ORIGINAL ARTICLE

Risk Factors for Postoperative Infectious Complications in Noncolorectal Abdominal Surgery

A Multivariate Analysis Based on a Prospective Multicenter Study of 4718 Patients

Patrick Pessaux, MD; Simon Msika, MD, PhD; David Atalla, MD; Jean-Marie Hay, MD; Yves Flamant, MD; for The French Associations for Surgical Research

Hypothesis: Infectious complications are the main causes of postoperative morbidity in abdominal surgery. Identification of risk factors, which could be avoided in the perioperative period, may reduce the rate of postoperative infectious complications.

Design: A database was established from 3 prospective, randomized, multicenter studies. Multivariate analysis was performed using nonconditional logistic regression expressed as an odds ratio (OR).

Setting: Multicenter studies (ie, private medical centers, institutional hospitals, and university hospitals).

Patients: From June 1982 to September 1996, a database was established containing the information of 4718 patients who underwent noncolorectal abdominal surgery.

Main Outcome Measures: The dependent variables studied included surgical site infection (SSI) (divided into parietal and deep infectious complications with or without fistulas) and global infectious complications (SSI and extraparietal and abdominal infectious complications).

Results: The rate of global infectious complications was 13.3%; SSI, 4.05%; parietal infectious complications, 2.2%; deep infectious complications with fistulas, 2.18%; and deep infectious complications without fistulas, 1.38%. In multivariate analysis, the following 7 independent risk factors for global infectious complications have been identified: age (60-74 years, OR, 1.64; ≥75 years, OR, 1.45); being underweight (OR, 1.51); having cirrhosis (OR, 2.45), having a vertical abdominal incision (OR, 1.66); having a suture placed or an anastomis of the bowel (OR, 1.48) in the digestive tract; having a prolonged operative time (61-120 minutes, OR, 1.66; 121 minutes, OR, 2.72); and being categorized as having a class 4 surgical site (ie, obese patients or having a risk factor of a healing defect) (OR, 1.66). Ceftriaxone sodium therapy was identified as a protective factor (OR, 0.43). In multivariate analysis, the following 5 independent risk factors for SSI have been identified: the existence of a preoperative cutaneous abscess or cutaneous necrosis (OR, 4.75), having a suture placed or an anastomosis of the bowel (OR, 1.82) in the digestive tract, having postoperative abdominal drainage (OR, 2.15), undergoing a surgicial procedure for the treatment of cancer (OR, 1.74), and receiving curative anticoagulant therapy (OR, 3.33) postoperatively.

Conclusions: Our data show that risk factors for SSI and for global infectious complications are disparate. Indeed, only the placement of a suture or having an anastomosis of the bowel in the digestive tract is a risk factor for both SSI and global infections. Some of these factors may be modifiable before or during the surgical procedure to reduce the infection rate or to prevent postoperative complications.

Arch Surg. 2003;138:314-324

From the Service de Chirurgie Digestive (Drs Pessaux and Atalla), Centre Hospitalier et Universitaire Angers, Angers, France, and the Service de Chirurgie Générale et Digestive, Centre Hospitalier et Universitaire Louis Mourier, Colombes, France (Drs Msika, Hay, and Flamant). A complete list of the members of The French Associations for Surgical Research appears on page 323.

INFECTIOUS COMPLICATIONS are the main causes of postoperative morbidity in abdominal surgery.[1] These complications have an important financial cost and are responsible for significant morbidity.[2,3] To reduce these complications, it is important to establish the risk factors that increase their incidence using multivariate analysis. If this issue has been already addressed for colorectal surgery,[4] it has not been well studied for abdominal noncolorectal surgery. Although the efficiency of antibiotic prophylaxis for reducing postoperative infectious complications has been demonstrated in previous prospective, randomized studies,[5-7] controversy still exists about which specific antibiotic agent to use.[8] Since 1992, the Centers for Disease Control and Prevention,[9] Atlanta, Ga, has modified the definition of surgical wound infection using the term "surgical site infection" (SSI), which includes parietal and deep infectious complications. To our knowledge, no studies reported in the literature consider postoperative global infectious complications including extraparieto-abdominal in-

fectious complications (ie, urinary tract infections, intravascular catheter–induced infections, lung infections, and late infections). The risk factors for SSI and for global infectious complications may differ. Our study estimated the risk factors for SSI and for global infectious complications in abdominal noncolorectal surgery in patients who received antibiotic prophylaxis. Identification of risk factors in the perioperative period may allow for a reduction in the rate of postoperative infectious complications.

METHODS

PATIENTS

A database was established from 3 prospective, randomized, multicenter studies (ie, private medical centers, institutional hospitals, university hospitals) led by the French Associations for Surgical Research on antibiotic prophylaxis in abdominal noncolorectal surgery. The first trial,[5] conducted from June 1982 to September 1986, compared the efficacy of a 24-hour antibiotic prophylaxis (ie, cefotaxime sodium or cefazolin sodium) with a control group who received no antibiotic prophylaxis (n=3156). The second trial,[10] conducted from June 1987 to June 1989, compared the efficacy of a single dose of ceftriaxone with 3 doses in 24 hours of cefazolin or cefotaxime (n=1363). The third trial, conducted from January 1994 to September 1996 (results of which are still unpublished), compared the efficacy of antibiotic prophylaxis using a combination of amoxicillin and clavulanic acid with ceftriaxone (n=1269). The information in this database was reorganized for 5798 patients who underwent an intra-abdominal, nonseptic surgical procedure with at least 1 abdominal incision. The following were exclusionary criteria: aged 17 years or younger, colorectal surgery, septic operations in which an antibiotic treatment was given systemically, patients who were already treated with antibiotic agents or those who received antibiotic agents within the previous 15 days, patients who had a drug allergy, patients who had chronic renal failure, patients treated with allopurinol, patients who had infectious mononucleosis, patients who were pregnant, and patients who were found intraoperatively to harbor an intra-abdominal infection.

INDEPENDENT RISK FACTORS

The independent risk factors analyzed were divided into preoperative, intraoperative, and postoperative variables.

Preoperative Risk Factors

The preoperative risk factors were as follows: age; sex; height; weight; loss of weight exceeding 10% of the patient's ideal weight; the presence of diabetes mellitus, cirrhosis, ascites, and other disease (chronic heart failure with an ejection fraction of <30%); and chronic respiratory failure (Pa_{O_2} <65% or liver insufficiency). Other factors influencing healing included corticotherapy, chemotherapy, or both during the last 6 months before surgery; previous abdominopelvic radiotherapy (irrespective of the interval since the end of treatment); anticoagulant therapy (preventive or curative dosage); if the surgery was scheduled and was it done as elective, emergency, or a deferred emergency because of the clinical reasons; type of administered antibiotic agents (cefazolin, cefotaxime, ceftriaxone, metronidazole hydrochloride, or a combination of amoxicillin and clavulanic acid).

Intraoperative Risk Factors

The intraoperative risk factors included the following: type of skin antiseptic agents used (ie, povidone-iodine, chlorhexidine hydrochloride, or iodized alcohol); type of abdominal incision; incision on a preexistent abdominal scar; associated surgical treatment of an abdominal hernia or defect; parietal protection (ie, sterile drape, dry fields, antiseptic-soaked fields, or skirt); preexistence of a skin infection (ie, inflammation, abscess, or necrosis, and gangrene); opening of the bowel in the digestive tract; degree of intraoperative contamination (subjective evaluation by the surgeon as being absent, minimal, moderate, or major); placement of a suture or having an anastomosis of the bowel in the digestive tract; surgical excision for cancer (ie, curative, palliative, or extensive); having a peritoneal or cutaneous closure; type of cutaneous closure and reinforcement (total number of stitches); having intra-abdominal or intraparietal drainage (ie, by blade, tube, or other); and the length of operative time.

Postoperative Risk Factors

The following were postoperative risk factors: receipt of anticoagulant therapy (preventive or curative dosage), underwent urinary catheterization (indwelling or not), and the degree of the surgical procedure's contamination according to the classification of the National Research Council.[11] Class 4 or "dirty" surgery deserves therapeutic antibiotic agents rather than prophylactic treatment and has been redefined according to preoperative factors particular to each patient in accordance with previously published definitions.[5,10] The new class 4 includes all patients who have diabetes mellitus, cirrhosis, chylous ascites, obesity exceeding 120% of the patient's ideal body weight, weight loss exceeding 10% of the patient's usual weight during the last 6 months, immunosuppression (corticotherapy during the last 6 months, immunosupressants, chemotherapy during the last 6 months, and previous abdominopelvic radiotherapy).

Some quantitative variables have been redefined in classifications: age has been redefined according to the following 3 age groups—59, 60 through 74, and 75 years. Weight and height were used to calculate the body mass index (BMI) (calculated as the weight in kilograms divided by the height in meters squared). Obesity was defined as a BMI of 30 according to the new World Health Organization's classification.[12] Operative time has been divided into 3 classifications—60 minutes, from 61 to 120 minutes, and 121 minutes or longer.

Several dependent variables were analyzed. Surgical site infection has been defined according to the Centers for Disease Control and Prevention's classification: infections of the incision scar at the surgical site or parietal infectious complications (superficial [infections of skin and subcutaneous tissues] and deep infections [extending to fasciae and muscles]), deep organ infection, interorgan spaces, and cavity infections or deep infectious complications.[9]

The parietal infectious complications, during hospitalization, included wound infection (present at the level of the scar of a spontaneous or provoked purulent drainage, presence of bacteria in a bacteriological specimen, or both) or the presence of cellulitis or gangrene (infection of subcutaneous tissues or tissue necrosis). Deep infectious complications included deep abscesses (the presence of a septic intra-abdominal collection diagnosed clinically, radiologically, or both, or by the presence of bacteria in the bacteriological specimen), generalized purulent peritonitis, and anastomotic leakage (the presence of contrast-medium leakage at the level of the anastomosis of the bowel in the digestive tract during radiological examination, the presence of digestive fluid by ab-

Table 1. List of Interventions

Intervention	No. (%) of Patients
Exploratory laparotomy or laparoscopy	114 (2.4)
Nissen fundoplication	97 (2.1)
Esogastric resection	50 (1.1)
Gastrostomy	30 (0.6)
Gastrectomy	201 (4.3)
Vagotomy	162 (3.4)
Jejunostomy	9 (0.2)
Small-bowel resection	53 (1.1)
Adhesiolysis	81 (1.7)
Appendectomy	538 (11.4)
Hepatectomy	44 (0.9)
Cholecystectomy	957 (20.3)
Biliodigestive anastomosis	47 (1.0)
Pancreatodigestive anastomosis	31 (0.7)
Pancreatic resection	48 (1.0)
Splenectomy	43 (0.9)
Adrenalectomy	38 (0.8)
Aortofemoral bypass	42 (0.9)
Salpingectomy	22 (0.5)
Ovariectomy	99 (2.1)
Hysterectomy	235 (5.0)
Genital prolapse	36 (0.8)
Prostatectomy	27 (0.6)
Nephrectomy	17 (0.4)
Inguinal hernia	1391 (29.5)
Incisional hernia	196 (4.1)
Other	110 (2.2)
Total	**4718 (100)**

dominal drainage, positive fistulography, or intraoperative finding of a fistula in the digestive tract during reoperation or during autopsy). Deep complications have been divided into 2 groups: those with or those without anastomotic fistulas.

Extraparietal and abdominal infectious complications have been also studied including urinary tract infections, septicemia, and catheter-induced infections. All patients have been seen again by their surgeon 30 days after hospital discharge allowing detection of late-infectious complications. Finally, all infectious complications (abdominal wall infections, deep infections, extraparietal and abdominal infections, and late-infectious complications) have been reclassified under the term "global infectious complications."

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS software version 10.0 (SPSS Inc, Chicago, Ill). Data are given as mean (SD). The univariate analysis was tested using the χ^2 test for qualitative variables and the 2-tailed Fisher exact test for few data. The multivariate analysis was done using a nonconditional logistic regression model expressed as an odds ratio (OR). To test the independence of the risk factors, the significant variables ($P<.10$) in the univariate analyses were entered into a multivariate logistic regression model with a likelihood ratio of $P<.05$.

RESULTS

The information from 5798 patients was in the database. Patients who did not received antibiotic prophylaxis (n=1080) were excluded from the analysis. An antibiotic prophylaxis had been administered to 4718 patients (the distribution was as follows: cefotaxime, 1492 patients; ceftriaxone, 1300; cefazolin, 1266; amoxicillin and clavulanic acid, 654; and metronidazole, 6 (these 6 patients' data were analyzed as intention-to-treat). The different types of operations performed are summarized in **Table 1**. When more than 1 procedure was performed during the surgical intervention, the main surgical procedure was considered for the analysis. There were 2459 men (52.1%) and 2259 women (47.9%). The mean (SD) age was 50.6 (19.0) years (age range, 18-96 years). The mortality rate was 2.4% (113 patients). The cause of death was known by autopsy in 57 patients; of these, 20 cases had infectious complications. The global infectious complications morbidity rate was 13.3% (628 patients). The SSI rate was 4.0% (191 patients): 104 patients (2.2%) had parietal infectious complications, 103 patients (2.2%) had deep infectious complications, and 16 patients had both parietal and deep infectious complications (and therefore are not included in the 191 patients' total). The postoperative anastomotic fistula rate was 6.3% (55 patients) in 874 patients who had a suture in the digestive tract or anastomosis of the bowel in the digestive tract during the surgical procedure. The urinary tract infection rate was 4.6% (217 patients); the intravascular catheter–induced infection rate was 4.7% (221 patients). In the 30 days after hospital discharge, 91 patients (1.9%) had an infectious complication.

Univariate analysis results are summarized in **Tables 2**, **3**, and **4**. The wound infection rate was 0.9% in patients with class 1 (clean), 1.6% in class 2 (clean contaminated), 2.7% in class 3 (contaminated), and 3.4% in class 4 (dirty) surgical sites ($P<.001$; linearity coefficient $<.05$)

Table 4 gives the 11 independent variables of SSI, parietal infectious complications, and deep complications in multivariate analysis. Obesity; underweight; presence of preoperative cutaneous abscess, necrosis, or both; use of an iodized alcohol skin antiseptic agent; a suture or anastomosis of the bowel in the digestive tract; parietal or abdominal drainage, or both; surgery for cancer; and receipt of anticoagulant therapy using a curative dosage during the postoperative period were risk factors for SSI. On the contrary, cutaneous closure and administration of cefotaxime or ceftriaxone reduced the rate of SSI. The risk factors for SSI, for parietal infectious complications, and for deep infectious complications with or without fistulas were different. The presence of preoperative cutaneous abscess, necrosis, or both was the most important risk factor for SSI (OR, 4.75) and for deep infectious complications with (OR, 7.61) or without(OR, 15.61) fistulas. Postoperative anticoagulant therapy using a curative dose was the most important risk factor for parietal infectious complications (OR, 3.29).

The multivariate analysis (**Table 5**) disclosed the following 7 risk factors for global infectious complications: age, being underweight, having cirrhosis, having a midline vertical incision, having a suture or an anastomosis of the bowel in the digestive tract, a prolonged operative time, and having a class 4 surgical site. The single protective factor identified was the administration of ceftriaxone therapy compared with other antibiotic agents used. An operative time exceeding 120 minutes was the most important risk factor for global infectious complica-

Table 2. Preoperative, Intraoperative, and Postoperative Risk Factors for Surgical Site Infection (SSI) in Univariate Analysis*

Variable	Total No. of Patients	SSI (n = 191)		Type of Infectious Complication					
				Parietal (n = 104)		Deep With Fistulas (n = 103)		Deep Without Fistulas (n = 65)	
		No. (%) of Patients	*P* Value	No. (%) of Patients	*P* Value	No. (%) of Patients	*P* Value	No. (%) of Patients	*P* Value
Preoperative Risk Factors									
Age, y									
≤59	3105	108 (3.48)	**.02**	67 (2.16)	.90	51 (1.64)	**.01**	34 (1.09)	**.03**
60-74	1070	57 (5.33)		24 (2.24)		37 (3.46)		23 (2.15)	
≥75	543	26 (4.79)		13 (2.39)		15 (2.76)		8 (1.47)	
Sex									
Male	2459	102 (4.15)	.71	46 (1.87)	**.10**	66 (2.68)	**.01**	40 (1.63)	**.07**
Female	2259	89 (3.94)		58 (2.57)		37 (1.64)		25 (1.11)	
Medical illness									
Obesity	409	24 (5.87)	**.05**	18 (4.4)	**.01**	6 (1.47)	.30	4 (0.98)	.47
Underweight	581	53 (9.12)	**<.001**	19 (3.27)	**.03**	40 (6.89)	**<.001**	21 (3.91)	**<.001**
Diabetes mellitus	166	11 (6.63)	**.07**	6 (3.61)	.17	6 (3.61)	.17	3 (1.81)	.54
Cirrhosis	130	7 (5.38)	.39	3 (2.31)	.75	4 (3.08)	.35	3 (2.31)	.28
Chylous ascites	98	5 (5.10)	.59	3 (3.06)	.46	3 (3.06)	.46	3 (3.06)	.11
Other disease	440	25 (5.68)	**.05**	14 (3.18)	**.10**	14 (3.18)	.11	6 (1.36)	.89
Immunodeficiency									
Corticocotherapy	57	3 (5.26)	.49	1 (1.75)	.9	2 (3.51)	.33	1 (1.75)	.72
Chemotherapy	76	4 (5.26)	.54	1 (1.31)	.9	4 (5.26)	.07	4 (5.26)	**.01**
Radiotherapy	50	6 (12.00)	**.01**	3 (6.00)	**.09**	4 (8.00)	**.02**	2 (4.00)	**.08**
Anticoagulant therapy									
None	4364	178 (4.08)	.21	94 (2.15)	**.02**	98 (2.25)	.35	61 (1.40)	.86
Preventive	337	11 (3.26)		8 (2.37)		4 (1.19)		4 (1.19)	
Curative	17	2 (11.76)		2 (11.76)		0		0	
Circumstance									
Elective	392	161 (4.10)	.75	82 (2.09)	.48	94 (2.39)	**.08**	60 (1.53)	.12
Emergency	483	20 (4.14)		14 (2.90)		6 (1.24)		4 (0.83)	
Deferred emergency	309	10 (3.24)		8 (2.59)		3 (0.97)		1 (0.32)	
Reoperation	3	0	.99	0	.99	0	.99	0	.99
Skin infection									
None	4019	156 (3.88)	**<.001**	81 (2.01)	**<.001**	85 (2.11)	**.05**	52 (1.29)	**.05**
Inflammation	645	26 (4.03)		17 (2.63)		14 (2.17)		10 (1.55)	
Abscess and/or necrosis	54	9 (16.66)		6 (11.11)		4 (7.41)		3 (5.55)	
Intraoperative Risk Factors									
Abdominal incision									
Vertical	175	99 (5.63)	**<.001**	55 (3.13)	**.002**	55 (3.13)	**<.001**	38 (2.16)	**<.001**
Horizontal	452	10 (2.21)	**.04**	7 (1.55)	.35	3 (0.66)	**.02**	1 (0.22)	**.03**
Oblique inside and low	168	34 (2.02)	**<.001**	24 (1.43)	**.01**	12 (0.71)	**<.001**	6 (0.35)	**<.001**
Oblique outside and low	829	50 (6.03)	**<.001**	18 (2.17)	.99	37 (4.46)	**<.001**	23 (2.77)	**<.001**
Skin antiseptic agents									
Povidone-iodine	3207	115 (3.59)	**.01**	59 (1.84)	**.01**	68 (2.12)	**<.001**	44 (1.37)	**<.001**
Chlorhexidin	1450	69 (4.76)		45 (3.10)		29 (2.00)		15 (1.03)	
Iodized alcohol	61	7 (11.47)		0		6 (9.84)		6 (9.84)	
Incision on a preexistent abdominal scar	814	44 (5.40)	**.03**	23 (2.82)	.22	24 (2.95)	**.09**	18 (2.21)	**.02**
Abdominal hernia repair	347	13 (3.75)	.74	10 (2.88)	.41	3 (0.86)	**.08**	3 (0.86)	**.4**
Parietal protection	3718	164 (4.41)	**.002**	85 (2.28)	.21	93 (2.50)	**.0007**	61 (1.64)	**.005**
Opening of a digestive bowel	2221	141 (6.35)	**<.001**	64 (2.88)	**.003**	87 (3.92)	**<.001**	49 (2.21)	**<.001**
Contaminated surgery									
None	3048	74 (2.43)	**<.001**	48 (1.57)	**<.001**	27 (0.89)	**<.001**	27 (0.89)	**<.001**
Minimal	1393	87 (6.24)		43 (3.09)		51 (3.66)		28 (2.01)	
Moderate	246	30 (12.19)		10 (4.06)		20 (8.13)		10 (4.06)	
Major	31	0		3 (9.68)		0		0	
Suture or anastomosis	874	97 (11.10)	**<.001**	32 (3.66)	**.001**	73 (8.35)	**<.001**	38 (4.35)	**<.001**
Peritoneal closure	3763	152 (4.04)	.99	80 (2.13)	.45	82 (2.18)	.69	50 (1.33)	.38
Cutaneous closure	4548	174 (3.83)	**<.001**	93 (2.04)	**<.001**	95 (2.09)	**<.001**	58 (1.27)	**<.001**
Parietal reinforcement	199	13 (6.53)	**.07**	11 (5.53)	**.002**	2 (1.00)	.44	0	.17
Parietal drainage	832	37 (4.45)	.47	27 (3.24)	**.03**	11 (1.32)	**.07**	8 (0.96)	.30
Abdominal drainage	1525	121 (7.93)	**<.001**	53 (3.47)	**<.001**	78 (5.11)	**<.001**	44 (2.88)	**<.001**

(continued)

Table 2. Preoperative, Intraoperative, and Postoperative Risk Factors for Surgical Site Infection (SSI) in Univariate Analysis* (cont)

Variable	Total No. of Patients	SSI (n = 191) No. (%) of Patients	SSI (n = 191) *P* Value	Type of Infectious Complication: Parietal (n = 104) No. (%) of Patients	Parietal *P* Value	Deep With Fistulas (n = 103) No. (%) of Patients	Deep With Fistulas *P* Value	Deep Without Fistulas (n = 65) No. (%) of Patients	Deep Without Fistulas *P* Value
Intraoperative Risk Factors (cont)									
Operative time, min									
≤60	1918	46 (2.40)	**<.001**	36 (1.88)	**.02**	14 (0.73)	**<.001**	13 (0.68)	**<.001**
61-120	1738	47 (2.70)		33 (1.90)		19 (1.09)		13 (0.75)	
≥121	1062	98 (9.23)		35 (3.30)		70 (6.59)		39 (3.67)	
Cancer	558	55 (9.86)	**<.001**	24 (4.30)	**<.001**	37 (6.63)	**<.001**	23 (4.12)	**<.001**
Antibiotic prophylaxis									
Cefazolin sodium	1266	60 (4.74)	.67	28 (2.21)	.34	39 (3.08)	**.009**	24 (1.90)	**.001**
Cefotaxime sodium	1492	57 (3.82)		41 (2.75)		18 (1.21)		10 (0.67)	
Ceftriaxone sodium	1300	47 (3.61)		26 (2.00)		25 (1.92)		12 (0.92)	
Amoxicillin and clavulanic acid	654	27 (4.13)		9 (1.38)		21 (3.21)		19 (2.9)	
Metronidazole hydrochloride	6	0		0		0		0	
Postoperative Risk Factors									
Class†									
1	1355	15 (1.11)	**<.001**	12 (0.89)	**<.001**	5 (0.37)	**<.001**	4 (0.29)	**<.001**
2	910	23 (2.53)		15 (1.65)		11 (1.21)		9 (0.99)	
3	986	52 (5.27)		27 (2.74)		31 (3.14)		19 (1.93)	
4	1476	101 (6.84)		50 (3.39)		56 (3.79)		33 (2.24)	
Urinary catheterization	851	77 (9.05)	**<.001**	36 (4.23)	**<.001**	47 (5.52)	**<.001**	26 (3.05)	**<.001**
Anticoagulant therapy									
None	1021	35 (3.43)	**<.001**	19 (1.86)	**<.001**	20 (1.96)	**.09**	7 (0.69)	**.004**
Preventive	2838	121 (4.26)		67 (2.36)		64 (2.25)		43 (1.51)	
Curative	117	15 (12.82)		9 (7.69)		6 (5.13)		5 (4.27)	
Unknown	742	20 (2.69)		9 (1.21)		13 (1.75)		10 (1.35)	

*Boldfaced values indicate statistical significance.
†Class 1 indicates clean; class 2, clean contaminated; class 3, contaminated; and class 4, dirty.

tions (OR, 2.72). Placement of 1 suture in the digestive tract or having an anastomosis of the bowel in the digestive tract was the only risk factor common both for SSI and for global infectious complications.

COMMENT

Among the 37 studied independent variables, the following 7 independent risk factors for global infectious complications have been identified: age, being underweight, having cirrhosis, type of incision, having at least 1 suture or an anastomosis of the bowel in the digestive tract, prolonged operative time, and having a class 4 surgical site. The only protective factor identified was the administration of ceftriaxone therapy. In multivariate analysis, the following 5 independent risk factors for SSI were statistically significant: the presence of preoperative cutaneous abscess, necrosis, or both; having at least 1 suture or an anastomosis in the digestive tract; having abdominal drainage; undergoing a surgical procedure for the excision of cancer; and received postoperative anticoagulant therapy with a curative dosage. Our data demonstrate that risk factors for SSI and for global infectious complications are different: the placement of a suture or site of an anastomosis in the digestive tract is the only common risk factor. Within the SSI, risk factors for parietal and deep infectious complications also differ, obesity and parietal drainage being specific risk factors for parietal complications while being underweight and receiving cefotaxime therapy are specific for deep complications.

To our knowledge, no multivariate study reported in the literature has evaluated risk factors for global infectious complications in abdominal noncolorectal surgery. A main advantage of this article is the inclusion of a significant number of patients. The prospective nature of the study allows for more complete data collection. Furthermore, this is a multicenter study that includes private medical centers, institutional hospitals, and university hospitals. Thus, our results are more representative of the daily surgical practice avoiding the bias of single-center recruitment.[13] In fact, some surgical procedures performed in specialized centers have lower mortality and morbidity rates. These rates are inversely proportional to the number of surgical procedures performed by staff in these medical facilities.[14-16] Daley et al[17] and Khuri et al[18] from the National Veterans Affairs Surgical Risk Study included only patients with a mean age of 60 years. It seems difficult to extrapolate results from these studies to the whole population. Finally, we have performed a multivariate analysis by logistic regression, not only for risk factors for SSI but, to our knowledge, for first-time risk factors for global infectious complications.

Age is a risk factor for postoperative complications commonly reported in the medical literature.[19,20] In our study, age is an independent risk factor for a global in

Table 3. Preoperative, Intraoperative, and Postoperative Risk Factors for Overall Infectious Morbidity and Extraparietal and Abdominal Infections in Univariate Analysis*

Variable	Total No. of Patients	Overall Infections (n = 628)		Urinary Infections (n = 217)		Catheter Infections (n = 221)		Late Infections (n = 91)	
		No. (%) of Patients	*P* Value	No. (%) of Patients	*P* Value	No. (%) of Patients	*P* Value	No. (%) of Patients	*P* Value
Preoperative Risk Factors									
Age, y									
≤59	3105	334 (10.76)		102 (3.28)		111 (3.57)		48 (1.54)	
60-74	1070	187 (17.48)	**<.001**	71 (6.63)	**<.001**	66 (6.17)	**<.001**	29 (2.71)	**.02**
≥75	543	107 (19.70)		44 (8.10)		44 (8.10)		14 (2.58)	
Sex									
Male	2459	302 (12.28)	**.03**	78 (3.17)	**<.001**	131 (5.32)	**.03**	44 (1.79)	.60
Female	2259	326 (14.43)		139 (6.15)		90 (3.98)		47 (2.08)	
Medical illness									
Obesity	409	73 (17.85)	**.05**	24 (5.87)	.18	24 (5.87)	.22	15 (3.67)	**.007**
Underweight	581	153 (26.33)	**<.001**	50 (8.61)	**<.001**	69 (11.88)	**<.001**	12 (2.06)	.57
Diabetes mellitus	166	37 (22.29)	**<.001**	14 (8.43)	**.01**	13 (7.83)	**.03**	4 (2.41)	.50
Cirrhosis	130	37 (28.46)	**<.001**	14 (10.77)	**<.001**	19 (14.61)	**<.001**	5 (3.85)	**.05**
Chylous ascites	98	25 (25.51)	**<.001**	8 (8.16)	**.06**	15 (15.31)	**<.001**	2 (2.04)	.57
Other disease	440	93 (21.14)	**<.001**	36 (8.18)	**<.001**	33 (7.5)	**>.001**	19 (4.32)	**<.001**
Immunodeficiency									
Corticocotherapy	57	9 (15.79)	.54	1 (1.75)	.51	3 (5.26)	.74	2 (3.51)	.99
Chemotherapy	76	13 (17.10)	.29	5 (6.58)	.87	4 (5.26)	.78	3 (3.95)	.99
Radiotherapy	50	14 (28)	**.001**	2 (4)	.84	4 (8)	.29	5 (10)	**.002**
Anticoagulant therapy									
None	4364	575 (13.18)		199 (4.56)		201 (4.61)		79 (1.81)	**.07**
Preventive	337	49 (14.54)	.36	18 (5.34)	.29	18 (5.34)	.32	11 (3.26)	
Curative	17	4 (23.53)		0		2 (11.76)		1 (5.88)	
Circumstance									
Elective	3926	528 (13.45)		189 (4.81)		184 (4.69)		76 (1.93)	.81
Emergency	483	65 (13.46)	.58	16 (3.31)	.31	26 (5.38)	.50	8 (1.66)	
Deferred emergency	309	35 (11.33)		12 (3.88)		11 (3.56)		7 (2.26)	
Reoperation	3	0	.99	0	.99	0	.99	0	.99
Skin infection									
None	4019	531 (13.21)		195 (4.85)		193 (4.80)	**.02**	77 (1.92)	
Inflammation	645	72 (11.16)	**<.001**	18 (2.79)	**.07**	22 (3.41)		13 (2.01)	.89
Abscess and/or necrosis	54	16 (29.63)		4 (7.40)		6 (11.11)		1 (1.85)	
Intraoperative Risk Factors									
Abdominal incision									
Vertical	1757	324 (18.44)	**<.001**	121 (6.89)	**<.001**	120 (6.83)	**<.001**	41 (2.33)	**.08**
Horizontal	452	53 (11.73)	.39	19 (4.20)	.78	17 (3.76)	.38	9 (1.99)	.9
Oblique inside and low	1680	101 (6.01)	**<.001**	22 (1.31)	**<.001**	24 (1.43)	**<.001**	21 (1.25)	**.01**
Oblique outside and low	829	156 (18.82)	**<.001**	54 (6.51)	**.002**	56 (6.75)	**.001**	25 (3.01)	**.004**
Skin antiseptic agents									
Povidone-iodine	3207	406 (12.66)		138 (4.30)		148 (4.61)		61 (1.90)	
Chlorhexidin	1450	212 (14.62)	**.06**	76 (5.24)	.43	71 (4.90)	.68	28 (1.93)	.95
Iodized alcohol	61	10 (16.39)		3 (4.92)		2 (3.28)		1 (1.64)	
Incision on a preexistent abdominal scar	814	142 (17.44)	**<.001**	50 (6.14)	**.03**	45 (5.53)	.22	22 (2.70)	**.05**
Abdominal hernia repair	347	46 (13.26)	.97	17 (4.90)	.82	13 (3.74)	.37	11 (3.17)	**.07**
Parietal protection	3718	532 (14.31)	**<.001**	180 (4.84)	**.001**	193 (5.19)	**<.001**	71 (1.91)	.65
Opening of a digestive bowel	2221	424 (19.10)	**<.001**	149 (6.71)	**<.001**	165 (7.43)	**<.001**	54 (2.43)	**.009**
Contaminated surgery									
None	3048	282 (9.25)		97 (3.18)		87 (2.85)		48 (1.57)	
Minimal	1393	263 (18.88)	**<.001**	93 (6.68)	**<.001**	93 (6.68)	**<.001**	39 (2.80)	**.02**
Moderate	246	72 (29.27)		22 (8.94)		37 (15.04)		4 (1.63)	
Major	31	9 (29.03)		5 (16.13)		4 (12.9)		0	
Suture or anastomosis	874	264 (30.21)	**<.001**	86 (9.84)	**<.001**	116 (13.3)	**<.001**	34 (3.89)	**<.001**
Peritoneal closure	3763	527 (14)	**<.001**	188 (5)	**<.001**	188 (4.99)	**.01**	68 (1.81)	.74
Cutaneous closure	4548	596 (13.10)	**<.001**	210 (4.62)	.63	212 (4.66)	**.001**	83 (1.82)	.99
Parietal reinforcement	199	41 (20.60)	**.002**	15 (7.54)	**.06**	15 (7.54)	**.05**	6 (3.01)	.14
Parietal drainage	832	102 (12.26)	.35	29 (3.48)	.13	26 (3.12)	**.02**	24 (2.88)	**.02**
Abdominal drainage	1525	377 (24.72)	**<.001**	140 (9.18)	**<.001**	161 (10.5)	**<.001**	37 (2.43)	**.06**

(continued)

Table 3. Preoperative, Intraoperative, and Postoperative Risk Factors for Overall Infectious Morbidity and Extraparietal and Abdominal Infections in Univariate Analysis* (cont)

Variable	Total No. of Patients	Overall Infections (n = 628) No. (%) of Patients	Overall Infections (n = 628) *P* Value	Urinary Infections (n = 217) No. (%) of Patients	Urinary Infections (n = 217) *P* Value	Catheter Infections (n = 221) No. (%) of Patients	Catheter Infections (n = 221) *P* Value	Late Infections (n = 91) No. (%) of Patients	Late Infections (n = 91) *P* Value
Intraoperative Risk Factors (cont)									
Operative time, min									
≤60	1918	122 (6.36)		30 (1.56)		24 (1.25)		18 (0.94)	
61-120	1738	212 (12.20)	**<.001**	84 (4.83)	**<.001**	73 (4.20)	**<.001**	37 (2.13)	**<.001**
≥121	1062	294 (27.68)		103 (9.70)		124 (11.7)		36 (3.39)	
Cancer	558	129 (23.12)	**<.001**	43 (7.71)	**<.001**	53 (9.50)	**<.001**	13 (2.33)	.32
Antibiotic prophylaxis									
Cefazolin sodium	1266	212 (16.74)		84 (6.63)		72 (5.69)		25 (1.97)	
Cefotaxime sodium	1492	217 (14.54)		74 (4.96)		67 (4.49)		25 (1.67)	
Ceftriaxone sodium	1300	119 (9.15)	**<.001**	32 (2.46)	**<.001**	54 (4.15)	**.004**	21 (1.61)	.27
Amoxicillin and clavulanic acid	654	77 (11.77)		26 (3.97)		26 (3.97)		20 (3.06)	
Metronidazole hydrochloride	6	3 (50)		1 (16.67)		2 (33.3)		0	
Postoperative Risk Factors									
Class†									
1	1355	65 (4.80)		18 (1.33)		15 (1.11)		13 (0.96)	
2	910	121 (13.30)	**<.001**	53 (5.82)	**<.001**	40 (4.39)	**<.001**	11 (1.21)	**<.001**
3	986	145 (14.71)		39 (3.95)		55 (5.58)		16 (1.62)	
4	1476	297 (20.12)		105 (7.11)		111 (7.52)		51 (3.45)	
Urinary catheterization	851	317 (37.25)	**<.001**	169 (19.9)	**<.001**	119 (13.9)	**<.001**	38 (4.46)	**<.001**
Anticoagulant therapy									
None	1021	119 (11.65)		46 (4.50)		37 (3.62)		16 (1.57)	
Preventive	2838	445 (15.68)	**.002**	159 (5.60)	.29	167 (5.88)	**.02**	56 (1.97)	.13
Curative	117	24 (20.51)		6 (5.13)		5 (4.27)		5 (4.27)	
Unknown	742	40 (5.39)		6 (0.81)		12 (1.61)		14 (1.88)	

*Boldfaced values indicate statistical significance.
†Class 1 indicates clean; class 2, clean contaminated; class 3, contaminated; and class 4, dirty.

fectious complication but not for an SSI. Because of the distinction between different types of infectious complications, we have noticed that age is related to extraparietal and abdominal complications (urinary tract infection, OR, 2.15; catheter-induced infections, OR, 1,82) but not to parieto-abdominal complications. In fact, age is neither a risk factor for SSI nor for one of its components (parietal infection or deep infection). Different pathophysiologic mechanisms have been proposed to explain the development of specific infectious complications. Aging leads to a progressive reduction in immunity (60% of the patients >75 years have cutaneous anergy)[21] and organ functional deterioration.[22] Finkelstein[23] considers elderly patients fragile with a higher prevalence of associated chronic diseases.

Being underweight reflects the nutritional state of patients.[24] A loss of weight exceeding 10% of the patient's ideal weight has already been shown to be a risk factor for postoperative infectious complications[25] caused by changes in the defense system against infection.[26,27] Nevertheless, data concerning the effects of renutrition on the immune system are somewhat contradictory. Law et al[27] demonstrated an improvement in immune function after malnutrition. Muller et al[28] showed that correction of preoperative malnutrition in patients being operated on for cancer reduced significantly the incidence of major postoperative complications and notably infectious complications. This perioperative renutrition can be performed according to different modalities. Eight prospective randomized trials comparing enteral with parenteral renutrition have been regrouped in a meta-analysis[29] concluding that enteral nutrition must be used if possible.

Ten percent to 30% of patients who have cirrhosis, when undergoing an abdominal surgical procedure, developed postoperative bacterial infections.[30,31] Cirrhosis is an independent risk factor for global infectious complication but not for SSI. In this study, 37 (28.4%) of 130 patients who had cirrhosis developed a postoperative infection. This high prevalence of infectious complications in cirrhosis can be explained by the presence of various dysfunctions in the mechanisms of defense against infection[32]: a decrease in the function of the reticuloendothelial system and of granulocyte function, a decrease in complement concentrations, or change in cell-mediated immunity. Changes in digestive flora and in the intestinal barrier may also play a role in the pathophysiology of bacterial infections during cirrhosis. Additionally, patients with cirrhosis often have other associated disorders such as malnutrition, acute hypovolemia, and hypoalbuminemia, which can worsen a preexistent immune dysfunction.

Comparison between vertical and transversal incision has been studied in 7 retrospective comparative studies and in 11 prospective randomized studies regrouped in a meta-analysis.[33] None of these studies has shown any statistically significant difference in the wound infection rate. To our knowledge, none of these studies has

Table 4. Risk Factors for Surgical Site Infection (SSI) in Multivariate Analysis*

Variable	SSI, OR (95% CI)	Type of Infectious Complication, OR (95% CI)		
		Parietal	Deep With Fistulas	Deep Without Fistulas
Preoperative Risk Factors				
Obesity	. . .	2.33 (1.05-5.17)	. . .	. . .
Underweight	. . .	. . .	1.96 (1.08-3.55)	. . .
Skin infection				
None	1.00	. . .	1.00	1.00
Inflammation	1.15 (0.62-2.14)	. . .	0.75 (0.29-1.93)	0.99 (0.32-3.06)
Abscess or necrosis	4.75 (1.08-20.92)	. . .	7.61 (1.28-45.28)	15.61 (1.36-179.2)
Intraoperative Risk Factors				
Skin antiseptic agents				
Povidone-iodine	. . .	. . .	. . .	1.00
Chlorhexidin	. . .	. . .	. . .	0.72 (0.33-1.56)
Iodized alcohol	. . .	. . .	. . .	10.06 (2.12-47.66)
Suture or anastomosis	1.82 (1.04-3.20)	. . .	. . .	. . .
Parietal drainage	. . .	2.27 (1.22-4.2)	. . .	. . .
Abdominal drainage	2.15 (1.30-3.57)	. . .	3.53 (1.57-7.98)	. . .
Cutaneous closure	. . .	. . .	. . .	0.20 (0.05-0.88)
Cancer	1.74 (1.07-2.82)	2.02 (1.07-3.80)	2.32 (1.23-4.38)	. . .
Antibiotic prophylaxis				
Cefazolin sodium	. . .	. . .	1.00	1.00
Cefotaxime sodium	. . .	. . .	0.32 (0.16-0.67)	0.30 (0.12-0.73)
Ceftriaxone sodium	. . .	. . .	0.48 (0.22-1.08)	0.21 (0.06-0.70)
Amoxicillin and clavulanic acid	. . .	. . .	0.59 (0.22-1.60)	0.59 (0.19-1.78)
Postoperative Risk Factors				
Anticoagulant therapy				
None	1.00	1.00	. . .	1.00
Preventive	0.87 (0.53-1.45)	1.01 (0.52-1.94)	. . .	1.35 (0.52-3.53)
Curative	3.33 (1.47-7.56)	3.29 (1.18-9.18)	. . .	4.75 (1.10-20.56)

Abbreviations: CI, confidence interval; ellipses, not applicable; OR, odds ratio.

considered postoperative global infectious complications. The multivariate analysis has shown that the vertical incision is an independent risk factor for infectious complications, thus, supporting the the advantage of transverse abdominal incision. Moreover, transverse abdominal incision is associated with less postoperative pain and less analgesic use.[33] This type of incision is related to less postoperative pulmonary complications (atelectasis, pneumonia, or respiratory failure), less evisceration, and secondary incisional hernia.[33] Two types of incisions offer equal exposure of different intra-abdominal organs[33] although the midline vertical incision allows for widening of the section more easily and gaining 4 to 15 minutes in operative time.[33] Laparoscopy could be of interest in this setting, a technique that is not evaluated in the current report because of the few procedures performed this way.

Placement of a suture in the digestive tract or an anastomosis in the digestive tract was the only common risk factor for SSI and for global infectious complications. An anastomosis or suture in the digestive tract is a necessary part of the procedure in most cases. The surgical site is then classified at the least as class 2 (clean contamination),[11] increasing the infection risk from 2% to 10%. These variables are usually known before the operation unless an accidental perforation of the bowel occurs (eg, perforation of the digestive tract during difficult adhesion lysis) or an intraoperative change in therapeutic decision owing to unsuspected intraoperative findings.

Cruse and Foord,[34] National Research Council,[11] and Public Health Laboratory Service[35] showed the existence of a direct relationship between operative time and postoperative infectious risk. These authors showed that risk doubled with each additional operative hour. Our results agree with this finding, as our rates of postoperative infection were 6.3% for 1 hour, 12.2% for 1 to 2 hours, and 27.7% for longer than 2 hours. Operative time is an unmodifiable variable. Thus, periodic reinjection of antibiotic agents (according to half-life) during the intervention should be favored.

The indications of antibiotic prophylaxis are based on infectious risks of the surgical act according to the classification of the National Research Council.[11] In a class 1 (clean) population, all patients do not have the same risk of postoperative infectious complications. Haley et al[36] showed that the risk of postoperative wound abscess formation varied from 1.1% to 15.8%. It would be interesting to define factors distinguishing between the group with low-risk and those with high-risk infectious complications. In contrast, a patient with a class 4 (dirty) surgery needs a therapeutic dose of an antibiotic agent. Antibiotic prophylaxis is not indicated in these patients. For this reason, we excluded patients belonging to this class from our study. Instead, we redefined the class 4 surgical site to consider preoperative variables.[5,10] In our study, the new class 4 seems to be an important independent risk factor of postoperative infectious complications. This new classification identifies

Table 5. Intraoperative and Postoperative Risk Factors for Overall Infectious Morbidity and Extraparietal and Abdominal Infections in Multivariate Analysis*

	Overall Infections	Urinary Infections	Catheter Infections	Late Infections
Preoperative Risk Factors				
Age, y				
≤59	1.00	1.00	1.00	. . .
60-74	1.64 (1.24-2.17)	1.50 (0.94-2.40)	1.43 (0.91-2.25)	. . .
≥75	1.45 (1.00-2.09)	2.15 (1.22-3.80)	1.82 (1.06-3.12)	. . .
Underweight	1.51 (1.08-2.10)	. . .	1.91 (1.18-3.07)	. . .
Cirrhosis	2.45 (1.37-4.38)	. . .	. . .	. . .
Ascites	. . .	. . .	4.81 (2.13-10.85)	. . .
Other disease	. . .	. . .	. . .	1.9 (1.02-3.54)
Radiotherapy	. . .	. . .	. . .	4.11 (1.4-12.04)
Intraoperative Risk Factors				
Abdominal incision				
Vertical	1.66 (1.10-2.49)	. . .	. . .	. . .
Oblique outside and low	. . .	2.10 (1.04-4.26)	. . .	. . .
Suture or anastomosis	1.48 (1.04-2.09)	. . .	. . .	. . .
Abdominal drainage	. . .	. . .	3.24 (2.05-5.12)	. . .
Operative time, min				
≤60	1.00	. . .	. . .	. . .
61-120	1.66 (1.05-2.04)	. . .	. . .	. . .
≥121	2.72 (1.9-3.91)	. . .	. . .	. . .
Antibiotic prophylaxis				
Cefazolin sodium	1.00	1.00	1.00	. . .
Cefotaxime sodium	0.84 (0.64-1.11)	0.57 (0.36-0.90)	0.64 (0.41-1.01)	. . .
Ceftriaxone sodium	0.43 (0.29-0.64)	0.17 (0.08-0.36)	0.42 (0.22-0.77)	. . .
Amoxicillin and clavulanic acid	0.68 (0.41-1.12)	0.54 (0.27-1.06)	0.62 (0.29-1.32)	. . .
Postoperative Risk Factors				
Class†				
1	1.00	. . .	. . .	. . .
2	1.37 (0.84-2.25)	. . .	. . .	. . .
3	1.54 (0.95-2.49)	. . .	. . .	. . .
4	1.66 (1.04-2.64)	. . .	. . .	. . .
Urinary catheterization	. . .	19.78 (11.83-33.05)	. . .	. . .

Abbreviation: Elllipses, not applicable.
*All data are expressed as odds ratios (95% confindence intervals).
†Class 1 indicates clean; class 2, clean contaminated; class 3, contaminated; and class 4, dirty.

preoperatively a subgroup of high-risk patients who need intraoperative antibiotic prophylaxis.

If the efficiency of antibiotic prophylaxis in abdominal surgery was demonstrated,[5-7] the controversy about the choice of agent still persists.[8] The choice of antibiotic relys on objective criteria. The main ones are bacteriological, pharmacological, and individual patient criteria (eg, age or pregnancy), medical and surgical history, comorbidity (the presence of renal failure, liver disease, or a drug allergy), and other prescribed treatments (drug interactions). Secondary ecological and economic criteria allow a more selective choice between many therapeutic possibilities. Administration of ceftriaxone therapy is an independent protective factor for postoperative global infectious complications, for deep infectious complications without fistulas, for urinary tract infections, and for vascular catheter-induced infection. Prospective randomized trials already showed the superiority of ceftriaxone given prophylactically for abdominal surgery[37,38]

Since 1957, Elek and Conen[39] have shown that a bacterial count of 6 million *Staphylococcus aureus* were needed to cause infection in a healthy subject. An inoculum of 600 staphylococci is enough to produce the same lesion in a person with only 1 suture. A cutaneous infection in the abdominal cavity is an entrance for bacteria, giving rise to secondary deep infections.

The main aim of abdominal drainage is to evacuate residual effusions to avoid infection. Thus, every drainage has its own limits because of obstruction and mobility. Preventive drainage is a risk factor for SSI. In colorectal surgery, drainage is useless.[40-42] It can be at the origin of retrograde bacterial colonization, especially when the drainage is no longer an aspirate. We discourage the placement of routine preventive abdominal drainage and we recommend that the guidelines of the French Society of Digestive Surgery be followed.[43] A meticulous hemostasis without unnecessary dissections must be done to reduce hematomas and the amount of postoperative residual collections. The indication of a curative dose of anticoagulant therapy administered postoperatively must be really justified. A preventive dose of anticoagulant therapy administered postoperatively must be allowed. Particular care must be taken withpatients who require a curative dose of anticoagulant therapy.

Patients affected with cancer, irrespective of receiving chemotherapy or radiotherapy, have deficits in immunity proportional to the extension and the gravity of

Participating Members of the French Associations for Surgical Research

Sens: Bernard Fethi, MD. *Orléans:* Jean-Louis Bernard, MD. *Clermont-Ferrand:* Jacques Chipponi, MD. *Limoges:* Bernard Descottes, MD; Xavier Pouget, MD. *Montargis:* Gérard Desvignes, MD. *Thonon les Bains:* Christian Dilin, MD. *Tunis, Tunisia:* Dziri Chadli, MD; Tahar Khalfallah, MD. *Aulnay:* André Elhaddad, MD. *Flers:* Jacques Emer, MD. *Créteil:* Pierre-Louis Fagniez, MD; Nelly Rotman, MD. *Poissy:* Abe Fingerhut, MD; Jean Pourcher, MD. *Colombes:* Yves Flamant, MD; Jean-Marie Hay, MD; Jean-Noël Maillard, MD; Simon Msika, MD, PhD; Guy Zeitoun, MD. *Quimperlé:* Jacques Francin, MD. *Saint-Brieuc:* Serge Hannoun, MD; François Poulton, MD. *Romorantin:* Henri Henne, MD. *Chatellerault:* Marc Kalfon, MD. *Strasbourg:* Daniel Keller, MD. *Corbeil:* Gérard Kohlman, MD. *Le Havre:* Matthias Krach, MD. *Pau:* Yves Laborde, MD. *Paris:* François Lacain, MD; Hughes Levard, MD. *Angers:* Gérard Lorimier, MD; Patrick Pessaux, MD; David Attala, MD. *Lyon:* Christian Mathon, MD. *Villeneuve St Georges:* Philippe Oberlin, MD. *Argenteuil:* Xavier Pouliquen, MD. *Orsay:* Michel Rodary, MD. *Juvisy:* François Rouffet, MD. *Auxerre:* Michel Sage, MD. *Nice:* Jean-Louis Sicard, MD.

the disease.[44,45] The infectious risks are correlated to this immunity deficit.[46]

Two risk factors specific for parietal infectious complications have been disclosed: obesity and parietal drainage. The findings from univariate and multivariate studies showed that obesity is a risk factor of wound infection.[47,48] Although weight loss is an important long-term health goal, it is important to recognize, with regard to the operative prophylaxis, that antibiotic agents should be adjusted to the patient's body weight. Forse et al[49] showed that by doubling the antibiotic's posology the wound infection rate was reduced from 16.5% to 5.6%. In the medical literature, the results are contradictory concerning the efficiency of preventive drainage of a noninfected abdominal wall.[50-53] A distinction must be made between preventive drainage of a noninfected abdominal wall and curative drainage of an infected abdominal wall. The only indication of preventive drainage is obesity.[53]

Several limitations of this study should be emphasized. First, because of the character of this study, we did not have a single person perform all the direct examinations of any suspicious infection. Because there are marked differences in the tendency of surgeons to make a diagnosis of infection,[54] the study protocol defined precisely each infection. Second, to minimize interhospital variations (eg, operating room discipline, sterility of instruments, handwashing, use of gloves and drapes, and others), the skin preparation was standardized in the protocol. The multicenter character of this study allows the extrapolation of the results to the daily surgical practice. Third, some variable found in the literature as infectious risk factors such as American Society of Anesthesiologists' classification,[55,56] ethnic group,[50] hypoxia,[57] hypothermia,[58] may be why biological variables as albuminemia,[59] glycemia,[60] and cholesterolemia[61] have not been studied.

With the aim of reducing the rate of global infectious complications and of SSI, the independent risk factors can be divided into the following 4 categories:

- Unmodifiable factors: age, intestinal tract suture or anastomosis, class 4 surgical site, and cancer surgery
- Factors needing to be improved: cirrrhosis, use of postoperative curative dose of anticoagulant therapy, and operative time
- Factors that are able to be modified before or during surgery: being underweight, type of incision, preoperative cutaneous status, and abdominal drainage
- Protective factor against infection: administration of ceftriaxone therapy

Could correction of the modifiable factors reduce the postoperative infectious complications? We propose resuming enteral nutrition as soon as possible in all patients in the preoperative and postoperative period, and to differ operative procedures in patients who have abdominal skin infection. Transverse abdominal incision is preferable. The use of abdominal drainage must be avoided. Among antibiotic agents tested, ceftriaxone may be preferable. The efficacy of these proposals should be evaluated by a prospective study.

This work will be followed by the introduction of a new scoring system being predictive of global infectious complications, to supplement the Noscomial Infections Surveillance System scoring system that predicts only wound infection[56] or the Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity score.[62] This scoring system will be tested on patients in our series and a definitive validation in a prospective study will follow.

Accepted for publication November 16, 2002.

Corresponding author and reprints: Patrick Pessaux, MD, Service de Chirurgie Digestive, Centre Hospitalier et Universitaire Angers, 4 Rue Larrey, 49033 Angers Cedex 01, France (e-mail: pessauxpchuangers@Yahoo.fr).

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