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Inpatient Emergencies Encountered by an Infectious Disease Consultative Service

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The spectrum of infectious disease (ID) emergencies in hospitalized patients was assessed in a prospective study of 3,626 inpatient ID consultations in a 1,350-bed teaching hospital. ID emergencies, defined by a need or anticipated need for advanced life support or by irreversible organ damage leading to permanent functional loss, were encountered in 175 patients. Infections of the central nervous system (26.3%), cardiovascular system (14.9%), alimentary system (13.1%), and lower respiratory tract (7.4%) and adverse reactions to antimicrobial agents (7.4%) were most common. In 18.9% of the cases, the referring clinicians were unaware of the emergency at the time of referral. Drug reactions (46.1%), severe alimentary and peritoneal infections (32.0%), upper respiratory tract infections (28.6%), and skin and soft-tissue infections (27.3%) were most frequently missed. The emergency ID conditions were not recognized because they had an atypical presentation (51.5%), were not commonly seen in the referring specialty (24.2%), were due to rare organisms (15.2%), or had unusual anatomical sites of involvement (9.1%). A close liaison between clinicians and the ID team is crucial for recognition of ID emergencies at their early stages so that appropriate investigations and management can be instituted expeditiously, before the occurrence of irreversible damage.

Infectious diseases (IDs) can present as medical emergencies that require immediate attention to prevent irreversible local tissue or whole-organ damage. Clinicians in any medical subspecialty are expected to be proficient in the diagnosis and management of commonly encountered ID emergencies. New, re-emerging, or drug-resistant pathogens have increasingly caused outbreaks in community and hospital settings [1–4]. This circumstance has fueled an exponential expansion of knowledge in infectious diseases, clinical microbiology, and antimicrobial chemotherapeutics and a correspondingly unsurpassed degree of complexity in the management of such patients.

Physicians and surgeons are generally familiar with infectious (or noninfectious) emergencies that are related to their own specialties. Despite a vast amount of literature on the possible serious consequences of IDs, the pattern of occurrence of ID emergencies in inpatients has never been addressed, and the degree of clinical awareness about such events is unknown. With a view to increasing awareness of such issues and facilitating higher standards of care, a prospective study was undertaken to evaluate the extent to which such emergencies are encountered and recognized among inpatients of an acute-care general hospital.

Patients and Methods

Data were collected prospectively over 28 months (July 1994 to October 1996) on patients referred for ID consultations in

our 1,350-bed teaching hospital (Queen Mary Hospital, Hong Kong). In addition to providing general and emergency medical services, the hospital also serves as a major center for bone marrow, kidney, liver, and skin transplantations. Consultations with the ID service were arranged either by phone or in writing. Each day one attending ID consultant and two residents (the team of the month) were responsible for responding to referrals.

When phone consultations were deemed to warrant a patient visit, a written consultation request would be solicited. Consultation requests were submitted in a standard format from various clinical specialties, including internal medicine, pediatrics, surgery, orthopedics, oncology and radiotherapy, and obstetrics and gynecology. All written consultation requests were attended to and relevant details were recorded. Pertinent details included demographic data, a brief medical history, a presumptive diagnosis, and the reasons/clinical problems prompting the consultation.

Handling of consultations. The procedure for handling clinical consultations was as described by Yuen et al. [5]. Before each patient was attended to, a list of the respective microbiological investigations already requested and of available results was printed from the laboratory information system. Test results were further updated by a visit to the relevant specimen-processing bench, and additional rapid tests were performed if necessary. At the bedside, clinical information was elicited from the patient, and relevant charts and records were reviewed. A working diagnosis and recommendations for further management were then communicated to the attending clinician; additional specimens might also be taken for rapid tests or conventional microbiological studies. The literature was reviewed for specific cases. Each patient was followed up for determining subsequent progress, and selected cases were also discussed in the weekly ID service round.

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Definition of ID emergencies. For the purposes of this study, an ID emergency was defined as any clinically and microbiologically documented infection that by itself or as a complication of its treatment was liable to result in (1) irreversible local tissue or organ damage, permanent functional loss, or imminent death without urgent medical or surgical intervention or (2) progressive systemic inflammatory response syndrome, to the extent that advanced life support or intensive care would soon be required [6].

Whether a referred case constituted an ID emergency was determined with use of the above criteria by the attending ID consultant, who followed the progress of the patient both clinically and microbiologically. Clinically suspected emergencies that could not be confirmed subsequently by microbiological tests were not included.

Assessing awareness of ID emergency. Nonawareness of the emergency on the part of the referring clinicians was defined according to the following criteria: (1) lack of specification of the urgent nature of the case on the consultation request form or during phone communication; (2) implementation of a treatment plan inappropriate for the emergency, as evident in the case notes; or (3) solicitation of an ID consultation after a prolonged delay (>24 hours) following the onset of relevant (although possibly subtle) symptoms or signs or the availability of investigation results indicating the emergency.

Data analysis. Demographic information, including the sex and age of the patients, and the specialty of the referring physicians were recorded. Clinical data were categorized and analyzed according to the type of infection, relevant microorganisms isolated, awareness of the emergency on the part of the referring physician, reasons for classifying the case as a medical emergency, and management modalities suggested by the ID team. The type of infection was classified according to the organ system involved or the acute problem initiating the consultation.

Results

There were 3,626 inpatient ID consultations over the study period, of which 175 (4.8%) were classified as ID emergencies.

The demographic characteristics of this group of patients are shown in table 1.

Categorization of these cases with respect to organ systems (table 2) revealed that involvement of the CNS, including the eye, was the most common (26.3%). The majority of these patients had bacterial or fungal meningitis, including infections due to *Cryptococcus neoformans* and *Mycobacterium tuberculosis*. They entailed presentations such as status epilepticus, focal neurological deficits, pressure effects on the spinal cord, and visual impairment, depending on the infection site. Cardiovascular infections were the second commonest group. Aortitis or vascular graft infection caused by *Salmonella* species was present in three cases. In addition to fever, heart murmur, and embolic phenomena, clinical presentations resulting from mechanical and electrical dysfunction were also encountered.

There were five respiratory tract ID emergencies with the potential for upper airway obstruction. For example, a bone marrow transplant recipient had a retropharyngeal abscess with postconditioning mucositis presenting as dysphonia. Most ID emergencies of the lower respiratory tract were caused by pyogenic bacteria and presented with deteriorating respiratory function. Other agents included *Aspergillus* species, *M. tuberculosis*, *Pneumocystis carinii*, and cytomegalovirus (CMV).

With regard to gastrointestinal ID emergencies, two cases of procedure-related mediastinitis were documented, one related to esophageal perforation after upper endoscopy and the other to insertion of a Sengstaken-Blakemore tube. Tertiary peritonitis not responding to standard antimicrobial treatment with β -lactam antibiotics, aminoglycoside, and metronidazole constituted a major problem; resistant bacteria or fungi colonizing the gastrointestinal tract and failure to eliminate the source were the main causes.

In the skin and soft tissue category, the main ID emergency was necrotizing fasciitis with a rapidly advancing edge. Incriminated pathogens included *Streptococcus pyogenes* and *Vibrio vulnificus*, while in some cases the infection was polymicrobial. Bone and joint ID emergencies often entailed a high probability of cartilage destruction. The majority were due to methicillin-susceptible *Staphylococcus aureus*.

Table 1. Demographic characteristics of patients and clinicians' unawareness of the ID emergency (IDE) before soliciting the infectious disease consultation.

| Clinicians' specialty | No. of patients with IDE | | Patient age range | Clinician unaware of IDE: no. (%) of IDEs |
|---------------------------|--------------------------|-------------|-------------------|---|
| | Total | Male:female | | |
| Medical | 73 | 37:36 | 15–80 y | 11 (15.1) |
| Surgical | 59 | 35:24 | 9 mo to 81 y | 9 (15.3) |
| Orthopedics | 25 | 18:7 | 20–89 y | 9 (36) |
| Pediatrics | 14 | 9:5 | 1 mo to 15 y | 3 (21.4) |
| Radiotherapy | 2 | 1:1 | 58–69 y | 1 (50) |
| Obstetrics and gynecology | 2 | 0:2 | 27–71 y | 0 |
| Total | 175 | 100:75 | 1 mo to 89 y | 33 (18.9) |

In this study, drug-induced problems such as Stevens-Johnson syndrome, other allergic reactions, organ dysfunction, and bone marrow suppression were a major cause of ID emergencies, with a variety of manifestations such as hearing and vision loss. In the category of severe sepsis, clinical conditions encountered included toxic shock syndrome and severe systemic melioidosis. Most of the immunocompromised patients had the systemic inflammatory response syndrome, resulting from fulminant infection. One liver transplant recipient had disseminated CMV infection, and another had fulminant hepatitis due to Epstein-Barr virus.

Overall, 18.9% of the cases were not recognized as emergencies when first referred to the ID team. These are summarized in table 3. Most commonly, clinicians did not appreciate the gravity of the conditions because they had atypical presenting features or presented in an atypical clinical setting (51.5%), were not commonly encountered in a particular specialty (24.2%), were due to a rare organism (15.2%), or had unusual anatomical sites of involvement (9.1%).

The most significant contribution of ID specialists to the management of ID emergencies was the recommendation of appropriate antimicrobial treatment, with reference to the clinical setting and probable underlying etiologic agents (58.2%). Symptoms and signs that were subtle but relevant to an ID emergency were noted in almost 10% of the patients. Although not commonly given, advice regarding surgical intervention was lifesaving in nine cases. Suggested procedures included urgent extensive debridement for necrotizing fasciitis, early aortic graft surgery for an infected aortic aneurysm, and surgical repair of a perforated esophagus following Sengstaken-Blakemore tube insertion. Other advice included isolating the patient for infection control and preemptive intubation.

Discussion

ID emergencies are not uncommon. However, even in a classical ID textbook [7], only intracranial infection, bacteremia, and fulminant pneumonia are included in the relevant chapter. As demonstrated in this descriptive study, in practice the spectrum of ID emergencies manifesting in an inpatient setting is much wider. Moreover, ID emergencies in special patient groups such as bone marrow transplant recipients were probably underrepresented, because in our setting ID specialists were an integral part of the patient care team. Except for the two cases of acute *Streptococcus suis* meningitis, the ID emergencies described in this report could be encountered in any locality.

All infections may initially be minor and appear innocuous, such as cellulitis developing from an inapparent skin wound. However, if uncontrolled by the host defense mechanisms or appropriate therapy, ID emergencies may result, including group A streptococcal necrotizing fasciitis and *S. suis* meningitis. It is essential that diagnoses be made when the area of necrosis or extent of meningeal involvement is still limited. At this early stage, even though the pathology has been established

Table 2. Distribution and percentage of unawareness (by clinicians) of ID emergencies (IDEs).

| System involved and/or disease entity | No. of cases | Unawareness of IDE: no. (%) of cases |
|--|--------------|--------------------------------------|
| CNS and eye | 46 | 9 (19.6) |
| Acute meningitis | 27 | |
| Cerebral/epidural abscess | 14 | |
| Cytomegalovirus retinitis | 2 | |
| Other | 3 | |
| Cardiovascular | 26 | 3 (11.5) |
| Infective endocarditis | 23 | |
| Infected aortic aneurysm/graft | 3 | |
| Upper respiratory tract | 7 | 2 (28.6) |
| Imminent upper airway obstruction, e.g., mucositis/abscess | 5 | |
| Fungal sinusitis | 1 | |
| Cavernous sinus thrombosis | 1 | |
| Lower respiratory tract | 13 | 1 (7.7) |
| Fulminant pneumonia | 11 | |
| Miliary tuberculosis | 1 | |
| Cavitary pneumonia with pneumothorax | 1 | |
| Alimentary system and peritoneum | 25 | 8 (32.0) |
| Procedure-related mediastinitis | 2 | |
| Tertiary peritonitis | 19 | |
| Toxic megacolon | 3 | |
| Neutropenic ileocectitis | 1 | |
| Skin and soft tissue | 11 | 3 (27.3) |
| Necrotizing fasciitis | 9 | |
| Gas gangrene | 1 | |
| Orbital cellulitis | 1 | |
| Bone and joint | 7 | 1 (14.2) |
| Pyogenic arthritis | 7 | |
| Severe sepsis | 12 | 0 |
| Sepsis in immunocompromised patients | 11 | 0 |
| Drug-induced | 13 | 6 (46.1) |
| Hepatitis/renal failure | 7 | |
| Xanthopsia/hearing loss | 2 | |
| Allergic reaction | 3 | |
| Convulsion | 1 | |
| Other* | 4 | 0 |

* Includes tetanus, severe falciparum malaria, hantavirus-induced hemorrhagic fever with renal syndrome, and chicken pox in the oncology ward.

and bacteria could be isolated from tissues or CSF, the clinical signs may not be typical. Nevertheless, the benefit of correct treatment at this stage is greatest.

Similarly, drug-induced morbilliform rash is not an ID emergency, but erythema multiforme involving the mucosa heralds one. It may be too late if an ID emergency is declared only when frank skin exfoliation or gastrointestinal bleeding occurs. Critical complications may not be clinically obvious, as illustrated in a case of esophageal perforation in which the diagnosis could be suspected only by the radiopaque collection of basic aluminum sucrose sulfate (sucralfate) on a chest radiograph (case 13, table 3).

Table 3. Infectious disease emergencies not recognized by referring clinicians.

| Organ system involved, patient no./sex/age (y); specialty of clinician | Presumptive diagnosis and empirical treatment by referring clinician | Clues implicating an infectious disease emergency | Final diagnosis | Contribution by the infectious disease team |
|--|---|---|---|--|
| CNS and eye | | | | |
| 1/M/36; medical | Group D streptococcal bacteremia; fever despite usual dosage of iv amoxicillin-clavulanate | Partial sensorineural deafness; worked as a butcher | <i>Streptococcus suis</i> meningitis | Lumbar puncture to document meningitis; meningitic dose of iv penicillin G |
| 2/F/69; medical | Group D streptococcal bacteremia with CVA; fever despite usual dosage of iv penicillin | Partial sensorineural deafness | <i>S. suis</i> meningitis with ruptured mycotic aneurysm | CT scan of brain and lumbar puncture to document meningitis; meningitic dose of iv penicillin G |
| 3/F/56; medical | Persistent community-acquired pneumonia, fever, and confusion despite antibiotics | History of rash; elevated hepatic enzyme levels; thrombocytopenia | Rickettsial encephalitis | Immunofluorescence test for <i>Rickettsia typhi</i> antibodies showed 64-fold increase in 7 d |
| 4/F/26; medical | Viral encephalitis and persistent low-grade fever | Low CSF glucose level, high protein level and cell count, mild 3rd cranial nerve paresis | Tuberculous meningitis | CT scan to document hydrocephalus; antituberculous therapy and steroid administration |
| 5/F/32; medical | Headache, vomiting, fever; <i>Plasmodium vivax</i> parasitemia despite oral chloroquine | CT scan showing cerebral edema | Vivax malaria with cerebral edema | IV quinine and doxycycline |
| 6/M/71; surgical | Total parenteral nutrition following gastrectomy; fever despite multiple antibiotics | Tender spot at L1 spinal level and bilateral lower-limb weakness | Candidal osteomyelitis, epidural abscess and cord compression | CT scan to document osteomyelitis; central venous catheter culture and blood culture yielded <i>Candida parapsilosis</i> |
| 7/F/69; oncology | Nasopharyngeal carcinoma post-radiotherapy; dexamethasone therapy for bilateral temporal-lobe radionecrosis; recent onset of confusion and persistent fever | Lumbar puncture findings normal; fundal changes of retinitis | CMV retinitis | CMV pp65 antigen test positive (143/10 ⁵ WBCs); iv ganciclovir |
| 8/F/53; medical | Steroid and methotrexate therapy for rheumatoid arthritis; low-grade fever; visual blurring; perianal ulcer | Fundal changes of retinitis | CMV retinitis | CMV pp65 antigen test positive (196/10 ⁵ WBCs); iv ganciclovir |
| 9/M/71; surgical | Carcinoma of bladder with resection and ileal conduit; persistent fever, confusion, and urinary infection despite iv ceftriaxone; creatinine clearance of 20 mL/min | Left eye congested, with cloudiness in anterior chamber; urine culture positive for <i>Candida albicans</i> (>10 ⁵ cfu/mL) | Candidal endophthalmitis and candidemia | Urgent consultation with ophthalmologist for vitreous aspiration and intravitreal amphotericin B; started iv fluconazole and flucytosine |
| Cardiovascular system | | | | |
| 10/M/53; surgical | Back pain, hematuria, and fever; <i>Salmonella enteritidis</i> bacteremia and bacteriuria; fever not responding to iv ampicillin | Vague pulsatile mass in epigastrium (obese patient); splinter hemorrhages | <i>S. enteritidis</i> aortitis and leaking aneurysm | CT scan with contrast for documentation of leaking aortic aneurysm; iv ceftriaxone and early aortic graft surgery |
| 11/F/66; medical | Dementia; diabetic ulcers involving multiple toes and persistent low-grade fever | Right groin surgical scar and lymphedema of right lower limb | Infected aortofemoral bypass graft | Multiple blood cultures yielding MRSE; CT scan to document periprosthetic collection; early removal of graft and below-knee amputation |
| 12/F/19; surgical | Right intracerebral hemorrhage, hydrocephalus, and external ventricular drainage; persistent fever | CSF culture positive for <i>Haemophilus aphrophilus</i> ; mitral regurgitation murmur | Infective endocarditis with mycotic aneurysm | Echocardiogram confirming mitral valve endocarditis |

Table 3. (Continued)

| Organ system involved, patient no./sex/age (y); specialty of clinician | Presumptive diagnosis and empirical treatment by referring clinician | Clues implicating an infectious disease emergency | Final diagnosis | Contribution by the infectious disease team |
|--|---|---|--|---|
| Alimentary system and peritoneum | | | | |
| 13/M/48; surgical | Aspiration pneumonia related to Sengstaken-Blakemore tube; HCV cirrhosis; persistent fever despite antibiotics | Chest radiographic finding of radiopaque collection at lower retrocardiac area | Sengstaken-Blakemore tube-induced traumatic esophageal leakage; mediastinitis | CT scan documentation of leaked sucralfate; surgical intervention expedited |
| 14/M/1; pediatrics | Neutropenic fever not responding to iv ceftazidime and amikacin | Progressive increase in abdominal distention | Neutropenic ileocectitis; blood culture positive for <i>Burkholderia pickettii</i> | Conservative treatment; added iv metronidazole and ampicillin |
| 15, 16/M, F/3, 2 $\frac{1}{2}$; pediatrics | Persistent fever and <i>Salmonella enteritidis/Shigella flexneri</i> gastroenteritis; history of anti-diarrheal agents | Progressive abdominal distention; abdominal radiography: transverse colon diameter >6 cm | Toxic megacolon | Conservative treatment; iv ceftriaxone and metronidazole |
| 17–19/M, F, M/56, 73, 64; surgical | Multiple laparotomies for perforated viscus; ventilation-weaning failure; poor nasogastric tube feeding; persistent fever despite antibiotic treatment | Signs of sepsis, including elevated serum alkaline phosphatase level; worsening pleural effusion after operation | Tertiary peritonitis due to <i>C. albicans</i> , enterococci, MRSA, and/or <i>Pseudomonas aeruginosa</i> | Ultrasonography or contrast CT scan to demonstrate fluid loculations; surgical exploration and antibiotics as directed by findings of gram smear of peritoneal specimens and susceptibility results |
| 20/M/52; surgical | Persistent fever despite iv antibiotics; debridement and T-tube drainage for acute pancreatitis | Pleural fluid yielded <i>Candida albicans</i> | Tertiary peritonitis | Re-exploration and debridement; tube-thoracostomy of left pleural cavity |
| Respiratory tract | | | | |
| 21/F/21; medical | Persistent fever despite multiple antibiotics; cerebral lupus on immunosuppressive treatment; nosocomial pneumonia | Pancytopenia; increased hepatic parenchymal enzyme levels; interstitial pneumonitis; fundal changes of retinitis | Disseminated CMV disease with retinal and pulmonary involvement | BAL specimen culture positive for CMV and cytology positive for owl eye inclusions, CMV pp65 antigenemia test positive (146/10 ⁵ WBCs); iv ganciclovir treatment |
| 22/M/35; medical | Day 46 post-BMT, immunosuppression for acute GVHD; persistent fever despite absolute neutrophil count of $2.4 \times 10^9/\text{mL}$ and multiple antibiotics | Right ear pain and discharge; mild right facial nerve palsy | Malignant otitis externa with extension to temporal lobe due to <i>Aspergillus niger</i> | CT scan documenting erosion of petrous temporal bone; ear discharge positive for septate hyphae with dichotomous branching; surgical intervention |
| 23/F/33; medical | Post-conditioning with Bu-Cy-TBI for allogeneic BMT because of AML (first relapse); persistent fever despite iv imipenem, vancomycin, acyclovir, and amphotericin B | Dysphonia, loss of laryngeal grating; blood culture positive for <i>Streptococcus mitis</i> | Severe mucositis with impending airway obstruction | Elective intubation and ventilation |
| Bone and joint | | | | |
| 24/F/49; orthopedics | Right-hip arthritis with persistent severe right hip pain and marked limitation of movement; fever not responding to iv cefuroxime | Persistent blood culture positivity for MSSA; right-hip aspirate negative for WBCs and bacteria; pelvic compression/distraction test positive; chronic anal fissure | Right sacroiliac joint arthritis | Bone scan and indium 111 WBC scan confirming right sacroiliac joint arthritis; high-dose iv cloxacillin and gentamicin |

Table 3. (Continued)

| Organ system involved, patient no./sex/age (y); specialty of clinician | Presumptive diagnosis and empirical treatment by referring clinician | Clues implicating an infectious disease emergency | Final diagnosis | Contribution by the infectious disease team |
|--|---|--|--|--|
| Skin and soft tissues | | | | |
| 25/F/52; medical | Infected diabetic ulcer and cellulitis of both legs; progressive deterioration and fever despite iv antibiotics | Systemic upset and local pain out of proportion to the cellulitis | Necrotizing fasciitis due to <i>Vibrio vulnificus</i> | Needle aspirate of lesion edge contained gram-negative curved rods; right below-knee amputation; left leg debridement; iv ciprofloxacin/gentamicin |
| 26, 27/M, F/71, 69; orthopedics | Persistent fever and cellulitis of right forearm/left leg despite iv ampicillin and cloxacillin | Systemic upset and local pain out of proportion to the cellulitis | Necrotizing fasciitis with <i>Streptococcus pyogenes</i> | Amputation and iv penicillin and rifampin |
| Antimicrobial-related adverse reactions | | | | |
| 28, 29/F, F/63, 82; orthopedics | Infected hip prosthesis; persistent fever despite iv cloxacillin (2 cases) or cefuroxime (1 case) | Low neutrophil counts ($0.6-1.3 \times 10^9/L$) and platelet counts ($78-94 \times 10^9/L$; erythema multiforme with mucosal involvement in both patients after >10 d of iv antibiotics) | β -lactam-drug induced Stevens-Johnson syndrome and marrow suppression | Stopped all β -lactam antibiotics; subsequently replaced with erythromycin or ciprofloxacin |
| 30, 31/M, M/42, 54; orthopedics | Tuberculosis of spine and wrist; persistent fever despite treatment | Severe nausea | Drug-induced hepatitis with prolonged prothrombin time (INR, 2.2–2.5) | Liver function test and withdrawal of drugs; stepwise reinstatement of therapy after normalization of liver function |
| 32/F/51; orthopedics | Persistent fever despite iv gentamicin for left-knee prosthesis infection by <i>Pseudomonas aeruginosa</i> | Tinnitus; infected drip site; creatinine clearance decreased to 15 mL/min only | Aminoglycoside-induced renal and cochlear toxicity | Renal function test and replacement by iv ceftazidime |
| 33/F/29; orthopedics | Tuberculous spine and lung; persistent low-grade fever despite 2 weeks' treatment | Xanthopsia | Ethambutol-induced optic neuritis | Withdrawal of ethambutol |

NOTE. AML = acute myeloblastic leukemia; BAL = bronchoalveolar lavage; BMT = bone marrow transplantation; Bu-Cy-TBI = busulphan-cyclophosphamide-total body irradiation; CMV = cytomegalovirus; CVA = cerebrovascular accident; GVHD = graft-vs.-host disease; HCV = hepatitis C virus; INR = international normalized ratio; MRSA = methicillin-resistant *Staphylococcus aureus*; MRSE = methicillin-resistant *Staphylococcus epidermidis*; MSSA = methicillin-susceptible *Staphylococcus aureus*.

Occasionally, the emergency is recognized when it may be too late for successful intervention, such as spinal cord compression secondary to an epidural abscess (case 6, table 3) or loss of vision (cases 7 and 8, table 3). Thus, when attending to patients, clinicians must always be on guard to anticipate the presence of or the possibility of progression to ID emergencies. Early detection of relevant symptoms, as in the examples in table 3, clearly will minimize the danger of progression to fully developed or late-stage organ damage.

Failure to recognize an emergency was related to several factors, the most common being a presentation that did not conform to classic descriptions of the disease, such as deafness rather than neck rigidity in acute pyogenic meningitis (case 1, table 3). Furthermore, typical features may present in an atypical clinical setting. For example, CMV retinitis is a well-known complication in HIV-infected patients, requiring urgent antiviral treatment [8], but suspicion of this entity may not be raised

in non-AIDS cases (cases 7 and 8, table 3). This illustrates the need to account for each acute clinical manifestation despite apparent incongruence.

Regarding the three cases of tertiary peritonitis diagnosed by ID specialists, the attending clinicians, having performed multiple laparotomies, may have been "too close to the problem" such that input from a nonsurgical colleague helped to delineate the problem. Conversely, diseases usually not directly related to the clinical specialty of the referring clinicians may also be missed (cases 11 and 12, table 3). In this era of specialization, clinicians often rely on their colleagues to deal with problems that do not fall strictly within their specialty. Thus, a considerable number of adverse reactions to antimicrobial agents were not recognized early.

Clinicians may also face difficulties with uncommon organisms and their associated pathology (cases 3 and 12, table 3). By the same token, rare complications of common infections

may not be appreciated (cases 15 and 16, table 3). Clearly, better liaison between the ID specialist and the clinician can enable mutual exchange of knowledge and experience and ultimately result in improved care of patients in the early stages of an ID emergency. In most of the consultations, solicitation of help from the ID service was due to persistent fever not responding to antimicrobial therapy (66.7%).

Regarding care of the 175 patients with ID emergencies, the most common contribution of the ID specialist was to advise about the choice of appropriate antimicrobials. The proficiency of ID specialists in antimicrobial chemotherapeutics also enables them to initiate modification of dosage or route of administration as appropriate. Another contribution of the ID team was the delineation, after thorough evaluation of patients and further investigations, of problems that were not apparent to the referring clinician. For example, necrotizing fasciitis due to *V. vulnificus* is known to be rapidly progressive, and an early diagnosis can make a significant difference in the eventual outcome [9, 10]. Our experience was that needle aspiration was pivotal to establishing an etiologic diagnosis and indicating the choice of antimicrobials. Early extensive debridement, as guided by the gram smear of the resected margin, was crucial for a favorable outcome. In the long run, ID specialists helped to raise the awareness of this ID emergency, alerting clinicians to future occurrences of similar conditions.

The cases in this study amply illustrate clues to the early recognition of ID emergencies. First, patients with a systemic inflammatory response should be carefully evaluated for any underlying focus of infection that may not be apparent initially. Occupational history (case 1, table 3), local signs (case 6, table 3), or subtle radiological findings (case 13, table 3) can also be useful pointers to the diagnosis and its emergency nature. Second, any condition involving vital organs such as the CNS (brain, spinal cord, and eye), the cardiovascular system (especially heart valves), and the upper airway should alert clinicians to the potential for irreversible damage due to an infection. Finally, emergencies commonly arise as a result of serious toxicity from treatment; they are usually due to drugs, including hypersensitivity reactions, potentially irreversible organ toxicity, or other side effects.

As yet there is no precise definition of an ID emergency in the literature. However, the main aim of our study among inpatients referred for ID consultations was to facilitate early recognition of cases in which urgent interventions could prevent irreversible problems. Thus, for the purpose of this study, a broad definition of ID emergencies was employed. Such an

all-encompassing approach best fulfilled our objective of early detection of any problem, before it progressed to a late stage. Another limitation of our study is that the outcome of attendance by an ID specialist was not specifically addressed, and the negative aspects of ID consultations (incorrect diagnoses, adverse drug reactions, and inappropriate extra investigations as well as drug costs) were not assessed. These aspects would require another comprehensive study.

In summary, we have described the spectrum of ID emergencies encountered in an inpatient consultation service. These cases illustrate the importance of detecting an ID emergency in an inpatient as it is still evolving. This may not be straightforward in comparison with the stage of fully developed symptoms. Constant vigilance, a systematic approach to any clinical problem, and timely consultation will enable early detection of conditions requiring urgent treatment, so that optimal management may be implemented early to prevent irreversible complications or death.

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