The role of clinical microbiologists in infectious disease management

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All infectious disease consultations directed to the clinical microbiologists at the Queen Mary Hospital in February 1995 were analysed. A total of 95 written and 111 telephone consultations were received. Fifty three percent of the written consultations involved patients with persistent fever despite multiple antimicrobial therapy. Of all written consultations, gram positive bacteria, gram negative bacteria, and fungi were encountered in 39%, 31%, and 19%, respectively. The majority of written consultations (55%) were from surgical units. In contrast, 65% of telephone consultations came from medical and paediatric units. This study indicated that a wide spectrum of infectious disease problems—both diagnostic and therapeutic—were encountered by clinical microbiologists. The unique combination of laboratory skill and clinical infectious disease knowledge gives the microbiologist a distinctive advantage in assisting clinicians to provide optimal care to patients suffering from infection.

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Introduction

Problems related to infectious disease are common challenges to clinicians practising in almost any field of medicine. With the rapid advance of medical science, it is increasingly difficult for frontline clinicians to update their knowledge in the fields of clinical microbiology, infectious disease, and antimicrobial chemotherapy. The availability of an infectious disease consultative service would be helpful to practising clinicians, who in turn would upgrade the standard of care given to patients suffering from infection. Such a specialist service has historically been rendered by clinical microbiologists in the United Kingdom and infectious disease physicians in the United States. In Hong Kong, clinical microbiologists are a rare species, existing only in large hospitals. Many clinicians are either unaware of their existence, or merely associate them with laboratory technicians or managers. In this paper, we attempt to introduce and document the role and contributions of clinical microbiologists by reviewing their daily routine service. Service duties can broadly be divided into the following categories:

1. Answering telephone consultations. These provide a rapid and direct means of communication with clinicians to tackle less complicated problems.
2. Responding to clinical consultations at the request of clinicians. A full assessment with follow-up is essential for complicated infectious disease problems.
3. Conducting laboratory bench rounds to solve laboratory diagnostic problems raised by laboratory staff. This in turn can improve the quality of laboratory reports which have a direct impact on the diagnosis and care of patients.
4. Alerting clinicians to unusual laboratory findings by providing unsolicited clinical comments after patient assessment.
5. The checking and issuing of laboratory reports.
6. Investigating suspected outbreaks of nosocomial infections.

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7. Liaising with the Department of Health in community outbreaks of infections with epidemic potential, such as cholera.
8. Relaying information to the public, mass media, and other institutions who are interested in certain issues of infection. This is a form of public health education.

This brief review aims to highlight the first and second categories: how clinical microbiologists, by their proficiency in infectious disease and microbiology, bring the resources of the laboratory to the bedside.

Materials and methods

All telephone and written clinical consultations during the one-month period of February 1995, directed to clinical microbiologists from clinicians in various specialties at a large teaching hospital (Queen Mary Hospital) were included in this study. Written clinical consultations, demographic data, the clinical problem to be addressed, and known diagnoses or infections were recorded on an agreed standard consultation form used for all interdepartmental consultations.

Written clinical consultations

The procedure of handling written clinical consultations was as follows:

1. Computer review

After receiving a consultation form, a search of all the results of the patient's previous microbiological tests ordered since admission was made on our network computer (using the identity number of each inpatient). A chronological print-out containing the type of clinical specimens, their laboratory accession numbers, dates of request, and reported results was obtained.

2. Bench update

For those specimens with results pending, the clinical microbiologist obtained from the relevant benches, the best available information before going to see the patient on the ward.

3. Ward visit and chart review

A thorough review of the patient's medical record was followed by the taking of a further history and conduction of a physical examination in order to ascertain the presence and/or the location of any infective focus. The type of antimicrobial agents used, positive cultures from normally sterile body sites, and other relevant investigative findings such as new radiographic changes were marked on the temperature chart chronologically.

4. Management recommendations

After analysing all the available clinical and microbiological findings, a working diagnosis and appropriate recommendations were written in the patient's record.

5. Provision of further tests

When further clinical specimens were needed for rapid diagnostic tests, the clinical microbiologist would collect and transport the specimens himself. Such specimens included needle aspirates of skin lesions, semiquantitative samples of surgical wounds, and punch biopsies, in addition to routine clinical specimens. Rapid diagnostic tests were performed when clinically indicated. Reports and further recommendations were discussed by telephone with the clinician-in-charge.

6. Follow-up

Patients were followed until they improved or died. Further amendments to clinical management were made in the light of new clinical and microbiological findings.

Telephone consultations

The clinical specialty of the enquiring clinician, the nature of the questions raised, and the response (including recommendations) to questions were recorded. In general, responses could be classified as:

1. Immediate reply by telephone.
2. Literature search, discussion during the clinical microbiologist's round followed by telephoning the recommendations back to the clinicians.
3. Eliciting a written clinical consultation.

The findings from a review of the recorded data are shown in Tables 1 to 5.

Results and discussion

During the one-month study period, 95 written clinical consultations and 111 telephone consultations were received by the clinical microbiologists (Table 1). Of the 95 patients seen with written clinical consultations, ages ranged from nine months to 90 years (mean 52.6 years) and the male to female ratio was 2:1. While the majority (55%) of clinical consultations were requested by the surgical department, 65% of the telephone consultations came from the medical and paediatric departments. This disparity reflects a different demand in the mode of delivery of infectious disease service. Physicians and paediatricians tend to seek from telephone consultations, updated literature and laboratory information to support their decisions in the management of patients, whereas surgical colleagues welcome a comprehensive clinical assessment by the clinical microbiologist. Understandably, telephone consultation is the only option available to other hospitals with-

Table 1. Types of consultative service utilised by various specialties

Clinical specialties	Written clinical consultation n = 95 (%)	Telephone consultation n = 111 (%)
Medical	20 (21)	39 (35)
Surgical	52 (55)	16 (14)
Paediatric	4 (4)	33 (30)
Orthopaedic	14 (15)	1 (1)
Others	5 (5)	22 (20)*

* Including 14 (13%) telephone consultations from other hospitals

out such a consultative service, and these constituted 13% of the consultations.

Written clinical consultations

As expected, persistent fever despite multiple antimicrobial therapy (53%) remained the most important reason for requesting the help of clinical microbiologists (Table 2). Of these 49 patients, 88% had received at least two antibiotics before being assessed. The mean number of antibiotics received by surgical and medical patients before consultation were 2.3 and 3.8 respectively. The difference in the amount of empirical or directed antimicrobial therapy reflects the difference in the threshold of consultation by the two specialties. Apart from fever, other important symptoms requiring our attention were persistent diarrhoea and unexplained cutaneous or soft tissue lesions (16%). Unexplained radiological findings, persistent leukocytosis, and unusual histopathology reports (13%) were common investigative findings that raised the suspicion of an ongoing infective process. Given a positive microbiological culture report, another common problem encountered by clinicians was the differentiation between colonising flora and pathogens (8%) to which specific antimicrobial therapy should be directed. Therapeutic difficulties (6%) related to specific clinical situations where information on the choice, duration, and/or mode of administration of

Table 2. Clinical problems specified by clinicians in written clinical consultations

Clinical problems to be addressed	n = 95 (%)
Persistent fever despite multiple antimicrobial therapy	49 (53)
Unexplained cutaneous or soft tissue lesions*	10 (11)
Differentiation between colonisers and pathogens in clinical isolates	8 (8)
Unexplained radiological findings†	7 (7)
Choice, duration, and/or mode of administration of antimicrobials	6 (6)
Persistent diarrhoea	5 (5)
Persistent leukocytosis	3 (3)
Unexplained histological findings‡	3 (3)
Miscellaneous	4 (4)

* Including rash, abscesses, chronic ulcers, and necrotising fasciitis

† Including chest radiographic shadows, ultrasonographic cystic hepatic lesions, hypodense magnetic resonance imaging cerebral lesions, and hypodense computerised tomography scan hepatic lesions

‡ Including poorly-formed granuloma of fistula-in-ano, hepatic granuloma, and septic vasculitis

Table 3. Spectrum of common diseases seen in clinical consultations

Common diseases	No.
Known infections	
Sepsis in compromised hosts*	34
Postoperative nosocomial infections†	29
Prosthetic implant infections	7
Infective endocarditis	5
New diagnoses documented after consultation	
Catheter-related thrombophlebitis	8
Antibiotic-induced fever and/or rash	3
Clostridium difficile-related diarrhoea	2
Others‡	8

* Including neutropenic fever, sepsis in patients with solid organ tumour, cirrhosis, uraemia, systemic lupus erythematosus, and sepsis after bone marrow or solid organ transplantation

† Including pneumonia, tertiary peritonitis, subphrenic abscess, meningitis, and cholangitis

‡ Including infective endocarditis, nosocomial pneumonia, pulmonary aspergillosis, and muco-cutaneous candidiasis

antimicrobials could not be easily found in the available literature, constituted the remaining problems.

The input of the clinical microbiologist in the management of these problems may be summarised as follows:

1. Finding additional clinical clues on history taking and physical examination that contributed to revised diagnoses (10%).
2. Collecting further clinical specimens for examination or ordering additional routine tests (45%).
3. Arranging rapid diagnostic tests that give preliminary information including direct staining of specimens (e.g. Gram, Ziehl-Neelsen, Gomori silver, India ink) and antigen detection (e.g. latex agglutination test for *Cryptococcus neoformans* and counter-immunoelectrophoresis for common encapsulated bacteria) (46%).
4. Suggesting addition of other antimicrobial agents, or altering the dose or route of administration of currently administered antimicrobial agents (76%).
5. Stopping treatment with unnecessary antimicrobial agents (14%).
6. Suggesting modifications to therapy (e.g. the removal of catheters, the need for surgical drainage, vaccination, and the use of immunoglobulin in 13% of patients).
7. Arranging therapeutic drug monitoring (immunoassays, bioassays, and serum bactericidal titre in 24% of patients).
8. Arranging additional antimicrobial susceptibility tests (disc diffusion tests, broth dilution MIC, MBC, antifungal and antimycobacterial susceptibility tests in 28% of patients).

Obviously, the most prominent contribution by clinical microbiologists was related to antimicrobial chemotherapy.[1] In 76% of cases, a change of antimicrobial agents, a different dosage and/or route of administration were suggested to cover appropriate pathogens or to replace the original antimicrobials with less expensive but equally effective alternatives. In 14% of cases, antimicrobial agents were considered to be unnecessary. The Gram smear constituted the most important test for rapid diagnosis and for the differentiation of colonisers from pathogens in 37 cases.

The majority of cases from the surgical and orthopaedic departments were associated with postoperative nosocomial infections and prosthetic implant infections, respectively. Those from the medical and paediatric departments were concerned with infections in immunocompromised hosts, especially those with neutropenia, and recipients of bone marrow or solid organ transplants. The most important nosocomial infections found in written consultations were intravascular catheter-related thrombophlebitis and bacteraemia. Second in importance were antibiotic-related complications including drug fever, rash, hepatotoxicity, nephrotoxicity, and *Clostridium difficile*-related diarrhoea.

The type of documented pathogens again reflected the spectrum of infectious diseases encountered in the setting of a teaching hospital. Given the frequency of intravascular catheter-related sepsis, it is not surprising to find that gram positive bacteria (especially methicillin-resistant *Staphylococcus* spp.) are now more prevalent than the multi-resistant gram negative bacteria. Since the first local report of penicillin-resistant *Streptococcus pneumoniae* in 1990,[2] the rate of penicillin resistance in *S pneumoniae* isolates has increased from 0.2% to 13%. Unlike methicillin-resistant staphylococcal infections which are usually

Table 4. Spectrum of significant pathogens encountered at clinical consultation

Pathogens	n = 105 (%)*
Bacteria	
Gram positive bacteria (Subtotal)	41 (39)
Methicillin-susceptible *Staphylococcus aureus*	7
Methicillin-resistant *Staphylococcus aureus*	12
Methicillin-resistant *Staphylococcus epidermidis*	5
Streptococcus pneumoniae	3
Clostridium difficile	3
Corynebacterium JK	3
Others†	8
Gram negative bacteria (Subtotal)	33 (31)
Multi-resistant aerobic gram negative bacilli‡	31
Salmonella spp.	2
Mycobacteria	8 (8)
Mycobacterium tuberculosis	5
Mycobacterium marinum	3
Fungi	20 (19)
Candida spp.	17
Others§	3
Viruses and parasites	3 (3)
Herpes simplex virus, Cytomegalovirus	2
Strongyloides stercoralis	1

* One patient may have more than one documented pathogen

† *Propionibacterium* spp., *Eubacterium* spp., *Streptococcus pyogenes*, viridans streptococci

‡ *Xanthomonas maltophilia*, *Pseudomonas aeruginosa*, *Acinetobacter anitratus*, *Flavobacterium* spp., Enterobacteriaceae.

§ *Aspergillus* spp., *Cryptococcus neoformans*, *Rhodotorula* spp.

hospital-acquired, penicillin-resistant *S pneumoniae* can cause serious community-acquired infections.

Fungal infections are increasingly important due to an increased population of immunosuppressed patients, the use of indwelling catheters, and antecedent use of broad spectrum antibiotics. In one of our cases, unsuspected invasive pulmonary aspergillosis was diagnosed in a patient who had been treated for two weeks with dexamethasone and then given intravenous imipenem, vancomycin, and netilmicin for unremitting fever. Potassium hydroxide examination of her tracheal aspirate was performed by the microbiologist which showed the presence of septate hyphae with dichotomous branching. Amphotericin B was commenced and later followed by itraconazole. Culture subsequently confirmed the presence of *Aspergillus fumigatus*. Generally, clinicians perceive fungi and mycobacteria as more difficult microbes to treat and tend to seek the assistance of clinical microbiologists when these are encountered.

Telephone consultations

Problems discussed over the telephone were usually limited to the relay of information, particularly regarding microbiological tests. Advice on the type of microbiological investigation for a specific clinical setting, the availability, collection, or mode of transportation of certain specimens for newer tests such as polymerase chain reaction assay, and the interpretation of a test result were the commonest questions. Further susceptibility testing for other antibiotics and advice on the choice of antibiotics for multi-resistant organisms were sought in patients with either drug allergy, or renal/liver dysfunction.

Overall, only 4% of the telephone consultations led to a written clinical consultation. The clinical microbiologist was able to provide a straightforward and comprehensive answer in 87% of cases. For example, we received an enquiry regarding the interpretation of a blood culture report positive for gentamicin-resistant methicillin-resistant *Staphylococcus aureus* (MRSA). The patient developed urticarial rash after intravenous vancomycin for two days. The clinician wanted to know whether intravenous netilmicin could be used alone in such a circumstance. Our reply was that intravenous teicoplanin should be used with close monitoring for cross-hypersensitivity because there were reports of successful use of intravenous teicoplanin in patients with hypersensitivity to vancomycin. Netilmicin is not reliable once an MRSA has been found to be gentamicin-resistant, because this indicates the presence of an aminoglycoside-

Table 5. Spectrum of problems encountered in telephone consultations

Problem	n = 111 (%)
Request for advice on microbiological investigations in a specific clinical situation	37 (33)
Request for a special test, enquiry as to its availability, guidance on specimen collection and transport	19 (17)
Interpretation of laboratory reports	18 (16)
Request for additional antimicrobial susceptibility tests	12 (10)
Verbal communication on the urgency of a written clinical consultation	5 (5)
Choice of antibiotics in special clinical situations	4 (4)
Tracing of updated laboratory results	4 (4)
Miscellaneous	12 (11)

modifying enzyme active against both gentamicin and netilmicin. In more complicated cases (9%), a literature search and discussion with colleagues was necessary before the consultation could be answered.

We have attempted to outline the role and contributions of clinical microbiologists in the management of infectious diseases. A detailed description of the consultative procedure has been provided as a working format for our trainees. The information collected during the consultation procedure may be used to audit the output and workload of the clinical microbiologist. The spectrum of problems met and the needs of various specialties for assistance are important factors in the future allocation of resources and manpower for clinical microbiology departments.

Currently, most medical graduates tend to ignore the specialty of clinical microbiology, considering it to have little to do with direct patient care and poor career prospects. In reality, the career path of clinical microbiologists (or infectious disease physicians) can be quite diverse and ranges from clinical practice to clinical microbiology, hospital epidemiology to public health, and from academic research to the pharmaceutical industry. Furthermore, as with other clinical specialties, such as cardiology or urology, a set of clinical approaches and laboratory techniques have been developed in clinical microbiology to enable microbiologists to tackle infectious disease problems. It is high time that their expertise and resources were fully utilised to optimise patient care.

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