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Surgical aspects of bacterial infection in African children

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Infections and their complications requiring surgical intervention are a frequent presentation in African children. Surgical site infection (SSI) is common with rates over 20%, even after clean procedures. The high rates of SSI are due in part to lack of infection control and surveillance policies in most hospitals in Africa. SSI is attended by complications, long hospital stay, and some mortality, but the economic consequences are unestimated. Typhoid fever and typhoid intestinal perforation are major problems with perforation rates of approximately 10%, which is higher in older children. The ideal surgical treatment is arguable, but simple closure and segmental resection are the present effective surgical options. Because of delayed presentation, complications after surgical treatment are high with a mortality approaching 41% in some parts of Africa. Nutrition for these patients remains a challenge. Acute appendicitis, although not as common in African children, often presents rather late with up to 50% of children presenting with perforation and other complications, and mortality is approximately 4% is some settings. Pyomyositis and necrotizing fasciitis are the more common serious soft-tissue infections, but early recognition and prompt treatment should minimize the occasional mortality. Though common in Africa, the exact impact of human immunodeficiency virus infection on the spectrum and severity of surgical infection in African children is not clear, but it may well worsen the course of infection in these patients.

Infections requiring surgical intervention are a frequent problem in African children. This section focuses on some of the infections that are more common, pose difficult challenges, or have severe consequences. Chest, bone and joint infections are beyond the scope of this section. The infections in focus include the following:

1. Surgical site infection;
2. Typhoid intestinal perforation;
3. Appendicitis;
4. Primary peritonitis;
5. Pyomyositis; and
6. Necrotizing fasciitis

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Surgical site infection (SSI)

SSI is recognized as a leading cause of nosocomial infection worldwide. It places significant burden on the patient as well as the health system,[1] especially in low- and middle-income countries, which have limited resources.[2] Given the problems of health care–associated infections (including SSI), the World Health Organisation's World Alliance for Patient Safety[3] has recently begun to focus on the control of these infections in poor countries.

Epidemiology

Although it is well known in clinical practice that SSI is a common problem in African children, there are only few reports focusing on this issue. In a report of 322 children undergoing surgery in Nigeria,[4] the SSI rate was high at 23.6%. In another report of nosocomial infection surveillance of 664 pediatric surgical patients,[5] SSI was responsible for 77.3% of the nosocomial infections with an overall SSI rate of 30.9%. In reports, including adults and children, the SSI rate in one eastern African country was 15.6% in children and 19.4% in adults.[6] In a systematic review of 57 studies focusing on SSI in developing countries,[2] the reported pooled cumulative incidence of SSI was 11.8/100 patients undergoing a surgical procedure and 5.6/100 surgical procedures. However, children were not separated from adults, making it difficult to appreciate the true burden of SSI in the pediatric age-group.

Risk factors

The risk factors for SSI in African children is somewhat similar to that in developed countries, but perhaps with higher prominence of some of the factors.

The degree of incisional contamination remains the most significant factor; in one report on children,[4] the SSI rates for various types of wounds were 14.3% in clean, 19.3% in clean-contaminated, 27.3% in contaminated, and 60% in dirty wounds ($P < 0.05$). One systematic review of SSI in developing countries[2] reports a median cumulative incidence in various wounds as clean (7.6), clean–contaminated (13.7), contaminated (14.3), and dirty (39.2) episodes per 100 surgical procedures, respectively.

Although the SSI rates in African children after emergency procedures appear more than elective procedures (25.8%-35.6% vs 20.8%-26.5%, respectively),[4,7] the difference does not seem to be significant. In Africa, laparotomy for typhoid perforation carries a high rate of SSI of 45%-60%.[7-11]

One report found that the carriage rates of *Staphylococcus aureus (S aureus)* among patients and surgical staff were 12.1% and 17%, respectively, and the bacterium was thought to colonize clean surgical wounds, resulting in a wound infection rate of 1.98%.[12]

Human immunodeficiency virus (HIV) is now endemic in Africa, and it is thought that it would have an impact on SSI rates in the region. Some reports have also indicated a high rate of SSI in HIV patients having abdominal surgery.[13] In one report of outcome of HIV-infected and exposed children undergoing surgery in South Africa,[14] 31.6% had postoperative complications considered to be related to HIV, of which 66.7% were related to wound breakdown and sepsis at the surgical site. However, as there was no comparison with noninfected children, it remains difficult to ascertain the impact of HIV infection on SSI rates in children in African region. The impact of other comorbid and premorbid factors on SSI in African children is also uncertain.[4]

Bacteriology

The bacteriology of SSI in low- and middle-income countries is varied. One systematic review[2] of 11 studies with 1078 patients (adults and children) shows that the organisms involved in health-associated infections were enterobacteriaceae (26%), *S aureus* (20%), *Escherichia coli (E coli)* (18%), *Pseudomonas* species (17%), and other bacteria less than 10 each. In African children, the organisms involved commonly are *E coli*, *Klebsiella*, *Pseudomonas*, and *S aureus*,[4,6] but one report showed that only 42.7% of cultures were positive. A report of inguinal hernia day-case surgery[8] with SSI rate of 4.8% indicates that *S aureus* was the single agent isolated.

Clinical profile

Most SSIs are noticed before eighth postoperative day.[4,6] In a report of adults, 36.4% of SSIs became apparent after the patient was discharged from hospital, and clinical experience in children indicates that many SSIs are noticed at follow-up clinic attendance.

Although SSIs are noticed as hyperemia or shiny skin around the incision site, frequently, in the African child, it presents as obvious discharge of purulent material, which may be offensive. In patients with clean and clean–contaminated wounds, fever may indicate SSI, but postoperative pyrexia especially from malaria is common in this setting and makes fever an unreliable sign. Fever is not useful in patients with dirty wounds, as most already have pyrexia preoperatively.

Majority of SSIs are superficial incisional (73%-85%),[4,5] deep incisional (6%-15%), and organ space (in approximately 20%).[5]

The wound should be opened by removing a few stitches to allow drainage of any purulent fluid or pus, and the wound should be dressed with Edinburgh University solution of lime or native honey until it is clean and secondary closure is done if necessary. Most of the wounds will contract and heal by secondary intention. Organ space infection requires drainage by open surgery or aspiration under imaging guidance.

Broad spectrum antibiotics may be required (if the patient is not already on antibiotics), if there are systemic features or the infection is severe.

Outcome

Commonly reported complications of SSI are wound dehiscence (partial or complete).[14] In addition, SSI prolongs hospital stay significantly in patients who develop it.[5] Although mortality from SSI should be unusual, in the African setting, mortality in children developing SSI compared with those who did not has been reported as 10.5% and 4.1%, respectively ($P < 0.05$), and the mortalities were considered to be directly related to SSI in that report.[5]

Prevention

Infection control policy and surveillance

A carefully planned and implemented control and surveillance helps to reduce SSI rates.[15] However, in many parts of sub-Saharan Africa, hospital infection control and surveillance policies and guidelines do not exist. There is also lack of good surveillance studies, and reliable data are often not available.[2] This scenario hampers efforts at control and prevention. Even the appreciation of the burden and importance of the problem by staff, hospital administrations, and policy makers is poor. Efforts are ongoing in some hospitals to address this, but the pace is rather slow.

Control of risk factors

Considering the fact that the degree of incisional contamination and operations lasting 2 or more hours are the main risk factors, it may seem that paying particular attention to these 2 factors may reduce SSI rates. However, the rates even in clean incisions are high,[4] indicating that there are multilevel failures in the infection control and asepsis chain.

Use of prophylactic perioperative antibiotics

The aim of prophylactic perioperative antibiotics is to ensure optimal blood levels of the appropriate antibiotic at the time of incision, to minimize SSI. However, reports from sub-Saharan Africa indicate that 87% of adults with SSI[16] and 97% of children with SSI[7] received perioperative antibiotics without having an impact on the SSI rate. Given the lack of antibiotic protocols and infection control and surveillance systems, antibiotics are often given erratically, sometimes after surgery,[16] and inappropriate ones may be given. Abuse and misuse of antibiotic in African setting is common.[17] These factors contribute to make perioperative antibiotics not as effective as desired. One report, however, is encouraging,[18] as a single dose of intravenous gentamicin given to children undergoing day-case herniotomy decreased the incidence of SSI significantly. The development of infection control and surveillance systems and antibiotic protocols should help to minimize SSI in Africa.

Operating room setting

The operating room environment in many sub-Saharan Africa hospitals is faulty; the design and poor ventilation and overcrowding may contribute to the high SSI rates in the setting. However, there are no studies objectively documenting operating room design as a cause of SSIs in our sub region.

Role of minimal invasive surgery

Minimal invasive surgery is not a commonly used modality in sub-Saharan Africa at the moment. Given the high rates of SSI in open surgery in the setting, more use of minimal invasive surgery in appropriate and suitable operations may well help to reduce the incidence of SSI. This needs to be carefully evaluated.

Typhoid intestinal perforation (TIP)

Typhoid fever is an infection acquired by fecal contamination of food and water by *Salmonella typhi* and has remained a public health challenge especially in sub-Saharan Africa. Typhoid fever is a systemic infection and is frequently accompanied by complications that require surgical treatment. However, intestinal perforation remains the most common[7,9,19,20] and most problematic complication.[21,22]

TIP frequently affects children almost as equally as adults.[9] The perforation rate of typhoid in children is reported to be approximately 10% of children with typhoid admitted into hospital, with an increase in perforation rate with age.[9]

Clinical presentation

A major challenge in the care of these patients is that fact that most present late, several weeks after onset of symptoms.[9] Intestinal perforation is usually heralded by increase in the intensity of abdominal pain and progressive abdominal distension, following several days or weeks of fever, general body weakness, and nonspecific abdominal pain. Some patients may have diarrhea or constipation, but stools may be bloody.[9]

The common findings on physical examination are those of a severely ill child with high pyrexia, dehydration, and anemia. Abdominal distension is marked, and there is generalized tenderness. The presenting features may be atypical in very young patients,[19] and in those who perforate while on medical treatment (approximately 10%), the clinical features may be masked and diagnosis may be difficult.[9]

Plain upright radiographs of the abdomen, including the lower chest, help in establishing a diagnosis of free intraperitoneal air, which suggests intestinal perforation. Often, especially where diagnosis is not so clear-cut, abdominal ultrasonography may help to exclude other causes of peritonitis. However, the need for imaging diagnosis should not delay surgical intervention. Serum electrolyte and urea levels should always be estimated to identify electrolyte derangements, particularly hypokalemia, and a complete blood count should identify anemia and leukocytosis. Stool, urine and blood cultures are done to help isolate the *Salmonella typhi*.

Management

The treatment of this condition should begin with a meticulous correction of fluid and electrolyte deficits. Hypokalemia should be carefully corrected, and anemia should be corrected by blood transfusion. It is important that resuscitation does not take unduly long (not more than 4-6 hours), as that would worsen severity of peritoneal contamination. Broad spectrum antibiotics, including a *Salmonella*-specific antibiotic, such as ciprofloxacin or cephalosporin, chloramphenicol or amoxicillin, and a metronidazole should be started parenterally at appropriate doses. The stomach is kept empty by nasogastric suction. Nutritional support is also provided by parenteral nutrients, but these nutrients are often unavailable in many parts of sub-Saharan Africa.

Definitive treatment

It is now generally agreed that the definitive treatment for TIP is surgical, but the best surgical option remains controversial. The surgical approach should begin with evacuation of peritoneal contents and identification of sites of perforation after meticulous and careful inspection of the small as well as large intestine.

The commonly used surgical options remain simple closure (after excision of the edges) of the perforation and segmental resection of affected segment.[7,9,10,20,23-27] Where the patient is too ill, the perforation site (if a single perforation) or healthy intestine after resection of affected segment (if multiple perforation) is exteriorized as enterostomy, which would be closed later when the patient is well enough.

The peritoneal cavity should be cleaned with large amounts of normal saline. The fascia and skin should be closed. However, if the anterior abdominal wall is edematous, the skin should be left open (delayed primary closure is done after 3 days if there is no evidence of wound infection). If the skin is closed in the presence of abdominal wall edema, SSI frequently occurs.

Where there is severe contamination of the peritoneal cavity with feculent peritoneal fluid and/or pus, then the alternative is to pack the peritoneal cavity with abdominal packs soaked in normal saline with temporary closure of the abdomen and return for a second look to close the wound in 48-72 hours. At this time, one is able to have a second look and inspect the peritoneal cavity for fluid/pus collection, inspect the suture line or anastomosis for leakage, and repair missed perforations during the first surgery or even reperforations.

Postoperative complications

Complications are frequently encountered after surgical treatment for TIP with complications occurring in about 53%-79% of patients (Table 1).[7,9,19,20] It has been suggested that the complication rates may be higher in children under 5 years.[19,26]

Table 1 Common complications after surgery for typhoid intestinal perforation[7-10,19,25,26]

Postoperative complications	Complication rate, %
Surgical site infection	49-89
Malnutrition	61
Chest infection	53
Enterocutaneous fistula	2-25
Anastomotic leakage	
Abdominal wound dehiscence	3-14
Intraperitoneal abscess	7-13
Reperforation	7-21
Adhesion intestinal obstruction	3

Mortality for TIP is high but varies widely ranging from 12% to 41%.[7-10,19,25,26] Most of the mortality is the result of overwhelming infection and hypokalemia. Late presentation seems to be a major factor responsible for such high mortality, and it is now generally agreed that the single most important predictor of mortality is duration of abdominal pain of more than 7 days.[9,19,23]

TIP is one surgical condition that can be controlled by public health measures by ensuring food sanitation and providing safe portable drinking water. Typhoid vaccines (Vi polysaccharide and Ty21a vaccines) are now available and recommended by World Health Organisation for short-term use in high-risk areas and also for control of outbreaks of typhoid fever.[21,22]

Appendicitis

Appendicitis, which is a common condition in developed countries, appears not to be a common problem in children in Africa. Although the prevalence appears to vary widely within and between countries, the condition is uncommon enough in hospitals, prompting one report from Gambia to note that "children are rarely admitted for appendicitis."[28]

Demographics

Most available reports are adult reports that include children,[29-33] and reports specifically on children are few.[34-37]

In a report of 182 children with peritonitis,[38] perforated appendicitis was responsible in 65.9%, but it was not clear how many children actually had appendicitis at the same time. Another report of 115 children from Nigeria with abdominal emergencies[39] indicated that 11 (9.6%) had appendicitis, ranking as the fourth leading cause of abdominal emergency, and a report from Ghana[40] ranked appendicitis as the second leading cause for an abdominal surgical emergency at 16%.

Presentation and diagnosis

The presentation of appendicitis in children in Africa is similar to the standard presentation in developed countries, but the features maybe vague including vague abdominal pain, vomiting, constipation, fever, and abdominal tenderness. Diagnosis maybe uncertain especially in those presenting early after the onset of symptoms; in this group of patients, one report[36] indicates that a combination of C-reactive protein, white blood cell count, and percentage of neutrophils along with clinical evaluation may help reduce the rate of negative appendectomy and delays in diagnosis. The sensitivity, specificity, and positive and negative predictive values for the 3 tests among children aged 3-13 years were 86%, 90.7%, 93%, and 81.2%, respectively. In another report of adults and children, the sensitivity and specificity of modified Alvarado score in the children was 93.3% each, respectively, but the report noted that sensitivity and specificity was higher in adults compared with children.[29]

Of note, however, is the fact that in many parts of Africa, there are several more common conditions, including malaria and parasitic infestation, which can produce symptoms similar to those of appendicitis. This may create diagnostic difficulties sometimes, especially in early stages of appendicitis, and use of some scoring method to aid diagnosis becomes important.

Complications appear to be frequent in African children with appendicitis, and a perforation rate as high as 50.7%[35] has been reported. Perforated appendicitis has been noted in one report[38] to be the leading cause of peritonitis at 65.9%, but in another report,[37] of 169 patients with appendicitis, only 8% presented with a complication. The high rate of perforation and complications may be due to delayed presentation, which is a common problem in the setting.

One report[34] has attempted to predict the risk of perforation in 147 children aged 13 years or younger presenting with a suspicion of appendicitis; on univariate analysis, the predictive factors were age less than 10 years, duration of illness more than 24 hours, history of treatment elsewhere before presentation, general abdominal tenderness, leukocytosis, and neutrophilia, but none of these factors was significant on multivariate logistic regression analysis.

Perforated typhoid should always be excluded in these patients with suspected perforated appendicitis.

Treatment

The treatment in most of Africa is open appendectomy. Although an appendix mass is still managed nonoperatively initially, this presentation is not common in children in the setting. In the African setting, most patients with perforated appendicitis present with general peritonitis with tenderness beyond the right lower quadrant, so that initial conservative treatment with antibiotics alone is not appropriate. Although laparoscopic surgery is gradually gaining ground in Africa, its use for appendectomy in children has not been widely reported in Africa.

Sometimes, parasites are seen in the appendix either at surgery or at histology and reported parasites include Schistosoma haematobium and ascaris lubricoides.[37]

Outcome

Wound complications are common after appendectomy, particularly in patients who had perforation. One report has reported a mortality of 9%[35] in children with appendicitis but usually in those with perforation.

Primary peritonitis (PP)

PP or spontaneous peritonitis is inflammation of the peritoneum by bacterial infection without an identifiable intra-abdominal pathology or source. The main challenge with this condition, particularly in Africa, is the fact that secondary peritonitis is very common in the African setting and needs to always be differentiated from PP.[38,41]

Epidemiology

PP does not appear to be very common in African children, but there are only few reports, and we believe the condition may be under reported. In one report of 182 children with peritonitis, 3 (1.6%) had PP,[41] and in another report of 955 children under 15 years undergoing surgery for an abdominal emergency, 10 (1%) were reported to have PP,[40] whereas another report of 69 children with acute general peritonitis[42] noted 4 (5.8%) with PP.

Although most reported children in Africa are more than 5 years of age, neonates are occasionally affected.[43] As in western countries, most patients (>90%) are girls.

Microbiology

The microbiology of PP is characteristically unimicrobial in patients who are otherwise healthy, but in those with underlying disease, it may be polymicrobial.[38] Commonly cultured organisms include β-hemolytic *Streptococcus* (in healthy patients), other gram-positive and gram-negative bacteria, as well as anaerobes. In Africa, cultures are frequently negative perhaps because of previous use of antibiotics before presentation and anaerobes are frequently not cultured. One report also indicated negative cultures in 15 of 26 (57.7%) patients with PP.[40]

Risk factors

PP occurs in 3 distinct settings (Table 2): patients who are otherwise healthy,[40] those with immune suppression, and those with preexisting ascites. In healthy girls, the condition is thought to be due to upward migration of bacteria from

Table 2 Settings for primary peritonitis

Settings	Common Examples
Otherwise healthy	Mostly girls
Underlying disease	Ascites (nephrotic syndrome, liver disease)
	HIV infection
Neonates	Omphalitis

the vagina through the fallopian tubes into the peritoneum and may be related to poor perineal hygiene. In patients with ascites, it is thought that there is transmigration of bacteria from the intestine into the ascitic fluid, and many of these patients also have a depressed immunity from the chronic condition. In neonates, a distinct category is those with omphalitis (a common problem in sub-Saharan Africa),[43,44] resulting from extension of the infection into the peritoneum.

Clinical profile

Most children with PP will present with features of acute abdomen, including abdominal pain, vomiting, diarrhea, and fever. These features are indistinguishable from those produced by secondary causes of peritonitis, particularly in this setting. In those patients with an underlying disease, especially ascites, abdominal pain and fever supervene and diagnosis may be easier to suspect. Occasionally, the infection may discharge spontaneously through the umbilicus.

Diagnostic evaluation

This condition in the African setting should always be a diagnosis of exclusion, and efforts should be made to exclude secondary causes of peritonitis. Therefore, diagnosis is often only made at laparotomy: in one report, all 10 patients were diagnosed intraoperatively.[44] Some useful investigations include the following:

1. Abdominal ultrasonography should help to identify any localized abscess as well as secondary causes, especially appendicitis.
2. Plain abdominal radiographs usually only show dilated intestinal loops and perhaps ground-glass appearance, which is similar to secondary peritonitis.
3. Contrast-enhanced computed tomography may help in diagnosis by showing intraperitoneal fluid, dilated bowel, and peritoneal enhancement. However, this imaging modality may not be readily available in the African setting.
4. Diagnostic aspiration may be done where there is a high index of suspicion (especially in patients with preexisting ascites) and the fluid obtained is cultured.
5. Culture of peritoneal fluid should always be done to help in isolating responsible bacteria.

Treatment

General measures including correction of fluid and electrolyte depletion and anemia should be done.

1. If there is a high index of suspicion (eg, patients with ascites), broad spectrum antibiotics should be given parenterally, and the patient should be monitored for clinical improvement. If there is no improvement, a laparotomy should be done.
2. If secondary causes cannot be excluded, a laparotomy should be done. The peritoneum should be thoroughly cleansed. A meticulous search for a secondary cause should be carried out (appendix, terminal ileum, and gall bladder should be given particular attention, as well as any suspicious areas). Peritoneal fluid should be taken for culture.

Outcome

In otherwise healthy children, full recovery is expected if identified and treated early. The outcome in those patients with an underlying pathology will largely be influenced by that disease.

Pyomyositis

Pyomyositis is an acute primary bacterial infection of skeletal muscles, resulting in suppuration and abscess formation. Although the disease is predominantly experienced in the tropics and relatively low-income countries, it can also occur in temperate and developed countries.

Pyomyositis is common among children in the tropics, accounting for 1%-4% of all hospital admissions in some tropical countries.[45,46] In sub-Saharan Africa,[45] 70% of affected children are under 10 years and both sexes are equally affected. In another large report from sub-Saharan Africa,[46] 36% of all affected patients were children.

S aureus is the most common primary causative pathogen. It is seen in up to 90% of cases in tropical areas.[46,47] Group A *Streptococcus* accounts for another 1%-5% of cases. Several other microorganisms implicated include *Streptococcus* groups B, C, and G, *Pneumococcus, Salmonella, E coli*, *Neisseria*, *Haemophilus*, *Aeromonas*, *Serratia, Yersinia*, *Pseudomonas*, *Klebsiella*, *Citrobacter*, *Fusobactrium*, and *Mycobacterium*. In tropical regions, pus cultures are sterile in 15%-30% of cases,[47] and 90%-95% of patients also have sterile blood cultures perhaps due to use of antibiotics before presentation.

A number of conditions predispose to skeletal muscle damage. These include trauma, nutritional deficiencies, immunosuppression, parasitic infestations, viral infections, and intravenous drug abuse.

In one report involving adults with pyomyositis, serum IgM level was found to be significantly lower, and mean levels of IgG and IgA were found to be significantly higher

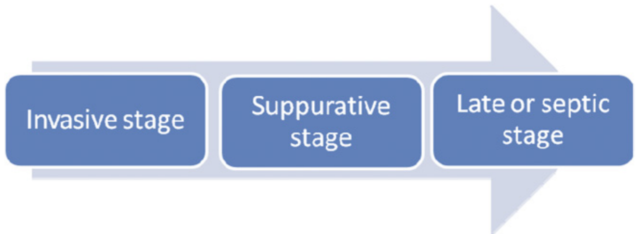

Figure 1 Natural history and sequence of pyomyositis. (Color version of figure is available online.)

than in controls. Complement levels were normal.[48] This prompted the proposition that deficits of opsonizing and complement-fixing IgM antibodies against microorganisms are implicated in the etiology of pyomyositis, at least in adults.

HIV infection may have led to an increasing incidence of pyomyositis in areas with high prevalence of HIV infection, and the later is now thought to be an important predisposing factor in the etiopathogenesis of pyomyositis.[49,50]

Clinical presentation

The large muscles of the lower limbs and trunk are particularly prone to involvement, but small muscles, such as those of the orbit, may rarely be involved. Commonly affected muscle groups include [44]lower limbs (51%), trunk (26%), upper limbs (22%), and multiple sites (6%). The disease follows a sequence that can be categorized into 3 stages (Figure 1).[46,51]

Investigations

When the diagnosis is suspected, the swelling should be aspirated with a large bore needle (not smaller than 18 gauge) to confirm the presence of pus and the pus should be cultured. Blood should also be cultured to identify any septicemic process.

Ultrasonography helps to confirm diagnosis and extent of abscess. Although magnetic resonance imaging is useful in better defining the extent of muscle involvement, this modality is rarely available in many hospitals in sub-Saharan Africa.

Plain radiograph of affected limb should always be done to exclude acute osteomyelitis, but it should always be remembered that in the early stages, x-ray may not diagnose osteomyelitis.

Complete blood count should identify anemia. HIV infection should be excluded by serologic tests.

Management

Antibiotics effective against the common causative bacteria should be started immediately after diagnosis is suspected. Anemia requires correction, and nutrition should be improved.

Abscess drainage

Open drainage is frequently preferred for adequate access and drainage, but percutaneous drainage under imaging guidance is also effective but may need to be repeated to achieve complete drainage.

An affected limb should be rested by light splinting. This helps to relieve pain and also aids resolution of edema. Splinting can be discontinued after edema has subsided. Adequate analgesia should always be given.

Outcome

Although mortality is low, morbidity could be high and hospital stay could be prolonged for several weeks. Extraskeletal complications (pneumonia, pericarditis) occurred in 6.5% of patients in one report[45] and could result in mortality of 3%. In one large series involving adults and children, mortality was less than 1%.[46]

Necrotizing fasciitis (NF)

NF, a rapidly progressive necrotizing inflammation of skin and subcutaneous tissue, including Fournier gangrene and Cancrum oris, is common in African children. It may start spontaneously in apparently healthy children but is often related to conditions causing impaired immunity.[51-54] Known predisposing factors include anemia, malnutrition, HIV/AIDS, specific infections, trauma, and postoperative as well as general conditions like malaria and measles.[55,56]

Microbiologically, it is usually produced by a synergistic effect of gram-positive bacteria, gram-negative bacteria, and anaerobes, and up to 80% of cultures are polymicrobial.[57]

Clinically, the natural history of the disease is in stages[55] (Figures 2 and 3) but is so rapidly progressive that stages overlap. The presentation and severity depends on the stage at which the patient presents.

Discharge and tissue from the lesion should be cultured, including anaerobic culture. Complete blood count should ascertain the extent of anemia and leukocyte reaction. Efforts should be made to identify any underlying condition, including HIV infection.

Treatment should start early, with parenteral administration of potent broad spectrum antibiotics, including those

Figure 2 Clinical stages and sequence of necrotizing fasciitis (NF). (Color version of figure is available online.)

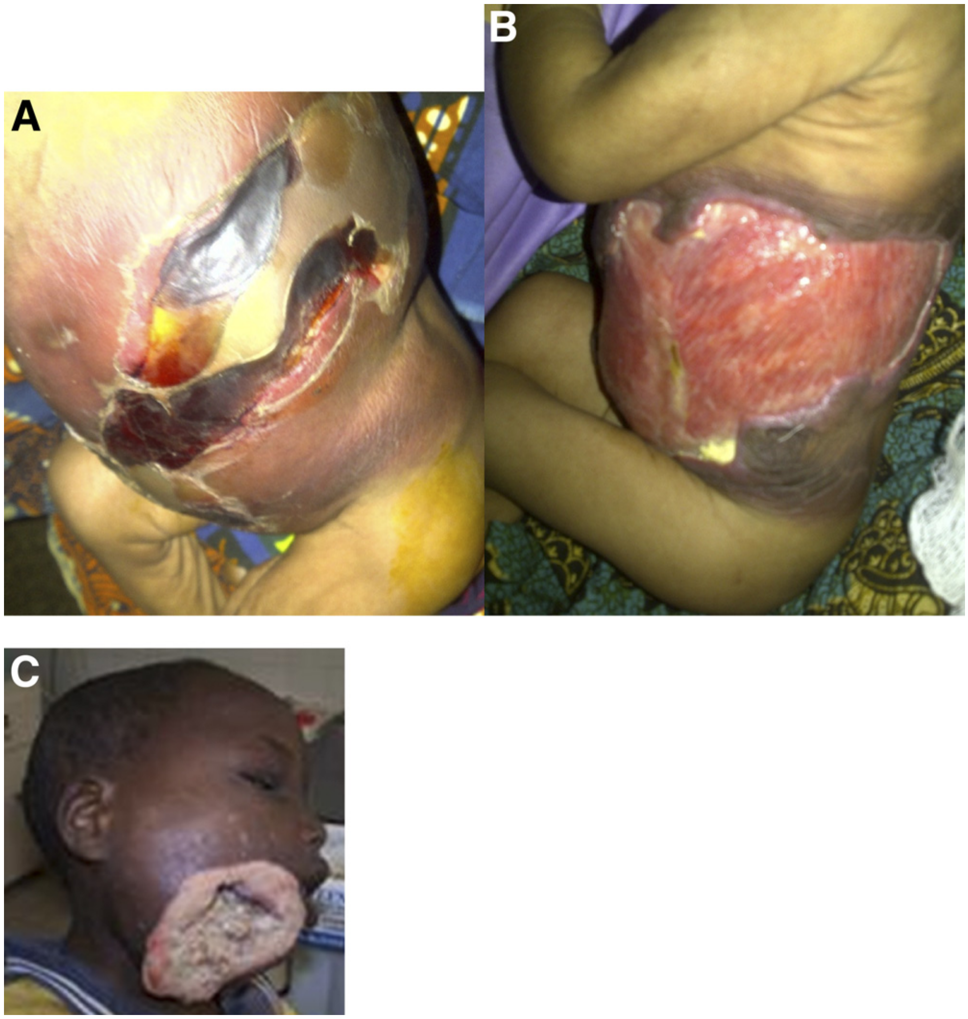

Figure 3 **(A, B)** Severe NF of trunk in a newborn (before and after debridement). (C) Acute Cancrum oris (noma, orofacial NF) in a boy. (Figure 3C is provided by courtesy of Dr E. Adu). (Color version of figure is available online.)

effective against anaerobic bacteria but should be guided by local sensitivity patterns.[56] If culture results are available, this could guide the choice of antibiotics. Tetanus prophylaxis is necessary in most African settings. Anemia should be corrected and nutritional support would be necessary in most patients.

All necrotic tissue should be removed to halt progression, and in neonates, this could be done by the bedside,[58] especially if the patient is too ill for general anesthetics. Some form of wound cover would be necessary after progression of the disease is arrested, and the wound is covered by healthy granulation tissue. Wound coverage may involve secondary suturing, skin grafts, or flaps. Healing by secondary intention should be avoided as much as possible to avoid contractures and unsightly scars. Any identified underlying condition should be treated.

Morbidity may be high and hospital stay may be prolonged.[52,53,55,59] Mortality is also high especially if presentation is late and may be up to 20%-80%, mostly because of overwhelming infection.

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