# Antibiotic Prophylaxis in Gastrointestinal Endoscopy

## Expert Opinion Statement on behalf of the Swiss Society of Gastroenterology

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**Abstract:** The need for antibiotic prophylaxis for endoscopic procedures, especially in the gastrointestinal tract, has long been a matter of debate. In recent years, the lack of randomized trials supporting a benefit of antibiotic prophylaxis, the very low incidence of infective endocarditis after endoscopic procedures and the potential adverse reactions of antibiotics have led to a more restricted use of antibiotic prophylaxis. The aim of this expert opinion statement is to provide an overview of current evidence and to propose a pragmatic approach to the use of antibiotic prophylaxis for endoscopic procedures in areas where clear evidence is lacking.

**Keywords:** Antibiotic prophylaxis, Endoscopy, Gastrointestal tract

**Antibiotische Prophylaxe bei gastrointestinalen Endoskopien**

**Zusammenfassung:** Die Indikation für eine antibiotische Prophylaxe in der Endoskopie, speziell im Gastrointestinaltrakt, ist nach wie vor Gegenstand von Diskussion. Der Mangel an randomisierten Studien, die sehr tiefe Inzidenz von infektiöser Endokarditis nach endoskopischen Eingriffen und die potenziellen Nebenwirkungen von Antibiotika haben zu einem restriktiveren Einsatz antibiotischer Prophylaxe bei gastrointestinalen Endoskopien geführt. Ziel dieser Richtlinie ist es, unter Einbezug der aktuellen Evidenz, einen praktischen Leitfaden für den Einsatz antibiotischer Prophylaxe bei Endoskopien im Gastrointestinaltrakt zu liefern.

**Schlüsselwörter:** Antibiotische Prophylaxe, Endoskopie, Gastrointestinaltrakt

## Introduction

The need for antibiotic prophylaxis for endoscopic procedures, especially in the gastrointestinal tract, has long been a matter of debate. In recent years, the lack of randomized trials supporting a benefit of antibiotic prophylaxis, the very low incidence of infective endocarditis after endoscopic procedures and the potential adverse reactions of antibiotics have led to a more restricted use of antibiotic prophylaxis.
The aim of this expert opinion statement is to provide an overview of current evidence and to propose a pragmatic approach to the use of antibiotic prophylaxis for endoscopic procedures in areas where clear evidence is lacking.
All recommended antibiotic regimens are summarized in Tab. 1.

### The GRADE system is used for rating the quality of evidence.

**High-quality evidence: recommendation grade A**
Evidence comes from one or more well-designed and well-executed randomized controlled trials that yield consistent and directly applicable results. Further research is very unlikely to change our confidence in the estimate of effect.

**Moderate-quality evidence: recommendation grade B**
Evidence comes from randomized controlled trials with important limitations and a very small number of participants, well-designed controlled trials without randomization, well-designed cohort or case-control studies, and multiple time series with or without intervention. Further research will probably have an important impact on our confidence in the estimate of effect and may change the estimate.

**Tab. 1** Summary of recommendations for antibiotic prophylaxis in GI endoscopy

| Type of intervention | Situation needing antibiotic prophylaxis | Goal of antibiotic prophylaxis | Suggested type of antibiotic | Dosing |
|---|---|---|---|---|
| ERCP | Incomplete biliary drainage<br>Primary sclerosing cholangitis<br>Hilar cholangiocarcinoma<br>After liver transplantation<br><br>Cholangioscopy | Prevention of cholangitis and sepsis | Ceftriaxone* | 2 g iv<br>Single dose 3-60 min prior to intervention |
| PEG | Always | Prevention of peristomal wound infection | Cefuroxime* | 1.5 g iv<br>Single dose 30–60 min prior to intervention |
| | | | Vancomycin (MRSA carriers) | 15 mg/kg (maximum 2 g) iv infused over 60 to 90 min beginning within 120 min before intervention (cave red man syndrome) |
| EUS-FNA/B | Mediastinal cysts | Prevention of cyst infection | Cefuroxime* | 1.5 g iv 30–60 min prior to intervention<br><br>Continue 3 days post procedure |
| Colonic EMR /ESD | Large endoscopic resections in the colon, site other than rectosigmoid | Prevention of PECS** | Cefuroxime* | 1.5 g iv 30 min prior to intervention<br>Can be repeated 6 h post intervention |
| EUS-guided transluminal drainage | If not already under antibiotic therapy | Prevention of cyst infection | Upper GI tract: Cefuroxime* | 1.5 g iv 30–60 min prior to intervention |
| | | | Lower GI tract: Cefuroxime* + Metronidazole | 1.5 g iv + 500 mg iv<br>Continue for 3 days post procedure |
| Any | Patients needing peritoneal dialysis | Prevention of peritonitis | Upper GI tract: Cefuroxime* | 1.5 g single dose iv 30–60 min prior to intervention |
| | | | Lower GI tract: Cefuroxime* + Metronidazole | 1.5 g iv + 500 mg iv |
| Any | Patients at high risk of infective endocarditis (Table 2) | Prevention of infective endocarditis | Amoxicillin/ Clavulanic acid 2.2 g | 2.2 g iv single dose 30–60 min prior to intervention |
| | | | Vancomycin (if allergic to penicillins) | 1 g iv over 60–90 min<br>(Cave red man syndrome)<br>Single shot 30–60 min prior to intervention |

* Can be safely given to patients who are allergic to penicillins. If anaphylactic reaction to penicillins is proven, specialist consultation is needed.
** PECS: Post-EMR Coagulation Syndrome

**Low-quality evidence: recommendation grade C**
Evidence comes from observational studies. Further research is very likely to have an important impact on our confidence in the estimate of effect and will probably change the estimate.

**Very-low quality evidence: recommendation grade D**
Evidence is conflicting, of poor quality, or lacking, and hence the balance of benefits and harms cannot be determined. Any estimate of effect is very uncertain as evidence is either unavailable or does not permit a conclusion.

## Risk of bacteremia

Transient bacteremia is very common during many routine daily activities, such as tooth brushing (up to 68 %), using toothpicks (up to 40 %), or even chewing food (up to 50 %). These numbers are essential to consider when evaluating the incidence of transient bacteremia associated with gastrointestinal procedures.
Gastroscopy, flexible sigmoidoscopy and colonoscopy are all considered low-risk procedures for bacteremia and infection, regardless of whether biopsies are taken or polypectomies are performed. Mean rates of bacteremia were estimated to be 1 % in sigmoidoscopy and 4 % in gastroscopy and colonoscopy, whereas esophageal dilation carries the highest risk for bacteremia. (Tab. 2)

### Endoscopic procedures with high-risk for bacteremia

**ERCP in an obstructed bile duct**
The risk for bacteremia increases from 6 % in the absence of biliary obstruction to 18 % with obstruction (2). Therefore, in cases of biliary obstruction the incidence of post-ERCP cholangitis is increased.

**Tab. 2** Incidence of bacteremia during/after gastrointestinal procedures (1)

| Intervention | Incidence of bacteremia |
|---|---|
| Esophageal dilation | 34–54 % |
| Sclerotherapy of esophageal varices | 4–56 % |
| ERCP | 11–18 % |
| Rectal digital examination | 4 % |
| Colonoscopy (with or without biopsy) | 2–4 % |
| EUS-FNA | 0–6 % |

#### Esophageal dilation

Bacteremia during or after esophageal dilation is found in up to 22 % of patients and may be higher in the case of multiple passes and/or in patients with malignant stenosis (3, 4).

#### Sclerotherapy of varices

The range of reported bacteremia rates is wide, spanning between 4 % and 56 % in different studies, with an average rate around 20 % in most studies (5).
In contrast, rubber band ligation of esophageal varices is not considered a high-risk procedure for bacteremia, with an estimated risk 9 % (6).

## Risk of infective endocarditis after endoscopic procedures

Although bacteremia, as outlined above, is a common event during endoscopic procedures, subsequent infective endocarditis (IE) is extremely rare. Despite the constantly rising number of endoscopic procedures performed worldwide, there has been no evidence of an increasing incidence of IE after such procedures.
Furthermore, only limited data exist regarding the impact of antibiotic prophylaxis for dental or surgical procedures on the prevention of IE. Failures of endocarditis prophylaxis, despite the correct administration of antibiotic prophylaxis, are well recognized (7). For these reasons, antibiotic prophylaxis is generally not recommended to reduce the incidence of infective endocarditis in GI endoscopic procedures.

### Patients at high risk of infective endocarditis

In the recently published guideline of the European Society of Cardiology, there is a novel recommendation for patients at high risk of infective endocarditis (Tab. 3), stating that "antibiotic prophylaxis may be considered for high-risk patients undergoing an invasive diagnostic or therapeutic procedure in the gastrointestinal and genitourinary tract, skin or musculoskeletal system" (8).
There is no evidence supporting the use of antimicrobial prophylaxis for cardiac transplant recipients who develop cardiac valvulopathy. The indication should be discussed on a case-by-case basis. Patients should contact their transplant specialist to evaluate the indication prior to an elective intervention.
*To prevent infective endocarditis, antibiotic prophylaxis may be considered in high-risk patients undergoing an invasive diagnostic or therapeutic procedure in the GI tract* (Tab. 2) *(low quality evidence).*

**Tab. 3** Patients at high risk of infective endocarditis (9)

| |
|---|
| Patients with a previous episode of infective endocarditis (IE) |
| Patients with any prosthetic valve (biological or mechanical), including a trans-catheter valve or those in whom any prosthetic material was used for cardiac valve repair |
| Patients with congenital heart disease (CHD)<br>– Any type of cyanotic CHD (i.e. unrepaired CHD)<br>– Any type of CHD repaired with prosthetic material, whether placed surgically or by percutaneous techniques, is at risk for up to 6 months after the procedure<br>– Any type of CHD repaired with prosthetic material whether placed surgically or by percutaneous techniques. At lifelong risk if residual shunt persists or if residual finding persists after the procedure (e.g., incomplete tissue ingrowth of prosthetic material or residual shunt after shunt closure) |

**Tab. 4** Peri-interventional prophylaxis in patients at high risk of IE

| Peri-interventional prophylaxis | No allergy to penicillin | Allergy to penicillin |
|---|---|---|
| Single dose 30–60 min prior to intervention | Amoxicillin/clavulanic acid 2.2 g iv | Vancomycin 1 g iv over > 1 h (Cave: red man syndrome) |

In patients at high risk of IE, the following antibiotic regimen is recommended (9). (Tab. 4)

### Endoscopic procedures due to infective disorders in high-risk patients of infective endocarditis

In the case of an established infection likely caused by enterococci, an empiric antibiotic regimen with anti-enterococcal activity should be used. These patients, if already receiving antibiotic therapy, do not need additional antibiotic prophylaxis when undergoing an endoscopic procedure (Tab. 3).

## Specific endoscopic procedures: When to use antibiotic prophylaxis

### Routine upper endoscopy and colonoscopy

Antibiotic prophylaxis is not required in routine gastrointestinal endoscopy including biopsies and polypectomy, even if high-risk procedures are performed during routine endoscopy (Tab. 2). Exceptions may include patients with severe neutropenia (< 500 cells/mm$^3$) and advanced hematologic malignancies (35).

### Colorectal endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD)

EMR and ESD are frequently performed to treat benign and early malignant colorectal lesions. However, infections following EMR and ESD are extremely rare.
Routine use of antibiotic prophylaxis is therefore not recommended.

#### Post-EMR/ESD Coagulation Syndrome (PECS)

In the context of large colorectal endoscopic resections, a novel complication known as "post-EMR/ESD coagulation syndrome" (PECS) has been recognized. The syndrome is characterized by pain, local peritonitis, fever and elevation of inflammatory markers. It occurs in up to 40 % of patients undergoing a large endoscopic resection.
Large lesions (>30 mm) and localization outside the rectosigmoid colon are independent risk factors for the development of PECS. Limited data are available on the effect

of antibiotic prophylaxis in such patients. In one randomized controlled trial of 409 patients (randomized to either cefuroxime 1.5 g iv half an hour before and 6 hours after the intervention or placebo), the rate of adverse events in the antibiotic group was significantly lower than in the control group: abdominal pain (2.8 % vs 14.9 %, $p < 0.01$), diarrhea (2.0 % vs 9.3 %, $p < 0.05$), and fever (0.9 % vs 8.4 %, $p < 0.05$), respectively. The levels of inflammatory markers were also significantly lower in the antibiotic group compared with those in the control group (11). Therefore, antibiotic prophylaxis can be applied to reduce the risk of PECS in patients with large endoscopic resections above the rectosigmoid colon.

*To prevent PECS, antibiotic prophylaxis can be considered in patients with large colonic endoscopic resections above the sigmoid colon (low-quality evidence).*

## Endoscopic retrograde cholangio-pancreatography (ERCP)

Cholangitis is the most common infectious adverse event in ERCP. Others are cholecystitis, duodenoscope-related transmission of infections, and endocarditis (12).

The role of antibiotic prophylaxis in reducing the risk of post-ERCP cholangitis has been evaluated in several studies. The most recent a meta-analysis from 2010 (9 RCTs with 1573 patients) (13) found a lower risk of post-ERCP cholangitis. In the subgroup of patients who were drained after the first ERCP, there was no benefit from antibiotic prophylaxis.

Subsequent studies did not find a benefit of antibiotic prophylaxis except in patients with biliary obstruction. A very recent randomized trial of 378 patients found a significantly reduced rate of infectious complications, especially cholangitis (2.8 % vs 9.8 % $p = 0.007$) in patients with biliary obstruction who received antibiotic prophylaxis (14).

*Antibiotic prophylaxis is not recommended if cholangitis is absent, if biliary drainage is likely to be successful, and in patients undergoing ERCP for reasons other than biliary obstruction (high-quality evidence).*

### Malignant hilar obstruction and PSC

Especially in patients with malignant hilar obstruction and primary sclerosing cholangitis, the risk of unsuccessful drainage is higher, which raises the risk of complicating cholangitis (15).

### Peroral cholangioscopy

Several studies have found that peroral cholangioscopy is associated with a high risk of bacteremia and cholangitis, regardless of the indication for the intervention. For this reason, all patients undergoing peroral cholangioscopy should receive antibiotic prophylaxis (16).

*To prevent post-ERCP cholangitis and/or sepsis, antibiotic prophylaxis is recommended for patients with biliary obstruction, PSC, and in patients undergoing cholangioscopy (moderate-quality evidence).*

In the case of failed biliary drainage, antibiotic therapy may be continued for 3–5 days (17).

## Endosonographic-guided tissue acquisition

EUS-guided puncture/biopsy is an important, minimally invasive technique for obtaining tissue diagnoses from a variety of pancreatic, intraabdominal, retroperitoneal, or mediastinal lesions in close proximity to the gastrointestinal tract. The major complications associated with EUS-FNA include hemorrhage, perforation, infection, and organ-specific complications, such as acute pancreatitis following puncture of pancreatic lesions. A previous systematic review of complications and deaths associated with EUS-FNA (51 reports, 10 941 patients) revealed an overall complication rate of 0.98 %. The risk of infection was very low, at 0.05 % (18). The risk of infection depends on the type of lesion being sampled. Data suggest that solid lesions carry a very low risk for infection (0.01 %–2 %). The risk of infection following EUS-FNA of cystic lesions is less clear, with reported rates of infection ranging from < 1 % to 14 % (19).

## Pancreatic lesions

### Solid lesions of the pancreas

EUS-FNA and EUS-FNB carry a low risk of bacteremia and sepsis, especially in solid lesions. In two large series involving 627 patients undergoing EUS-FNA for a variety of solid lesions of the pancreas, sepsis developed in only 3 patients.

*Antibiotic prophylaxis is not recommended before EUS-FNA/B of solid lesions of the pancreas (moderate-quality evidence).*

### Cystic lesions of the pancreas

It has been a long-standing practice to administer antibiotic prophylaxis in patients undergoing EUS-FNA of cystic pancreatic lesions, since older data suggest that this intervention is associated with higher rates of infection and antibiotic prophylaxis appeared to be efficient in such patients.

However, newer data do not support this practice and the role of antibiotic prophylaxis has been questioned. A meta-analysis from 2020 (six studies, including one randomized controlled trial and five retrospective studies, with 1706 patients) evaluated the efficacy of antibiotic prophylaxis prior to EUS-FNA of cystic pancreatic lesions. Overall, 8 infectious events were observed in the antibiotic group (0.77 %), and 12 events in the control group (1.7 %), (odds ratio (OR) 0.65, 95 % confidence interval (95 % CI) 0.24–1.78; $p = 0.40$). No difference was observed between the two study groups in terms of either severe infection (OR 0.88, 95 % CI 0.13–5.82; $p = 0.89$) or overall adverse event rate (OR 1.09, 95 % CI 0.73–1.65; $p = 0.67$). These findings suggest prophylactic antibiotics do not substantially reduce the risk of infections after EUS-FNA of cystic lesions of the pancreas (20).

One randomized trial from Spain compared the effect of antibiotic prophylaxis versus placebo in patients undergoing EUS-FNA of cystic lesions of the pancreas. More than 200 patients were randomly assigned to prophylaxis with ciprofloxacin (n = 112) or saline solution (n = 114, placebo). The only case of FNA-related infection (0.44 %) occurred in a patient in the placebo group (0.87 %). Prevention of infection was not inferior in the control group,

and there were no differences between groups regarding the occurrence of post-interventional fever or other adverse events (21).
*We suggest that antibiotic prophylaxis can be retained in patients undergoing EUS-FNA of cystic lesions of the pancreas and may be reserved for special situations (moderate-quality evidence)*

### Rectal and perirectal lesions

EUS-guided transrectal tissue acquisition is a safe technique to obtain tissue diagnosis of solid perirectal lesions. The infection rate after such interventions is very low.
In a prospective study, 100 patients underwent a total of 471 fine needle aspirations of rectal or perirectal lesions. Blood cultures were taken in all patients before and after the intervention. Of these, cultures were positive in 6 patients and 4 patients had contamination. Two patients developed bacteremia with either Bacteroides fragilis or Gemella morbillorum. No signs or symptoms of infection developed in any patient. Therefore, EUS-FNA of solid lesions in the lower GI tract can be considered a low-risk procedure for infection and does not warrant antibiotic prophylaxis (22).
*Antibiotic prophylaxis is not recommended in patients undergoing EUS-FNA of solid perirectal lesions (moderate-quality evidence).*

### Mediastinal lesions

EUS-guided transesophageal puncture is a safe technique that allows tissue acquisition for diagnosis of undetermined mediastinal lesions. Special caution is required with cystic lesions, as post-interventional infection of such lesions may be life threatening.

#### Solid mediastinal lesions

The complication rate is low when EUS-FNA is performed in mediastinal lymph nodes and solid tumors. A systematic review and meta-analysis of EUS-FNA in mediastinal lymph node lesions in patients with non-small cell lung cancer (18 reports, 1201 patients) (23) observed only minor complications, such as sore throat and fever, in a minority of patients (0.8 %). No infectious complications, such as mediastinitis, have been reported.
*Antibiotic prophylaxis is not recommended for EUS-FNA of solid mediastinal lesions (moderate-quality evidence).*

#### Cystic mediastinal lesions

Several case reports and case series describe infections following EUS-FNA of cystic mediastinal lesions of different etiologies, making it a high-risk procedure for infection. Some of these infections occurred despite the use of prophylactic antibiotics (24), thus the indication for EUS-FNA of such lesions should be chosen wisely. Needles with smaller diameters (25G/22G) may have a lower risk of infection and larger needles should be avoided (25). In cases of EUS-FNA of a cystic mediastinal lesion, a second-generation cephalosporin should be used.
*To prevent cyst infection and/or mediastinitis antibiotic prophylaxis is recommended prior to and for about 3 days following EUS-FNA of cystic mediastinal lesions (low-quality evidence)*

### EUS-guided transluminal interventions

The most common reason for EUS-guided transluminal drainage of fluid collections is infection. As a result, these patients are usually receiving antibiotic therapy. If drainage is performed for indications other than infection (e.g., obstruction, pain, other) antibiotic prophylaxis is recommended: cefuroxime can be used in the upper GI tract, cefuroxime plus metronidazole in the lower GI tract.
*To prevent cyst infection and/or sepsis antibiotic prophylaxis is recommended in patients undergoing EUS-guided transluminal interventions (low-quality evidence).*

### Percutaneous endoscopic gastrostomy (PEG)

Peristomal wound infection is the most common complication of PEG placement. A Cochrane review of 12 randomized trials including 1271 patients (OR 0.36, 95 % CI 0.26 – 0.50) (26) found that antibiotic prophylaxis is effective in preventing this complication, with an NNT of 5–10 to prevent one wound infection. First and second generation cephalosporins (cefazolin, cefuroxime) can also be safely given to patients who are allergic to penicillin (27). They should be avoided in patients who have had a proven anaphylactic reaction to penicillin or angioedema. Patients who are already on broad-spectrum antibiotic therapy do not need additional antibiotics.
*To prevent peristomal wound infection antibiotic prophylaxis is recommended in patients undergoing PEG tube placement (high quality evidence).*

#### Methicillin-resistant Staphylococcus aureus (MRSA)

MRSA is likely a negligible problem in Switzerland. Only about 4 % of the Swiss population are MRSA carriers. In contrast, the carrier rate among patients in health care facilities is significantly higher, particularly in long-term care facilities that care for patients requiring feeding tubes. In patients with nasopharyngeal colonization by MRSA, a significant proportion of peristomal wound infections are MRSA-related. In these situations, MRSA decolonization, if feasible in the clinical context, can reduce the risk of MRSA-related wound infections (28).
If decolonization is not possible, vancomycin is effective in preventing wound infections in patients undergoing PEG placement, as confirmed by two small trials (29, 30).

## Endoscopy in patients with liver cirrhosis

### Compensated cirrhosis

For patients with compensated liver cirrhosis, the same standards for antibiotic prophylaxis apply as for non-cirrhotic patients.
*Antibiotic prophylaxis is not recommended in patients with compensated liver cirrhosis undergoing endoscopy (moderate-quality evidence)*

### Cirrhosis with ascites

Studies supporting the use of prophylactic antibiotics in patients with liver cirrhosis and ascites are lacking. As a result, antibiotic prophylaxis is generally not recommended.

*In contrast to patients with active variceal bleeding, routine antibiotic prophylaxis for patients undergoing elective rubber band ligation of esophageal varices is currently not recommended (moderate quality evidence).*

**Cirrhotic patients with gastrointestinal bleeding**

Patients with liver cirrhosis presenting with acute gastrointestinal bleeding are at high risk of bacterial infection, especially bacterial peritonitis and respiratory tract infections, which occur in about 20 % of these patients. Bacterial infections lead to a higher risk of re-bleeding and an increased overall mortality rate.

A Cochrane analysis of 12 randomized trials including over 1200 patients with gastrointestinal bleeding showed that antibiotic therapy is associated with lower overall mortality (including lower mortality from bacterial infections, lower rates of rebleeding and shorter hospital stay) (31). Antibiotic therapy should be initiated at admission for cirrhotic patients presenting with GI bleeding. Antibiotic therapy should be continued for 7 days. Intravenous ceftriaxone is superior to norfloxacin (32) in the prevention of infection in variceal and non-variceal bleeding in cirrhotic patients.

*To prevent infection and rebleeding, antibiotic prophylaxis is recommended in cirrhotic patients presenting with GI bleeding. Treatment should be continued for 7 days. (high quality evidence)*

## Endoscopy in special situations

### Ventriculoperitoneal or lumboperitoneal shunts

There are no data on antibiotic prophylaxis for endoscopy in patients with ventriculoperitoneal or lumboperitoneal shunts. By analogy with abdominal surgery, antibiotic prophylaxis is not recommended because, even in non-sterile abdominal surgery, infectious shunt complications are rare (33).

*Antibiotic prophylaxis is not recommended in patients with ventriculoperitoneal or lumboperitoneal shunts undergoing endoscopy (moderate quality evidence).*

### Peritoneal dialysis

Antibiotic prophylaxis is recommended in peritoneal dialysis patients undergoing colonoscopy (especially with polypectomy) due to the risk of bacterial translocation,

One retrospective study showed that the risk of peritonitis after colonoscopy without antibiotic prophylaxis was 6.3 % (34). Before endoscopy, ascites should be completely drained (35, 36).

*To prevent peritonitis, antibiotic prophylaxis is recommended in patients undergoing peritoneal dialysis and endoscopy (moderate quality evidence)*

### Orthopedic prosthesis

Infection of prosthetic joints related to endoscopic procedures in the GI tract is extremely rare. Given the low incidence of joint infections following endoscopy, prophylactic antibiotics are not currently recommended by the American Society of Gastroenterologists or the American Society of Colon and Rectal Surgeons (37, 38).

In addition, prophylactic antibiotics are no longer recommended in the antibiotic prophylaxis guidelines from the American Academy of Orthopedic Surgeons (AAOS) (39).

*Antibiotic prophylaxis is not recommended in patients with orthopedic prostheses undergoing endoscopy (moderate quality evidence).*

### Endoscopy in patients with vascular grafts

The administration of antibiotic prophylaxis is not recommended in patients with synthetic vascular grafts and other non-valvular cardiovascular devices, such as pacemakers, defibrillators, coronary artery stents, peripheral vascular stents, and vena cava filters.

According to the American Heart Association (AHA), there is no evidence that microorganisms associated with GI endoscopic procedures cause infection of non-valvular cardiovascular devices, including synthetic vascular grafts, at any time after implantation. Thus, antimicrobial prophylaxis is not recommended for any endoscopic procedure in patients with cardiovascular implantable electronic devices (40, 41).

*Antibiotic prophylaxis is not recommended in patients with vascular grafts and non-valvular cardiovascular devices (moderate-quality evidence).*

### Endoscopy in immunocompromised patients

In severe neutropenia (absolute neutrophil count < 500 cells/mL) and in patients with advanced hematologic malignancies, there is an increased risk of bacteremia and sepsis after GI endoscopy (42). Although not extensively studied, it seems reasonable, especially in patients undergoing endoscopic procedures that are associated with a high risk of bacteremia, to administer antibiotic prophylaxis.

*To prevent bacteremia and sepsis, antibiotic prophylaxis is recommended in patients with severe neutropenia and hematologic malignancies undergoing endoscopy (low-quality evidence).*

In immunocompromised patients (i.e., organ transplant recipients, patients with HIV) who have normal neutrophil counts, routine administration of prophylactic antibiotics is not recommended. It is unclear whether patients with other causes of immunosuppression (including those on high doses of glucocorticoids) benefit from antibiotic prophylaxis.

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**Conflict of interest**
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**Abbreviations**

| | |
|---|---|
| **CHD** | Congenital Heart Disease |
| **EMR** | Endoscopic Mucosal Resection |
| **ERCP** | Endoscopic Retrograde Cholangio-Pancreatography |
| **ESD** | Endoscopic Submucosal Dissection |
| **EUS-FNA** | Endoscopic Ultrasound guided Fine Needle Aspiration |

**EUS-FNB** Endoscopic Ultrasound guided Fine Needle Biopsy
**GI** Gastrointestinal
**IE** Infective Endocarditis
**MRSA** Methicillin Resistant Staphylococcus Aureus
**NNT** Number Needed to Treat
**PECS** Post EMR / ESD Coagulation Syndrome
**PEG** Percutaneous Endoscopic Gastrostomy
**PSC** Primary Sclerosing Cholangitis
**RCT** Randomized Controlled Trial

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