CROSS INFECTION IN THE ARTIFICIAL KIDNEY UNIT

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Infection is frequent and serious in patients with acute renal failure, for not only does the original illness predispose to infection but uraemia itself appears to depress immunological mechanisms\(^1\). Routine blood cultures show that about 30% of seriously ill patients with essentially recoverable renal lesions have a positive blood culture at some time during their period of anuria.

In Newcastle upon Tyne when patients first arrive on the Kidney Unit infection is frequently present. Of surgical renal failure patients admitted in 1964, 40% had a staphylococcal infection on admission, 38% had a chest infection (all organisms), 46% had a wound infection (all organisms) and 77% had infection somewhere (all organisms).

We chose to study Staphylococcus aureus as an index of infection in general, because it is the commonest single infecting organism in patients when they arrive on the unit, and of cross infection in particular because of the facilities which exist for phage typing.

The aim is to eliminate infection already present and to prevent new infection from developing - a much more difficult task\(^2\). 'Asepsis' is obviously preferable to 'antisepsis', for the metabolism of antibiotics in patients with renal failure is variable and there is a distinct risk of drug complications and of breeding further resistant organisms. That this is possible has been shown in transplant units where patients are nursed aseptically while their antibacterial systems are depressed. However, this not only requires a specially constructed unit separate from the rest of the hospital but it is formidable in the expenditure of personnel time.

One doctor and eight nurses are required to care for one patient. In a unit such as ours, where the number of patients varies from 4 - 12 at any one time, 96 nurses and 12 doctors would be required. A compromise is therefore necessary. We have gradually increased the rigour of segregation of anuric patients in 3 main steps without an increase in either medical or nursing staff.

Prior to and including 1962 we used 'Fever Hospital' barrier nursing, which is effective in the isolation of enteric infections. The patient was in a cubicle with 'Barrier Nursing' marked on the door. A mask was worn by all entering the cubicle and if the patient or his effects were to be touched, the hands were washed (Figure 1). A short-sleeved gown, which hung inside the cubicle and was changed daily, was put on (Figure 2).

This method was not successful in preventing cross infection in kidney patients (Figure 3). This graph shows the cumulative % of patients with a staphylococcal infection of any severity, from boils to septicemia, according to length of stay on the unit. Saprophytic staphylococci were not included. Thus in 1962 20% of patients either came with or developed a staphylococcal infection by the end of their first week in the unit. This percentage increases with length of hospitalization until, by 4 weeks, 58% of patients were so infected.

The unit was seldom free from staphylococci. On top of a fairly steady background of infection there were superimposed epidemics occurring

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every two to three months, usually following the admission of a patient with a heavy open staphylococcal infection. These patients, coming from dif-
ferent hospitals, had staphylococci of differing phage types which enabled us to follow the spread of a single organism. The phage type was constant from epidemic to epidemic and was usually different from that prevalent in the hospital as a whole. Nasal swabs from medical and nursing staff showed only occasional colonization by resistant staphylococci, usually of the phage type prevalent in the rest of the hospital, so we concluded that staphylococcal infection was spreading within the unit from patient to patient.

As a result of this situation, changes were made in 1963. A cupboard containing long-sleeved autoclaved gowns was outside the cubicle, each gown being worn only once. The gowns, unless soiled, were re-autoclaved without washing. Disposable polythene gloves supplemented hand washing and, as before, disposable masks were worn (Figure 4). Referring to Figure 3; for 1963 it can be seen that there was a decrease in infection with this regime. This decrease is significant at the 5% level but as we were by this time dialysing slightly more frequently and had altered the cannula-
tion technique, this improvement was probably due to a combination of factors and not solely to the more stringent barrier nursing. During the 6 months we carried out this type of barrier nursing 2 epidemics occurred, but neither lasted so long nor spread to so many patients as in 1962. With both of the previous types of barrier nursing it was easy to neglect the precautions, as the cubicles opened directly on to the ward corridor.

By May 1964 we had acquired cubicles with positive pressure filtered ventilation. The cubicles are entered through an airlock containing dispos-
able gloves, masks, facilities for hand washing and autoclaved gowns in individual packets (Figure 5). Figure 6 shows a nurse dressed ready to go into the cubicle - mask, gloves and gown, which is tied with a single waist-
tie for speed. An intercom, which incorporates radio and television sound, links the patient to the nursing station (Figure 7). In spite of this attempt to reduce the necessity for nursing staff visits, the cubicle doors are open-
ed at least 50 times a day when the patient is seriously ill.

By referring again to Figure 3 it can be seen that there has been a further drop in infection. Although no case of frank cross infection has occurred as yet, we have evidence that cross colonization is occurring.

During the 1964 study swabs were taken routinely from the usual carrier sites (nose, throat, axilla, groins and perineum) when patients began and ended barrier nursing, and at weekly intervals while they were in the cubicles, in addition to the usual cultures from wounds, sputum, urine and blood. These demonstrated two examples of cross colonization, but not infection, occurring at two weeks after admission in one patient and at three weeks after admission in another.

We therefore looked critically for remediable loopholes in the present system. The most obvious is that the patient must leave the barrier nursing cubicle for dialysis. Our dialysing room is a considerable distance from the ward, two floors down, and is not a modified operating theatre. However, the cubicles are small and not equipped for efficient bath water changes. By the end of a six-hour dialysis the bath water is heavily con-
taminated with bacteria - usually Pseudomonas pyocyaneus and Proteus
vulgaris. As we find it impossible not to spill some bath water when emptying the dialyser in the cubicle, dialysis there would at present contaminate the cubicle itself. We are therefore developing a modified Kolff twin-coil kidney which retains its efficiency but uses a single continuous passage of bath water from a tank in the attic and out down the sink. This reduces bath water contamination and subsequent contamination of the cubicle. It will also enable us to dialyse more than one patient at once, without an increase in medical staff (Figure 8).

Another loophole is the number of medical and nursing staff visits to the cubicle, approximately 50 per day. This may be cut down by an increasing in monitoring equipment.

More complete coverage of street clothes, including theatre caps and shoe covers, is also necessary. Masks could be totally occlusive instead of merely deflective, as they are at present. Instead of using gowns, caps and shoe covers, a single complete covering garment such as a 'siren' suit may be more effective.

REFERENCES

Figure 1. Barrier Nursing type 1 - handwashing and mask.

Figure 2. Barrier Nursing type 1 - short sleeved gown.

Figure 3. % patients with staphylococcal infection related to length of stay in A.K.U.

Figure 4. Barrier Nursing type 2 - long sleeved gown, mask and gloves outside cubicle.
Figure 5. Barrier Nursing type 3 - air lock entry to Barrier Nursing cubicle.

Figure 6. Barrier Nursing type 3 - nurse entering cubicle.

Figure 7. Intercom linking patient to nursing station.

Figure 8. Dialysis in cubicle using enclosed twin coil and single pass dialysing fluid.
THE CHAIRMAN, G. RICHET (Paris): L'analyse logique du problème qu'a fait le Dr. Clarkson est excellente. Les propositions qu'elle a énoncées sont toutes extrêmement souhaitables. Pour ceux d'entre nous qui ont à construire ou à moderniser une unité de rein artificiel, il faudra prévoir l'organisation architecturale en fonction du danger de l'infection. Je voudrais poser une question à Miss Clarkson : est-ce qu'elle utilise à Newcastle une circulation d'air à pression positive?

B. CLARKSON (Newcastle upon Tyne): Yes, we do use a positive pressure air circulation in the cubicles.

M.G. McGEOWN (Belfast): I should like to ask Dr. Clarkson what she has done about foot coverage. Feet obviously walk from one part of the hospital to another and must be a likely source of cross-infection. She mentioned foot coverage, and this is a difficult problem. What sort of foot covering would she recommend?

B. CLARKSON (Newcastle upon Tyne): We have on order disposable shoe covers which have not yet come after being on order for six months. These are just simple shoe covers which will quickly pull on over the shoes. If we do try siren suits we intend that they should include a covering for the shoes.

J.S. CAMERON (London): You are not alone in having to wait six months for some things! You have obviously shown very well that you have cut down the incidence of cross-infection as measured bacteriologically, but you have not said anything - and I think I and others might like to know more - about what this reduction has meant in terms of patient morbidity and patient mortality. That is to say, how much do the bacteria matter? I should imagine that most of the people in this room have baths for their artificial kidneys in which they grow pyocyanes, and if they do not they probably have not looked!

The question is, does it matter? Could you tell us in these terms what the results have been?

B. CLARKSON (Newcastle upon Tyne): We have been using this new system of barrier nursing for less than six months now, so anything I have to say is an impression rather than definite information. We have no evidence at present that staphylococci are spreading from the dialyzing bath, but with the lessening of staphylococcal infection we are finding that pyocyanes and proteus infections are increasing in seriousness in the patients. We think that in due course they are going to be as serious as the staphylococcus is at present. Certainly we have the impression - again an impression - that patients who do not have infection recover very much more quickly than those with infection; in fact, this is definite. But I have no figures, I am afraid, at present.

V.C. MARSHALL (Melbourne): Following on the last speaker's point, do you not feel that Gram-negative infection is a greater problem now? It has seemed to us that Gram-negative infection now greatly outweighs staphylococcal infection. On this point, we have some recent evidence that the bacteriostatic effect of blood decreases, both with reference to staphylococcal and Gram-negative organisms as the urea level rises. The critical level appears to lie about at 250 mg.% . It would seem to us that adequate
control of uraemia by dialysis has been of much greater importance in reducing this.

B. CLARKSON (Newcastle upon Tyne): I agree that this is true and, as I say, we are now dialyzing much more frequently, but 40 per cent of surgical renal failure patients - this includes post-traumatic and post-operative - have a fairly serious staphylococcal infection on admission to the unit. The impression is that staphylococcal infection has seemed to spread very easily, so with us it is still a very serious problem.

S. SHALDON (London): I got the impression, Dr. Clarkson, that you thought that the modern treatment of uraemia played a part in the reduction of cross-infection. If you carry your treatment to its logical conclusion, that is the prophylactic treatment of uraemia, do you really think that these patients require the rigorous isolation that you are putting them in? From the point of view of the morale of the patient, it must be quite depressing to be isolated from the rest of the ward. Do you really think it would be necessary if you were able completely to control uraemia during the hypercatabolic phase?

B. CLARKSON (Newcastle upon Tyne): I think it would still be essential. These patients are ill in themselves, let alone with their uraemia, many of them have large operation wounds, the majority of them have bad chest infections, and any ill patient is liable to infection whether he is uraemic or not, as I am sure any surgeon could tell you. Therefore, I think that this isolation is going to continue to be important.

D. S. KERR (Newcastle upon Tyne): Could I just add one point on that? As Dr. Clarkson has said, the artificial kidney unit contains a large number of ill patients, and I think we have a particular responsibility because, by virtue of having an artificial kidney, we concentrate seriously ill patients with cross-infection problems in one place. Therefore, we have to bear the responsibility for preventing cross-infection more than many other straight-forward surgical units.