

Health Professionals' Knowledge of *Streptococcus bovis* and its Association with Colonic Malignancy, Extra-Colonic Malignancies, and Liver Dysfunction

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Abstract

The relationship between *Streptococcus bovis* endocarditis/bacteremia and gastrointestinal abnormality, especially colon cancer, is well known. It is important to screen all patients diagnosed with *S. bovis* bacteremia or endocarditis for gastrointestinal abnormalities, especially colonic pathologies, as they can play a major role in decreasing the incidence of colon cancer. This study aims to assess the level of knowledge and attitude of health professionals toward the association between *S. bovis* and its related pathologies. A cross-sectional survey was conducted using a questionnaire that was distributed electronically to physicians (consultants, specialists, residents, and medical interns) from different specialties in Saudi Arabia. The analysis revealed insufficient knowledge of the association between *S. bovis* and gastrointestinal disorders. Additionally, more than half of the participants did not know about the importance of a colonoscopy as a screening method for colon cancer in patients diagnosed with *S. bovis* bacteremia and endocarditis. Moreover, only 22% of the participants knew that liver function tests could be abnormal in *S. bovis* bacteremia. In conclusion, this study showed physicians' lack of knowledge about the relationship between *S. bovis* endocarditis/bacteremia and gastrointestinal disorders. This relationship should be emphasized in medical schools and hospitals.

Keywords: *Salmonella typhi*; Colon Cancer; Endocarditis; Liver Dysfunction; Physician Knowledge; *Streptococcus bovis*

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Introduction

The relationship between *Streptococcus bovis* (*S. bovis*) endocarditis or bacteremia and gastrointestinal abnormalities, especially colon cancer, has been reported in several studies [1-4]. This association was first reported in 1977 by Klein RS, et al. (1977). Since then numerous studies confirmed the relationship between *S. bovis* and colon cancer. Many studies recommended a careful evaluation of the colon to detect occult colon cancer as part of the management of patients with *S. bovis* bacteremia, with or without endocarditis [1,3-6].

In an animal study, a group of rats was injected with wall-extracted antigens from *S. bovis*, and 50% of the rodents developed colonic adenoma [7]. The mechanism underlying the development of colonic adenoma in these rats is unclear; however, it has been proposed that colonic neoplasia helps in the growth and translocation of *S. bovis* [3]. Another explanation is that *S. bovis* is considered a cause of colon cancer [3,7]. Additionally, researchers have documented a significant increase of *S. bovis* fecal carriage in patients with colonic neoplasia [3].

S. bovis has also been linked to extra-colonic malignancies. A case study reported an association between *S. bovis* and pancreatic adenocarcinoma [8]. A retrospective study that investigated patients with duodenal adenocarcinoma, gallbladder adenocarcinoma, pancreatic adenocarcinoma, lung cancer, ovarian cancer, endometrial carcinoma, chronic myelogenous leukemia, and chronic lymphocytic leukemia, concluded that *S. bovis* bacteremia was associated with extra colonic malignancies [9].

Furthermore, the relationship between *S. bovis* and liver abnormalities has been documented [6]. In a study conducted in Spain on 20 patients with *S. bovis* bacteremia, 11 patients had chronic liver disease (nine had liver cirrhosis) [10]. Another study conducted in the United States showed that the prevalence of liver disease was 52% in patients with *S. bovis* endocarditis and 57% in patients with *S. bovis* bacteremia. Moreover, the study suggested that all patients with *S. bovis* endocarditis or bacteremia should undergo colonic and liver evaluation [6].



Studies show that physicians are generally unaware of the association between *S. bovis* and colon cancer. This might indirectly affect the early detection of colon cancer and, consequently, the survival rates of these patients [5,11]. In Saudi Arabia, since 2002, colon cancer has been reported as the most common cancer in men and the third most common cancer in women [12]. This study aims to be to determine whether physicians referred patients with *S. bovis* infection for colonoscopy.

Material and Methods

Participants

This cross-sectional study was conducted in October 2007 on medical interns, residents, specialists, and consultants from different specialties in Jeddah, Makkah, Riyadh, and other cities in Saudi Arabia. A questionnaire was distributed electronically to physicians through links placed on smartphone applications. The study was approved by the Research Ethics Committee at King Abdulaziz University, Jeddah, Saudi Arabia.

The questionnaire was constructed in English and consisted of two parts. The first part asked physicians about the type of hospital where they worked as well as their specialty, subspecialty, and years of experience. The second part assessed the physicians' level of knowledge about the relationship between *S. bovis* endocarditis or bacteremia and colon cancer. The following questions were asked:

- Which of the following diseases is associated with *S. bovis* bacteremia (endocarditis)?
- A patient diagnosed with *S. bovis* bacteremia (endocarditis) should undergo which of the following?
- For a patient with uncomplicated *S. bovis* bacteremia (endocarditis), which of the following laboratory tests could be abnormal?

Also, perceived knowledge was assessed by asking the participants to rate their knowledge of *S. bovis* as follows: "I am an expert on the subject," "I have fair information about it," "I have little information about it," and "Never heard about it."

The main outcome variables in the study were physicians' knowledge of colonoscopy screening required for patients diagnosed with *S. bovis* bacteremia and a general knowledge score. Participants' responses to the three knowledge questions were coded as "1" for a correct answer and "0" for an incorrect answer. The knowledge questions were then summed to give a total general knowledge score for each physician, which ranged from 0 to 3.

Categorical variables were presented as frequencies and proportions, whereas continuous variables were presented as means and standard deviations. The association between physicians' characteristics and knowledge of colonoscopy screening was assessed using a chi-square test. The association between physicians' characteristics and general knowledge score was assessed using a t-test and one-way analysis of variance (ANOVA). Tukey post-hoc tests were used if one-way ANOVA was significant. The significance level was set at $P < 0.05$. STATA (Stata Corp, College Station, Texas, USA) version 13 was used to analyze the data.

Results

A total of 307 physicians from different specialties were included in this study. Most participants were working in non-academic institutions

(70%). Of the 307 respondents, 76% did not work in oncology-related specialties. Consultants were mostly represented in the sample (40%), followed by residents (30%), interns (17%), and Specialists and General Practitioners (14%). Fifty-one percent of the participants had less than five years' experience in the medical field (Table 1).

Physicians' knowledge about *S. bovis* and its management is depicted in table 2. Approximately 58% of the physicians did not know that colonic and extracolonic malignancies were linked to *S. bovis* bacteremia or endocarditis. Moreover, 56% did not know that patients with *S. bovis* bacteremia should undergo colonoscopy, but 22% knew that liver function tests could be abnormal in patients with this infection. Approximately 55% of the participants perceived their knowledge of *S. bovis* as limited, 28% as fair or expert, and 17% never heard about it.

Table 3 displays the association between physicians' characteristics and knowledge about colonoscopy screening for patients with *S. bovis* bacteremia. Physicians' position, specialty, and years of experience were associated with their knowledge of colonoscopy as a screening method for *S. bovis* bacteremia. A significantly higher proportion of consultants (51%) knew about the importance of colonoscopy than interns (20%) (P -value = 0.002). A significant association was found between specialty and knowledge (p -value = 0.002): 52% of physicians specialized in surgery, medicine, oncology, and family medicine, as opposed to 75% of physicians in obstetrics and gynecology and other specialties who did not know the value of colonoscopy as a screening method in *S. bovis* infection. Approximately 64% of physicians with less than five years' experience, versus 51% of physicians with more than 11 years' experience, did not know about the importance of colonoscopy as a screening tool (Table 3).

Table 4 shows the association between the physicians' characteristics and total knowledge scores. We found that knowledge was significantly

Table 1: Characteristics of the study population.

Characteristics	Frequency	Percent	
Hospital	Academic	91	29.64
	Non-academic	216	70.36
Specialty	Surgery/Medicine/Oncology	255	83.06
	Family medicine/ Ob-Gyn/Others	52	16.94
Sub-specialty	Related to oncology	74	24.1
	Not related to oncology	233	75.9
Position	Consultant	122	39.74
	Specialist/GP	42	13.68
	Resident	92	29.97
	Intern	51	16.61
Years of experience	< 5	158	51.47
	5–10	73	23.78
	≥ 11	76	24.76

Abbreviations: GP: General practitioner; Ob-Gyn: Obstetrics and Gynecology

Table 2: Knowledge questions about *S. bovis* and its management.

Questions and Correct Answers	Correct		Incorrect	
	N	%	N	%
Which of the following diseases is associated with <i>S. bovis</i> bacteremia (endocarditis): Colonic and extra-colonic malignancies.	128	41.7	179	58.3
A patient diagnosed with <i>S. bovis</i> bacteremia (endocarditis) should undergo which of the following: Colonoscopy.	135	44	172	56
In a patient with uncomplicated <i>S. bovis</i> bacteremia (endocarditis), which of the following laboratory tests could be abnormal: liver function test.	240	78.2	67	21.8



Table 3: The association between background characteristics and physicians' knowledge of colonoscopy screening in *S. bovis* bacteremia.

Characteristics		Correct		Incorrect		P-value
		N	%	N	%	
Hospital	Academic	40	44	51	56	0.997
	Non-academic	95	44	121	56	
Specialty	Surgery/Medicine/Oncology	122	47.8	133	52.2	0.002
	Family medicine/ Ob-Gyn/Others	13	25	39	75	
Sub-specialty	Related to Oncology	31	41.9	43	58.1	0.679
	Not related to Oncology	104	44.6	129	55.4	
Position	Consultant	62	50.8	60	49.2	0.002
	Specialist/GP	19	45.2	23	54.8	
	Resident	44	47.8	48	52.2	
	Intern	10	19.6	41	80.4	
Years of experience	< 5	57	36.1	101	63.9	0.011
	5-10	41	56.2	32	43.8	
	≥11	37	48.7	39	51.3	

Table 4: The integration between characteristics and knowledge score.

Characteristics		Knowledge Score		P-value*
Hospital	Academic	0.95	1.1	0.212
	Non-academic	1.13	1.2	
Specialty	Surgery/Medicine/Oncology	1.16	1.2	0.007
	Family medicine/Ob-Gyn/Others	0.67	1	
Sub-specialty	Related to oncology	0.93	1.1	0.234
	Not related to oncology	1.12	1.2	
Position	Consultant	1.25	1.2	0.002†
	Specialist/GP	1.11	1.2	
	Resident	1.14	1.1	
	Intern	0.51	1	
Years of experience	< 5	0.86	1.1	0.003 ‡
	5-10	1.38	1.2	
	≥ 11	1.22	1.2	

Where: * T-tests or ANOVA tests were used followed by Tukey post hoc tests.

† Consultant > Intern; Specialist/GP > Intern; Resident > Intern

‡ 5-10 years > less than 5 years

associated with specialty (p-value = 0.007), physician's position (p-value = 0.002), and years of experience (p-value = 0.003). Physicians specializing in obstetrics and gynecology, interns, and physicians with less than 5 years of experience had the lowest mean knowledge scores. Conversely, the mean knowledge scores were highest among physicians specializing in surgery, medicine, oncology, and family medicine; the mean score was also highest among consultants and physicians with 5-10 years of experience.

Discussion

The association between *S. bovis* bacteremia or endocarditis and gastrointestinal disease is well established, especially in colonic pathology. However, evidence shows *S. bovis* bacteremia or endocarditis could also be associated with liver, pancreatic, or even duodenal pathology. This study aims to assess health professionals' knowledge of *S. bovis* and its association with colonic malignancy, extra-colonic malignancies, and liver dysfunction in Saudi Arabia. The relationship between bacterial infection and malignancies is not a new phenomenon, as evidenced by the reported relationship between *Helicobacter pylori* (*H. pylori*) and gastric carcinoma.

More than half of the participants in this study were unaware of the association between *S. bovis* and colonic or extra-colonic malignancies. Contrary to our report, studies conducted by Ghanaei FM, et al. (2011) in Iran and Goh BB, et al. (2012) in Singapore showed that the physicians

surveyed knew of the association between *H. pylori* and gastrointestinal disorders- *H. pylori* plays a predominant role in the etiology of gastric cancer (91%) and peptic ulcer (98%) [13,14]. In addition, more than half of the participants in our study did not know about the importance of colonoscopy as a screening method. Conversely, Ghanaei FM, et al. (2011) in Iran and Goh BB, et al. (2012) reported that 92% and 96% of physicians, respectively, had knowledge of the role of endoscopy as a diagnostic method for gastric cancer in patients with *H. pylori* [13,14]. Furthermore, we found that only 22% of the physicians knew about the abnormalities in liver function tests in patients with *S. bovis* bacteremia/endocarditis. On the contrary, Ghanaei FM, et al. (2011) found that more than 90% of the participants knew about the relationship between *H. pylori* and peptic ulcer disease [13].

In our study, more than half of the physicians specialized in surgery, medicine, oncology, and family medicine were not aware of the use of colonoscopy as a screening method for colon cancer. In contrast, Ghanaei FM, et al. (2011) reported that 92% of the internists were knowledgeable about the use of endoscopy as a diagnostic tool for gastric cancer associated with *H. pylori* [13]. In another study conducted by Boltin D, et al. (2016), about 69% of primary care physicians identified the use of endoscopy as the most effective method for gastric cancer detection [15].

The discrepancy in knowledge about *S. bovis* and *H. pylori* among physicians may be explained by the fact that *H. pylori* infection primarily affects the stomach, causing gastritis and peptic ulcer and even increasing the risk for gastric malignancy; however, it is difficult to appreciate how *S. bovis* endocarditis can lead to colon cancer, as there is no direct relation between the colon and the heart. Moreover, this variation in physicians' level of knowledge may have a strong relation to the fact some guidelines mention that patients with *H. pylori* infection have an increased risk of developing gastric carcinoma. Consequently, a screening plan is necessary for these patients to detect gastric cancer early. Furthermore, there are guidelines for diagnosing and treating *H. pylori* infection, but it is not the case for *S. bovis* endocarditis.

Conclusion

Our study highlights the importance of raising awareness about the association between *S. bovis* and colon cancer among physicians, medical interns, and medical students. Therefore, we recommend that universities and hospitals in the government and private sectors organize more educational campaigns for medical students and physicians to increase awareness of the association between *S. bovis* endocarditis and colon cancer.



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