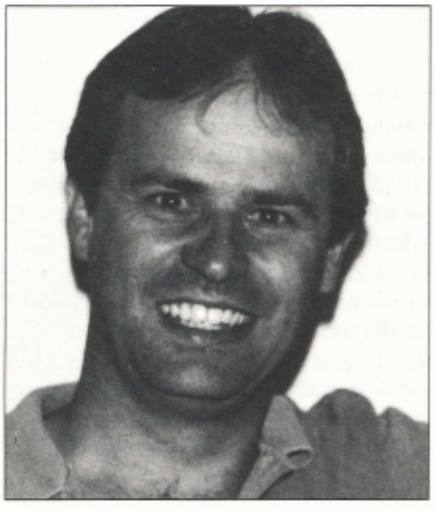
Outbreak of a Multiply-Resistant Klebsiella Infection in a Paediatric Ward at Frere Hospital — Dr Warwick Darlow



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Curriculum vitae

Warwick Darlow matriculated in East London at Cambridge High School and went on to obtain the MBChB at UCT in 1986. He did his internship at Frere Hospital before doing two years National Service in the SADF. He commenced the vocational training program at Frere Hospital in 1990 and registered as a part-time student at MEDUNSA for the MPrax Med degree. His interest is in Family Medicine.

Summary

An outbreak of Klebsiella pneumoniae septicaemia (KPS) was detected in a general paediatric ward at Frere Hospital. An investigation was made to determine the source as well as any contributory factors. The findings showed that this was a nosocomially acquired infection of low virulence. Mainly immunocompromised children within the ward were being infected, the probable source being handbasins in the ward, and the likely mode of transmission of the organism was by hand. The control measures instituted included admitting immunocompromised patients to other wards, rigid adherence to handwashing between patients and regular flushing of handbasins with a drain cleaner. In the three months following the implementation of these measures only one further patient with KPS was detected. This was felt to be due to the control measures instituted and underlined to us the importance of continual surveillance of blood culture results and strict adherence to accepted hygiene measures.

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KEYWORDS:
Klebsiella Infections; Child; Hygiene.

Introduction

It came to our attention that we were seeing an unusually high number of patients with Klebsiella pneumoniae septicaemia (KPS) when a closer look was taken at one patient in whom three consecutive blood cultures grew the same organism despite the patient having been put on the appropriate antibiotics (cefoxitin & amikacin – the second culture having been taken eight days after commencing the antibiotics and the third culture two days subsequent to the second). This occurred during May 1991 and a review of the other blood culture results from the ward over the period from January 1991 to May 1991 showed 15 patients with KPS.

We felt that we were dealing with a significant outbreak and needed to investigate to determine the source and any contributing factors so that control measures could be implemented.

The genus Klebsiella belongs to the Enterobacteriaceae group of organisms. Traditionally three species have comprised this genus, K pneumoniae, K ozaenae, and K rhinoscleromatis. More recently the indol-positive strains of K pneumoniae have been shown by DNA homology studies to be relatively unrelated to the indol-negative Klebsiella, and the CDC has recommended that they constitute a fourth species K oxytoca.[2] All are nonmotile and encapsulated. All strains ferment, lactose and on solid media produce large, mucoid colonies due to the prominent polysaccharide capsules. As with other pathogens, the capsule is believed to enhance the virulence of Klebsiella, although the mechanism is ill defined.

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It is accepted that patients with debilitating diseases are especially susceptible to K pneumoniae.[4] In our study 73% of patients were immunocompromised.

There are over 80 serotypes of K pneumoniae and this reflects the formidable task involved in defining the epidemiology of certain infections. Extensive studies of K pneumoniae infections have indicated that a relatively large proportion of infections are caused by a certain limited number of serotypes.[3] We were unable to serotype the K pneumoniae in our study for technical reasons.

Debilitated patients are particularly susceptible to KP infection

Klebsiella pneumoniae is an important nosocomial pathogen, accounting for up to 10% of the hospital acquired infections.[5] Multi-drug resistant strains of Klebsiella have become endemic in many hospitals.[6,7] Virtually all strains remain sensitive to amikacin, (this was the case with the outbreak at Frere Hospital), however, this agent should be reserved for gentamycin-resistant organisms. It has been observed that E coli is the most common nosocomially acquired pathogen and that K pneumoniae is the second most frequent.[8]

The gastrointestinal system is a known site for colonization by gram-negative rods that precedes other organ involvement or systemic infection.[9] Besides the gastrointestinal route there are clearly other pathways to invasion of the host. One of the most obvious mechanisms involve acquisition via exposure to contaminated inhalation therapy equipment. A wide variety of other sources for gram-negative rods invasion are possible including indwelling vascular catheters, monitoring devices, urinary tract catheters, drainage tubes, percutaneous resevoirs, contaminated intravenous fluids, and so forth. We tried to exclude as many of these as possible by swabbing or culturing any of the above which were in use in the ward.

Methods

Definition of terms

Klebsiella pneumoniae septicaemia

Any patient in the paediatric ward concerned from whom a blood culture was taken which grew a Klebsiella pneumoniae organism with the identical sensitivity pattern (viz: sensitive only to cefoxitin, netilmycin, amikacin and cefotaxime and resistant to sulphuroxazole, gentamycin, penicillin, trimethoprim, cefamandole, ampicillin/amoxycillin, chloramphenicol, tetracycline, tobramycin and pipericillin) was considered as having KPS. No facilities were available to do further typing of the organism, however we felt that the sensitivity pattern of this organism was specific enough for us to assume that it was the same organism in all the patients. All the patients had the blood cultures done in response to a spike in temperature. All patients (except one) had been admitted with some diagnosis other than suspected septicaemia and it was felt that this new spike in temperature represented a secondary septicaemia to their primary illness.

Immunocompromised Patients

Immunocompromised patients included those diagnosed with kwashiokor, marasmus, or measles. Kwashiokor was diagnosed in those with clinical features of the condition and with a low serum albumin and oedema. Those below 50% of expected weight, without oedema, were considered marasmic.[10] Measles was diagnosed on clinical features including erythematous maculopapular rash with fever and associated with, or preceded by, coryza, cough and conjunctivitis.[11]

Bottom pastes

Cream used on buttocks when nappies were changed.

Bottom bowls

Bowls used to discard dirty nappies when changing babies.

Neonates are considered to have an increased susceptibility to infection

Intervention

Once it came to our attention that we had a possible epidemic in the ward, a committee was formed to investigate the matter. In consultation with various experts the committee formulated the following action plan

1) An attempt was made not to admit any more patients to that ward, especially those considered at risk (eg malnourished/ immunocompromised patients).
2) Nursing staff from other wards

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were requested not to visit the ward.

3) All staff in the ward were reminded to wash hands after dealing with any patient and the sisters in the ward were requested to monitor whether this was being done.

4) Swabs and/or cultures were taken from the following to try and isolate a source

   i) Throat and hand swabs from: Day and Night nursing staff, Domestic Staff and Doctors in paediatric dept.

   ii) Cultures from all liquid soaps, handrinses and chlorhexidine solutions.

   iii) Cultures from all vacolitres and giving sets used.

   iv) Swabs from all drip sites when IVs removed.

   v) Swabs from all moisturising creams and bottom pastes.

   vi) A medifeed giving set from one patient.

   vii) Cultures from all oxygen humidifiers.

   viii) Cultures from all feeds used in the ward.

   ix) Swabs from all used bottom bowls.

   x) Swabs from all basins in each cubicle in the ward.

5) The blood culture records in the microbiology laboratory were examined and details of every patient in whom the KP was grown were extracted. From this the folders of the patients were traced and details were charted to determine common factors.

Results

Table 1 compares the number of KPS's against the total number of blood cultures sent from the ward and against all other "positive" blood cultures (all those that grew an organism including those considered contaminants).

vi) A medifeed giving set from one patient.

vii) Cultures from all oxygen humidifiers

viii) Cultures from all feeds used in the ward.

Table 1 Number of blood cultures positive for resistant Klebsiella pneumoniae compared with total number of cultures and all other positive blood cultures from the ward

Month	Total No B/C	KP (% Total B/C) (B/C = Blood Count)	All Other (% of) +VE B/C Total B/C
Jan	73	2 (2,7%)	25 (34%)
Feb	60	1 (1,7%)	15 (25%)
Mar	70	2 (2,7%)	13 (18%)
Apr	50	1 (2%)	13 (26%)
May	56	9 (16%)	12 (21%)
Total	309	15	78

X^2 18,6 df=1 p=0,0001 (Comparing May with the preceeding 4 months) From Table 1 it can be seen that during May 16% of the total blood cultures sent from the ward grew the KP compared with a minimum of 1,7% and a maximum of 2,7% over the preceding four months

Results of swabs and cultures

1) None of the following grew the KP

   i) Throat and hand swabs from: Day and Night nursing staff, Domestic Staff and Doctors in paediatric dept.

   ii) Cultures from all liquid soaps, handrinses and chlorhexidine solutions.

   iii) Cultures from all vacolitres and giving sets used.

   iv) Swabs from all drip sites when IVs removed.

   v) Swabs from all moisturising creams and bottom pastes.

2) KP was grown from one bottom bowl used by a patient with KPS.

3) Four out of the eight handbasins in the ward grew the KP.

Outcome of patients with Klebsiella pneumoniae septicaemia

One of the KPS patients died, the remaining patients all eventually being discharged from hospital. The patient who died had initially clinically improved from the septicaemia but subsequently deteriorated and developed a DIC before dying. A repeat blood culture before death failed to grow any organism.

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Table 2. Details of the individual patients diagnosed as having Klebsiella Pneumoniae Septicaemia

Name	Age in Months	Admission Date	Diagnosis	Investigation	Treatment
AG	8/12	5/5/91	Gastro-Enteritis (GE)	B/C 17/5 = No Growth (NG) B/C 31/5 = KP	IV R/H (Rehydration) Pen/Genta/Bactrim/ Erythro/TPN
NX	3/12	8/5/91	Pneumonia Kwashiokor	B/C 8/5 = NG B/C 14/5, 22/5, 24/5 = KP	Pen/Mefoxin/ Amikacin/Claforan/ Chloro
RM	13/12	13/5/91	GE, Kwashiokor	B/C 17/5 = S Epiderm B/C 27/5 = KP	IV R/H Pen/Genta/ Mefoxin/Amikacin
AT	12/12	19/5/91	GE, Kwashiokor O Media	B/C 21/5 = NG B/C 29/5 = KP	Ampi/Genta Bact/ Erythro/Mefoxin
NM	18/12	22/4/91	GE, Kwashiokor	B/C 27/4 = NG B/C 12/5 = KP	Ampi/Genta/Mefoxin
YK	3/12	22/2/91	GE, Marasmus	B/C 4/3 = KP	Pen/Genta Mefoxin/ Cefril
LM	1/12	25/4/91	Pneumonia Marasmus	B/C 2/5 = KP	Pen/Genta/Mefoxin/ Amik
OM	14/12	21/4/91	GE, Measles	B/C 21/4 = NG B/C 26/4 = NG B/C 10/5 = KP	Pen VK Bactrim/ Ampi/Netilmycin/ Amkacin/Flagyl/ Acyclovir
LM	1/12	15/4/91	GE	B/C 2/5 = KP	IV R/H Bactrim/ Erythro
AM	0,5/12	23/4/91	Pneumonia	B/C 23/4 = NG B/C 9/5 = KP	Pen/Genta/ Netilmycin/Mefoxin
OZ	8/12	22/5/91	GE, Pneumonia Kwashiokor	B/C 22/5 = KP	Ampi/Genta/ Amikacin/Claforan

The above data was abstracted from patient's records; only 11 of the 15 were found!

B/C = Blood count; NG = No Growth; R/H = Rehydration

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Discussion

Fifteen patients with septicaemia due to a single organism from one ward over a five month period, is probably a significant outbreak. Especially as there was a definite clustering from late April to the end of May 1991. (See Figure 1) There was also a statistically significant increase in the proportion of blood cultures growing KP during May compared with the four preceding months. Morgan, et al found 12 patients with a Klebsiella pneumoniae septicaemia over a nine month period and this was considered a significant outbreak.[1] This however was in a neonatal ICU where the patient population differs from a general paediatric ward. The number of admissions per annum was virtually equal in both wards.

It was considered whether the outbreak was not as a result of the increased number of malnourished (and therefore immuno-compromised) children in the ward. Figure 2 shows that there was a peak in the number of malnourished patients admitted to the ward in April, this was the month when most of the KPS patients were admitted. This, together with the fact that most of the KPS patients were malnourished, indicates that there was an association between the outbreak and the number of malnourished children in the ward.

Reviewing the data abstracted from the patients' records the following emerged:

1) 7 (64%) patients had a negative blood culture before the blood culture that grew the KP. The mean stay in hospital of all patients, before the blood culture was taken which grew the KP, was thirteen days. This, together with the fact that the blood cultures were all taken within 48 hours of a spike in patient's temperature, provides strong support for the opinion that this was a nosocomially acquired infection.

2) 8 (73%) were noted to be immunocompromised in some way (either Kwashiokor, marasmus or measles). It has been

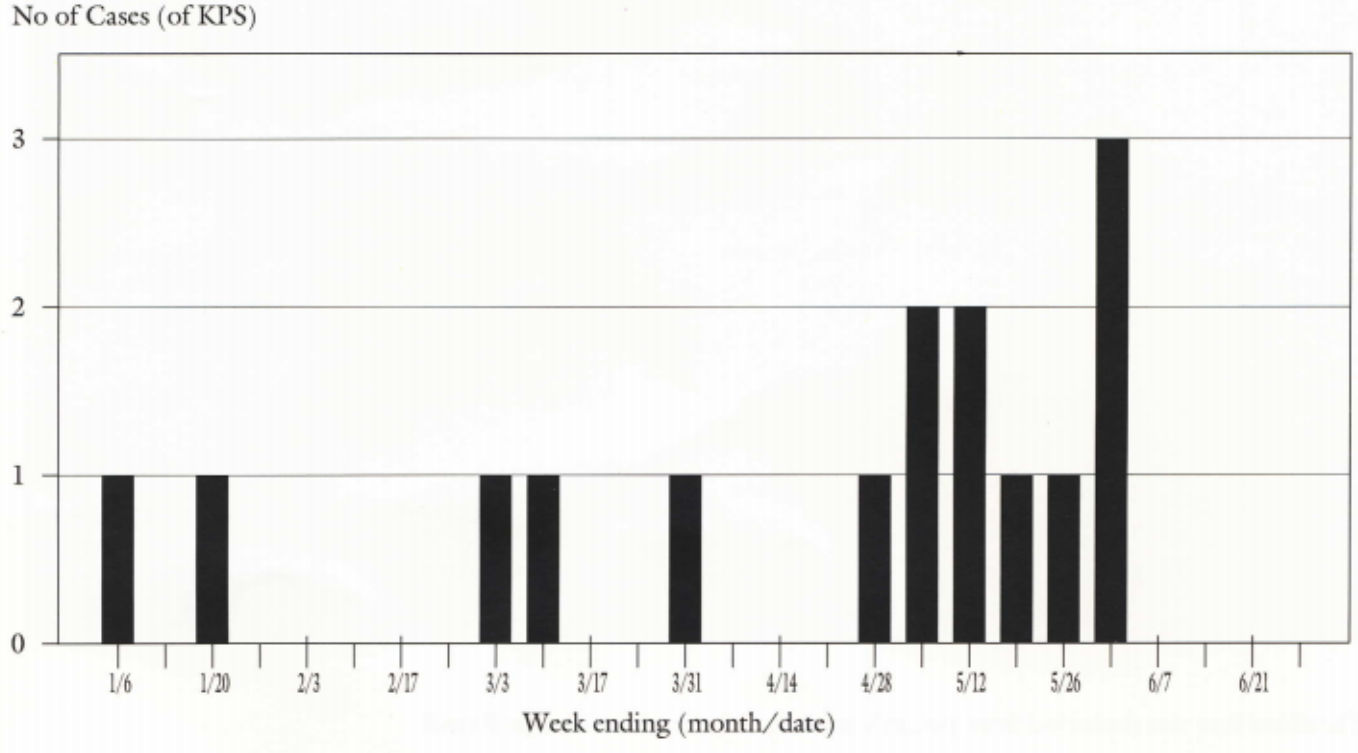

Figure 1 shows the number of KPS's seen in the ward from January 1991 to May 1991.

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shown that debilitated patients are particularly susceptible to KP infection.[4]

3) Two of the patients recovered without being given appropriate antibiotics, and neither of these were immunocompromised as in (2) above. The only other patient not noted to be immunocompromised was 2 weeks old on admission, and generally neonates are considered to have an increased susceptibility to infection.[12] The fact that only one of the patients died, the rest all eventually being discharged home, also supports the hypothesis that this organism was of low virulence. The cause of death of the patient who died was not proven. A blood culture taken shortly before death failed to grow any organism. It is possible that the death was due to complications of the initial diagnosis of gastro-enteritis, pneumonia and kwashiokor and unrelated to the KPS.

Records for only 11 of the 15 patients were found. This is a weakness of the study, however the striking common factors found in the eleven records examined cannot be dismissed. There is a likelihood of some of the KP cultures being contaminants and not true septicaemias. There was no standardised blood culturing technique and blood cultures were taken by four different medical officers as well as by nursing sisters in the ward. However, all the blood cultures (except one) were taken as a result of a spiking temperature in children admitted for reasons other than suspected septicaemia. Only one patient grew the KP on a blood culture taken on admission. This patient had been referred to us from a peripheral hospital where he had been an inpatient for 14 days prior to referral. This raised the question as to whether this was a contaminant or

Figure 2. Graph of Malnourished Patients Admitted

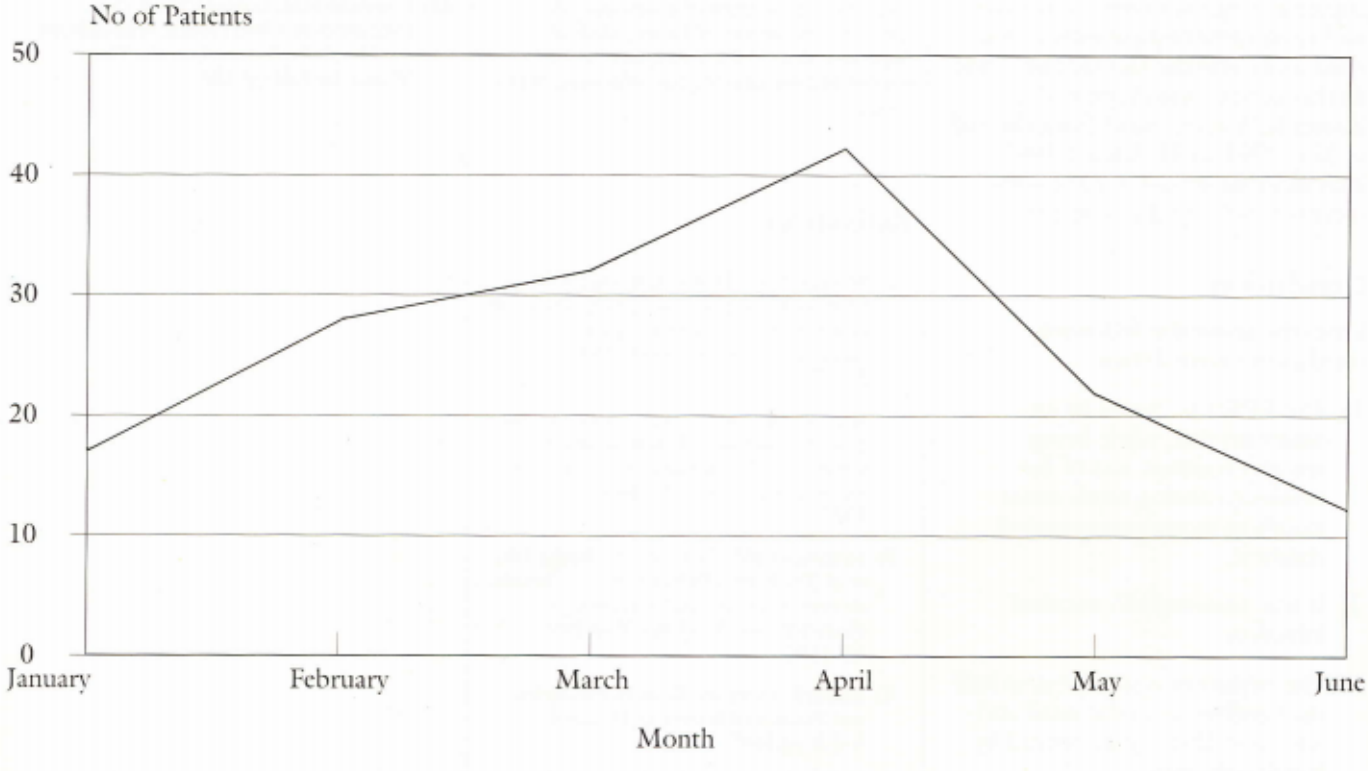

Figure 2 is a graph showing the number of malnourished (kwashiokor and marasmus) patients admitted between January and June 1991.

whether the organism is present in other hospitals. This was not followed up, and is possibly something which should be done in the future.

The control strategies implemented were basic common sense measures (viz: accepted hygiene standards coupled with the observation that mainly immunocompromised children were being infected). The only additional measure taken after the results of the study were known, was to flush the handbasins in the ward on a weekly basis with a drain cleaner (containing caustic soda), something which had not been done previously.

Approximately three weeks after implementing the control measures we began admitting patients to the ward again and the fact that only one further patient was diagnosed as having KPS in the ward from the end of May 1991 to 31 August 1991 indicates that we did achieve some success in solving the problem.

Conclusion

From the above the following conclusions were drawn:

1) The KPS was caused by an organism that, while being *multiply resistant,* was of *low virulence,* causing septicaemia mainly in *immunocompromised* children.
2) It was a *nosocomially acquired* infection.
3) The organism was present in half the handbasins in the ward and was most likely being spread by hand to the patients.

Increased awareness of the above, again stressed the importance of rigid adherence to the requirements of handwashing and other similar hygiene measures in all hospital wards, especially where there are large numbers of immunocompromised patients. Also stressed was the importance of reviewing results of investigations like blood cultures, especially where patients are being cared for by different doctors and where trends like a small outbreak of a particular infection may be missed.

Acknowledgements

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