ORIGINAL ARTICLE

Association of *Streptococcus bovis* Bacteremia With Colonic Neoplasia and Extracolonic Malignancy

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Background: The association between *Streptococcus bovis* bacteremia and colonic neoplasia is well described; however, the relationship between *S bovis* and neoplasia outside the colon has not been well evaluated.

Hypothesis: *S bovis* bacteremia may be associated with colonic neoplasia and extracolonic malignancy.

Design: Retrospective review of all documented cases of *S bovis* bacteremia identified by a search of computerized bacteriology records.

Setting: One tertiary referral hospital and 1 community hospital located in the same city.

Patients: Forty-five patients (41 adults, 4 children) with documented *S bovis* bacteremia during a 12-year period were identified.

Main Outcome Measures: Available patient records were reviewed to identify the presence of colonic neoplasia, the use of gastrointestinal endoscopy, and the presence of gastrointestinal or extraintestinal malignancies.

Results: Seventeen patients (41% of adult patients) underwent colonoscopy. Colonic neoplasia was present in 16 patients (39% of adults), with 3 of these patients having invasive colorectal cancer (7% of adults). Invasive cancer was present in 13 patients (32% of adults). Eight patients had malignant lesions arising within the gastrointestinal tract, and 5 patients had extraintestinal malignancies.

Conclusion: *S bovis* bacteremia is associated with both colonic neoplasia and extracolonic malignancy.

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AN ASSOCIATION BETWEEN *Streptococcus bovis* bacteremia and gastrointestinal disease, particularly colonic neoplasia, has been well documented in the literature. McCoy and Mason[1] published a case report of "enterococcal" endocarditis associated with a carcinoma of the cecum in 1951. It is likely that the organism in this case was truly *S bovis*.[2] Since that time, a connection between *S bovis* septicemia and colonic neoplasia has been confirmed by several other case reports as well as reviews of case series and a case-control study. On the basis of these data, several authors have recommended that all patients with *S bovis* bacteremia undergo complete evaluation of the colon.[3-12]

The reason for this association has not been elucidated. Among the theories are that colonic neoplasia specifically allows for the overgrowth or translocation of this organism[3] and that *S bovis* is in fact causative of the neoplasia itself.[3,13] One study demonstrated a significantly higher rate of fecal carriage of *S bovis* in patients with colorectal cancer as opposed to controls.[3] Subsequent studies, however, have failed to confirm this finding.[14-16] In a laboratory investigation, antigens from the cell wall of *S bovis* promoted neoplastic progression in chemically induced tumors in a rat model.[13]

In contrast to the literature regarding an association with colonic neoplasia, less is written about associations of *S bovis* with other gastrointestinal disease or with other cancers. Some authors have noted that a subset of patients with *S bovis* bacteremia have cirrhosis or liver dysfunction.[2,6,8-10,12,17-19] One group has postulated a triad of *S bovis* bacteremia, liver disease, and colonic pathology whereby the liver disease may account for the increased fecal carriage, entry to the portal venous system, or passage from the portal to systemic circulation of *S bovis*.[9]

The purpose of this study was to review the experience with *S bovis* bacter-

emia in our community with respect to associated gastrointestinal pathology, the use of gastrointestinal endoscopy, and associated infections, as well as associated gastrointestinal and extraintestinal malignancies.

METHODS

Cases of *S bovis* bacteremia were obtained from a review of all available computerized bacteriology records at 2 hospitals (Yale–New Haven Hospital and the Hospital of Saint Raphael, New Haven, Conn) for the period between January 1986 and January 1999. Hospital records, including pathologic reports, were reviewed for all patients identified as having *S bovis* bacteremia. Clinical parameters including age, sex, the presence of anemia, the presence of signs or symptoms of gastrointestinal pathology, the use of upper or lower gastrointestinal endoscopy, the presence of infections at extravascular sites at the time of documented bacteremia, and other associated medical conditions such as cancer were recorded. All work was governed by human investigation committee protocols 10491 (Yale–New Haven Hospital) and 1123 (Hospital of Saint Raphael).

The 2-sided *t* test was used to examine for differences among continuous variables, and the 2-sided Fisher exact test was used to examine for differences among categorical variables.

Literature review was conducted by MEDLINE searches using combinations of the term "*Streptococcus bovis*" with "colon," "intestine," "gastrointestinal," "liver," "cancer," "neoplasia," and "malignancy." Abstracts and/or full text of all articles written in English were reviewed. Particular attention was paid to series of more than 10 patients. The references of the reviewed articles were also used to identify pertinent literature.

RESULTS

PATIENT CHARACTERISTICS

There were 45 patients with *S bovis* bacteremia documented at 2 hospitals in 1 city during a 12-year period. Of these, 4 were children (newborn, 6 weeks, 6 weeks, and 3 years), and 41 were adults. The median age of the patients was 74 years (range, newborn to 90 years). Thirteen of the patients were female and 32 were male. The clinical characteristics of the patients with *S bovis* bacteremia are presented in **Table 1**. There were no significant differences in the demographic and clinical characteristics of the patients seen at the 2 institutions except that the mean age was lower at the tertiary referral hospital (63.0 vs 79.7 years; $P=.01$), reflecting the fact that all of the pediatric patients were seen at this hospital; the mean age of the adult patients was not statistically different (71.3 vs 79.9 years; $P=.10$).

Eighteen patients underwent upper or lower gastrointestinal endoscopy after the diagnosis of *S bovis* bacteremia (1 upper, 17 lower). One colonoscopy was performed 2 years after the diagnosis of *S bovis* bacteremia; the other examinations were performed within 1 month. In all but 1 of the patients examined, gastrointestinal pathology was diagnosed. The most common pathology identified was colonic polyps (14 patients, 13 with adenomatous polyps and 1 with a hyperplastic polyp). One patient had diverticulosis in addition to an adenomatous polyp. One patient had ischemic colitis. The patient who underwent upper endoscopy had an invasive duodenal adenocarcinoma.

Table 1. Clinical Characteristics of Patients With *Streptococcus bovis* Bacteremia

Characteristic	No. (%) of Patients (N = 45)
Endocarditis present	12 (27)
Signs or symptoms of gastrointestinal pathology	11 (24)
Anemia	12 (27)
Signs or symptoms of gastrointestinal pathology or anemia present	17 (38)
Gastrointestinal endoscopy performed	18 (40)
Pathologic abnormalities identified on gastrointestinal endoscopy	16 (36)*
Neoplasia identified on gastrointestinal endoscopy	14 (31)†
Invasive cancer identified on gastrointestinal endoscopy	2 (4)†
Duodenal adenocarcinoma	1 (2)
Colon carcinoma	1 (2)†
S bovis bacteremia diagnosed shortly after diagnosis of colon cancer, prior to treatment	2 (4)
Colon cancer present	3 (7)†
Any type of cancer present	13 (29)†‡
Liver failure present	5 (11)

*One patient who had not undergone endoscopy had adenomatous polyps in the colon revealed by autopsy.
†One additional patient had a large mass noted in the colon; biopsies only revealed necrotic material.
‡One additional patient was suspected of having hepatoma and cirrhosis with an α-fetoprotein level of 400 ng/mL.

USE OF ENDOSCOPY IN *S bovis* BACTEREMIA

Gastrointestinal endoscopy was not performed subsequent to a diagnosis of *S bovis* bacteremia in 27 patients (23 adults). Interestingly, 8 patients with signs and symptoms of gastrointestinal pathology or anemia (7 of whom were adults) did not undergo gastrointestinal endoscopy. Three of these patients, all adults, had anemia only. Six of the 7 adults with signs and symptoms of gastrointestinal pathology or anemia in whom endoscopy was not performed had either a known malignancy or liver failure. The additional adult, who had a history of bright red blood per rectum and had not previously had colonoscopy, was 85 years old and had diabetes mellitus, coronary artery disease, severe congestive heart failure, and chronic renal insufficiency.

In total, of the 23 adults who did not undergo endoscopy subsequent to a diagnosis of *S bovis* bacteremia, 19 were being treated for a known malignancy (11 patients), had liver failure (5), had an extravascular infection thought to account for the *S bovis* bacteremia (6), or had a combination of these factors (2 with malignancy and infection, 1 with malignancy and liver failure, and 1 with liver failure and infection). The details of the concurrent malignancies are listed in **Table 2**. Four additional adults who did not undergo endoscopy had no signs or symptoms of gastrointestinal pathology or anemia. One of these patients died of *S bovis* endocarditis; the autopsy revealed adenomatous polyps in the colon.

Table 2. Clinical Setting of Neoplasia Associated With *Streptococcus bovis* Bacteremia

Type of Neoplasm	No. of Patients (n = 26)*†
Colonic adenomatous polyps	14‡
Invasive colorectal cancer	3‡†
Initial presentation	1‡
Locally recurrent	1
Metastatic, previously resected	1
Duodenal adenocarcinoma	1
Pancreatic adenocarcinoma	3
Resected	2
Unresected	1
Gallbladder adenocarcinoma	1
Lung cancer	1
Ovarian cancer	1
Endometrial cancer	1
Chronic myelogenous leukemia with blast crisis	1
Chronic lymphocytic leukemia	1

*One additional patient was suspected of having hepatoma and cirrhosis with an α-fetoprotein level of 400 ng/mL.

†One additional patient had a large mass noted in colon; biopsies only revealed necrotic material.

‡One patient (included) had adenomatous polyps and invasive colorectal adenocarcinoma.

Table 3. Active Infections Associated With *Streptococcus bovis* Bacteremia

Infection	No. of Patients (n = 23)
All endocarditis	12
Without prosthetic valve	6
With prosthetic valve	6*
Cholangitis	3
Without biliary prosthesis	2
With biliary prosthesis	1
Gastroenteritis in infants	2
Chorioamnionitis	2†
Pneumonia	1
Septic arthritis	1*
Intra-abdominal abscess	1
Neutropenic fever	1
Septic shock	1

*One patient had prosthetic valve endocarditis and septic arthritis from *S bovis*.

†In one case, the mother developed *S bovis* bacteremia; in another case, it was the newborn.

ACTIVE INFECTIONS ASSOCIATED WITH *S bovis* BACTEREMIA

There were 23 clinically significant infections associated with the diagnosis of *S bovis* bacteremia as seen in **Table 3**. The most common infection was endocarditis, which was present in 12 patients. Of the 12 patients with endocarditis, 6 had prosthetic valves and 6 had native valves affected. One case of *S bovis* bacteremia was associated with septic shock, and another occurred in the setting of a neutropenic fever in a patient treated for endometrial cancer.

In 10 patients, *S bovis* bacteremia was felt to be associated with an extravascular site of infection. Cholangitis was present in 3 of these patients, 1 of whom had a biliary stent secondary to an obstructing pancreatic adenocarcinoma. Two cases of *S bovis* bacteremia were associated with gastroenteritis in infants. *Streptococcus bovis* bacteremia was also associated with 2 cases of chorioamnionitis. In one case, the mother developed *S bovis* bacteremia; in another case, it was the infant. One patient with *S bovis* endocarditis had a septic arthritis documented with a joint aspirate that was cultured for *S bovis*. *Streptococcus bovis* bacteremia was diagnosed in a patient with liver failure hospitalized for pneumonia. *Streptococcus bovis* bacteremia was also diagnosed in a patient hospitalized for an intra-abdominal abscess after resection of a pancreatic adenocarcinoma.

NEOPLASIA ASSOCIATED WITH *S bovis* BACTEREMIA

Neoplasia was associated with *S bovis* bacteremia in 26 (58%) of the 45 patients. The types of neoplasia present in patients with *S bovis* bacteremia are listed in Table 2. Colorectal adenomas or adenocarcinomas were diagnosed in 16 patients with *S bovis* bacteremia, and an additional patient had a large ulcerating ascending colon mass, but colonoscopic biopsies revealed only necrotic material. Colonic adenomas were diagnosed within 1 month of *S bovis* bacteremia in 13 patients, 12 by colonoscopy and 1 by autopsy. An additional patient underwent colonoscopy to reveal an adenomatous polyp 2 years after *S bovis* bacteremia was diagnosed.

Malignancy was associated with *S bovis* bacteremia in 13 patients (29%), excluding the patient with the undiagnosed colon mass. Three patients had colorectal adenocarcinomas, 1 found on colonoscopy after the diagnosis of *S bovis* bacteremia and 2 other recurrent lesions, 1 locally recurrent, and 1 with liver and lung metastases. One patient had a duodenal adenocarcinoma, and 1 had gallbladder adenocarcinoma. Three patients had pancreatic adenocarcinoma, 2 having undergone resection. One developed *S bovis* bacteremia in the setting of an intra-abdominal abscess after resection of pancreatic cancer. The patient with the unresected pancreatic cancer who developed *S bovis* bacteremia did so in the setting of cholangitis. Three patients developed *S bovis* bacteremia with solid-organ malignancies outside the gastrointestinal system. One patient had advanced lung cancer, 1 had ovarian cancer, and 1 had endometrial cancer. The patient with endometrial cancer developed *S bovis* bacteremia in the setting of a neutropenic fever during adjuvant therapy. Two patients developed *S bovis* bacteremia in the setting of a non–solid-organ malignancy; one had chronic myelogenous leukemia with blast crisis, and the other had chronic lymphocytic leukemia with end-stage liver disease.

COMMENT

It is now well established that *S bovis* bacteremia is associated with gastrointestinal disease, particularly colonic neoplasia. Although the nature of this relationship remains unknown, it is accepted that clinicians should screen patients for occult colon cancer whenever possible. The association between *S bovis* bacteremia and

Table 4. Studies of the Association of *Streptococcus bovis* Bacteremia and Colorectal Neoplasia

Source	No. of Patients	No. (%) With Endocarditis	No. (%) With Colon Evaluation	No. (%) With Colon Pathology	No. (%) With Colonic Neoplasia	No. (%) With Invasive Colon Cancer	No. (%) With Other GI Pathology	No. (%) With Liver Dysfunction
Hoppes and Lerner[2]	14	14 (100)*	NA	5 (36)	4 (29)†	0 (0)	NA	3 (21)
Murray and Roberts[4]	36 adults, 5 infants	26 (72)	NA	15 (42)	9 (25)†‡	3 (8)‡	3 (8), 3 (60)	NA
Klein et al[25]	29	13 (45)	15 (52)	NA	12 (41)§	2 (7)§	20 (69)	NA
Wilson et al[22]	21	21 (100)*	NA	13 (62)	5 (24)†	1 (5)	NA	NA
Friedrich et al[5]	25‖	NA	25 (100)*	15 (60)	7 (28)	2 (8)	1 (4)	NA
Reynolds et al[34]	18 adults, 1 infant	14 (78), 0 (0)	10 (56)	10 (56)	6 (33)	2 (11)	1 (6)	NA
Beeching et al[6]	12	10 (83)	NA	9 (75)	7 (58)	5 (42)	2 (17)	1 (8)
Hønberg and Gutschik[23]	90	NA	NA	NA	14 (16)	13 (14)	1 (1)	NA
Leport et al[7]	34	34 (100)*	23 (68)	20 (59)	15 (44)¶	3 (9)¶	NA	NA
Pigrau et al[8]	16	5 (31)	NA	1 (6)	1 (6)	1 (6)	6 (38)	4 (25)
Robson and Cannan[18]	20 adults, 4 children	7 (35), 0 (0)	NA	2 (10)	NA	NA	8 (40), 4 (100)	1 (5)
Ruoff et al[27]	21	19 (90)	NA	NA	15 (71)	NA	NA	NA
Zarkin et al[9]	92	26 (28)	NA	43 (47)	22 (24)	16 (17)	6 (7)	48 (52)#
Hoen et al[10]	32	32 (100)*	32 (100)*	NA	18 (56)	3 (9)	NA	1 (3)
Ballet et al[11]	53	53 (100)*	43 (81)	NA	27 (51)†	2 (4)	8 (15)	0 (0)
Kupferwasser et al[12]	22	22 (100)*	NA	10**	6**	2**	5**	1 (5)
Duval et al[19]	20	20 (100)*	16 (80)	NA	11 (55)†	3 (15)	NA	4 (20)
González-Quintela et al[17]	20	10 (50)	13 (65)	6 (30)	6 (30)	3 (15)¶	1 (5)	10 (50)
Pergola et al[26]	40	40 (100)*	40 (100)*	22 (55)	18 (45)†	4 (10)	5 (12)	NA
Herrero et al[24]	12	12 (100)*	9 (75)	6 (50)	3 (25)	2 (17)	2 (17)	NA
Present study	41 adults, 4 children	12 (29), 0 (0)	17 (41),†† 0 (0)	19 (46), 0 (0)	16 (39),†† 0 (0)	3 (7),‡‡ 0 (0)	5 (12), 2 (50)	5 (12), 0 (0)

Abbreviation: GI, gastrointestinal; NA, not applicable.
*Criterion for entry into study.
†All polyps were counted; histology was not specified in study.
‡One bleeding rectal mass was not counted.
§Three lesions on barium enema were suggestive of neoplasia but are not included as pathology was not obtained.
‖Thirty-five patients with *S bovis* bacteremia were identified; those with colonic evaluations were reviewed.
¶One colon cancer occurred before *S bovis* bacteremia.
#Included all patients with abnormalities on diagnostic imaging, serum transaminases, serum bilirubin, or serum alkaline phosphatase.
**Number of lesions; number of patients not specified.
††Includes only colonoscopies performed after diagnosis of *S bovis* bacteremia.
‡‡One additional patient had a large mass noted in colon; biopsies only revealed necrotic material.

liver dysfunction, particularly cirrhosis, has been described,[9,17] although this relationship is not as well validated and clinical implications of this association are not readily apparent. An association between *S bovis* bacteremia and extraintestinal malignancy has not been well established. This study, however, indicates that malignancy may be a common feature of *S bovis* bacteremia, and clinicians should be alert to cancer both inside and outside the gastrointestinal system.

The first description of colorectal carcinoma occurring in association with *S bovis* bacteremia is often attributed to a 1951 case report.[1] In this report, a woman who had recently undergone resection of a sigmoid adenocarcinoma developed endocarditis with an organism identified as *Streptococcus fecalis*. *S bovis* was often mislabeled as an enterococcus, such as *Enterococcus fecalis* (formerly *S fecalis*), before identification of this organism based on standardized biochemical and physiological methods was described.[20] The sensitivity of the organism to penicillin in this case report is much more typical of *S bovis* than *E fecalis*.[2,21]

Several subsequent case reports also noted associations between *S bovis* bacteremia and colorectal cancer. Beginning in the early 1970s, larger series of patients with *S bovis* bacteremia were reported. **Table 4** presents all series of patients (n>10) with *S bovis* bacteremia who were examined for associations with gastrointestinal or liver pathology and described in the English-language literature. In these series, colonic neoplasia was present in 6% to 71% of patients.

Notably, Klein et al[25] prospectively studied 29 patients with *S bovis* bacteremia. They recommended gastrointestinal evaluation for all their patients, although this was completed in only 15 patients owing to patient refusal, inability to tolerate examinations, or death. Colonic neoplasia was found in 12 patients (11 of whom underwent complete gastrointestinal evaluation), and colorectal cancer was found in 2 patients (both of whom underwent the recommended evaluation).[25]

Two studies have compared the incidence of gastrointestinal pathology in patients with endocarditis from *S bovis* with that in patients with endocarditis due to other microorganisms. In the study by Leport et al,[7] despite similar demographic characteristics and similar use of colonic studies among groups, polyps, carcinoma in situ, and invasive colon cancer were significantly more frequent in the cases of *S bovis* endocarditis (12, 3, and 6 of 34, respectively) vs endocarditis from other organisms

(3, 0, and 1 of 43).[7] Similarly, in the study by Pergola et al,[26] gastrointestinal lesions were found in 22 of 40 patients with *S bovis* endocarditis compared with 7 of 166 patients with endocarditis from other organisms. The gastrointestinal lesions were predominantly colonic polyps (14 patients) or cancers (4 patients) in the patients with *S bovis* endocarditis.[26]

Hoen et al[10] performed a case-control study comparing patients with *S bovis* endocarditis who underwent colonoscopy with sex- and age-matched unaffected patients who had undergone this procedure. Colonic adenomatous polyps were present in twice as many cases as controls (15 of 32 vs 15 of 64), and colorectal cancer was present approximately 3 times as often (3 of 32 vs 2 of 64).

Notably, a sizable proportion of the colon pathology found in patients with *S bovis* bacteremia in the previous studies was otherwise occult. Thus, several authors have advocated complete evaluation of the colon for all patients found to have *S bovis* bacteremia.[3-12] Nevertheless, colon evaluation has not been uniformly performed in patients with *S bovis* bacteremia even in the more recent studies, including our own.[8-10,17,18,27] The reasons for this are difficult to discern in retrospective studies. Comorbidities, advanced age, or an infection outside the gastrointestinal tract thought to account for the bloodstream infection may be reasons not to perform colonoscopy. Because it cannot be otherwise determined which patients with *S bovis* bacteremia will harbor malignancies, all adult patients who can tolerate evaluation of the colon and who might possibly benefit from identification of an occult neoplasm should be studied after an episode of *S bovis* bacteremia has been documented.

As seen in Table 4, the reported prevalence of liver dysfunction in patients with *S bovis* bacteremia varies between 0% and 52%, probably reflecting differences in definitions of liver dysfunction. In the series reporting the largest percentage of patients with liver disease, this was defined by abnormalities of liver function tests or radiographic imaging.[9] However, some variability among studies may be explained by variation in patient populations served by different hospitals. A small study from Spain of 20 patients with *S bovis* bacteremia describes 9 patients with cirrhosis defined by more stringent criteria, with an additional patient also having a history of alcohol abuse and abnormalities on liver function testing.[17] A significant proportion of the patients with liver dysfunction in both of these studies also had colonic pathology.[9,17] Whereas colonic neoplasia associated with *Streptococcus bovis* bacteremia can often be occult,[25] it is unclear if clinically significant liver disease was found incidentally. Thus, the clinical ramifications of the association between *Streptococcus bovis* bacteremia and liver disease are not clear.

In our study, from 17 colonoscopies, 13 adenomas and 1 (possibly 2) carcinomas were identified. Although the incidence of colon cancer was not as high as in other series, there was a striking association of *S bovis* bacteremia with malignancy irrespective of site, with 29% of patients harboring a cancer. Patients in this series had malignancies in the colon, duodenum, gallbladder, pancreas, ovary, uterus, lung, and hematopoietic system. Previous case reports have noted the occurrence of *S bovis* bacteremia in patients with pancreatic cancer,[28] squamous cell carcinoma of the mouth,[29] endometrial cancer,[30] melanoma metastatic to the gastrointestinal tract,[31] lymphosarcoma,[32] and Kaposi sarcoma.[33] Similarly, in larger series of patients with *S bovis* bacteremia, isolated patients with esophageal carcinoma,[8,25] gastric carcinoma,[10,12,25,34] gastric lymphoma,[25] and pancreatic carcinoma[17,18] were described.

A recent series examining antibiotic resistance in *S bovis* noted 31% of patients with *S bovis* bacteremia to be harboring neoplasia (58% in our study). Among these, 23% had a malignancy (29% in our study). About half of the malignancies originated from the gastrointestinal system.[35] Taken together with our results, these data lead us to believe that physicians caring for patients with *S bovis* need to be alert to the possibility of malignancy, and searching for extracolonic malignancies may be warranted.

In conclusion, our results substantiate the previously reported associations of *S bovis* bacteremia with colonic neoplasia and liver disease. Furthermore, our results bring to light the underutilization of colonoscopy in patients with *S bovis* bacteremia despite the well described association with occult colonic malignancies. This study also suggests that extracolonic malignancy is a common feature of a large proportion of patients with *S bovis* bacteremia. Further studies are needed to determine if *S bovis* bacteremia is an independent predictor of malignancy and to determine the pathophysiologic features of this relationship.

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REFERENCES

1. McCoy WC, Mason JM III. Enterococcal endocarditis associated with carcinoma of the sigmoid: report of a case. *J Med Assoc State Ala.* 1951;21:162-166.
2. Hoppes WL, Lerner PI. Nonenterococcal group-D streptococcal endocarditis caused by *Streptococcus bovis. Ann Intern Med.* 1974;81:588-593.
3. Klein RS, Recco RA, Catalano MT, Edberg SC, Casey JI, Steigbigel NH. Association of *Streptococcus bovis* with carcinoma of the colon. *N Engl J Med.* 1977; 297:800-802.
4. Murray HW, Roberts RB. *Streptococcus bovis* bacteremia and underlying gastrointestinal disease. *Arch Intern Med.* 1978;138:1097-1099.
5. Friedrich IA, Wormser GP, Gottfried EB. The association of recent *Streptococcus bovis* bacteremia with colonic neoplasia. *Mil Med.* 1982;147:584-585.
6. Beeching NJ, Christmas TI, Ellis-Pegler RB, Nicholson GI. *Streptococcus bovis* bacteraemia requires rigorous exclusion of colonic neoplasia and endocarditis. *Q J Med.* 1985;56:439-450.
7. Leport C, Bure A, Leport J, Vilde JL. Incidence of colonic lesions in *Streptococcus bovis* and enterococcal endocarditis [letter]. *Lancet.* 1987;1:748.
8. Pigrau C, Lorente A, Pahissa A, Martinez-Vazquez JM. *Streptococcus bovis* bacteremia and digestive system neoplasms. *Scand J Infect Dis.* 1988;20:459-460.
9. Zarkin BA, Lillemoe KD, Cameron JL, Effron PN, Magnuson TH, Pitt HA. The triad of *Streptococcus bovis* bacteremia, colonic pathology, and liver disease. *Ann Surg.* 1990;211:786-792.
10. Hoen B, Briancon S, Delahaye F, et al. Tumors of the colon increase the risk of developing *Streptococcus bovis* endocarditis: case-control study. *Clin Infect Dis.* 1994;19:361-362.
11. Ballet M, Gevigney G, Gare JP, Delahaye F, Etienne J, Delahaye JP. Infective en-

docarditis due to *Streptococcus bovis*: a report of 53 cases. *Eur Heart J*. 1995; 16:1975-1980.
12. Kupferwasser I, Darius H, Muller AM, et al. Clinical and morphological characteristics in *Streptococcus bovis* endocarditis: a comparison with other causative microorganisms in 177 cases. *Heart*. 1998;80:276-280.
13. Ellmerich S, Scholler M, Duranton B, et al. Promotion of intestinal carcinogenesis by *Streptococcus bovis*. *Carcinogenesis*. 2000;21:753-756.
14. Dubrow R, Edberg S, Wikfors E, et al. Fecal carriage of *Streptococcus bovis* and colorectal adenomas. *Gastroenterology*. 1991;101:721-725.
15. Potter MA, Cunliffe NA, Smith M, Miles RS, Flapan AD, Dunlop MG. A prospective controlled study of the association of *Streptococcus bovis* with colorectal carcinoma. *J Clin Pathol*. 1998;51:473-474.
16. Norfleet RG, Mitchell PD. *Streptococcus bovis* does not selectively colonize colorectal cancer and polyps. *J Clin Gastroenterol*. 1993;17:25-28.
17. González-Quintela A, Martinez-Rey C, Castroagudin JF, Rajo-Iglesias MC, Dominguez-Santalla MJ. Prevalence of liver disease in patients with *Streptococcus bovis* bacteraemia. *J Infect*. 2001;42:116-119.
18. Robson SC, Cannan C. *Streptococcus bovis* bacteremia and endocarditis at Groote Schuur Hospital. *S Afr Med J*. 1989;75:597.
19. Duval X, Papastamopoulos V, Longuet P, et al. Definite *Streptococcus bovis* endocarditis: characteristics in 20 patients. *Clin Microbiol Infect*. 2001;7:3-10.
20. Facklam RR. Recognition of group D streptococcal species of human origin by biochemical and physiological tests. *Appl Microbiol*. 1972;23:1131-1139.
21. Ravreby WD, Bottone EJ, Keusch GT. Group D streptococcal bacteremia, with emphasis on the incidence and presentation of infectious due to *Streptococcus bovis*. *N Engl J Med*. 1973;289:1400-1403.
22. Wilson WR, Thompson RL, Wilkowske CJ, Washington JA 2nd, Giuliani ER, Geraci JE. Short-term therapy for streptococcal infective endocarditis: combined intramuscular administration of penicillin and streptomycin. *JAMA*. 1981;245:360-363.
23. Hønberg PZ, Gutschik E. *Streptococcus bovis* bacteraemia and its association with alimentary-tract neoplasm. *Lancet*. 1987;1:163-164.
24. Herrero IA, Rouse MS, Piper KE, Alyaseen SA, Steckelberg JM, Patel R. Reevaluation of *Streptococcus bovis* endocarditis cases from 1975 to 1985 by 16S ribosomal DNA sequence analysis. *J Clin Microbiol*. 2002;40:3848-3850.
25. Klein RS, Catalano MT, Edberg SC, Casey JI, Steigbigel NH. *Streptococcus bovis* septicemia and carcinoma of the colon. *Ann Intern Med*. 1979;91:560-562.
26. Pergola V, DiSalvo G, Habib G, et al. Comparison of clinical and echocardiographic characteristics of *Streptococcus bovis* endocarditis with that caused by other pathogens. *Am J Cardiol*. 2001;88:871-875.
27. Ruoff KL, Miller SI, Garner CV, Ferraro MJ, Calderwood SB. Bacteremia with *Streptococcus bovis* and *Streptococcus salivarius*: clinical correlates of more accurate identification of isolates. *J Clin Microbiol*. 1989;27:305-308.
28. Herrington P, Finkelman D, Balart L, Hines C Jr, Ferrante W. *Streptococcus bovis* septicemia and pancreatic adenocarcinoma. *Ann Intern Med*. 1980;92:441.
29. Gelfand MS, Alford RH. *Streptococcus bovis* endocarditis and squamous-cell carcinoma of the mouth. *N Engl J Med*. 1981;305:284-285.
30. Anaf V, Noel JC, Thys JP, Simon P, Buxant F. A first case of *Streptococcus bovis* bacteremia and peritonitis from endometrial cancer origin. *Acta Chir Belg*. 2001; 101:38-39.
31. Brooks RJ, Ravreby WD, Keusch G, Bottone E. More on *Streptococcus bovis* endocarditis and bowel carcinoma [letter]. *N Engl J Med*. 1978;298:572.
32. Levy BS, von Reyn CF, Arbeit RD, Friedland J, Crumpacker C. More on *Streptococcus bovis* endocarditis and bowel carcinoma [letter]. *N Engl J Med*. 1978; 298:572-573.
33. Glaser JB, Landesman SH. *Streptococcus bovis* bacteremia and acquired immunodeficiency syndrome. *Ann Intern Med*. 1983;99:878.
34. Reynolds JG, Silva E, McCormack WM. Association of *Streptococcus bovis* bacteremia with bowel disease. *J Clin Microbiol*. 1983;17:696-697.
35. Siegman-Igra Y, Schwartz D. *Streptococcus bovis* revisited: a clinical review of 81 bacteremic episodes paying special attention to emerging antibiotic resistance. *Scand J Infect Dis*. 2003;35:90-93.

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Early Predictors of Severity in Acute Lower Intestinal Tract Bleeding

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Background: Identification of high-risk patients with lower intestinal tract bleeding (LIB) is challenging, and prognostic factors have not been clearly defined. The aim of this study was to determine risk factors for severe acute LIB.
Methods: A total of 252 consecutive patients admitted with acute LIB were identified. Data were collected on 24 clinical factors available in the first 4 hours of evaluation. The outcome was severe bleeding, which was defined as continued bleeding within the first 24 hours of hospitalization (transfusion of ≥2 units of blood and/or hematocrit decrease of ≥20%) and/or recurrent bleeding after 24 hours of stability (additional transfusions, further hematocrit decrease of ≥20%, or readmission for LIB within 1 week of discharge).
Results: Severe LIB occurred in 123 patients (49%). Independent correlates of severe bleeding were as follows: heart rate, ≥100/min (odds ratio [OR], 3.67; 95% confidence interval [CI], 1.78-7.57); systolic blood pressure, ≤115 mm Hg (OR, 3.45; 95% CI, 1.54-7.72); syncope (OR, 2.82; 95% CI, 1.06-7.46); nontender abdominal examination (OR, 2.43; 95% CI, 1.22-4.85); bleeding per rectum during the first 4 hours of evaluation (OR, 2.32; 95% CI, 1.28-4.20); aspirin use (OR, 2.07; 95% CI, 1.12-3.82); and more than 2 active comorbid conditions (OR, 1.93; 95% CI, 1.08-3.44).
Conclusion: Clinical data available on initial evaluation can be used to identify patients at risk for severe LIB, who may benefit most from urgent intervention. (*2003;163:838-843*)

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