one-third of all admissions require artificial ventilation and the machines used during the period of this study included Cape Mark I (Cape Engineering), 'Servo 900' (Siemens-Elema), and

Engstrom ER 150 and 300 (L.K.B. Medical). In September 1972 an 'Aseptor' (Draeger Medical) for formaldehyde disinfection of respiratory machines was introduced over the course of a few months (Phillips, King, Jenkins & Spencer, 1974).

Routine sampling

All patients in this ward received particularly thorough bacteriological monitoring. Not only were the appropriate bacteriological specimens sent for investigation at the earliest suggestion of infection but, where possible, tracheostomy wounds, tracheobronchial aspirates, sputum and urine specimens were examined every day. Swabs from accessible established lesions, such as wound infections, were also examined daily to detect pathogens and changes in flora. Whilst in use, ventilators were sampled daily from the waterbath humidifier, the inspiratory and expiratory limbs of the tubing connecting the ventilator to the patient, and the Y-piece adjacent to the patient. Catheter mounts were also sampled daily.

Isolation and typing of Klebsiella *spp.*

The clinical bacteriology laboratory has a separate section allocated for the examination of all I.C.U. specimens. Urines were cultured semiquantitatively on cystine-lactose-electrolyte-deficient agar, (Oxoid, C.L.E.D. agar CM 971). All other samples were inoculated on blood or MacConkey agar. *Klebsiella* spp. were identified by methods based on those of Cowan & Steel (1965). For the 4 year period from November 1969 all clinical klebsiella isolates were stored on nutrient agar slopes at room temperature until the capsular typing method had been established.

RESULTS

For the 4 year study period there were 2315 admissions. Of these patients 551 (24%) became colonized or infected with *Klebsiella* spp. The sites of origin of 904 specimens from these patients are shown in Table 1. A total of 986 colonies were biochemically identified as *Klebsiella* spp. (967 *K. aerogenes*, 7 *K. pneumoniae*, 8 *K. ozaenae* and 4 'intermediate' species): 18 isolates subsequently died and therefore were not available for typing. Of the remaining 968 isolates, 843 (87·1%) were successfully typed.

On 273 occasions the same serotype was isolated more than once from the same patient (all non-typable strains from any one patient being counted as one type). The frequency distribution of klebsiella capsular types among the remaining 695 patient-isolates is shown in Fig. 1, and Table 2 shows the frequency distribution and cumulative percentages of the 14 commonest serotypes.

During the 4 year period, patients were most commonly infected or colonized with types 47 and 21, these two types accounting for 13·1% of the 695 patient-isolates. The 14 commonest serotypes accounted for 47·3% of klebsiella isolates, a proportion that is significantly ($P < 0{\cdot}001$) greater than that expected for a random distribution of these types.

Figure 2 shows the distribution in time of the nine commonest serotypes. All these strains, together with the five next most common types (K74, K12, K44,

Table 1. *Sites of origin of* 904 *specimens yielding* Klebsiella *species*

Source of specimens	No. of specimens
Respirators	32
Respiratory tract	635
Urinary tract	96
Wounds	70
Abdominal	53
Blood cultures	11
Miscellaneous	7
Total	904

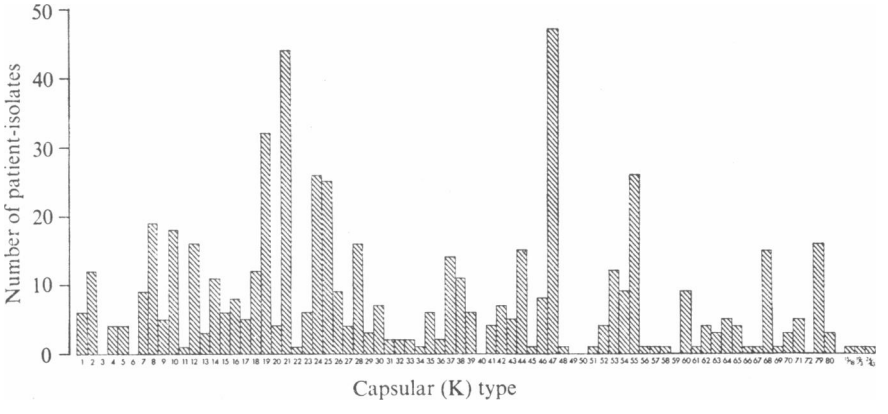

Fig. 1. Frequency distribution of *Klebsiella* capsular types among 695 patient-isolates (1969–73).

Table 2. *Frequency distribution and cumulative percentages of the* 14 *commonest serotypes of* 695 *patient-isolates* (1969–73)

Capsular (K) type	No. of patients	Cumulative % of 695 patient-isolates
47	47	6·8
21	44	13·1
19	32	17·7
55	26	21·4
24	26	25·2
25	25	28·8
8	19	31·5
10	18	34·1
28	16	36·4
74	16	38·7
12	16	41·0
44	15	43·1
68	15	45·3
37	14	47·3

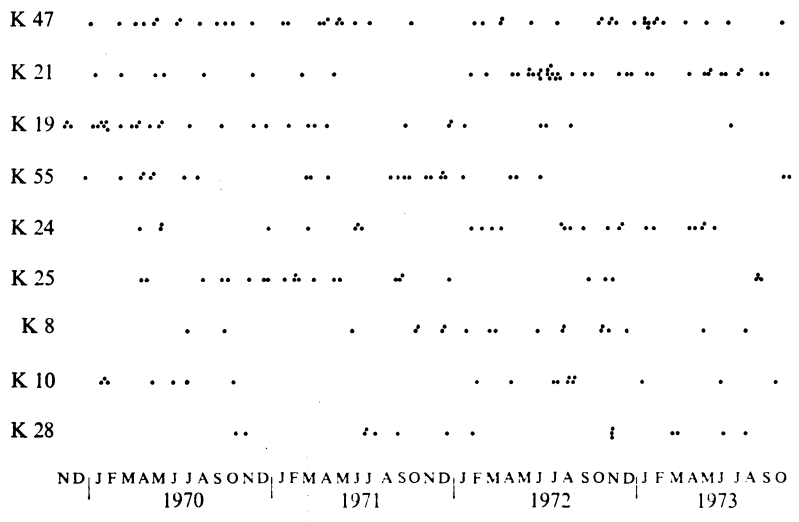

Fig. 2. Distribution in time of *Klebsiella* serotypes from intensive care patients. The nine commonest types all show clustering.

K68 and K37) appeared to have a non-random distribution and showed clustering, i.e. they were isolated from three or more different patients within the same 4-week period.

Clustering was obvious in strains that had a high total incidence, e.g. K47, K21 and K19 (Fig. 2), although a cluster of infection was occasionally seen with a strain of low incidence, e.g. K7 in May 1973 when 5 patients acquired this type within a 5 week period.

Although some serotypes such as K47 were isolated throughout the 4 year period, other types predominated for a few months and then were replaced by another. For example, Fig. 2 shows that in 1970 Type 19 was isolated from 17 patients, but in 1973 it was found in only one patient; type 21 was much more common during 1972 and 1973. Type K12 was one of the less frequent serotypes, but of 15 isolates 14 occurred during the first half of the 4 year period.

DISCUSSION

Our series of klebsiella typing results appears to be the largest published for a single unit, and it can be seen that a smaller collection from a larger part of any one hospital may have failed to identify the epidemiological patterns revealed in this study.

As expected, by far the commonest biochemical species was *K. aerogenes*, and it was not until these organisms had been capsular typed that the epidemiologically significant patterns of infection and colonization could be recognized.

Although nearly all the known 75 capsular types were represented in patient strains, certain capsular types occurred more commonly than others. Strains infecting or colonizing patients throughout the four year period must be regarded as definite endemic types. Furthermore, the 14 commonest serotypes accounted for as many as 47·3% of all isolates. These results do not indicate whether these

strains were especially able to colonize and infect patients. As we have not found these types to be particularly common in other wards of the hospital (Casewell & Phillips, 1977) this seems unlikely.

As there seem to have been no surveys of the frequency distribution of klebsiella capsular types found in a single ward or hospital in this country, it is not possible to compare the prevalent types found in this ward with those in other British hospitals. In Denmark, however, Ørskov (1955) recorded that Type 47, our commonest serotype, was the commonest (6·9%) serotype in 89 klebsiella strains derived from the sputum of in-patients from about 50 different hospitals.

Published studies from North America (Eickhoff, Steinhauer & Finland, 1966; Dans, Barrett, Casey & Finland, 1970; Martin, Yu & Washington, 1971) have not shown a particular prevalence of Type 47 or 21. In New Zealand in renal transplant patients (Montgomerie *et al.* 1970) there were no predominant serotypes in patients' infections but there were only nine infections and of these only five were typed.

The distribution in time of the 14 commonest strains showed a clear epidemiological pattern. These types occurred in clusters and could be isolated from at least 3, and sometimes as many as 17, patients within certain 4 week periods. Such clusters of infection suggest cross-infection, a changing common source, or both. Clearly, such patterns must be explained by any hypothesis on the epidemiology of klebsiellas in a ward of this kind.

We thank Mrs V. Dawes and Miss A. King for technical help. This study was supported by a grant from the Medical Research Council.

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