1. Introduction
Over the past 200 years after the Industrial Revolution blossomed in England, prosperity still has not reached half the world’s peoples, particularly those who live in the tropics (1). Indeed, with the concurrent growth of globalization since the late 15th century, selected technologies have spread exogenously to developing countries in ways that have lowered death rates and thereby exploded population densities but without improving economic growth (2), consequently fomenting poverty and sparking civil conflict in vicious cycles that have collectively ruined the health and well-being of billions of people and simultaneously deprived them of the means to improve their lot (3; 4).
Hence, particularly in sub-Saharan Africa, home to the most destitute, yet most resourceful and resilient, people on earth, living conditions, disease patterns and infrastructure have blended into a most challenging environment, but one that also offers unique, encouraging opportunities for real progress. In this review, I explore just one of those arenas, that of intestinal obstruction and similar abdominal emergencies. On the basis of my personal experience as a surgeon throughout the Third World over the last 12 years, I hope to offer some guidance to doctors in Africa and other developing parts of the globe on substituting their enormous wealth of human capital for the dearth of other resources, to deal successfully with these difficult, abundant clinical problems.

2. Surgical abdominal emergencies in sub-Saharan Africa

The spectrum of abdominal pain in Africa differs from that observed in developed countries. At a large teaching hospital in Boston, Massachusetts (USA), for example, a total of 536 adults presenting to the emergency department with acute, non-trauma-related abdominal pain comprised 308 men (57%) and 228 women (43%), for a male:female ratio of 1.35:1. The five most common diagnoses, accounting for 72% of all cases, were: urinary tract stone (31.4%), appendicitis (23.6%), intra-abdominal abscess (17.4%), diverticulitis (16.9%) and small-bowel obstruction (10.6%) (5).

By contrast, intestinal obstruction of all causes, acute appendicitis, typhoid ileal perforation, perforated peptic ulcer and trauma are, according to the available information, the most common causes of non obstetrical/gynecological surgical abdominal emergencies in adults in sub-Saharan Africa (Table 1) (6; 7; 8; 9; 10). Of the four top diagnoses, appendicitis and typhoid perforation occur most frequently in young adults between 25 and 33 years, whereas the peak incidences of intestinal obstruction and peptic ulcer perforation occur in the sixth decade (7). In African children (by definition, patients 15 years old or younger), acute appendicitis accounts for more than 60% of all abdominal emergencies, followed by nearly equal frequencies of typhoid ileal perforation and intestinal obstruction, whereas ill children presenting specifically with peritonitis tend to suffer most commonly from typhoid fever and then from either intestinal obstruction or appendicitis (Table 1, “Centr. African Rep.” and “Nigeria,” respectively). In all cases, males present with abdominal emergencies nearly twice as commonly as females, and even more frequently in selected locations.

<p>| TABLE 1: MAIN SURGICAL CAUSES OF ACUTE ABDOMINAL PAIN IN SUB-SAHARAN AFRICA |
|---------------------------------------------------------------|----------------------|----------------------|----------------------|----------------------|
| Adults                                                       | Children             | Adults               | Children             |
| Sierra Leone (1)                                             | Ghana (2)            | Centr. African      | Nigeria (4)          |
| # Patients                                                   | 68                   | 2,197                | 162                  | 69                   |
| Male:Female ratio                                           | 3.6:1                | 1.9:1                | 1.8:1                | 2.3                  |
| % Mortality                                                  | 22.1                 | 9.9                  | Not reported         | 11.6                 |
| % Appendicitis                                               | 22.1                 | 31.8                 | 62.3                 | 13.0                 |
| % Typhoid Perf.                                              | 10.3                 | 23                   | 19.1                 | 56.5                 |</p>
<table>
<thead>
<tr>
<th>Condition</th>
<th>% Incarcer. Hernia</th>
<th>% Intussusception</th>
<th>% Other Int. Obstr.</th>
<th>% Perf. Peptic Ulcer</th>
<th>% Trauma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Studied</td>
<td>22.1</td>
<td>6.8</td>
<td>2.5</td>
<td>11.8</td>
<td>8.8</td>
</tr>
<tr>
<td>9.3</td>
<td>5.8</td>
<td>17.8</td>
<td>11.6</td>
<td>11.8</td>
<td>11.8</td>
</tr>
</tbody>
</table>

1 Adapted from (6). This series included an additional 30 cases of reducible hernias, 43 cases of ectopic pregnancy, 9 cases of uterine rupture, 11 cases of gynecologic conditions and 10 others, all of which were excluded from the above tabulation. This study also included a small minority of children, which is reflected in the above numbers.

2 Adapted from (7). This series included 917 other cases distributed among 16 other diagnoses, including nonspecific abdominal pain (306 cases, 9.8% of total), acute cholecystitis (102 cases, 3.2% of total), abdominal TB (100 cases, 3.2% of total), medical conditions (95 cases, 3% of total), gynecologic cases (70, 2.2% of total) and others (liver abscess, urologic cases, acute non-perforated peptic ulcer disease, hepatoma, amebic colitis, gastroenteritis, perforated colon cancer) that collectively accounted for less than 8% of the 3,114 total patients.

3 From (8). These 162 surgical cases comprised 52.2% of the 312 total cases of acute abdominal pain. Of the remainder, 78 (25%) were caused by medical conditions including malaria and 71 (22.8%) resolved without spontaneously, without diagnosis.

4 From (9). As the title states, this study was limited to more ill children with acute peritonitis, not merely abdominal pain.

These conditions are true emergencies and require prompt intervention. The extensive Ghanaian study found that mortality increases from 1.6% for those ill less than six hours, to 10% for patients ill for 2 days, to 14% for patients ill for 3 days (7). Thereafter, the mortality levels off at 6% (7), perhaps because the most seriously ill patients who delay that long die at home, without reaching the hospital. In the experience from rural Sierra Leone, 80% of those with gastrointestinal perforation and 33% of those with intestinal gangrene die (6).

3. Etiology and pathophysiology of intestinal obstruction

Worldwide, the etiology of intestinal obstruction is relatively uniform, in adults most commonly adhesions, followed by incarcerated hernias and either volvulus or tumors in developing and developed countries, respectively, and in children most often hernias, then intussusception and adhesions (Table 2) (11; 6; 12; 8; 13). (In African neonates—which I will not discuss further in this review—the causes of intestinal obstruction are anorectal malformation, 43%; Hirschsprung’s disease, 18.7%; jejunoileal atresia (15.6%), duodenal atresia, 7.8%; hernia, 6.3%) (14). In developed countries, after adhesions the relative frequency of the other causes often depends on the selection bias and service populations of the reporting institutions. The Chicago data reported in Table 2 are from an inner-city university hospital, whereas in four nearby general hospitals in northern England with a prominence of elderly patients, intestinal obstruction stems from adhesions in 32%, cancer in 26% and incarcerated hernias in 25% (15), and in a Montreal referral hospital with an interest in inflammatory bowel disease, the etiologies are adhesions in 74%, Crohn’s disease in 7%, cancer in 5% and hernia in 2% (16).

Similarly, the relative plethora of hernias and paucity of adhesions in Sierra Leone (Table 2)
reflects political and economic factors, as does the high case mortality rate (17). Those data were collected from September 1992 through September 1994 (6), during the height of the civil war in the embattled Southern Province of that impoverished country, whose per capita GDP (US$700 in purchasing power parity) now ranks 223rd out of 229 and is half that of Ghana and one-third that of Nigeria (18) (Figure 1). In this last country as well, during the decade following the devastating Biafran War hernia was also the predominant cause of intestinal obstruction (19; 20).

### TABLE 2: MAIN CAUSES OF INTESTINAL OBSTRUCTION

<table>
<thead>
<tr>
<th>Country</th>
<th>Adults</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ghana (1)</td>
<td>Nigeria</td>
</tr>
<tr>
<td># Patients</td>
<td>391</td>
<td>128</td>
</tr>
<tr>
<td>Male:Female</td>
<td>--</td>
<td>1.7:1</td>
</tr>
<tr>
<td>% Mortality</td>
<td>--</td>
<td>8</td>
</tr>
<tr>
<td>% Adhesions</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>% Incarcerated Hernia</td>
<td>Not Studied</td>
<td>18</td>
</tr>
<tr>
<td>% Intussusception</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>% Volvus</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>% Cancer</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>% Ascaris</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

1 From (7). Of the volvulus cases, 86% were of the sigmoid colon. Of the cancers, 71% were of the colon.
2 Adapted from (11). Of the 20 total cases of intussusception, the above tabulation excludes from the original series of 142 patients the 14 (70%) that occurred in children. Of the volvulus cases, 57% occurred in the small intestine and the remainder in the colon.
3 From (13).
4 Adapted from (6).
5 Adapted from (12). The mortality quoted here excludes the 17 patients with malignant tumours, seven of whom died; including these cases, the overall mortality rises to 5.5%. The 3% incidence of volvulus includes only those of the small intestine.
6 From (8).
FIGURE 1: Per Capita GDP (Gross domestic product) for 2007 in USS, at purchasing power parity (PPP) for all of Nigeria, Ghana, Central African Republic and Sierra Leone pointed out at the down arrows. For comparison, the richest and poorest countries in the Western Hemisphere, respectively, and the world as a whole are shown at the from (18).
In places like that of the Sierra Leone series, where surgeons, operating rooms and, hence, surgical operations are scarce, so are adhesions. In that same environment, unrepaired hernias are abundant (Figure 2) (21; 22; 23). Likewise, the deprivation in rural Sierra Leone explains the high mortality observed by McConkey (Tables 1 and 2), who pointed out that one-third of deaths occurred in extremely ill patients and that better equipped facilities and more experienced surgeons would have reduced the mortality rate (6). On the other hand, the Central African Republic study was carried out in the capital, at the country’s national hospital (8); the recent Nigerian study was carried out in Ile Ife, in the surgery department of a major university (11), and the Ghanaian study was carried out in Kumasi, at the country’s second largest hospital (7).
Although the best provisioned hospitals in sub-Saharan capitals and elite cities provide the best care and produce most of the clinical literature, only a tiny fraction of the people in their countries have access to their expertise and other resources. For the vast majority in sub-Saharan Africa, and the doctors and nurses who treat them, the conditions in rural Sierra Leone are more relevant.

Mindful of this reality, after reviewing the current knowledge about the causes of intestinal obstruction I would like to present what I believe to be the most prudent strategy for the rural doctor in Africa and other similar locations to deal most effectively with these difficult clinical problems.

3.1. Adhesions

All abdominal surgeons know that adhesions occur frequently after laparotomy. Upwards of 93% of patients who have undergone a prior abdominal operation, particularly in the lower peritoneal cavity, have adhesions, compared to 10.4% of those who haven’t (\textsuperscript{24; 25}). The peritoneum that produces these adhesions comprises a delicate single layer of mesothelial cells supported by a submesothelial matrix of loose connective tissue, which in the uninjured state manifests a fibrinolysis-thrombosis balance weighted more to the former (\textsuperscript{26}). This balance is controlled by the local relative abundance of fibrolytic enzymes and their inhibitors, mostly tissue plasminogen activator (tPA) and plasminogen activator inhibitors 1 and 2 (PAI-1 and PAI-2), respectively (\textsuperscript{26; 27}). Some stimuli, such as concentrated ambient CO\textsubscript{2} as used in laparoscopy, can up-regulate PAI-1 gene expression in human peritoneal mesothelial cells directly, and perhaps shift this balance (\textsuperscript{28}).

More commonly however, in response to the peritoneal injury of a routine laparotomy, neutrophils surge into the abdominal fluid for the first several days and are then replaced during the next week by monocytes, which differentiate into macrophages (\textsuperscript{27}). These activated cells in turn release metabolites of arachidonic acid, including prostaglandin E\textsubscript{2} (a mediator of inflammation), thromboxane B\textsubscript{2} (a mediator of platelet aggregation) and various cytokines, including substance P (SP), intracellular adhesion molecule (ICAM-1), vascular cell adhesion molecule (VCAM-1), and, most importantly, interleukin-1 (IL-1) and transforming growth factor-\textbeta (TGF-\textbeta), the last two of which spur the peritoneum to increase the local concentrations of PAI-1 and PAI-2 relative to tPA, thereby shifting the coagulation balance more toward the thrombosis needed for hemostasis and healing of injured tissues (\textsuperscript{27; 26}). The sticky fibrin thereby exuded by adjacent peritoneal wounds adheres to itself. Toward the end of the first postoperative week, the cytokine mix usually returns to one favoring fibrinolysis, but not entirely before the prevailing milieu ostensibly directs the influx of fibroblasts (which are amply endowed with IL-1 receptors) and the organization of fibrinous into more durable fibrous adhesions (\textsuperscript{26; 27}).

Despite these interesting details, none of the methods suggested to prevent (not just to minimize) adhesions have proven efficacious, including, anti-coagulants, anti-inflammatories, barrier
methods and even meticulous surgical technique, and (except for the latter) most are not economical (26). This is just as well, because the same processes that form adhesions also assure healing of anastomoses and incisions, and, furthermore, adhesions are largely inconsequential. Between 6 and 10% of laparotomy patients ultimately return with symptoms possibly related to adhesions, such as pain, but in only between 5.7 and 23% of them are adhesions ultimately proven responsible (29; 30). Patients younger than 60 have a nearly three-fold increased risk for adhesion complications, as compared to older patients (31). According to the British Surgical and Clinical Adhesions Research (SCAR) Group, after lower abdominal operation there is a 5% risk of readmission within five years for adhesion-related complications (31). Risk of such readmission following specific lower abdominal operations are: total proctocolectomy (15.4%), ileostomy (10.6%), total colectomy (8.8%) and appendectomy (0.9%); but because of the high frequency of appendectomy, these patients comprise 7% of all those readmitted (31).

Of these complications, intestinal obstruction is but a fraction. Within one year of laparotomy, 1% of patients return to hospital with small-bowel obstruction secondary to adhesions, half within the first postoperative month (24); over 10 years only 3.9% require re-exploration (30). Based on a series of 144 admissions in 1980s Australia, patients with adhesive small-bowel obstruction will have a past history of appendectomy in 23%, colorectal resection in 21%, gynecological surgery in 12%, upper gastrointestinal (gastric, biliary or splenic) surgery in 9%, small bowel surgery in 8%, and more than one previous abdominal operation in 24% (25). An operation will be necessary to relieve the obstruction in 42%, 97% of whom will have a single adhesive band causing the blockage; but 30% will also have strangulated intestine (25). Because of the high incidence of laparotomy, coupled with the low frequency of deleterious adhesions, 3.3% of all laparotomies stem from adhesive intestinal obstruction (24), which, as detailed in Tables 1 and 2, therefore constitutes an important share of surgical abdominal emergencies.

3.2. Hernia
In industrialized countries, inguinal hernias manifest the highest prevalence in infants, reach lowest levels during childhood and then increase in prevalence and incidence continuously after age 15 (32; 33) at a cumulative incidence of 14% for men and 2% for women followed for 20 to 35 years (34; 35) and a lifetime cumulative incidence of 46% for men and 13% for women (32; 33), who account for only 10% of all inguinal hernia operations (36). Incisional and other ventral hernias occur nearly always in adults and at a much lower incidence, but at nearly equal rates in men and women (32). In Nigeria, incisional hernias reportedly result from approximately 3% of cesarean sections, exclusively after midline incisions as compared to Pfannenstiels (37).

The prevalence of inguinal hernia in adult men seems to be the same in developed countries and central Africa, approximately 25% (33; 38). As evidenced in the Netherlands (39; 40), northern Jordan (41), and Nigeria (42; 43), throughout the world between 50 and 60% occur on the right, 35-40% on the left and the remainder bilaterally, and with the same 90% predilection for men as noted above, although the laterality decreases as the proportion of direct hernia increases (44). For adults presenting to the university hospital in Ile Ife, Nigeria, their inguinal hernias tend to be large, with 31% expanding the scrotum and 22.4% incarcerated, but they enjoy a low mortality rate of 1.6% (43). Of the incarcerated inguinal hernias treated at the nearby Wesley Guild Hospital in Ilesa, which comprise 26.4% of all groin hernias, 80% are in men, 76% are scrotal, 47% contain only omentum, but 14% contain gangrenous intestine, the latter of which account
for the 2.7% mortality (45). In children 4% of inguinal hernias are incarcerated, but 75% of these cases (15 of 20 incarcerated inguinal hernias over 10 years) are also strangulated (42).

Generally in Africa, however, only 42% of hernias are repaired (21). Hence, for patients who present with external hernias of all types to Komfo Anokye Hospital in Kumasi, Ghana, including from the remote northern provinces (46), 65% are suffering acute incarceration (which Ohene-Yeboah inaccurately terms “strangulated”) of which 66% are in men, 72% are inguinal or inguinoscrotal, 10% femoral (all in women), 11% umbilical and 8% incisional (46). Overall, 24% of these Ghanaian patients with incarceration require intestinal resection for gangrene and 12% die, even though 75% are younger than 50 (46). Incarcerated hernias are particularly dangerous by causing closed-loop obstruction, in which a length of intestine is blocked at its proximal and distal ends by the hernia orifice (or adhesions or other pathology in cases not caused by hernias), which then pinches off the adjacent mesenteric blood supply as the hernia swells during delay of treatment and strangulates the contained viscera (47).

Closed loop obstruction is a particular problem with internal hernias, which contain gangrenous intestine in more than 63% of cases (48; 49), potentially increasing the mortality to above 40% (48; 50). In these hernias, a loop of intestine pushes through a normal orifice, such as the foramen of Winslow, or through a fold of peritoneum or mesentery (51; 52). They are spontaneous (also termed “congenital”) more than half the time; the others result from peritoneal defects created by surgical operations or trauma (48). Half of all internal hernias tend to be paraduodenal, in which the intestine gets caught in a congenital defect near the ligament of Treitz or, less commonly, a defect further within the base of the jejunal mesentery; other sites are transmesocolic or transmesosigmoid, transomental or pericecal (51; 53). They are not common, accounting for approximately 2% of all intestinal obstruction cases not caused by external hernias (54; 51; 48), but occur in children (55) and adults (56). Although internal hernias are reportedly rare causes of intestinal obstruction in Nigeria (11), I have personally encountered two cases during a recent three-month period in northern Uganda (Figure 3).
3.3. Volvulus
Most cases of volvulus in developing tropical countries involve the sigmoid colon. Sigmoid volvulus is a bit of an etiologic misnomer, for the pathology involves not an S-shaped (more accurately Σ-shaped) colon, but rather an Ω-shaped one, in which the mesentery is elongated but anchored on a very narrow base, around which it can easily twist (57; 58; 59). In industrialized countries, this pathology occurs in older, institutionalized individuals suffering from constipation (57), whereas in the “volvulus belt” of South America, sub-Saharan Africa and South Asia, high-fiber diets are responsible (58). Hence, in developed countries, sigmoid volvulus accounts for less than 2% of all intestinal obstructions and only a small minority of colon obstructions (57), as compared to Africa, where sigmoid—more accurately “omegaoid”—volvulus occurs at an annual incidence of 12/100,000 population (60) and accounts for half of all cases of blocked colons (61). In the former instance, only between 7 and 19% of patients develop gangrene of the twisted bowel and the mortality is 6 or 7% (57; 58); in the latter, upwards of 95% suffer gangrenous colon and, in the best of hospitals, 17% die (61; 62).

Occasionally the ileum wraps itself like a noose around the neck of a sigmoid volvulus, often leading to gangrene in both lengths of bowel (63; 64). Patients with this condition, termed ileosigmoid knot, are very ill. In Ethiopia, for example, 90% of such patients presenting to elite hospitals in Addis Ababa develop gangrene in either or both loops of involved intestine, 60% suffer stormy postoperative courses and 20% die, despite the majority of patients being relatively young men between 30 and 50 years old (65). In the more remote northwest of the country, two-thirds present with peritonitis, more than 40% in shock, and 44% die (66), similar to the mortality observed in rural Ghana (67).

3.4. Intussusception
In intussusception, a length of bowel, the intussusceptum, turns inside out and peristalsis propels it and its mesentery progressively down the lumen of the distal bowel, the intussuscipiens. The intussusceptum swells, sheds blood and occludes the intestinal lumen, usually causing crampy abdominal pain, vomiting and bloody, mucoid stools and jeopardizing its own viability (68; 69). If permitted to progress long enough, the forward end of the intussusceptum (its lead point) can advance all the way to the rectum, where the physician can palpate it unmistakably on digital examination (70), as I did with astonishment in two patients, 4- and 6-year-old boys, who presented to me in rural Haiti.

Children suffer between 90 and 95% of all intussusceptions (71; 72), nearly always of the ileocolic variety, which cause more than one-third of their episodes of intestinal obstruction (8) (Table 2). In less than 10% of these cases can a definite mass lesion be found at the lead point to have dragged the intussusceptum through the intussuscipiens, usually a Meckel’s diverticulum or a hamartomatous polyp (68), although these culprits seem to cause more than 40% of those rare cases limited more proximally in the small intestine and not progressing into the colon (69). The
remainder are said to be idiopathic, although viral enteric infections, which cause mass-like
enlargement of ileal Peyer’s patches, are likely responsible (73). In developed countries, various
non-surgical options are available to diagnose and treat the problem, such as reduction under
fluoroscopy by barium enema, fluoroscopic air reduction and sonographically guided hydrostatic
reduction (74; 75), which can replace a surgical operation in upwards of half of children but are
unavailable or impractical in Africa where all these children need laparotomy urgently (68). As
compared with small children at selected inner city and referral children’s hospitals in America,
those in western Nigeria present with twice the duration of symptoms (3.8 days), more than
twice as often (68%) with a palpable abdominal mass and more than three times as often (20%)
with a palpable intra-rectal intussusceptum (68). Nigerian children develop nonviable bowel in
36% of cases, as compared with 14% and 28% in the referral and inner-city American hospitals,
respectively, associated with a delay in treatment twice (at 5.7 days) that of the African patients
with viable intussusceptum (68). Of those Nigerian children with necrotic intestine, 39% die,
contributing to an overall 18% mortality (68). In the selected American hospitals, these children
don’t die, even those with gangrenous bowel (68). Delay is deadly in Africa, as those who
succumb are often misdiagnosed as suffering tropical enteric infections for upwards of one week
before finding their way to remote hospitals capable of correctly identifying and correcting the
problem (68).

As children grow into adolescents and young adults, intussusception occurs more rarely and
those that do occur increasingly reveal a definite pathologic lead point, the majority of which are
benign (76). In Addis Ababa the mortality in these older patients matches that in Nigerian
children (76; 68). By middle age intussusception is distinctly uncommon—busy referral surgical
services in America (71; 77), France (78), Turkey (79) and Singapore (80) rarely see more than
one or two such cases annually—and almost always occur in association with pathologic lesions
(71; 77; 79; 78; 80). These cases account for merely 1% of intestinal obstruction (71) and begin
in the small bowel between two-thirds (77; 78) and three-fourths of the time (71; 79). Regardless
of where in the gastrointestinal tract they start, the inciting lesions are malignant nearly half the
time (71; 79; 78; 80). In the colonic intussusceptions, the malignant causes are nearly always
primary adenocarcinoma (71; 77; 79; 78; 80) associated with a 33% mortality. The malignancies
causin enteric adult intussusceptions are mostly metastatic, usually malignant melanoma but
also lymphomas and sarcomas, with a poor prognosis and therefore associated with mortality in
52% (71; 78). For these reasons, intussusceptions in adults should be resected, except for the rare
idiopathic and definitely benign case, which simply need be reduced surgically (71; 77; 79; 78;
80).

More than 30 years ago, benign idiopathic ceco-colic intussusception was the commonest cause
of intestinal obstruction in Nigeria, where it is now unusual (81; 82; 83; 84), consistent with the
frequencies in Table 2, above. In rural Rwanda until 26 years ago, this problem caused 57% of
intestinal obstruction in adults, followed by external hernia in 29%, sigmoid volvulus in 5% and
adhesions in 2% (85), an etiologic pattern suggestive of poverty, as noted above for McConkey’s
observations in Sierra Leone (6; 17) and perhaps explaining the increasing rarity of this entity in
Nigeria as its economy has improved over the years. Destitution might cause ceco-colic
intussusception through altered gut motility related to irregular eating and Ascaris infestation
(85; 17).
3.5. Ascaris
The soil-transmitted roundworm Ascaris lumbricoides occurs throughout the tropics, but is most prevalent in niches with warm, but not too-hot, moist soils that favor embryonation of the geohelminth’s eggs, which small children deprived of adequate hygiene then swallow, eventually enriching the soil with the next generation of eggs in their feces (86; 87; 88; 89). These ecological limitations seem to make Ascariasis more of a problem in subequatorial tropical countries such as India (90) and Colombia (91), rather than in those in sub-Saharan Africa, where the occurrence is much spottier. In Cameroon, for example, the prevalence of Ascaris in the more humid south is 66%, as compared to the 42% prevalence in the country as a whole and a much lower level in the arid north closer to the Sahara Desert (87; 92; 93). And in Kenya, Uganda and South Africa, Ascariasis is largely limited to small ecological pockets of dense vegetation near the Great Lakes or major rivers, areas with shadier, moister, slightly cooler soils (94; 88; 89). Moreover, the mass treatment of school children in endemic areas with anthelmintics, such as albendazole, has reduced very effectively and economically the prevalence and intensity of Ascaris and other geohelminth infestation (95; 96; 97; 98). Ascariasis, therefore, has become a less important cause of intestinal obstruction in Africa over the years, especially where the etiologic pattern of intestinal obstruction reflects improved socio-economic conditions (99; 100) (Table 2).

Nonetheless, the rural tropical doctor must be prepared to assuage the morbidity and mortality inflicted largely on children by A. lumbricoides, especially where the typical socio-economic and environmental factors converge. The larvae from swallowed eggs can settle not only in the small intestine, but also in the pancreatico-biliary tree or liver before growing into adult worms that measure between 12 and 16 inches long (101). Patients can, therefore, present with obstructive jaundice, hepatic abscess or pancreatitis (101; 17). In the gut, the worms compete with their host for the available luminal nutrients, causing malnutrition and stunted growth (95). If more than 60 adult worms crowd into the bowel lumen, the host usually suffers intestinal obstruction, the most common complication of Ascariasis for which patients present emergently to hospital (102; 103). Most of these patients are children less than five years old, but adults can also be affected (104). Often they have defecated or even vomited adult worms; they exhibit all of the symptoms and signs of intestinal obstruction and plain abdominal radiographs frequently reveal a wormy “swirl” shadow within the dilated gut (91). Nearly three out of every four patients present without signs of peritonitis or toxicity and can be treated conservatively, with nasogastric suction, intravenous infusion and then vermifuge with oral anthelmintics (90; 91). The others are very ill and sometimes—but not always—up to half die even with urgent laparotomy, at which any gangrenous bowel needs resection (12-32% of cases), the obstructing worms need to be extracted via enterotomy (13 to 58% of cases) or milked into the colon, which is possible and sufficient in 10 to 48% of cases, depending on patient population and locality (90; 104; 91).

3.6. Tumour
In African Americans, the annual incidence of colon adenocarcinoma is 60 per 100,000 population, as contrasted to less than 1 per 100,000 in native sub-Saharan Africans (105), apparently related more to the carcinogenic effects of the large quantities of red meat and animal fat in the Western diet than to the protective effects of fiber (106; 107; 108; 109). Hence, not surprisingly, in regions of increasing affluence in Africa, as judged by the proxy of rising motor-vehicle ownership and related accidents, colon cancer has become a more noticeable, albeit still
minority, cause of intestinal obstruction (99; 110; 111; 112) (Table 2). Furthermore, in regions endemic with Schistosoma mansoni, patients afflicted with Schistosomal colitis appear to develop histologically more aggressive colorectal cancers, associated with alterations in the expression of the p53 tumour suppressor gene, and present at a younger age with more clinically advanced disease (113).

In my own experience in Africa’s lymphoma belt, young patients occasionally present with colon obstruction secondary to Burkitt’s lymphoma (114) (Figure 4). Children and young adults can also suffer acute abdomen with intestinal obstruction from the benign tumour, mesenteric cystic lymphangioma (115; 116) (Figure 5).

FIGURE 4: Obstructing tumor of the transverse colon in a 20-year-old man. The proximal transverse colon, in the photo’s left, is dilated from the
obstruction. The distal transverse colon, below the clamp at right, is collapsed (arrow). Upon resecting the transverse colon and opening the bowel, the waxy tumor proved to have destroyed the adjacent colonic mucosa. Histologically, it demonstrated the “starry sky” appearance of Burkitt’s lymphoma. (Northern Uganda, May 2008. Author’s photo.)

**FIGURE 5:** Kishnath, an 8-month-old boy who presented to the hospital with four days of worsening abdominal distension and lethargy (left). On examination, his temperature was 102 °F and he mustered no response except when I palpated a grapefruit-sized mass in his right lower abdomen, which resulted in a faint whimper. His leukocyte count was 30,000. He underwent an immediate laparotomy and was found to have an obstructing cystic lymphangioma of the mesentery to the right colon. He was treated by resecting the mass en bloc with the right colon (center). The terminal ileum is at lower right, the cecum is along the top and the multilocular cystic lymphangioma is visible at the lower left of the photo (arrow). Kishnath woke up from the anesthesia fully alert immediately after the operation and went home 10 days later (right). (Batticaloa, Sri Lanka, October 1996. Author’s photo)

4. Management of intestinal obstruction and similar abdominal emergencies
Physicians in developing countries faced with cases of intestinal obstruction and other abdominal
emergencies must, as explained above, consider their economic environment and the consequent local disease patterns, available technological resources and surgical expertise. However, any savvy, dedicated physician with a minimum of surgical experience and only rudimentary operating facilities can—and should—successfully mitigate the morbidity and mortality attendant to abdominal emergencies, notwithstanding limitations of technology and experience. To do so, the doctor must commit to just two aims:

1. Never find intestinal perforation or gangrene in any patient whose operation was delayed to provide for a period of observation.

2. Never have any patient die whose operation was denied or delayed to provide for a period of observation.

In achieving these goals, the responsible physician must understand that the more limited the resources in the community and hospital, the lower must be his or her threshold to carry out prompt exploratory laparotomy.

Patients with intestinal obstruction complain of colicky abdominal pain, nausea and/or vomiting, abdominal distension and obstipation (117). Surgeons often characterize the blockage as either proximal ("high") or distal ("low") and either complete or partial, depending on the onset of vomiting relative to the pain and the degree of obstipation, respectively (117), but for doctors working in challenging environments these distinctions are irrelevant. More importantly, the physician must determine the duration of symptoms before presentation to hospital and if the patient has previously undergone a laparotomy, and for what reason. Women must be questioned carefully about their obstetrical and recent menstrual history.

On physical examination, the physician must know the patient’s vital signs accurately, particularly assessing for fever and tachycardia. The degree of dehydration manifests itself in the quality of facial skin turgor and moistness of the conjunctivae and tongue. The abdomen is usually distended. Sometimes, the physician can see or feel the dilated intestine contract vigorously through an emaciated abdominal wall or even feel an obstructing mass (117). On auscultation, the bowel sounds are often hyperactive, with the unmistakable high-pitched sounds of fluid rushing to and fro under pressure. Occasionally, however, the abdomen may be as silent as an echo chamber, in which the physician’s gentle tapping at one end transmits quickly to the other, where the examiner can hear it crisply with a stethoscope, accompanied by the patient’s wincing. In such cases, the abdomen is locally if not diffusely tender from obvious peritonitis. In all but the most extremely ill of patients, the physician must carry out a digital rectal examination and a bimanual pelvic examination in all women, in both cases to assess for tenderness and masses, including an unmistakable intussusceptum in children. Lastly, the examiner must note any abdominal scars and search for any hernias in them, the umbilicus and groins.

The astute physician needs nothing more than this—a stethoscope and focused clinical intellect—to arrive at a proper working diagnosis and treatment plan. A leukocyte count is useful but not necessary. If available, I find that a single upright abdominal radiograph is also very helpful, but no physician should ever be deterred or delayed by the lack of laboratory tests or radiography. The upright abdominal film distinguishes the characteristic aspects of small bowel obstruction from simple ileus and visceral perforation (Figure 6), notwithstanding the few
reservations expressed about the value this single radiographic view in developed countries, with access to radiologists and unlimited technology (118; 117; 47). Furthermore, the upright radiograph is often diagnostic for sigmoid volvulus, the commonest cause of colon obstruction in the developing world (57) (Figure 7).

**FIGURE 6:** Upright abdominal radiographs in a case of small-bowel obstruction (left) and pneumoperitoneum (right). At left, the radiograph shows at least seven loops of dilated small intestine. In the limbs of the inverted “U” of each loop, the air-fluid levels are at different heights (e.g., arrows), causing an overall “laddering” pattern, characteristic of a higher intraluminal pressure at the downstream side of each loop (closer to the blockage) than the upstream side, which overflows into the stomach. This and the total absence of gas shadows in the colon (compare with Figure 7) are diagnostic of complete small-bowel obstruction. At laparotomy, this patient proved to have adhesions. In the radiograph at right, there are no air-fluid levels other than a very small one comprising the gastric bubble (small black arrow). The crescentic air shadow at the large black arrow is not limited inferiorly by an air-fluid level, which would appear as a
With this small amount of important information, the physician must arrive at only one treatment decision: does the patient need a laparotomy emergently, or will observation suffice? Most patients in destitute areas who travel to remote hospitals have already subjected themselves to a period of observation at home, and have only presented to the doctor because they have not improved and are seriously ill. Hence, as noted above for Ghana, mortality increases from 1.6% for those ill less than six hours before presenting to hospital, to 10% for patients ill for 2 days, to 14% for patients ill for 3 days (7). The doctor must consider whether the patient manifests the physical signs of fever, tachycardia, abdominal tenderness or leukocytosis (if leukocyte counting is available). Patients with severe abdominal complaints who have none or just one of these signs almost never prove to harbor intestinal gangrene; 25% of those with two or three of these are found to have gangrenous bowel and two-thirds of those with all four of these signs have necrotic bowel (12). By definition, anyone with two or more of fever, tachycardia or leukocytosis is suffering from the systemic inflammatory response syndrome (“SIRS”) (see, http://www.ptolemyn.ca/members/archives/2008/Shock/index.htm) and will succumb to a serious illness unless the doctor rapidly alleviates the underlying pathology (119; 120).

Hence, especially for the less expert physician practicing in more remote locations with facilities to perform laparotomy but limited supplies of nurses, monitors and medications, the doctor should commit to operating early on any patient with abdominal pain, vomiting and obstipation, unless the patient has been symptomatic for less than two days and displays none or just one of fever, tachycardia, abdominal tenderness or leukocytosis (121).
FIGURE 7: Upright abdominal radiograph in a 9-year-old boy with a large gas-filled colon loop; the proximal and distal ends are twisted together in the left lower quadrant (arrow). At laparotomy, he proved to have a sigmoid volvulus. (Northern Uganda, April 2008. Author’s photo).
Notice that this criterion should exclude from operation all patients with bacillary or amebic
dysentery, cholera and most of those with simple typhoid fever, who are not obstipated and can
should all be treated with intravenous fluids and parenteral antibiotics. Additionally, young
women with pelvic pain and fevers starting within one week after a menstrual period, who also
demonstrate cervical motion tenderness and pus at the cervical os, are suffering from acute
salpingitis and can also be treated exclusively (at least initially) with intravenous antibiotics.
Except for these patients, the physician practicing in resource-poor locations should never
administer parenteral antibiotics to any patient with abdominal pain, unless the patient will
proceed shortly thereafter directly to the operating theatre.
Of course, certain other findings constitute absolute indications for a surgical operation, even in
the absence of SIRS. Children with a palpable abdominal mass and/or a palpable intrarectal
intussusceptum need urgent laparotomy. Patients with pneumoperitoneum, as revealed in an
upright abdominal radiograph, need laparotomy without delay (122). Similarly for patients with
radiographic signs of sigmoid volvulus (57). From my personal experience I firmly believe that,
in hospitals with limited resources, patients ill for more than 2 days and with unequivocal signs
of intestinal obstruction on a plain upright radiograph (e.g., Figure 6, left) should undergo
expeditious laparotomy, even in the absence of other worrisome signs. Although surgeons in
industrialized countries advocate that these patients may initially be observed, in that setting
observation frequently fails, and approximately 30% of these patients will require bowel
resection (120), making anything other than early laparotomy too risky in developing countries.
In any setting, patients with intestinal obstruction, no prior laparotomies and no external hernias
are suffering from internal hernias or other conditions, such as volvulus, associated with a higher
incidence of closed-loop obstruction and intestinal gangrene and need expeditious laparotomy
(118; 49). Of course, any patient with intestinal obstruction and a hernia incarcerated in the
abdominal wall or groin also needs an operation urgently.

Patients needing emergency laparotomy must be readied and resuscitated within one or two
hours in the emergency department. In rapid sequence, the patient must be provided with
nasogastric drainage tube, which likely will discharge more than a liter of bilious fluid
immediately, Foley transurethral catheter, likely to yield only several milliliters of concentrated
urine, and intravenous infusion. Because these patients have lost large quantities of gastric acid
by vomiting, the best fluid to counteract the resulting metabolic alkalosis is normal saline. Infuse
two liters rapidly (or the equivalent proportion in children) and then continue rapid infusion until
the urine output appears less concentrated and flows at least 5 cc every 10 minutes.

Next, all of these patients need intravenous antibiotics. In general, a regimen of ampicillin,
gentamicin and metronidazole will cover synergistically the usual gram negative enteric aerobic
and anaerobic flora. It’s best to administer the full daily dose of gentamicin undivided, which
usually means a full 240 mg (4-7 mg/kg if renal function is normal) for the typical adult on
presentation, before operation, and 5-7.5 mg/kg for children with normal renal function. Children
and young adults severely ill with obvious signs of peritonitis, including all of those with
pneumoperitoneum on the upright radiograph (e.g., Figure 6, right), might have perforated a
gangrenous closed loop but are most likely to have suffered typhoid ileal perforation (7) (Table
1, “Nigeria”) and must receive a different antibiotic regimen to cover for Salmonella typhi. My
first preference for these patients is ceftriaxone (2 gm. intravenously for adults, 50-75 mg/kg in children), in addition to gentamicin and metronidazole (123). If ceftriaxone is unavailable, intravenous ciprofloxacin is a good alternative, followed by chloramphenicol if the physician has neither ceftriaxone nor ciprofloxacin (124; 123). As cautioned above, all of these patients, for whom the doctor has felt the need to prescribe parenteral antibiotics, must proceed not to the ward but directly to the operating theatre.

For understandable reasons, I have sometimes (but not always) observed the opposite in developing countries, where overworked young or inexpert doctors bear responsibility for the care of seriously ill patients, as have other Western surgeons such as McConkey (6). Of course, because of the realities of a crushing patient load, a paucity of nursing and ancillary personnel, an absence of suitable mentors and the doctor’s own personal lack of confidence in his or her ability to deal with a frighteningly ill patient surgically, it is all too tempting simply to give these patients intravenous antibiotics, admit them to the ward and hope for the best. But patients thusly treated almost always die (Figure 8). I urge the doctor saddled with the daunting task of caring for these patients to remember that no patient is too ill to undergo, and no doctor is too inexperienced to perform, a lifesaving surgical operation.

Any intelligent, caring doctor able to perform a cesarean section can also manage successfully in the operating theatre all of these other dire abdominal emergencies, even with a paucity of fully trained anesthetists (125). If you are one of these doctors, your success will increase with experience, both the good ones and the bad ones. If you to operate expeditiously despite your own personal reservations, at first perhaps two-thirds of your patients with abdominal emergencies will die quickly and one third will survive. But if you avoid operating, all of these patients will die.
FIGURE 8: Tanapiriyan (left), a 10-month-old boy who underwent a laparotomy shortly after birth (see scar), was admitted to the pediatric service with vomiting. He was treated with a nasogastric tube and intravenous fluids. When he did not improve after four days, a radiograph (center) was obtained and a surgical consult requested. The radiograph reveals characteristic signs of complete small-bowel obstruction (compare with Figure 6, left). Antibiotics were given and a laparotomy was carried out immediately, which revealed a closed loop obstruction with gangrene (right). The gangrenous bowel was resected. Twelve hours later Tanapiriyan stopped producing urine and minutes thereafter he suddenly died. (Batticaloa, Sri Lanka, October 1996. Author’s photo).

With persistence, reflection and continuing surgical experience, you will save half and eventually two-thirds or more, most of whom will be able to return home within one or two weeks. And none of these patients, even those who die, will suffer needlessly or waste time in the hospital.
and impoverish their families. Of course, I also urge that you avail yourself of the best expertise available to you and that you not operate on patients such as those in Figure 2, who are not acutely ill and for whom an operation risks more harm than good, but only on those with severe, persistent abdominal complaints and objective signs of SIRS (e.g., Figure 5). Any patient whom you choose to observe should be noticeably improved after 12 hours; if not, you must proceed to laparotomy without delay. Occasionally you might operate on some of these patients and find simple typhoid fever or acute salpingitis or other pathology that would have resolved solely with intravenous fluids and antibiotics, but in such cases after ruling out surgical pathology you can simply and easily close the incision and rest assured that your patient will recover. This is a small, and appropriate, price to pay to avoid losing any patient, like the little boy in Figure 8, that you could have saved if you operated or operated sooner (Figure 5).

Fortunately, operations for adhesive intestinal obstruction are often relatively easy, because the pathology usually involves just a single obstructing band or a few adhesions of the intestine to the laparotomy incision, prior surgical site or another loop of bowel (24; 25). In these and most other abdominal emergencies not caused by external hernias, the doctor should enter the peritoneal cavity through a midline incision from the midepigastrium to slightly below the umbilicus, taking care to cut with dissecting scissors any adhesions to the peritoneal surface of the incision and thereby avoid injuring the underlying viscera. If possible, gently deliver the small bowel through the incision onto the anterior abdominal wall (as in Figure 8, right) and then trace the viscera, always markedly dilated and boggy because of the downstream blockage, from the ligament of Treitz as far distally as possible. Then find the ileo-cecal valve in the right lower quadrant; if the adjacent terminal ileum is collapsed, the point of obstruction lies between this site and the distended proximal intestine. Working from both ends, palpate and compress between the thumb and index and middle fingers of your non-dominant hand the scar tissue adjoining the loops of bowel. Some of these adhesions will simply fall apart with this maneuver; those that do not you should cut with Metzenbaum or Mayo scissors in your other hand. In the easy cases, this “enterolysis” will take you 10 or 15 minutes, when you will then observe a distinct transition point between the obstructed (bloated) and unobstructed (collapsed) intestine and can easily trace the jejunum and ileum from the duodeno-jejunal ligament (of Treitz) to the ileo-cecal valve. Once you have run the jejunum and ileum between your hands several times from one end to the other, looking and feeling for any blockages, gangrene, perforations or other injuries, it’s best (if the bowel proves to be non-defective) to milk the intraluminal contents back into the stomach and then through the nasogastric tube (by gently compressing the distended stomach against the posterior abdominal wall). Replace the viscera within the peritoneal cavity and draw the omentum over the gut immediately posteriorly to the incision, which you are now ready to suture closed.

In a significant minority of cases at the other extreme of the spectrum, upon opening the abdomen the physician will be confronted with an overwhelming mass of scar tissue and nothing that even resembles normal intestine. In these cases, the surgeon needs no additional resources other than patience and understanding that the principles are the same as just described for the easier operations. Simply start cutting and hand-dissecting adhesions wherever most convenient and easiest, and then shift to the next easiest location and so on. At first, this process moves along with discouraging slowness. But as you define loops of bowel the enterolysis accelerates
and becomes increasingly easier, until you find yourself in the more familiar situation of the typical simple case.

When operating for intestinal obstruction or any other abdominal emergency, upon opening the peritoneal cavity and dividing adhesions, the doctor may encounter the complications of enterotomies—holes that he or she has created in the intestine, which occurs in the complicated cases even in the best of hands (126)—perforation, usually from typhoid ileitis or peptic ulcer disease, or gangrene of a closed loop obstruction (Figure 9). If you make a hole in the obstructed bowel, control the leakage between your fingers and then allow the enteric contents to run into a small sterile bowl, from which the foul fluid can be serially discarded until the gut is empty. Then suture the defect. When dealing with any perforation, whether iatrogenic or from typhoid ileitis, you must remember to close the hole transversely, not longitudinally, so as not to narrow the intestinal lumen and risk a postoperative obstruction or dehiscence of the repair. Any flimsy lengths of bowel riddled with enterotomies or typhoid enteritis, and any lengths of bowel afflicted with gangrene or tumour, you must resect, and then reestablish intestinal continuity by sewing an anastomosis or, in difficult situations, create an ostomy at the skin surface. Before closing the abdomen in these cases, rinse out the peritoneal cavity, including above and below the liver and spleen and in the pelvis, with at least several liters of sterile saline. The beginner should read about each of these techniques and other aspects of laparotomy in the Oxford textbook, Primary Surgery, Volume 1, Chapter 9, “Methods of abdominal surgery” (available online at: http://ps.cnis.ca/wiki/index.php/Methods_for_abdominal_surgery) (127).
In any operation in which you encounter intestinal perforation (either iatrogenic or pathological), gangrene or purulent infection (so called “dirty wounds” (128)), when closing the abdomen suture the fascia and peritoneum in a single layer, but leave the more superficial (subcutaneous and skin) layers open and packed with saline-moistened gauze dressings, which should be
changed daily. The skin will be fully healed in approximately one week. If you suture the skin closed, at least 60% of the time the incision will become infected (12). In my experience in developing countries, before the pus comes bursting out of the skin wound, it first destroys the underlying fascia and leads to a difficult, prolonged convalescence that strains not only the patient, but also his or her family and the already overworked nursing staff, followed by an incisional hernia with all of its potential future catastrophes. It’s much better to avoid these disasters where resources are limited, especially with such easy strategies as leaving open the superficial wound and operating before gangrene sets in. Although it might be tempting to close the skin incision after dealing with intestinal perforation, gangrene or purulent infection, based on personal experience in remote locations I recommend leaving the skin and subcutaneous tissues open, for secondary closure on daily moist dressings, unless you are an experienced surgeon whose patient population and resources permits you to close these wounds with no or few infections and no dehiscences.

Operating on internal hernias is not much different from dealing with adhesions, except that the stricture is caused by a peritoneal defect rather than a band of scar tissue, and the physician is more likely to find gangrene (49; 48; 50; 51). The pathologic anatomy can be confusing, however. If you find yourself disoriented, simply find the dilated proximal intestine and the collapsed distal bowel and then trace them both inwardly, where they will converge at the strictureing hernia defect. Because the incarcerated or strangulated intestinal loop will be edematous, you will not be able to reduce it without first identifying the margins of the peritoneal defect and enlarging the hole by incising the peritoneum, while taking care not to cut any mesenteric or other nearby vessels (Figure 3). Then you will be able easily to pull the herniated bowel back through the enlarged defect, which you must sew closed to prevent a recurrence. Thereafter, you need to assess viability of the hernia contents and resect them if necessary.

When diagnosed by its typical radiographic appearance, sigmoid volvulus can often be reduced and decompressed by passing a sigmoidoscope, which, if successful, yields a blast of gas and stool and converts an emergency laparotomy to an elective one, provided the patient’s pain and obstipation resolve and there are no other signs of gangrene (58). Otherwise, including for all of the cases that lack access to sigmoidoscopy, proceed urgently to the operating theatre. After untwisting the colon the remainder of procedure depends on the condition of the sigmoid. Gangrenous colon must be resected. Usually, the proximal and distal resection margins will nearly touch each other (i.e., O) and can be anastomosed primarily without needing to mobilize the descending colon. However, it is probably safer, especially in less experienced hands, to free up the distal descending colon and exteriorize the proximal resection margin in the left lower quadrant as an end colostomy, while suturing the distal end closed as a blind rectal pouch—the so-called Hartmann procedure (129). If the volvulus is viable, the redundant sigmoid can be resected and the remaining ends anastomosed. Alternatively, you can carry out a mesosigmoidoplasty, in which the mesentery to the volvulus is incised along its long axis (in an area free of vessels) and then sutured transversely, so as to widen its base and make it less likely to re-twist (59). Both methods are probably equally effective (129), but the mesenteric procedure is quicker and avoids sewing a poorly prepared colon distended with feces (59).

With most intussusceptions, upon following the jejunum distally you will find that the small intestine leads into an invaginated, foreshortened colon (Figure 10). The cecum and appendix
will not be visible, and in the extreme cases neither will the remainder of the colon all the way to
the left lower quadrant. This entire missing bowel comprises the intussusceptum. To reduce it,
pulling on the small intestine will not work. Instead, you must follow the intussuscipient distally
until you can feel the lead point within it. Then, with the thumb opposed to the index and middle
fingers of each hand across the colon just distal to the lead point, gently push the lead point back,
as if squeezing toothpaste from the bottom of the tube toward the cap. The intussusception will
reduce. If you find gangrenous bowel or pathology that caused the telescoping, such as a polyp
or Meckel’s diverticulum, you must resect it. Otherwise, after reducing intussusceptions in
children, remove the appendix and then close the laparotomy incision.
FIGURE 10: Ileo-colic intussusception in a 6-year-old boy. On the preoperative physical examination, the lead point was palpable on digital rectal examination. In this intraoperative photograph, the small intestine disappears into the invaginated colon (black arrow). The lead point, after partial reduction, is in the colon at the level of the white arrow. The outer bowel between the two arrows is the intussuscipliens. To reduce the intussusception, push the lead point proximally, as if the intussuscipliens were a tube of toothpaste and the intussusceptum were the toothpaste itself. (Rural Haiti, May 2006. Author’s photo.)

Four principles govern the operation on any hernia anywhere in the body: (a) dissect the sac free from the surrounding structures, (b) open the sac and reduce its contents, (c) close and reduce the sac and (d) repair the defect through which the sac herniated. The beginner should read about the details in the Oxford textbook, Primary Surgery, Volume 1, Chapter 14, “Hernias” (available online at: http://ps.cnis.ca/wiki/index.php/Hernias (130). When patients present with intestinal obstruction secondary to incarcerated external hernias, proceed urgently to the operating theatre, so as to avoid the increasing likelihood of gangrene associated with delay (46). Don’t try to reduce any tender hernia, because if the contents are already gangrenous the reduction will convert a contained extra-abdominal calamity into an uncontained intra-abdominal catastrophe. Gangrenous hernia contents can usually be resected through the hernia incision.

Most importantly, doctors working in remote areas with limited resources must endeavor to repair all groin and other hernias of the abdominal wall electively, before these patients return with horrid complications (19; 46; 131), including giant hernias like that in Figure 2. Even in older patients with co-morbidity, the mortality is a low 1.6% for elective hernia repair (43), but soars to 12% for emergency, incarcerated hernias, even in patients mostly younger than 50 (46).

Postoperatively, all patients treated for abdominal emergencies will need intensive surveillance. Except for those patients with no findings of acute bacterial infection, the intravenous antibiotics will need to continue for another week. Intravenous fluids will be needed in large volumes so as to maintain a brisk urine output. If blood is available for transfusion, it should be given if the hematocrit falls below 20% in children and most adults or 30% in patients with evidence of ischemic cardiovascular disease or diabetes mellitus. The bilious nasogastric drainage might remain elevated over 1 liter daily for upwards of 10 days before gastrointestinal activity returns and the bowels move, but during this time the patient’s overall status should gradually and continuously improve (120). However, patients treated for intestinal perforation, gangrene or other conditions requiring intestinal resection are particularly prone to suffer postoperative complications such as anastomotic disruption and subphrenic and other intra-abdominal abscess (132; 6). In industrialized countries, patients have ready access to advanced technology such as CT scanning, which can help diagnose these problems accurately (133). In hospitals where resources are scarce the lack of advanced technology must be replaced with hyper-vigilance and a much lower threshold to re-operate. Any patient who initially improves and then relapses into fever, tachycardia, hypotension, dyspnea, diaphoresis or other serious signs should be re-explored without delay.

5. Conclusions
The same economic, geographic and climatic factors that prevented sub-Saharan Africa and
other tropical locations from keeping pace with the growing affluence of the world’s richest countries have also affected the spectrum of abdominal emergencies, their etiology, their severity and the resources available to cope. Among these consequences is the relative paucity of surgeons trained to the exacting standards of those in North America, Europe and East Asia. But these hurdles should not deter any doctor with limited resources from tackling successfully the problems presented by any patient with intestinal obstruction or similar abdominal emergencies. Even if consigned to a remote facility as the only doctor, you should not give up on any of these patients by sending them to the ward without a fighting chance. If you can carry out a cesarean section, you have everything you need to reduce to admirable levels the morbidity and mortality of the acute abdomen. Although you might lack the latest of modern technology and more senior colleagues, you have unique, privileged access to a wealth of the most challenging clinical material. If you apply the above recommendations to that rare asset, you will become among the most skilled, artful and seasoned of surgeons anywhere in the world. I wish you the best of success.

**6. Summary of Recommendations**

1. On physical examination, assess for fever, tachycardia, abdominal tenderness and leukocytosis. Always examine the groins, umbilicus and incisions for hernias. Always do pelvic and digital rectal examinations, unless the patient is too ill to reposition.

2. Operate early (within two hours) on any patient with abdominal pain, vomiting and obstipation, unless the patient has been symptomatic for less than two days and displays none or just one of fever, tachycardia, abdominal tenderness or leukocytosis.

3. Except for patients with bacillary or amebic dysentery, cholera, simple typhoid fever or pelvic inflammatory disease, the physician practicing in resource-poor locations should never administer parenteral antibiotics to any patient with abdominal pain, unless the patient will proceed shortly thereafter directly to the operating theatre.

4. In children and young adults with pneumoperitoneum or severe peritonitis, include intravenous antibiotic coverage for Salmonella typhi, using either ceftriaxone, ciprofloxacin or chloramphenicol in conjunction with gentamicin and metronidazole.

5. If you encounter intestinal perforation (either iatrogenic or pathological), gangrene or purulent infection, which results in either a “contaminated” or “dirty” wound, when closing the abdomen suture the fascia and peritoneum in a single layer, but leave the more superficial (subcutaneous and skin) layers open and packed with saline-moistened gauze dressings, which should be changed daily until the wound heals.

6. Re-explore promptly any patient who deteriorates postoperatively.

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